Survey of Israel Three-Dimensional Cadastre and the ISO 19152 - The Land Administration Domain Model

Report 1 (updated version)
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Summary
This report contains the results of the first phase of the 3D Cadastre and LADM investigations in context of possible future renewal of the Cadastral database at the Survey of Israel. This report complements the presentations given on '3D Cadastres' and 'Land Administration Domain Model (LADM, ISO 19152)' on respectively 9 and 10 February 2014 at the Survey of Israel, Tel Aviv. For completeness both presentations are included as annexes to this report. The first phase of the investigations covered two studies: 1. the state of the art of three-dimensional cadastre and 2. current cadastral procedures, land model and database. Both studies focus on Israel, but are conducted from international perspective in order to provide comparison and possible best practises. The two topics of 3D Cadastres and LADM are highly related and therefore this report covers both studies. The report concludes the first phase of the investigations with a series of short and long(er) term recommendations in order to realize the inclusion of 3D Cadastral objects in the registration. In July 2014 the second phase of the investigations is planned and will continue the 3D Cadastre/LADM study (standards, procedures, case studies, SDI, LADM country profile, data transfer, DBMS schema, query and visualization) and prepare for future 5D Cadastre research (2D/3D integration, temporal, legal-physical objects, vario-scale).

Contents

Chapter 1.
Introduction

Israel was among the first countries in the world to address the topic of 3D representations in the cadastral registration (Benhamu and Doytsher 2001, Forrai and Kirschner 2001, Grinstein 2001, Sandberg 2001, Benhamu and Doytsher 2003, and Sandberg 2003). This was reinforced by a two year 3D Cadastre R&D project during the years 2002-2004 (Shoshani, Benhamu, Goshen, Denekamp and Bar 2004, Shoshani, Benhamu, Goshen, Denekamp and Bar 2005, Benhamu 2006). This was not by coincidence, as Israel is a relatively small country, with a rapidly growing population, the pressure on the available land/space is increasing. A decade ago there was no country in the world having an operational Cadastre including the legislation, 3D survey plans/ mutation plans, 3D Cadastral database, and 3D dissemination. Technology was still limited (e.g. the spatial DBMS did not yet support 3D volumetric primitives), and legislation needed adoptions. Therefore, the early R&D in Israel was not directly transformed in an operational system, most likely due to a mixed set of factors: legal (introducing new law or changing existing regulations takes time), organizational (financial/ cost aspects and cooperation with partners such as licensed surveyors and the land registry office, Ministry of Justice), and technical (no operational 3D Cadastral system implementations available).

Despite the fact that the 3D representation was not yet included in the Israeli registration, the 3D interest always remained and further studies where conducted, covering both the legal (Caine 2009, Sandberg 2014) and technical (Peres and Benhamu 2009) aspects. This puts Israel in a position of a high knowledge level. The starting position is healthy and based on well-investigated recommendations from the mentioned activities. Further, the pressure on land/ space has only increased over the last decade, which further emphasizes the importance of 3D Cadastral registration in the future of Israel. Now, after a decade of more experience with real-world (3D) developments in Israel, other countries also progressing, and an accepted international ISO standard for Land Administration supporting 3D representations, it is time to realize the 3D Cadastre in Israel. This report provides the next step in that direction by first analysing the current state of the art of 3D Cadastre (Chapter 2) and land administration procedures, models (Chapter 3) and providing recommendations for realization (Chapter 4). The recommendations can be separated into actions that should start very soon and those that to belong to a longer-term, more ambitious, perspective, in which the short term actions do fit as first steps.

Chapter 2.
State of the art of three-dimensional cadastre

In this chapter an overview is given of the international 3D cadastre developments (section 2.1). Next some 3D Cadastre attention points for Israel are raised (section 2.1).

