Directions in modeling Land Registration and Cadastre Domain – Aspects of EULIS glossary approach, semantics and information services

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Key words: property information, land register, cadastre, semantics, harmonization, standardization, modeling, terminology, ontology

SUMMARY

Experiences and lessons from the EULIS Project show that semantic modeling or standardization in land register and cadastral domain is possible to and should be based on real world functions. For carrying this through focus should be shifted more on services representing the real world context, instead of information contents and systems that only reflect the real world.

Ontology explication and semantic translators can be used as surrogates to connect the existing systems to the ICT infrastructure related. A roadmap to this with quality assurance by quality labeling has been outlined, detailing the harmonization-standardization process. The structuring process is naturalistic aiming to 'common sense' terms in terminology standardization and by measuring the quality against user needs, and maybe slightly heuristic searching for most likely choices of the information community.

As for cadastre, it may be stated that the legal aspects make up the 5th dimension in the information system domain. Another initiative for cadastral domain, and EULIS, is mapping the trustworthiness and matching the criteria for quality certification labels as detailed.

RESUMÉ

Les expériences du projet d'EULIS prouvent que modeler sémantique ou étalonnage le domaine cadastral est possible à et devrait être basé sur de vraies fonctions du monde. Pour accomplir ceci le foyer devrait être décalé plus aux services représentant le vrai contexte du monde, au lieu du contenu de l'information et des systèmes seulement reflétant le vrai monde. L'interprétation d'Ontology ou les traducteurs sémantiques peuvent être utilisés comme surrogats pour connecté les systèmes existants à l'infrastructure d'ICT reliée. Une carte routière avec la garantie de la qualité par marquer de qualité a été décrite, détaillant le procédé d'harmonisation-standardisation. Le processus structurant et naturalistique, peut être légèrement heuristique, recherchant des choix le plus évidents de la communauté de l'information et modifiés avec des enquêtes complètes d'utilisateur.
Quant au cadastre, on peut affirmer que les aspects légaux forment la 5ème dimension dans le domaine de système d'information. Une autre initiative pour le domaine cadastral, et EULIS, trace le trustworthiness et assortit les critères pour des étiquettes de certification de qualité comme détaillé.

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1. STANDARDIZATION AND EULIS PROJECT

The EULIS Glossary and the approach applied have widely been considered successful. The aim of this contribution is to make a review of possible benefits for cadastral domain modeling based on the same fundamental approach, and even for the INSPIRE context as well as further standardization of land and property information and process technology. The resulting guidelines and conclusions, which are to be understood as a whole, may perhaps reshape some previous views on the topic.

Fundamentally, the EULIS Project has not been a research project that aspires to achieve standardization or harmonization, but rather to produce comprehensive and easily comprehensible descriptions of land and property information (cadastre included) from different countries for the purpose of creating a Europe-wide portal that integrates and provides access to cross-border property and cadastre information services of EULIS member countries. These descriptions are produced, at the initial stage, by creating an all-applicable standard structure for uniform process and information descriptions, applicable regardless of the disparate systems and legislations (demonstrator available on www.eulis.org). (Gustafsson, 2003)

The EULIS Glossary uses common and generic definitions of core concepts related to land register and cadastre and discovered by use of uniform process descriptions. The resulting generic definitions, specified as EULIS-definitions, identify the semantically harmonious and common concepts for which the EULIS-terms have been agreed, and act as semantic bridges between (national) concepts used in different jurisdictions. Thus the EULIS Glossary is, first and foremost, a translation aid to users through the EULIS portal. (Tiainen, 2003, 2004b)

As for the standardization and modeling of the cadastral domain, the approach and results of the EULIS project need improvements, such as formal and sophisticated methods, further explication, and even ontology work. Further results could also be used to improve comprehensibility and conformity in the EULIS descriptions and terminology. Furthermore impacts can be envisioned on harmonization issues, and improved transparency will promote interoperability and widen the scope of cadastral information services. (Tiainen, 2004a)

2. PROCESS BASED APPROACH

2.1 Stepwise approach

The theoretical approach applied in EULIS reflects a rather practical approach. Therefore the creation of the concepts and generic definitions for the semantics of the EULIS Glossary is

presented step-by-step, as originally worked out, for the purpose of suggesting the way forward in modeling and ontology.

2.2 Graphical description model

A uniform graphical description model was introduced for a high-level description of the essential phases and routines involving different parties in land transaction and the registration process. The principal legal effects of registration in each of these phases are also described (figures 1-3; examples from England and Wales, Finland and the Netherlands presenting the principally disparate cadastral system types).

It was necessary to include conveyance, titling, mortgaging and land survey or other property mapping in order to achieve the *necessary* common understanding.

Important aspects in modeling were the legal effects, such as

- Priorities and rights gained through registration
- Which property can be mortgaged and when (whether registration be required for property objects for mortgaging)
- Public knowledge – security against third parties
- State guarantee for registration

These essential legal effects, which are predefined as key stages of the process, are identified in the uniform structure as possible.

