The Final Steps Towards an International Standard for Land Administration

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Key words: Land administration, standards, ISO, cadastral modeling, LADM

SUMMARY

The Land Administration Domain Model (LADM) moved forward to the FDIS stage (FDIS = Final Draft International Standard): ISO FDIS 19152. This is the last stage before becoming an International Standard (expected in July 2012), after a four year standards development process within ISO/TC211 (Geographic Information) and six years of preparation within the FIG, while the original idea for such a standard was launched at the 2002 FIG congress in Washington D.C.

This paper presents an overview of the last (sometimes minor) modifications from DIS to FDIS. Most modifications are improvements to increase the flexibility of the LADM, e.g. the relationships between rights and arbitrary sets of spatial units (parcels). Consequently, with more flexibility, the notion of conformance testing has been adjusted. Also, the ever increasing adoption of the LADM is illustrated via a number of new country profiles. This clearly shows the need, and practically, the growing support for the LADM over the past years (in addition to the ever growing number of positive votes for the LADM within ISO).

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1. INTRODUCTION

The Land Administration Domain Model (LADM) moved forward to the FDIS stage (FDIS = Final Draft International Standard): ISO FDIS 19152. This is the last stage before becoming an International Standard (expected in July 2012) after a four year standards development process within ISO/TC211 (Geographic Information. www.isotc211.org) and six years of preparation within the FIG, while the original idea for such a standard was launched at the 2002 FIG congress in Washington D.C.

First an historic overview is presented of the incremental development of the LADM. All the steps in this development have been published in a series of papers. There have been workshops, expert group meetings, and scientific reviews. Then the initiative was taken to submit the results so far to the TC211 of ISO for standardisation. The proposal has been accepted and the LADM was developed and improved on the basis of this proposal. A group of experts from different organisations and international institutions contributed to this development within ISO/TC211. An overview is given in Section 2 of this paper. This includes also an overview of the informative part of the draft standard as in (ISO, 2011). Then, the paper presents the final steps. An overview of the last (minor) modifications from DIS to FDIS is presented in Section 3. Most modifications concern improvements to increase the flexibility of the LADM, e.g. the relationships between rights and arbitrary sets of spatial units (parcels). In the discussion in Section 4 the ever increasing adoption of the LADM is illustrated. This clearly shows the need, and practically, the growing support for the LADM over the past years (in addition to the ever growing number of positive votes for the LADM within ISO). An overview of conformance testing is included in Section 5, this approach has been recently finalised. The paper ends with conclusions and a recommendation in Section 6.

2. LADM DEVELOPMENT

2.1 Preparations

As already mentioned Section 1 the announcement of the development of the LADM was at the FIG Congress held in Washington DC, USA in April, 2002. In a paper by (Van Oosterom and Lemmen, 2002a) the impact of GeoICT developments was analysed. The paper emphasized that efficient design, development, testing and maintenance of cadastral systems allows for the introduction of such systems within acceptable time and budgets. A basic condition for such development is analysis of user requirements. The paper concluded that cadastral systems are dynamic; they have to develop continuously in order to support society in a sustainable manner because of changing user requirements (UNECE, 1996). The paper

was the starting point of the development of the LADM. It was based on a lot of experience of building of a large spatial database in The Netherlands (see the peer reviewed publication in Computers, Environment and Urban Systems by Van Oosterom and Lemmen, 2001).

Version 0.1 of the LADM was presented in September 2002 at a meeting of the Open GeoSpatial Consortium (OGC), organized in Noordwijk, The Netherlands, and also at a COST Workshop in Delft, The Netherlands in November 2002 (Van Oosterom and Lemmen, 2002b).