2.1. Overview of international developments

The two special issue of the international journal Computers, Environment and Urban Systems: 3D Cadastres (Lemmen and van Oosterom, 2003) and 3D Cadastres II (van Oosterom, 2013) give a very good impression of the developments over the past decade.
In between many other publications at the various FIG (and other) events, other journal publications (see http://www.gdmc.nl/3DCadastres/literature/) and the FIG 3D Cadastre 2010-2014 questionnaire (see http://www.gdmc.nl/3DCadastres/participants/) illustrate well the developments. A quote from the conclusion of the analysis of the questionnaire, indicating the 3D Cadastre status at 2010 (van Oosterom, Stoter, Ploeger, Thompson and Karki, 2011): 'Broadly, one can observe that apartments are registered with drawings in the deed registration. But a true 3D registration in the cadastre does not exist anywhere…' and '… it was approached by Spain, although the representation uses a standard height per floor layer. Techniques for 3D data acquisition, management and distribution will be within reach. The next step is to optimally exploit this in order to meet the growing information needs in 3D cadastres, matching specific organizational and legal contexts.'
So, only partial 3D cadastre solutions existed until a few years ago. In some countries (Scandinavian countries, Australian states and Canadian provinces) the legislation is allowing/ supporting 3D volumetric parcels and these can be submitted for registration. However, these 3D volumetric parcels were not yet stored in the Cadastral database. Perhaps by surprise, but the first operational 3D Cadastral system, including a database and web-based dissemination was reported from Asia: Shenzhen, China (Guo, Li, Ying, Luo, He and Jiang, 2013) and also other Chinese mega-cities have reported operational cadastral systems including 3D support; see Figure 1. These implementations are soon to be followed by operational 3D systems from other Asian countries that have opened tenders for the development by industry contractors or have reported their plans: Singapore (Khoo 2011, Soon 2012), Bahrein (Ammar and Neeraj 2013), and Malaysia (Zulkifli, Rahman and van Oosterom 2013).

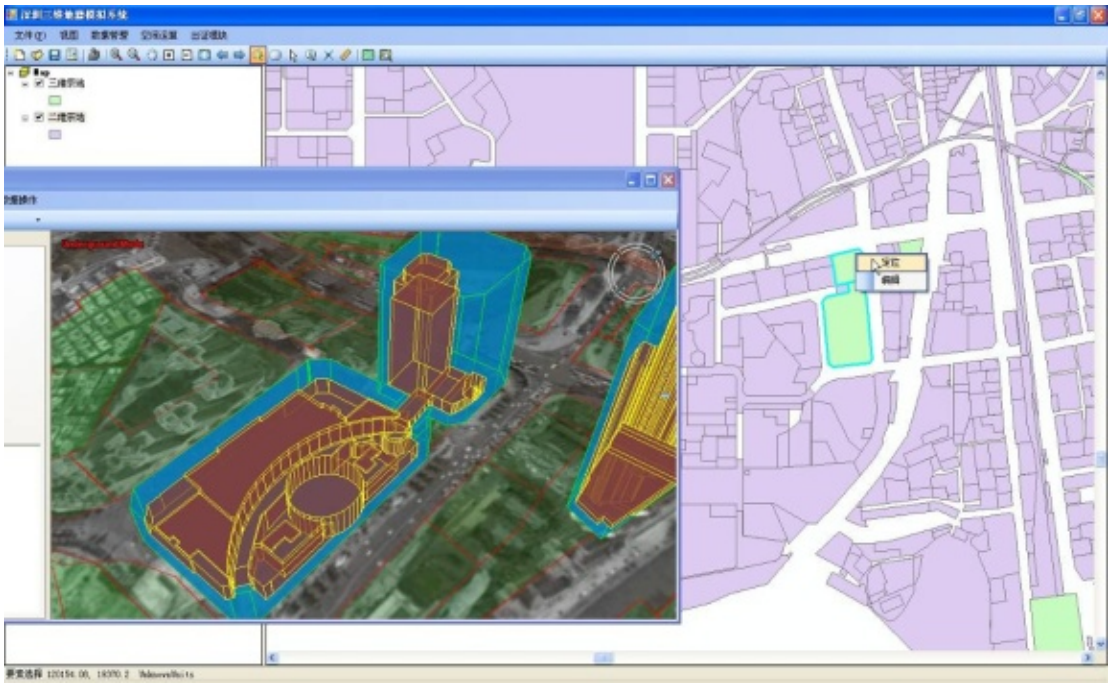

Figure 1. Example from the operational 3D Cadastral system (Shenzhen, China).