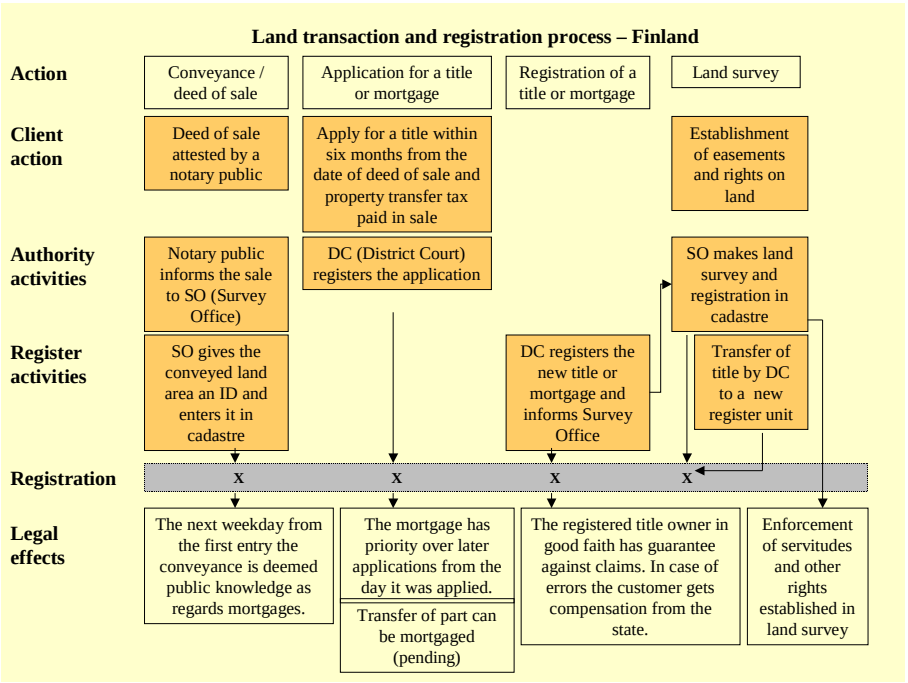

Figure 1: Land Registration system in Finland

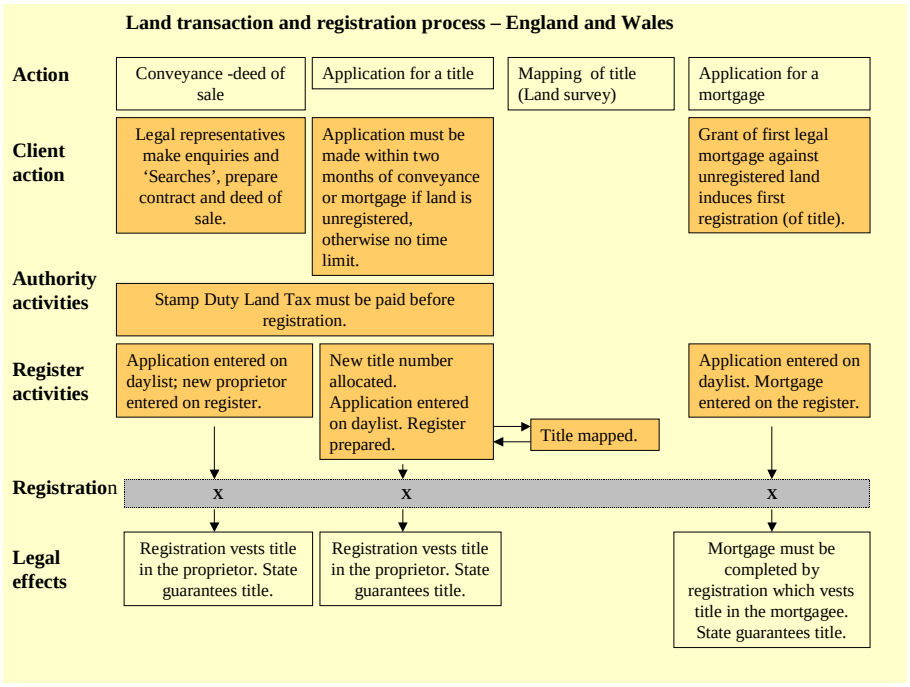

Figure 2: Land Registration system in England and Wales

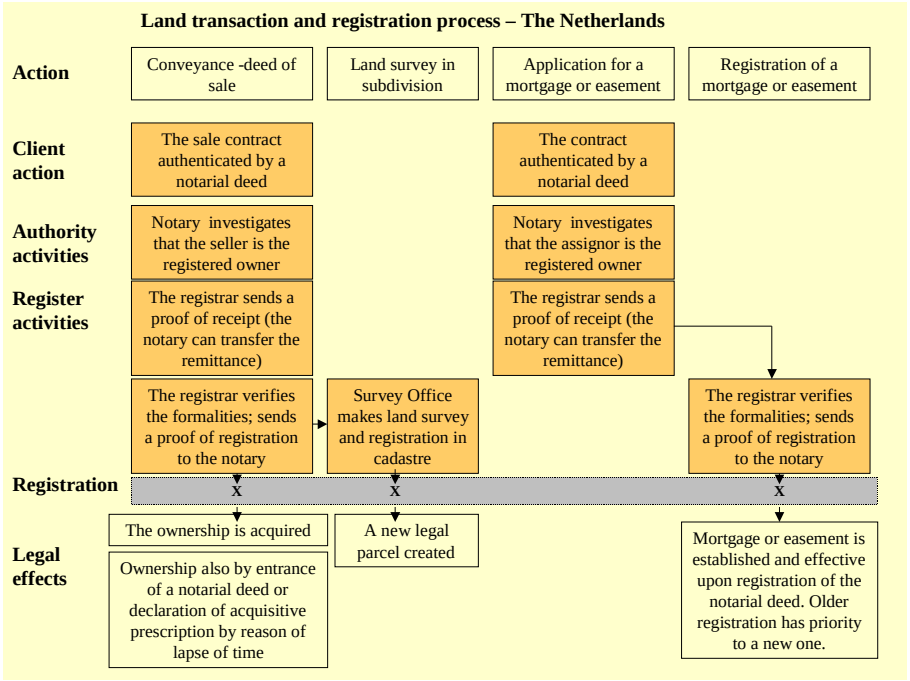

Figure 3: Land Registration system in the Netherlands

2.3 Modeling method

The graphical descriptions of the processes also provide a meta-model view on the processes. Table 1 illustrates the overall method used in defining terminology. With the help of uniform diagrams:

- Identical phases, meanings and functions are identified
- Basic similarities are recognized and
- Level of present semantic integration is discovered;
- Common, generic definitions are depicted.