Version 0.2 of the LADM was presented (after expert reviews) at a workshop on Cadastral Data Modeling at the International Institute for Geo-Information Science and Earth Observation (ITC) in Enschede, The Netherlands in March 2003 (Van Oosterom and Lemmen, 2003a), and during the FIG Working Week, in Paris, France, April 2003 (Lemmen and Van Oosterom, 2003a). Further, several publications related to this have been made in GIM International (Lemmen and Van Oosterom, 2003b; Lemmens and Lemmen, 2003). In the latter feature in GIM International, experts have been invited to give their opinion on a column written by the last author of this paper (Van Oosterom, 2002c). Eight replies were received. Those replies concerned the environment of land administration, the dynamic processes in cadastre, country specific legislation and culture, and the many differences within countries. Further needs and user requirements were specified. One example here is from Enemark. He proposes to use the legal unit of 'real property' as the key unit, not the parcel. In this way, the model will enable the control of land as a legal, fiscal and physical object. This proposal was subject of debate during the developments of the LADM. Such a Basic Property Unit (BPU) is also included in the hierarchy in ownership as recognized in (UNECE, 2004). In the Draft International Standard of LADM (ISO, 2010), the BPU is included, but under different name: Basic Administrative Unit. Further specific requirements (boundary surveying) can be found in (Wakker et al, 2003). Attention to informal rights and communal rights was included in a presentation at an annual meeting of the FIG Commission 7 on Cadastre and Land Management, held in Pretoria, South Africa, 2002 (Lemmen, 2002; see also FIG, 1996).

Version 0.3 of the LADM was presented during Digital Earth, September 2003 in Brno, Czech Republic (Lemmen et al, 2003c), and at the 2nd Cadastral Congress, held in Krakow, Poland (Van Oosterom et al, 2003b) and at the European Land Information Service (EULIS) Seminar on 'Land Information Systems and the Real Estate Industry', Lund, Sweden, April 2004. Version 0.3 included 3D extensions, new functionality for restrictions, and there was attention to the dynamic aspects, and customary and informal tenure. There were refinements and more authors as domain specialists. Also the paper from Van der Molen (Paris FIG 'Cadastre beyond 2014') was important input (Van der Molen, 2003). Version 0.3 can be seen as a 'mature' initial version of the LADM, at that time called the Core Cadastral Domain Model (CCDM).

Input from the Expert Group Meeting on Secure Land Tenure, in Nairobi, Kenya, November 2004 was most relevant to improve the model and to include customary tenure (Van der Molen and Lemmen, 2004). The Nairobi meeting provided input from developing countries, which was worked out in the version of the model presented during the Second Workshop on Standardization of the Cadastral Domain, held in the Auditorium of the University of Bamberg, Germany, 9-10 December 2004 (Van Oosterom et al, 2004). In this version 0.4, as presented in Bamberg, there has been attention to the system boundary and

some other suggestions for further improvement have been included in the conclusions.

Version 0.5 of the LADM was presented at the FIG Working Week in Cairo, April 2005 (Lemmen et al, 2005). This version was mainly improved on the legal, or administrative side of the model (based on the Bamberg workshop). The model was made 100% compliant with the OGC and ISO/TC211 standards. This version included reflection on the Arab world cadastral registration at the FIG meeting in Jordan, September 2005.

Version 0.6 of the LADM was presented at the UN-HABITAT expert group meeting in Moscow, October 2005 (Van Oosterom and Lemmen, 2006a), and the FIG regional conference in Accra, Ghana, March 2006, including the third LADM workshop (Augustinus et al, 2006).

After review of version 0.5, the written comments have been addressed in version 0.6. This resulted into the inclusion of a class Building in the model, improvements in relationships between rights and restrictions (often 'the positive and negative side of the same coin'), a better explanation of the role of PartOfParcel and in a remark on the need of not only standardizing the model but also possible information services. Version 0.6 was presented in a peer reviewed scientific journal and it was decided to present the whole model, instead of the increments only, because of reasons related to completeness and readability (Van Oosterom et al, 2006b).

Finally, version 1.0 of the LADM was presented at the FIG Congress in Munich in October 2006 under the name of 'version 1.0 of the FIG Core Cadastral Domain Model' (Lemmen and Van Oosterom, 2006a).

In 2003 Lemmen, while working on the design of the LADM, also started the technical design of the STDM to address the challenges and fundament and concepts outlined in (Fourie, 1998); see also (Lemmen et al, 2007) and (Lemmen, 2010).

After the FIG conference in Munich in October 2006 many cases and examples were worked through, including the initial filling of several code lists, which were until then only mentioned but not described with content. This document became the input for the ISO standardization process (ISO/TC 211, 2008a), over which was subsequently reported in (Lemmen et al, 2009).

2.2 Developments within ISO

In the beginning of 2008, FIG submitted a proposal to develop an International Standard for the Land Administration (LA) domain to the ISO/TC 211 on Geographic Information of the International Organization for Standardization (ISO/TC211, 2008a). The proposal received a positive vote from the TC 211 member countries on May 2, 2008, and a project team started to work on the development of the standard.