In the Netherlands, with more cadastral legacy, first a smaller step was taken by enabling the submission of 3D pdf drawing, documenting a 3D object for registration, but without storing this in the Cadastral database (Stoter, Ploeger and van Oosterom 2013); see Figure 2. Advantages of this approach are that it fits well in the current workflow (registration of legal documents as pdf), is supported well by current technology (standard Adobe Acrobat or Reader is enough to read/visualize the pdf document with 3D model), and no changes in the cadastral database are needed. Some non-cadastral samples of 3D pdf documents are available on http://www.tetra4d.com/content/samples (e.g. a 3D model of a house and an office) and with the standard pdf reader one can zoon, rotate, pan, slice the 3D model and can also change visualization style (solid, semi-transparent, wireframe, shading, perspective/ orthographic project, etc.). However, with just the registration of 3D pdf legal documents, it is not possible to validate the correctness of 3D cadastral representations; e.g. are the volumes closed?, are the neighbors non-overlapping?. Therefore, it is currently investigated how to realize the actual inclusion of the 3D data in the registration (database), enabling complete validation and even better 3D data management and dissemination.

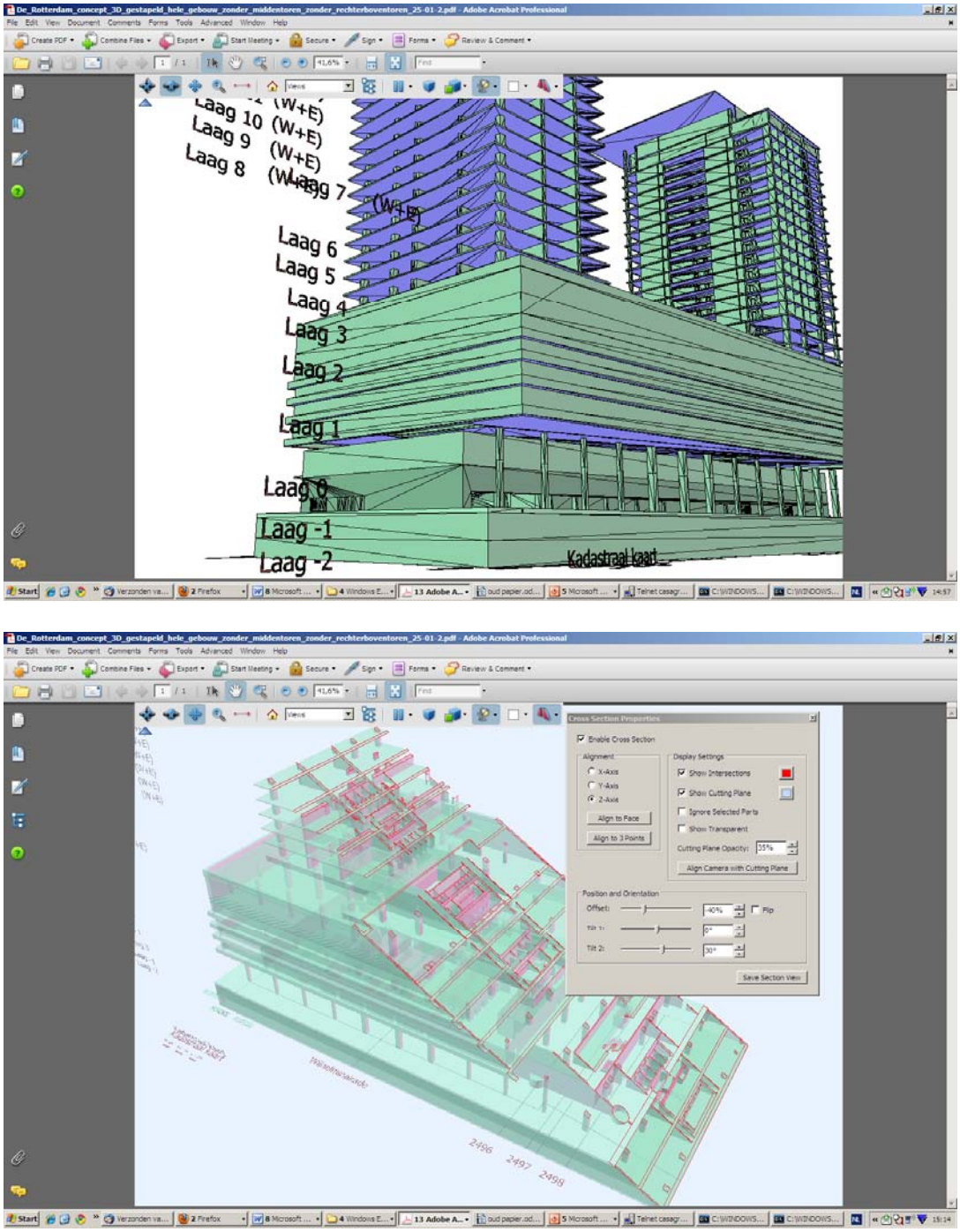