In parallel the level of country specific deviations can also be recognized with an analytic insight obtained in the process, thus approaching ontology of related terminology.

Property and cadastre information modeling method
◆Metamodel level – Recognizing basic similarities to define the common definitions
◆Conceptual level – Identifying the specific features versus common definitions

Table 1: Modeling process in EULIS

2.4 Generic definitions as semantic bridges

Generic definitions with the descriptions of country specific features or deviations of correspondent national terms provide semantic translations of national terms. Table 2 shows, as an example, the EULIS term and definition, the national (Swedish) synonym and specification.

Concept (EULIS)	Definition (EULIS)	**National synonym**	**National description**
Guarantee for register information	Responsibility of register authorities to compensate for losses incurred.	Rätt till ersättning av staten i vissa fall/skadestånds-ansvar vid fel i vissa fall	In Land Code Chap 18 Section 4 the rightful owner is entitled to compensation from the State for his loss. Bona fide acquisition by virtue of title is possible due to Land Code Chap 18 section 1
Mortgage	A right in property granted as security for the payment of a debt.	Inteckning	In Sweden a registration of the mortgage refers always to the property. When a mortgage has been granted, a mortgage certificate shall be issued on the basis of mortgage. The right of lien is granted by the property owner surrendering the mortgage certificate as security for the claim or through registration in the mortgage certificate register.

Table 2: EULIS-term and definition, national (Swedish) synonym and specification

Presently the EULIS Glossary consists of about 50 terms provided with definitions and national descriptions. From a pull-down menu list the user can select the EULIS term, or a term in any native language to be translated into the selected language and the respective specification. It was intentional to leave the EULIS Glossary as such in the EULIS Project, since using Glossary terms for instance as search words for textual descriptions of the reference information (country descriptions) would easily have caused inconsistency for the user because of the extent and complexity of these descriptions, especially the legal ones (Tiainen, 2003).

2.5 Modeling features and interoperability

The process approach applied in EULIS proved successful, and includes a dynamic approach, which is indispensable (Visser and Schlieder, 2002, p 15). It also provides

- Possibility to model different implementations in a common framework
- Possibility to identify generic terminology
- A contribution for the purpose of achieving legal conformity (legal effects, priorities)
- A temporal aspect on modeling (time pending from conveyance to title or cadastral registration, lifespan of the object from conveyance to registration)
- An objective description of land transactions and real property information.

EULIS is exceptional in providing essentially cross-border access to information. However regarding IT modeling the same conditions also applies to the interoperability of different environmental system domains, the cadastral system being one of the most primary information sources in general. According to Visser et al., each system that interoperates with other systems has to transfer its information into a common framework and then interoperability is achieved by explicitly considering the contextual knowledge in this (translation) process (Visser, Stuckenschmidt, Schuster, and Vögele, 2002, p 7).

Furthermore, according to (Visser, Stuckenschmidt, Schlieder, Wache and Timm, 2002, p 3) a conceptual model of the context of each information source provides a basis for integration on the semantic level. They call this process context- transformation, taking the information about the context of the source providing a new context description for that entity within the new information source. They specify context-transformation by classification and context-transformation with rules. Both of these apparently share the common goal of providing objective (explicit) definitions for concepts and the data entities representing these concepts.

To meet the requirements of objectivity it seems necessary to widen a contextual basis of definitions and concepts also to be use or service directed. EULIS Glossary is based on a meta-model replicating the real world on high level, thus reflecting the universe of discussion on high level of objectivity. This composition provides the basis for the way forward in our ambitious plan to outline a safe roadmap for modeling cadastral domain through harmonization and standardization with the necessary level of semantic conformity.

3. HARMONIZATION AND STANDARDIZATION

3.1 Harmonization aspects in the EULIS approach

Harmonization is an issue that is difficult to disregard in connection with the EULIS Glossary, since

- The actual level of harmonization is recognized
- Land transactions of real property are described in an objective way
- National deviations are identified along with meaning and level of them.

Glossary with other descriptions is a possible tool in a harmonization study. Further analysis may reveal which differences can be overcome with minor adjustments of formal nature – and which require difficult or expensive changes in the basic structures. The latter involve strong professional traditions, disciplines and interests. Possible topics of interest may also be public-private relationship, the role of consumer protection etc.

Another point of view is that the transparency of national systems, like in the EULIS service and the EULIS Glossary with the comparative information on legislation, is likely to promote best practices in land transaction and registration process technology.

3.2 Stepwise process

Institutional changes are, as a rule, incremental. In these conditions swift changes and progress are not possible in harmonization because of legal, structural, financial and other reasons, including the need for continuous provision of information services. Thus harmonization shall, at the initial stage, be of technical nature. This in turn involves standardization. However it is important to clarify the stages involved in the harmonization and standardization in more detail, to initiate the process properly - and basically to determine which stage actually precedes the other.