Within TC 211, many issues and comments have been discussed during several meetings (in respectively May 2008, October 2008, December 2008, May 2009 and November 2009), held with a project team composed of 21 delegates from 17 countries. A significant contribution to the development of the standard has been provided by the research communities of the Faculty of Geo-Information Science and Earth Observation of the University of Twente (ITC) and Delft University of Technology, the Netherlands.

After positive results of voting on the so-called New Working Item Proposal (NWIP) in May 2008 (ISO/TC211, 2008a) and on the Committee Draft (CD) on October 12, 2009

(ISO/TC211, 2009) the Draft International Standard (DIS) received a positive vote on June 27, 2011 (ISO/TC211, 2011); see Table 1. The stage of Final Draft International Standard is expected in (July 2012). Each step in the developments within ISO includes reviews from countries involved in the development process.

Table 1 Voting results at the various stages of ISO 19152

Voting	NWIP	CD	DIS
Approve	15	22	26
Disapprove	6	3	2
Abstain	4	4	4
Not Voted	7	3	0

During the development of the LADM many reviews have been performed resulting in new insights, improvements and proposals for extensions. All together the development took place from 2002-2012. Already existing ideas written in papers or books which could be used as possible input or requirements for the development of the LADM came available during this period. Not all of the existing materials were known at the start of the development. See as a good example (Kalantari, 2008).

Apart from the versions published during the development of the international standard within (and published by) ISO/TC211 (ISO/TC211, 2008a; ISO/TC211, 2008b; ISO/TC211, 2009; ISO/TC211, 2011) there are publications in scientific journals related to the LADM (and its predecessor the CCDM). Those publications are: Lemmen et al, 2001; Van Oosterom et al, 2001; Elia, 2011; Lemmen et al, 2006b; Hespanha et al, 2006, Van Oosterom et al, 2006; Van Oosteom et al, 2009, and Döner et al, 2010.

2.3 Informative documentation in ISO 19152

It should not be forgotten that, apart from the normative part, there is comprehensive informative documentation included in the Draft International Standard. A set of examples (instance level cases) is documented in Annex C. Implementation of the LADM can be performed in a flexible way; the standard can be extended and adapted to local situations. See country profiles in Annex D of the ISO 19152 draft standard. Spatial and legal profiles are included in Annexes E and F. The integration with the INSPIRE Cadastral Parcel Model (INSPIRE, 2009) is documented in Annex G and with the Land Parcel Identification System (LPIS) in Annex H. The Social Tenure Domain Model is included in Annex I. A set of codes for parties, group parties, party roles, right types, restriction types, responsibility types, source types, level type, building unit type, register type, utility network type, volume type, area type, point type, etc is provided in Annex J. External links to other databases, e.g. addresses, can be included, see Annex K. Interface classes in Annex L and modeling processes in Annex M. Attention to history and dynamic aspects is in Annex N and the re-use of other ISO standards is dealt with in Annex O.

3 LATEST DEVELOPMENTS

First of all a complete set of definitions, which has been under discussion for a long time has been finalised. This is the basis for knowledge exchage. The overview is in Table 2 below.

Table 2 Terms and Definitions used in the Draft International Standard ISO 19152.

Term	**Definition**
administrative source	source with the administrative description (where applicable) of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected
basic administrative unit (baunit)	administrative entity consisting of zero or more spatial units against which (one or more) unique and homogeneous rights (e.g. ownership right or land use right), responsibilities or restrictions are associated to the whole entity, as included in a Land Administration system
boundary	set that represents the limit of an entity [ISO 19107:2003, definition 4.4]
boundary face	face that is used in the 3-dimensional representation of a boundary of a spatial unit
boundary face string	boundary forming part of the outside of a spatial unit
building unit	component of building (the legal, recorded or informal space of the physical entity)
face	2-dimensional topological primitive [ISO 19107:2003, definition 4.38]
group party	any number of parties, forming together a distinct entity, with each party registered
land	the surface of the Earth, the materials beneath, the air above and all things fixed to the soil [UN/ECE, 2004]
land administration	process of determining, recording and disseminating information about the relationship between people and land
level	set of spatial units, with a geometric, and/or topologic, and/or thematic coherence
liminal spatial unit	spatial unit on the threshold between 2D and 3D representations
party	a person or organization that plays a role in a rights transaction; ISO 19153 Geospatial Digital Rights Management Reference Model (GeoDRM RM) – to be published
party member	party registered and identified as a constituent of a group party
point	0-dimensional geometric primitive, representing a position [ISO 19107:2003]
profile	set of one or more base standards or subsets of base standards, and, where applicable, the identification of chosen clauses, classes, options and parameters of those base standards, that are necessary for accomplishing a particular function [ISO 19106:2004, definition 4.5]
required relationship	explicit association between either spatial units, or between basic administrative units
responsibility	formal or informal obligation to do something
restriction	formal or informal entitlement to refrain from doing something
right	action, activity or class of actions that a system participant may perform on or using an associated resource [ISO 19132:2007]
source	document providing facts
spatial source	source with the spatial representation of one (part of) or more spatial units
spatial unit	single area (or multiple areas) of land and/or water, or a single volume (or multiple volumes) of space
spatial unit group	any number of spatial units, considered as an entity
utility network	network describing the topology of a utility