Figure 2: Visualizing a 3D Cadastral model in a 3D pdf document: in screen dump above a solid with wireframe visualization, and in screen dump below the same model with semi-transparent visualization and (non-horizontal) slicing, enabling an inside look. Note: other parts of the pdf documents can contain legal text and/or 2D cadastral map for orientation purpose (source of pdf document: Kees van Prooijen, Bentley).

2.2. 3D Issues to consider in Israel

As indicated in the introduction, Israel has already quite a long track record in exploring 3D Cadastre solutions. It is therefore wise to remember the earlier recommendations of which the main two aspects are (Shoshani, Benhamu, Goshen, Denekamp and Bar 2005): 1. prepare appropriate legislation and regulation, 2. foundation of 3D Cadastre solution is the 3D sub-parcel principle; see Figure 3. The 3D sub-parcel concept is based on subdivision of the unlimited column of space implied by the 2D surface parcel into at least one completely bounded 3D volume and a remaining (unlimited) space. The bounded 3D volume is within the column of the 2D surface parcel. This approach fits relatively well in the current approach with some extensions. In addition, the recommendation also included more detailed suggestions how to represent the third dimension (analytical x,y,h coordinates with h absolute, that is in orthometric heights above or below sea level) and 3D sub-parcel numbering (extension of current block and parcel number with additional sub-parcel sequence number).