On ontology level conditional terms, which can be divided into necessary conditions and sufficient conditions, are used as a typical application of ontology. It shows a larger extent of explication than the pure taxonomy of concept terms. A first step to gain more formality is to prescribe a structure to be used for the description (pre-standardization). (Visser, Stuckenschmidt, Schuster, and Vögele, 2002, p 5 and 9, details in 4.2.1)

Furthermore we may see, e.g. from the lessons that EULIS has provided, that semantic pre-harmonization is a necessary prerequisite for standardization and, as stated in 2.5 above, ontology methodologies are promising tools and key issues in semantic modeling.

Another important question is where the added value is. One has to consider if EULIS, the Cadastral Domain initiative (Lemmen et al, 2003) or INSPIRE are different in scope or regarding user segments. Any case furthers the discussion on the dilemma of how these approaches could support each other in a sustainable way, since their time perspectives in setting up the operational service (in different countries) seem to differ.

3.2.1 INSPIRE steps

INSPIRE presents the process of standardization and harmonization and finally integration identifying four steps in all. The process is generalized as follows (http://inspire.jrc.it/):

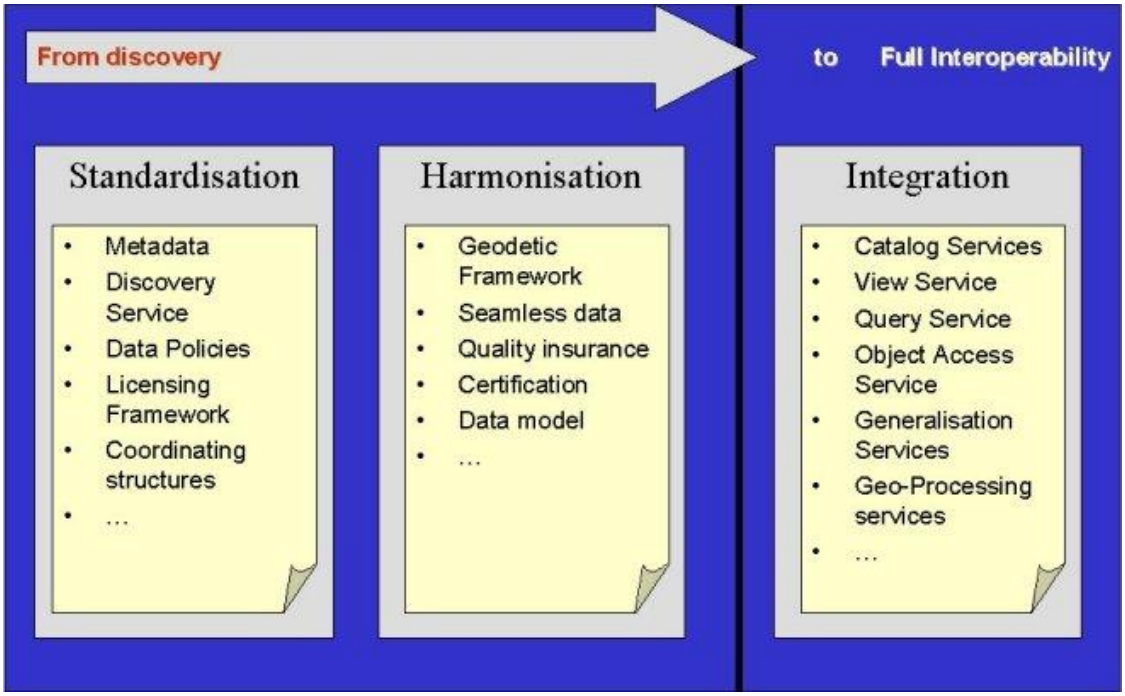

Table 3: INSPIRE stepwise approach

An overall harmonization would be a major task, which is simplified by focusing on standardization and harmonization of documentation (metadata) at the initial stage.

In the second step accessing spatial data sets located by use of metadata is a step towards integration. An example given is “visual inspection of spatial relations between phenomena by overlay of datasets”.

In the third step modeling is introduced by mapping existing data sets to “a common set of models” that also reveals and identifies the conceptual disparity (linguistic and semantic deviations). - This is where the (EULIS Glossary) approach presented might be useful.

“The fourth and last step will build upon the previous steps and concentrate on completing the common models and on providing the services to fully integrate data from various sources and various levels, from the local to the European level into coherent seamless datasets supporting the same standards and protocols. This step will allow real time access to up-to-date data across the whole of Europe.” (http://inspire.jrc.it/ Stepwise approach)

The last step is a major one in terms of modeling efforts, and no doubt appropriate semantic and ontology methods will be required.

3.2.2 Service aspect

In every major system development task, the continuity and lifespan of the service(s) shall be considered. Especially concerning land register and cadastral information this point of view is essential to the market economy, companies and customers at large – including consumers.

Initiatives approaching the topic from different angles, such as Cadastral Domain Modeling, INSPIRE and EULIS, clearly have a different scope or involve different user segments although some overlapping may occur. They also seem to have at least partly different time perspectives in setting up an operational service in different countries, which may enable and accelerate sustainable co-operation. A common and immediate task in all of these initiatives is the need for semantic harmonization, an area where we are trying to specify the (common) roadmap forward. Thus the objectivity requirement stated earlier in section 2.5 could be better met considering different services, scopes and by catering to user needs.