A list of (minor) changes:

- The Administrative Package (Figure 1) has been slightly changed in the association between LA_Mortgage and LA_Administrative source. This direct association has been eliminated because it is inherited from the association between LA_RRR and LA_AdministrativeSource.
- The indirect inheritance from LA_GroupParty to VersionedObject has been corrected (via LA_Party); the same applies to LA_Mortgage, with also an indirect inheritance to VersionedObject (via LA_RRR and LA_Restriction); see Figure 2.
- The name of the data type Rational changed into Fraction (more correct English); see Figure 2.
- The quality and sources attributes as included in VersionedObject, are also added to LA_Source (a non-VersionedObject).
- The role name ‘conveyor’ changed into ‘conveyancer’ (in the association from LA_Mortgage to LA_Party).
- The data type name of the timeSpec attribute in LA_RRR changed from ’ISO8601_Type’ into ’ISO8601_ISO14825_Type’.
- In LA_RequiredRelationshipBAUnit the attribute relationship has become mandatory (instead of optional [0..1]).
- In LA_RequiredRelationshipSpatialUnit the attribute relationship has become mandatory (instead of optional [0..1]).
- In LA_Level the attribute registerType has become optional (was mandatory before).
- The multiplicity of the hierarchical relationship of LA_SpatialUnit with itself has been added (this was omitted by mistake): 0..1 and 0..*.
- In Surveying and Representation subpackage the multiplicity of several associations has been changed, making it more general.
- Some small corrections to a number of instance level diagrams C.7, C.10, C.14, C.15 (all in the informative annex C).
- New country profiles for the Russian Federation and the Republic of Korea in informative Annex D.
- Correction, and extension of code list values in LA_Avaialbility-StatusType and LA_BAUnitType (in informative Annex J).
- The new external class ExtPhysicalBuildingUnit (and associated to the LA_LegalSpaceBuildingUnit) added in informative Annex L.