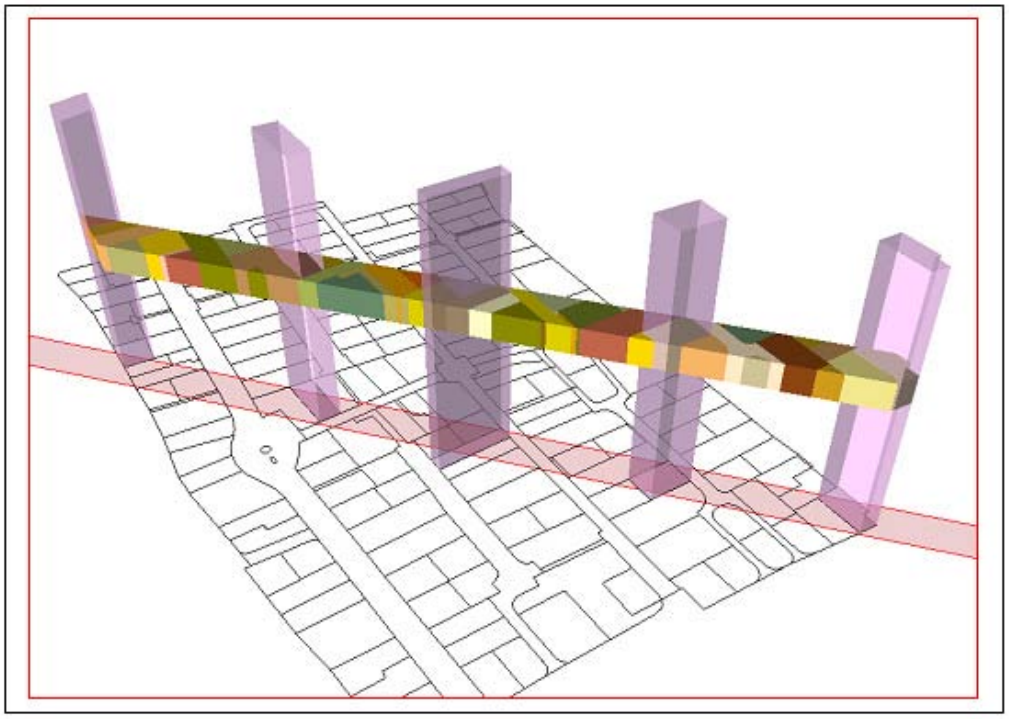

Figure 3: 3D Presentation of the spatial sub-parcels on the background of the existing land parcels. Source: (Shoshani, Benhamu, Goshen, Denekamp and Bar 2005).

Annex C contains the key concepts and terms used in earlier activities in order to realising Israeli 3D cadastre. An number of interesting observations can be made by analysing these terms and definitions:

- Spatial Physical Object, Displacement Distances: there is a clear distinction between real world object (physical or planned) object and the 3D (sub-)parcel describing the legal object;

- Spatial Lot, Spatial Parcel: strong relationship with spatial planning and cadastral registration (especially in 3D). Note that in Israeli literature the term ‘Spatial’ is often used as synonym for ‘3D Volumetric’; and
- Subterranean Space, Above Terranean Space: two concepts from town-plan, which indicate that besides absolute height (in national vertical reference system) also relative height is relevant (above, below Earth surface).

The logic behind the sub-parcel is clear: the owner of the surface parcel (3D column of space) splits the owned space and sells one part to another party. For long infrastructure type of objects the result is that one object, such as a tunnel, is to be represented with many 3D sub-parcels. To each of the 3D sub-parcels the same right and party should be attached, both initially, but also in future transactions (e.g. tunnel is sold to a company). This is redundant information and error prone. It is better to allow 3D parcels crossing many surface parcels. They could be created in one transaction involving all surface parcels, each selling a part of their property, to create a single 3D subsurface parcel to which the right and party can be attached (for the tunnel).
A more in-depth legal analysis concluded in 2009 (Caine 2009): ‘Using existing legal tools (notably leases, easements and condominiums laws) without changing their essence and features would create a huge gap between factual and legal reality,… To date, there seem to be consensus among all those versed in the subject that a legislative amendment is necessary in order to make special rights possible and viable in Israel.’ Next the above cited paper describes four main legal paths which can be taken in order to reach that aim:

1. use of the existing legal tools and stretch them to support 3D spatial parcels;
2. adopt a "non invasive" legal technique (as there is no direct legal obstacle to the creation of 3D spatial parcels under Israeli legislation);
3. establish an 3D "object registry", external to the Land Registry, in which rights to subterranean and aerial objects could be registered and managed; or
4. establish specific legislation for the creating spatial parcels.

After discussing the benefits and drawback of the various options in the Israeli setting, it was stated that the preferred position of the Ministry of Justice was the fourth option. This was among others based on statements by Justice Barak (and supported by Justice Rivlin) in the context of the Supreme Court case Akonas vs. State of Israel (Civil Appeal 119/01 2003) who urged ‘the legislature to consider the topics of subsoil ownership…’ (Caine 2009). It must be noted that there are always multiple legal option/routes that could work and therefore this is not a black/white decision. If something is not explicitly included in a law, it can often be included in practical procedures, directions, guidelines or regulations of the relevant authorities (e.g. Survey of Israel and Land Registry). Also, the legal aspects are connected to practical organizational aspects: who registers 3D spatial parcels and how is this related to other registrations (also see option 3 above). Most important aspect is that all stakeholders agree and are able to design a practical approach for 3D cadastre.
Another aspect to consider in Israel and related to 3D Cadastre concept is spatial planning (and related law and regulations) as raised by Sandberg (2014), which is also moving towards multi-layered and sub-surface planning. The National Master Plan 40 is being prepared and the 2011 policy paper describes two main goals, which have both a 3D

aspect: the improvement of protection against attacks and better utilization of sub-surface. When this Master Plan is to be realized, it will generate more cases for 3D cadastral parcels in the future.