Even the continuity aspect would be better served if services on different levels would use the same modeling basis, where reasonable or possible. Hence different user communities have adopted (semantically) different user views. This applies especially to legal conformity, which is of utmost importance with respect to cadastral data, as evident from figures 1-3.

3.2.3 Information community

The current situation with the initiatives mentioned above emphasizes the significance of integration, and the increasing infrastructure involvement of cadastre. The infrastructure is also increasingly dependant on the cadastre, as recent NSDI (national spatial data infrastructure) developments and the INSPIRE initiative prove. Quality differences on the semantic level cause disintegration and multiple efforts in data updating and maintenance.

The cadastral development has characteristically been incremental in societies. Swift changes are not possible because of legal, structural, financial, information service and other reasons. As a result harmonization needs to be of technical nature in the initial stage.

Harmonization and standardization require appropriate technology tools and methods, and their ontology needs emerge as key issues. The information community related to cadastre should agree to the use of compatible methods for best results, best benefits and to ensure sustainability of the work for each party since integration should preferably not be made into, and fundamentally is not, an issue of competition but co-operation.

3.2.4 Modeling and interoperability

Interoperability is achieved by explicitly considering contextual knowledge in the (translation) process of data exchange (Visser, Stuckenschmidt, Schuster, and Vögele, 2002,

p 7). Here semantic translators come into focus. Even well established methods, for instance UML, have shortcomings as far as semantic integration is concerned.

According to (Visser and Schlieder, 2002, p 4) well known modeling with UML has advantages since UML supports both static knowledge and dynamic behavior. A major disadvantage of UML-based modeling is, however, the non-existence of model checking, i.e. consistency checking. It is also not possible to make implicit knowledge explicit. The latter is the main advantage of formal ontologies. If written down in a logic-based language, consistency-checking and the explicit construction of hidden knowledge with the help of inference mechanisms is possible. On the other hand, describing processes, e.g. workflow events, is not possible (for formal ontology methods).

Nevertheless, describing legal entities and processes in different stages of entity-lifespan (with different legal properties) and standardizing legal conformity is difficult even in UML. This applies also to the cadastral domain model; the temporal aspect shall be considered: Dynamic view of the registration process (figures 1-3) reveals the different stages in the lifespan of property transaction object, in addition to often rather long time pending from conveyance to title or cadastral registration. The same dilemma seems to appear in ISO/CD 19126. (The impact of BoundAttributes in their figures 5-6 on register schemas of CD makes a major complexity. The structural role of BoundAtrributes should be further determined).

For interoperability purposes there are different ways to employ the ontology. In general, three different directions can be identified: single ontology approaches, multiple ontology approaches and hybrid approaches (Visser, Stuckenschmidt, Schlieder, Wache and Timm, 2002, p 1-2). Figure 4 below gives an overview of the three main architectures.

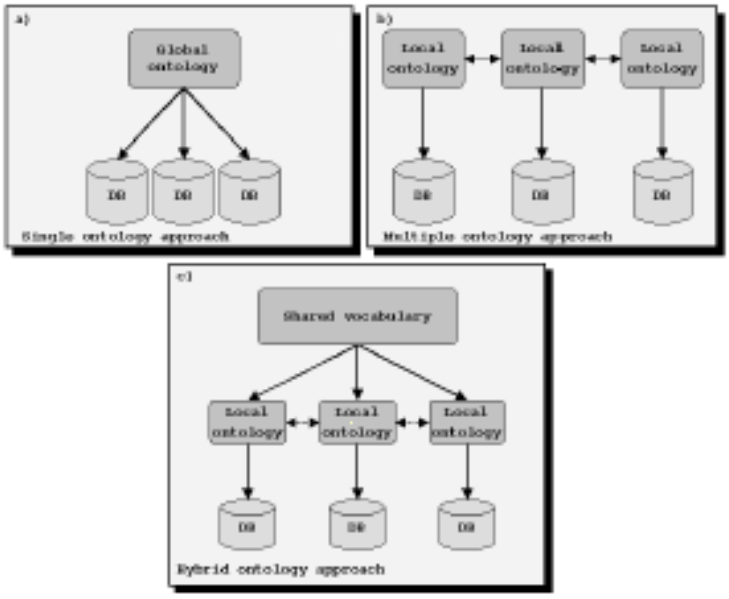

Figure 4: The three possible ways for using ontology for content explication (Visser, Stuckenschmidt, Schlieder, Wache and Timm, 2002, p 2 or Stuckenschmidt and Van Harmelen, 2004)

• **Single Ontology approaches**: Single ontology approaches use one global ontology providing a shared vocabulary for the specification of the semantics (see fig. 4a). All information sources are related to one global ontology. A prominent approach of this kind of ontology integration is SIMS.
• **Multiple Ontologies**: In multiple ontology approaches, each information source is described by its own ontology (fig. 4b). For example, in OBSERVER the semantics of an information source is described by a separate ontology.
• **Hybrid Approaches**: To overcome the drawbacks of the single or multiple ontology approaches (e.g. finding the minimal ontological commitment), hybrid approaches were developed (fig. 4c). Similar to multiple ontology approaches the semantics of each source is described by its own ontology. But in order to make the source ontology comparable to each other they are built upon one global shared vocabulary. The shared vocabulary contains basic terms (the primitives) of a domain. In order to build complex terms of source ontology the primitives are combined by some operators. Sometimes the shared vocabulary is also ontology.