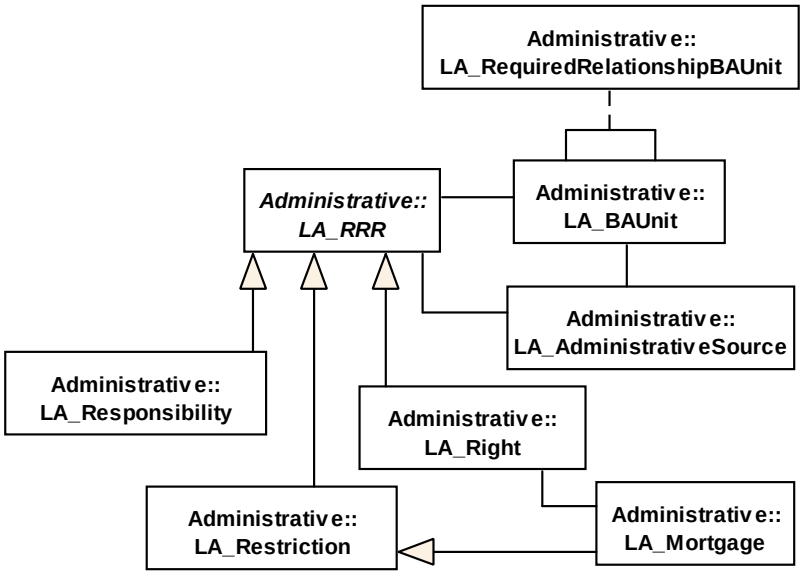

Figure 1 Classes of Administrative Package and associations between them

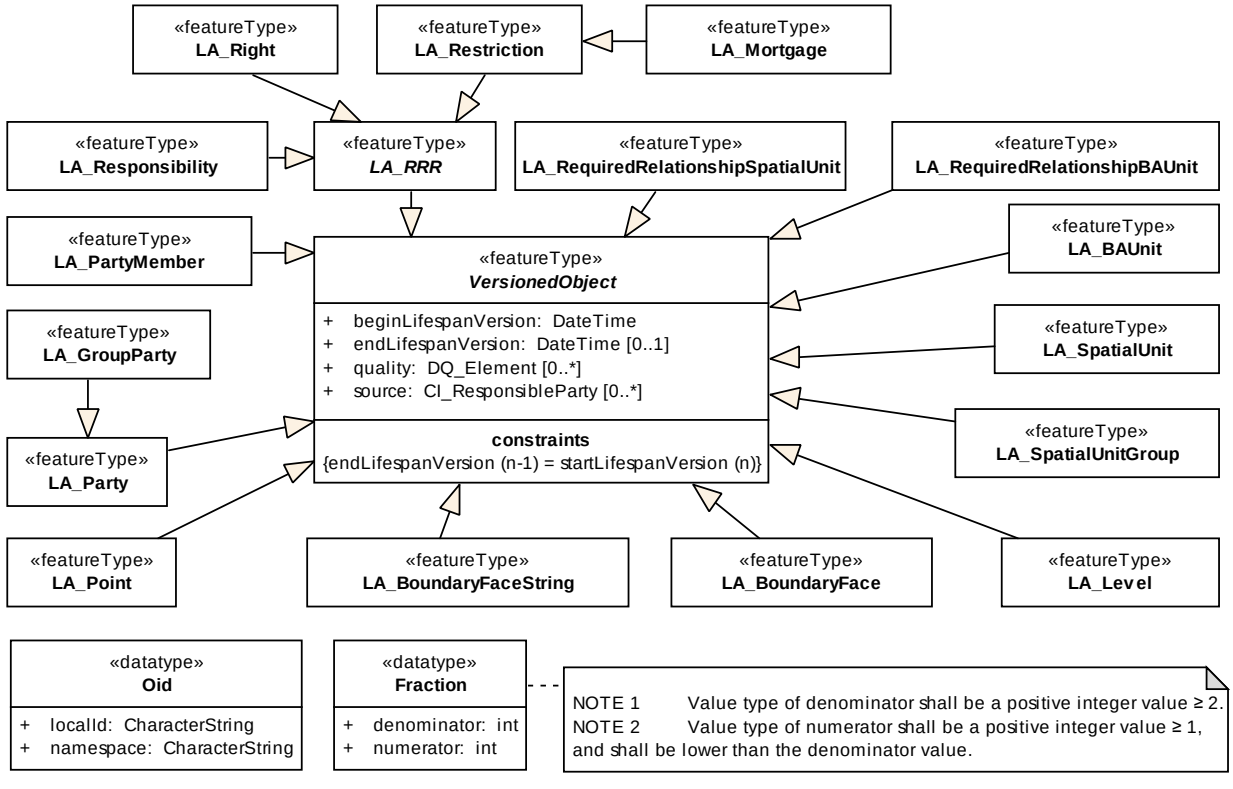

Figure 2 VersionedObject and indirect inheritance of LA_Mortgage and LA_GroupParty. The data type Rational was renamed into Fraction

4 LADM SPECIALIZATIONS AND COUNTRY PROFILES

After many years of preparations and development within ISO it can be stated that in LADM there is a basis for structuring and organising the representations of people-to-land related information in a generic way. The Social Tenure Domain Model (Augustinus et al, 2006) is a specialization of LADM and has been developed for informal and customay environments. In the proposals from (McLaren, 2011a, 2011b) the use of Open Source software using *Open Standards as STDM* is highlighted. McLaren refers to the Solutions for Open Land Administration (SOLA) from FAO based on the LADM. He discusses Open Toolkits for mobile phone platforms. He talks about LA systems apps for non-literate users. This requires further research on how to integrate crowd sourcing for land administration with LADM and Open Toolkits. An application schema is needed for software development, but this can only be developed after the local demands are precisely known. The application schema can be built on the generic conceptual schema of LADM, combined with local needs. This is demonstrated in FAO Free and Libre Open Source Software Solutions for Open Source Land Administration - FLOSS SOLA, see (FAO, 2010, 2011a, 2011b, 2011c, 2011d and 2011e). LADM has been used as a starting point for this development.