3.2.5 Initialization – the necessary steps

The general conclusion about harmonization-standardization issue is that semantic pre-harmonization is needed even for the purpose of standardization. However, to achieve this, first a high-level semantic pre-standardization view, such as the EULIS process-models, must be developed and agreed upon for achieving the necessary objectivity required to compile a shared and harmonized vocabulary as result of the semantic pre-harmonization (respectively EULIS Glossary). This step provides the basis for universal modeling and explication, resulting in possible standardization or (semantic) harmonization whichever the objective may be. We also have to keep in mind different user communities in the ICT infrastructure, and the obvious need for different user views as regards cadastral information.

In the Stepwise approach of INSPIRE the initial semantic harmonization is obviously thought to be achieved by a quantitative method. The other aspects introduced, and relating in particular to the cadastral domain, emphasize preferably qualitative methods to ensure the consistency, and conclude to use of formal methods and ontology explication. The established UML modeling may be used for data modeling after the semantic harmonization steps.

4. ONTOLOGY EXPLICATION

4.1 OGC semantic modeling approach

The essential model for semantics and information communities is defined by OGC using concepts (notions) of information communities, project worlds and sub-worlds, where integrity is achieved by testing (the unambiguity of) properties or property/value pairs (OGC, 1999, p 2):

(- Including Abstract Specification of Open GIS Consortium on Topic 14: Semantics and Information Communities):

It should be possible to move information easily and without semantic loss from Project Worlds having naive schema into Project Worlds with more sophisticated and inclusive schema. Moving information the other way requires the truncation and loss of information. A Project World that is more naive than another is called a subworld of the other.
Note that a sophisticated schema should not be denied potential subworlds only because they fall outside the physical extent of its Project as specified in its Project Schema. We ignore the physical extent of projects when comparing them to check if one is a subworld of the other.

Definition: Let S1 and S2 be two Project Worlds in A. Let S2* be the Project World obtained by extending the physical extent of Project S2 (if necessary) until it covers the extent of Project S1. We say S1 is a subworld of S2 if there are three functions, R1, R2, and R3, that behave as follows:

i. R1 is a one-to-one change-of-spatial-reference from the reference system of S1 to that of S2*
ii. R2 is a mapping from the feature instances of S1 into those of S2* such that F is a feature of S1 occupying a point P if and only if R2(F) is a feature of S2* occupying R1(P),
iii. R3 is a mapping from the set of property/value pairs of all features in S1 into the set of property/value pairs of all features of S2* that preserves semantics, and is canonical with R2.

The OGC modeling approach is specified for geographical information, but may be applicable in general, and it should also be suitable to the cadastral community. We find the approach of OGC useful in (high-level) semantic standardization in specifying how to handle different user segments. However it may be good to mention here already that the high-level process-based approach presented in the EULIS context seemed to be necessary as first step of the high-level semantic standardization to create a global domain glossary, which is needed in hybrid approaches presented in 3.2.4.

4.2 Semantic translators

4.2.1 The role of ontology and semantic translators

Visser, Stuckenschmidt, Schuster and Vögele have defined the role of ontology and the process of semantic translation (much resembling the approach of OGC), which are both needed to achieve cross-border interoperability and to promote data exchange from diverse source databases, and the increasing exploitation of GIS, especially in INSPIRE contexts.

The role of ontology is distinguished on three levels: operational information level, ontology level and ontology language level (Visser, Stuckenschmidt, Schuster and Vögele, 2002, p 9):

- *On the operational information level* the real task is to determine the concept category an information entity belongs to in a new context, so that it is rather translating type annotations than the information entity itself.

- *On the ontology level* specification of contextual knowledge explicates the intended meaning of terms. Each information source to be integrated is supposed to be specified by such ontologies to enable us to use its contextual knowledge in the translation process.

- *On the ontology language level* properties of concept (defining necessary and sufficient conditions, *see clarification in section 6.2.2*) serve as a common vocabulary used to build the ontologies of different information sources to be integrated.

The process of translation and supporting technologies are described in three stages (Visser, Stuckenschmidt, Schuster and Vögele, 2002, p 10-11):

- *Authoring of shared terminology* is to define a common terminology that is general enough to be used across all information sources to be integrated but specific enough to make meaningful definitions possible. Different tools such as ontology editors exist, whether they are appropriate to specific needs of the domain concerned is another matter, and a source or institution independent expert is employed. - Actually this is a stage that has been completed in creating the EULIS Glossary based on system structuring in a high-level service process approach with legal effects and the temporal aspect included, basically *dealing primarily with services and service processes*. The expertise needed involves an in-depth knowledge of the application area.

- *Annotation of information sources* can be made once a common vocabulary exists. Annotation means in this context that the inherent concept hierarchy of an information source is extracted and each concept is described by necessary and sufficient conditions (*see clarification in section 6.2.2*) using the terminology built in step one. An annotation tool applicable with different vocabulary repositories according to *different domains of interest* is needed.

- *Semantic translation of information entities*; the existence of ontologies for all information sources to be integrated enables the translator to work on these ontologies instead of treating real data. This is a way of using ontologies as surrogates for information sources. The new concept term describing the type of an information entity in the target information source is determined automatically by a classifier that uses ontologies of source and target structures as classification knowledge. This is possible, because both ontologies are based on the same basic vocabulary that has been built in the first step of the integration approach. (- A very interesting feature here is that a classifier that uses ontologies of numerous possible source structures and the target structure as classification knowledge may be able to determine appropriate information source automatically.)

4.2.2 Semantic translators and continuity

Enhanced semantic translators facilitate interoperability also with existing databases by "using ontology as surrogates for information sources" as stated in (Visser, Stuckenschmidt, Schuster, and Vögele, 2002, p 10) without special capabilities.

4.3 Standard views of different user communities

Creating a global vocabulary for the cadastral domain and domain modeling requires sophisticated knowledge about the importance of cadastral information in various needs, present and future, as far as possible. Hence it is a challenging task for ontology study to identify specific user views as universal standards through necessary user surveys.

As lessons learned from EULIS have indicated, it seems to be possible to identify diverse service needs for cadastre, even considering different registration institutions and legislation, since the fundamental functions of cadastre in society are very similar everywhere where there is a cadastre or land registration institution. Service for standard needs could be simplified with a predefined set of selected properties and property values of information entities, and should be taken to objective of further ontology explication and extensions of cadastral information services.

5 QUALITY LABELING

5.1 Quality labeling for cadastral information

For cadastral information the quality or trustworthiness as specified by (Zevenbergen, 2004) is of crucial importance. This is, of course, a question that dominates in the case of data exchange and interoperability, too.

The semantic approach with ontology explication enables quality labeling of information, if we consider the OGC approach more closely. Properties and property values of data entities also reflect quality if the semantic explication displays an adequate high-level of objectivity. A common understanding of reliability for the property/value aggregation needs to be achieved as a prerequisite, and equally advanced ontology explication or qualitative methods are needed. The simple aim is to *measure the quality against user needs.*

The examples in table 4 offer only a hint of the possibilities; a very strict semantic study and ontology explication are needed to enable the classification of the quality of properties or property/value pairs for legal effects and different rights on land, real and subjective.

Concept	Property/value		Concept	Property/value
Mortgage	- No mortgages - Transferable - Priority / 1…n - …		**Owner**	- Not yet registered (buyer) - Registered titleholder - Reg. cad. unit owner / not yet titled, title transferred...

				- (Registered leasehold / temporal extend of lease, classification for other extend of lease) - …
Parcel (Register unit)	- Not yet registered (transfer of part) - Titled, not yet registered as cadastral unit - Cadastral unit with valid title / not yet valid title / title transferred… - (Registered leasehold unit) - With other holding rights…		**Boundary type**	- General - Boundary marks fixed, coordinate approximation / ISO classification for positional accuracy estimation - Coordinate fixed / ISO classification for positional accuracy estimation - …

Table 4: Properties/values defining the quality for concept items

For properties of spatial representation, topology and the coordinate reference system, the standards of ISO 19100 (even on ISO 19115 metadata level) may be appropriate as classification.

The next step after quality labeling might be issuing recommendations for quality improvements and adjustments to process technologies when the quality standards are not met, which in itself directs to standardization or harmonization along with the time.

5.2 Quality labeling for information services

Another stage of quality labeling might be giving quality labels for cadastral information services based on the predefined standard views of different user communities or groups according to section 4.3. Table 5 shows an extract of such a predefined standard view.

In this manner the user would be able to determine immediately if a certain logical set of information is available online, through data transfer or some other way.

Parcel (Register unit)	- Titled, not yet registered as cadastral unit, **or** - Cadastral unit with valid title, **or** - (Registered leasehold unit)
Mortgage	- No mortgages, **or** - Transferable mortgages

Table 5: A part of predefined standard data set as combination of selected properties

6. ROADMAP TO MANAGEMENT OF CROSS-DISCIPLINE SEMANTICS

6.1 Benefits of EULIS approach

There are various ontology explication methods and tools with special features (Visser, Stuckenschmidt, Wache, Vögele, p 7, or Visser, Stuckenschmidt, Schuster and Vögele, 2002, p 5-7; 3.2) applicable for semantic harmonization and translations, the end goal being to promote data exchange and the integration of cadastral systems to ICT infrastructure and INSPIRE framework. The hybrid approach for the management of semantic integration seems to be a beneficial strategy that enables the possibilities created by interoperability to be exploited more quickly (Stuckenschmidt and Van Harmelen, 2004, p 37).

This paper has described the development and the objectives of the EULIS Glossary and compared these with other developments and studies relating to ontology explication and semantics. Some benefits of the experiences from the EULIS Glossary and the approach adopted have been investigated for the purpose of charting the way forward in semantics and integration. As for the EULIS Glossary, further formal research of terminology would produce more sophisticated results, should these be needed with respect to the future EULIS service. Widening the terminology contents and adding more detailed levels to the EULIS Glossary would require specific resources were allocated to this work. On the other hand the EULIS approach seems to provide a valuable contribution to cadastral ontology explication and thus to promoting the development of a global vocabulary needed in the hybrid approach and semantic harmonization in general, particularly in terms of legal conformity. The necessary steps have been defined initially in section 3.2.5 in the beginning of the paper.

The semantic pre-standardization step in the process modeling for the EULIS Glossary is identified to achieve a high-level objectivity needed to create the global vocabulary, and as a prerequisite for harmonization. Joining EULIS will produce the basic standard level in this pre-harmonization to new member countries, as joining is possible only on reference information level including the EULIS Glossary and the knowledge within (and without connection of national information services to the EULIS portal).