The draft standard is in the focus of interest in Cyprus (Elia, 2011), Portugal (Hespanha, 2006, 2012), it is under development as software tool at FAO (see before) and UN-HABITAT. See for an implementation case from Cyprus a description in the peer reviewed journal Survey Review (Elia et al, 2011). Countries are interested, see the country profiles in the Annex D of the standard: from Portugal, Queensland, Indonesia, Japan, Hungary, The Netherlands, Russian Federation and the Republic of Korea (see Figure 3, one of the new country profiles in the LADM FDIS version). The 3D aspects find a lot of recognition, see a series of examples in (Van Oosterom, 2011).

Structuring and organizing data may be in interaction with data in other databases. Databases can be implemented in a distributed environment in different organizations with different responsibilities in Land Administration. Spatial Data Infrastructure concerns the data exchange between organizations involved in land administration, packages have been introduced in LADM for a proper representation of tasks and responsibilities. LADM can be a basis for combining data from different LA systems; e.g. systems with datasets on formal and informal people-to-land relationships. The LADM opens options to bridge the gaps between cultures where people-land relationships are concerned, definitively not only in support of globalization, but also with a strong attention to bring support in the protection of land rights (tenure certainty) for all.

The draft standard can be extended and adapted to local situations; in this way all ‘people-land relationships’ may be represented. This can be supportive in the development of software applications built on database technology, where LADM describes the data contents of land administration in general.

After all the developments, the Land Administration Domain Model (ISO, 2011) provides a comprehensive set of functionality, based on Model Driven Architectures. The LADM can be supportive in business process reengineering, with normalised data models to avoid data duplication (also in relation to external databases). The LADM includes all documents, this

means building a complete and full digital cadastre. A major advantage in adopting LADM is the classification and structuring of RRR, where classifications in categories are possible, see (Elia, et al, 2011). 3D Cadastres are treated in such a way that these integrate seamlessly with existing 2D registrations; see Annex B of the LADM (ISO, 2011).