6.2 Roadmap for semantic harmonization

The semantic harmonization process and different approaches are sufficiently described in the preceding chapters, the purpose of the description being to outline a roadmap for harmonization and standardization, respectively. The roadmap is intended as a guideline on principals:

6.2.1 Semantic pre-standardization

A high-level semantic pre-standardization view shall be developed and agreed upon and on sufficiently high objectivity level (meta-model level). The level of objectivity can be improved by high-level standard description of services or the very technology processes. The EULIS process-models are an example of this step. Sophisticated and independent expertise is needed.

6.2.2 Semantic pre-harmonization

As result of the pre-standardization it is possible to compile a shared and harmonized vocabulary in this step (respectively the EULIS Glossary as a simple example). This step provides the basis for universal modeling and explication and may result in the standardization or (semantic) harmonization of data, whichever the objective may be. Independent expertise (and ontology tools in complex domains) is needed.

Some experts, especially from the point of view of semantic web, consider that the shared vocabulary should be according to the minimum amount needed. This may depend on the level of conceptualization, and the user community or different user segments involved. In this paper *the necessary and sufficient conditions* as regards modeling are simplified to imply information and features that are, considering the future visions:

- Exploitable *or* indispensable, and
- Trustworthy regarding the process of producing this information

(Nykänen, 2004)

6.2.3 Semantic translation process

A detailed example of the translation process is given in section 4.2.1. This step involves here (Visser, Stuckenschmidt, Schuster, and Vögele, 2002, p 10-11):

- *Annotation of information sources*

W Annotation means here that the inherent concept hierarchy of an information source is extracted and each concept is described by necessary and sufficient conditions. An annotation tool applicable with different repositories of vocabularies according to different domains of interest is needed.

- *Semantic translation of information entities*

W The new concept term describing the type of an information entity in the target information source is determined automatically by a classifier that uses ontologies of source and target structures as classification knowledge. In this way ontology may be used as a surrogate for information sources.

The OGC semantic modeling approach described in section 4.1 (OGC, 1999, p 2) resembles very much these stages of the semantic translation process, and may be used as well, if appropriate. The main difference is that the OGC approach directs to the property level, and if that is the preliminary intention, might be advisable to follow.

6.2.4 Quality labeling for cadastral information

Quality labeling for cadastral information in section 5.1 implies explication for classification of data quality with labels by properties or property values. This is included in the OGC semantic modeling approach in 4.1. User surveys for evaluation may be added.

6.2.5 Quality labeling for information services

Quality labeling for information services in section 5.2 is giving quality labels for cadastral information services based on standard views of different user communities or groups according to section 4.3. User participation and surveys for evaluation may be added.

6.3 Possible benefits for EULIS

Further ontology explication could provide EULIS with a more comprehensive and structured terminology to be included in the EULIS Glossary as well as throughout the reference information descriptions. Also, the use of EULIS terms as search words in user interface would be promoted, since present EULIS terms may not satisfy the consistency requirements to be used as search words to a sufficient degree.

Quality labeling stage would significantly improve the services to the benefit of end users, and enable anyone to understand the meaning of property and cadastral information provided.

7 CONTEXTUAL FRAMEWORK FOR SEMANTIC HARMONIZATION AND CADASTRAL DOMAIN MODELING

The experiences and lessons from the EULIS project show that semantic modeling or standardization in the land register and cadastral domain should and is possible to be based on the real world (institutions, rules, functions, processes, diverse user segments and services), not only on existing information systems reflecting that real world in a system specific way, often incomplete and restricted or too simplified. This also implies *widening the extent of investigation* first on a more general level (*pre-standardization*) to achieve a profound unambiquity for terminology and conceptualization, before defining the details. Some approaches are given as examples on how ontology explication and semantic translators can be used as surrogates to connect the existing systems (even with their restrictions) to the ICT infrastructure related. A roadmap with the necessary quality assurance by quality labeling has consequently been outlined. The author's intention has been to review the results presented also with ISO 19100 perspectives.

The requirement for a real world basis is necessary due to the diverse and dynamic dimensions of cadastral and property information; spatial, temporal and legal, even socio-economical as well, and in addition the services must be reality-based. It may even be stated that with respect to cadastre the legal aspects make up the 5th dimension, the four others being established and well-known dimensions in environmental information system domain.

Nevertheless different aspects are possible to assimilate sufficiently based on real world functions and abstractions of them with available semantic methods or ontology explication, using adequate and independent expertise, or more properly, *qualitative* human knowledge or comprehensive user surveys. Accordingly the structuring process is naturalistic, arising from the very acts and functions. It may also be slightly heuristic, searching for most likely choices of the information community, and not necessarily or solely by hierarchical categorizing.

Also existing user survey results can be exploited with appropriate methods for quality labeling and amending the domain model in more details (entity properties and property values). The author's insight is that modeling in general should shift *focus more to services or qualitative conditions* and the real world context, instead of information contents only.

Terminology standardization, where the EULIS approach was given as an example in this paper, provides a feasible knowledge base for further results, following the roadmap given. Besides legal and procedural views, EULIS reference information includes compilation of core data contents, datasets and product services of various countries, increasing in number, and in a uniform structure for cadastral domain modeling.

Another initiative for cadastral domain is charting the trustworthiness and matching the criteria for quality certification labels consequently as presented and detailed.

The evaluation criteria for successful progress may be ambiguous whether the main objective is to improve data access and interoperability, to reduce land transactions costs or time spent, to raise security, to improve completeness or integrity of data or services etc. The ultimate criteria might be better services with *better transparency and reliability* of the complex information domain, promoting best practices in technology processes of land registration, the same also being necessary in standardization and harmonization.

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BIOGRAPHICAL NOTES

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