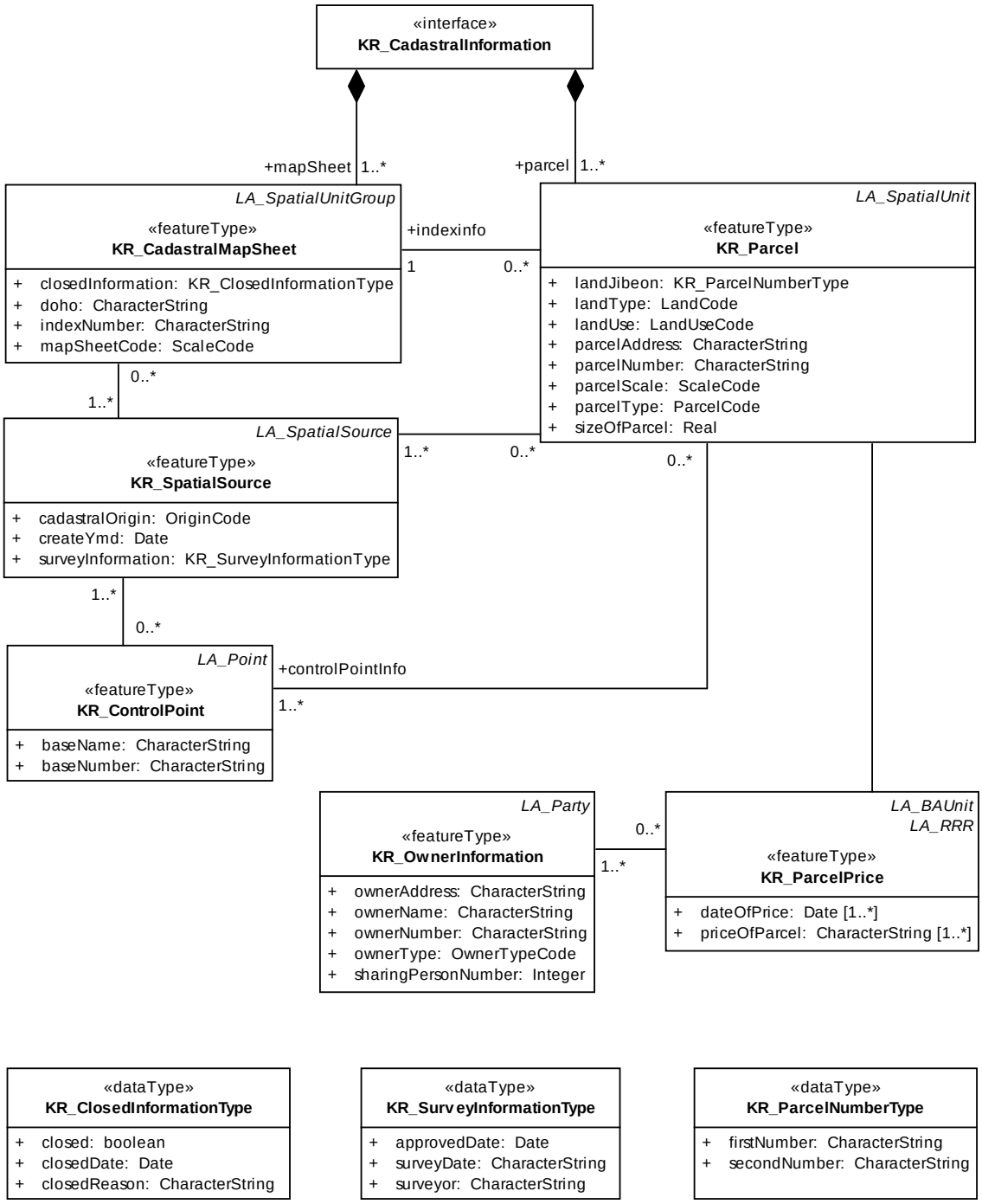

Figure 3 The Republic of Korea country profile as included in Annex D

5 CONFORMANCE TESTING

A lot of effort has been made to improve conformance testing. Any land administration system claiming conformance to this International Standard has to satisfy the requirements as in Annex A ('Abstract Test Suite') of the draft standard.

The abstract test suite is in conformance with ISO 19105. The LADM specifies a conceptual schema. Actual use of the LADM requires that an application schema, such as a country profile, is developed. The Annex A to the draft standard specifies how to test whether a specific application schema is conformant with the LADM in terms of package and level. Testing whether a specific data set is conformant, means checking the data set content against the corresponding conformant LADM application schema.

The test suite in Annex A of the draft standard specifies the requirements that the implementation under test has to meet in order to be conformant to this International Standard. For each test the metadata conformity element takes one of the following values:

- Conformant (conformant). The resource is fully conformant with the cited specification
- Not Conformant (notConformant). The resource does not conform to the cited specification, or:
- Not evaluated (notEvaluated). Conformance has not been evaluated.

The LADM consists of three packages and one subpackage, and for each of them a conformance test is specified. Three conformance levels are specified per (sub)package: level 1 (low level), level 2 (medium level), and level 3 (high level). A package is level 1 compliant if the classes with level 1 indicators are passing the conformance test. A package is level 2 compliant if the classes with levels 1 or 2 indicators are passing the conformance test. A package is level 3 compliant if the classes with level 1, 2 or 3 indicators are passing the conformance test.

Table 3 gives an overview per package to check for LADM compliancy. Conformance tests on the LADM can be done per package. Conformance tests shall be done on interdependencies between applicable packages when two or more packages are tested. The mandatory and optional attributes are given in the class diagrams.

The test method in this Annex is used in all test cases 'to examine the application schema of the implementation under test, including class, attribute(s) and association definitions.' There are a number of different ways to document the positive results of the test method:

- show inheritance structure between the LADM and the tested model (elements), or
- show mapping of elements between the LADM and the tested model.

In order to realize this conformance test explicitly and completely, knowledge and understanding is required of both the LADM and any specific profile used. The profile should not include different structures or solutions where the LADM has standard provisions.
Conformance testing per right type, responsibility type or restriction type is possible. In the code lists for rights, responsibilities or restrictions, specific (user defined) code list values can be added, indicating a partial responsibility or restriction. Or a right, which is not

homogeneous in time. This affects the complete spatial unit with regard to registration (therefore in a sense homogeneous), but in reality only a part of the spatial unit. In addition, a text spatial unit can be defined, describing the location of the part.

Table 3 The LADM conformance requirements table.

LADM package	**LADM class**	**Cl**[a]	**Dependencies**
-	*VersionedObject*	1	
	LA_Source	1	Oid, LA_AdministrativeSource (as a minimum, this specialization must be implemented)
Party Package			Exist only if Administrative Package is implemented
	LA_Party	1	VersionedObject, Oid, LA_PartyType
	LA_GroupParty	2	VersionedObject, Oid, LA_Party, LA_GroupPartyType
	LA_PartyMember	2	VersionedObject, LA_Party, LA_GroupParty
Administra-tive Package			Exist only if Party Package is implemented
	LA_RRR	1	VersionedObject, Oid, LA_Party, LA_BAUnit, LA_Right (as a minimum, this specialization shall be implemented), LA_AdministrativeSource
	LA_Right	1	LA_RRR, LA_RightType
	LA_Restriction	2	LA_RRR, LA_RestrictionType
	LA_Responsibility	3	LA_RRR, LA_ResponsibilityType
	LA_BAUnit	1	VersionedObject, Oid, LA_RRR, LA_BAUnitType
	LA_Mortgage	2	LA_Restriction
	LA_AdministrativeSource	1	LA_Source, LA_Party, LA_AdministrativeSourceType, LA_AvailabilityStatusType
	LA_RequiredRelationshipBAUnit	3	VersionedObject, LA_BAUnit
Spatial Unit Package			
	LA_SpatialUnit	1	VersionedObject, Oid, LA_SpatialSource
	LA_SpatialUnitGroup	2	VersionedObject, Oid, LA_SpatialUnit
	LA_LegalSpaceBuildingUnit	3	LA_SpatialUnit
	LA_LegalSpaceUtilityNetwork	3	LA_SpatialUnit
	LA_Level	2	VersionedObject, Oid, LA_RegisterType
	LA_RequiredRelationshipSpatialUnit	3	VersionededObject, LA_SpatialUnit
Surveying and Repre-sentation Subpackage			
	LA_Point	2	VersionededObject, Oid, LA_SpatialSource, LA_PointType, LA_InterpolationType

	LA_SpatialSource	2	LA_Source, LA_Point, LA_Party, LA_SpatialUnit (unless it is changed), LA_SpatialSourceType
	LA_BoundaryFaceString	2	VersionedObject, Oid, LA_Point (if using geometry)
	LA_BoundaryFace	3	VersionedObject, Oid, LA_Point (if using geometry)
A CI = Conformance level			

6 CONCLUSIONS AND RECOMMENDATION

It is concluded that there is support for the LADM from FIG, ISO/TC211, UN-HABITAT, EU, FAO, several countries and many professionals. The LADM is now (March, 2012) at the stage of Final Draft International Standard (FDIS) and available for final voting by the members of TC211.

We hope for a positive result of voting. The result is expected in July 2012. Then the LADM will be stable for the next years.

FIG may be involved in the development of other domain standards in the future, those standards make SDI working.

Acknowledgements

Many thanks go to the editorial committee drafting the ISO 19152 Land Administration Domain Model: Danilo Antonio and Solomon Haile (UN-HABITAT, Kenya); Antony Cooper (South Africa); Wim Devos (Joint Research Centre of the European Union, Italy); Paul Egesborg and Christian Lord (Canada); Tomohiko Hatori (Japan); TaikJin Kim (Korea); Julie Binder Maitra (United States); Tarja Myllymäki (Finland); Jesper Paasch (Sweden); Markus Seifert (Germany) and Frederique Williams (France).

Many thanks also to Iain Greenway (United Kingdom) for the submission of the new working item proposal to ISO on behalf of the International Federation of Surveyors (FIG) and for all the advice “on the road”. We want to thank the FIG Council 2007 – 2010, under President Stig Enemark (Denmark) and the FIG Council 2011 – 2014, under President CheeHai Teo (Malaysia) and FIG’s director Markku Villikka (Finland) for continuous support. Special thanks to Bjørnhild Sæterøy (Norway) for always giving advice and especially for bringing the feeling to be at home in the Technical Committee 211 of the International Organization for Standardization (ISO/TC211) environment. And to John Herring (United States) and Serena Coetzee (South Africa) for their management and support within ISO/TC211.

Rod Thompson (Australia) contributed in the development of the 3D aspects. Clarissa Augustinus (Kenya) and Jaap Zevenbergen (The Netherlands) in the developments of STDM.

Many others contributed by developing country profiles, performing reviews, participation in discussions and so on. Thanks. Without all those contributions this result would not have been there.

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