Legal inspiration, according to the option 4 thinking, can be found is some other countries; for example in Queensland, Australia (Karki, Thompson and McDougall 2013). The Queensland Land Title Act (Queensland Government, 1994) specifies two methods for defining 3D cadastral objects: Building Format Plans (BFPs with '2D' floor plans for the different levels) and Volumetric Format Plans (VFPs with true 3D geometric description). In addition to the Land Title Act there are directions specifying details for the submission of survey plans (or mutation plans according to Israeli terminology): Registrar of Titles Directions for Preparation of Plans, Section 10 for VFPs (DNRM 2013).

Similar to the scoping questions raised by the FIG Working group 3D Cadastres (van Oosterom, Stoter, Ploeger, Thompson and Karki 2011) Israel, as any other country, has to consider where, when, and how to apply 3D Cadastre:

1. What are the types of 3D cadastral objects? Related to (future) constructions (buildings, pipelines, tunnels, etc.) any part of the 3D space, both airspace or subsurface?
2. 3D Parcels also for simple apartments/ condominium buildings with possible related (subsurface) facilities such as storage or parking or use more traditional 2D floor plans for the different levels?
3. 3D Parcels for infrastructure objects, such as long tunnels, pipelines, cables: divided by surface parcels or one object?
4. For representation of 3D parcel, has legal space own geometry or specified by referencing to existing topographic objects

It may be wise to design a more generic solution, from legal, organizational and technical points of view, of which initially only the most urgent cases will be represented in 3D. However, it is to be expected that in less urgent cases the needs or expectations of society in the future may also change and it is wise to anticipate or even stimulate these future uses of 3D registration (e.g. registration of air-space or the registration of apartments in 3D). It is therefore now the right time to reconsider earlier proposals made during the past decade in Israel.

Other relevant issues to consider are of practical nature: how well will a future 3D Cadastre extension fit within the current systems, which are using an Oracle database and Esri ArcGIS. Since a number of years Oracle spatial supports a 3D volumetric geometric primitive (Kazar, Kothuri, van Oosterom and Ravada 2008). Note that Oracle's solid type does not allow inner ring in faces (must be split in multiple faces, which is always feasible). Esri's Geodatabase does not yet have a 3D geometric primitive. However, a multipatch can be used, and there is a function to check is a volume is enclosed (IsClosed3D_3d), but validation rules are not explicitly described. For example, it is unclear if dangling faces (patches) or self intersection is allowed. So, most likely the validation should be done elsewhere (e.g. in Oracle spatial or own code). Currently both Oracle and Esri do not yet support 3D topology structure.

Chapter 3.
Current cadastral procedures, land model and database of the state of Israel

The current cadastral procedures and practice at the Survey of Israel are based on approval of block maps and mutation plans (Forrai, Murkes, Voznesensky and Klebanov, 2004). The Israeli setting is further characterized by the national policy of having a small government and significant role for industry. This results among others in the role of licensed surveyors (commercial sector) preparing the mutation plans according the prescribed rules and also in the IT industry, having an important role in system development. In this Chapter the current structure of the BNKL, the Israeli national cadastral database will be analysed and compared to ISO 19152, LADM (Section 3.1) including some considerations for future Cadastral registration in Israel (Section 3.2).

3.1. Comparison of the Israeli model to the ISO 19152 – LADM

The Israeli national cadastral database, the BNKL, is stored in an Oracle database and managed using an Esri's ArcGIS. The parcels are the smallest area unit in the cadastral database and currently limited to 2D representations. A number of parcels is grouped in a block ('Gush'), traditionally a map sheet and used in the parcel numbering hierarchy. The parcels consist of arcs and nodes in topological relationships, so the parcels do not overlap. As there are no left and right references in the parcel_arc table, the topological structure is not explicitly stored. This results in each parcel having a convenient complete polygonal description, but also some redundancy as normally every boundary is stored twice. Figure 4 illustrate these key classes, tables in the database. The changes (new, deleted, updated parcels) are originating from a mutation plan ('Talar'), which are created and submitted to the Survey of Israel by external, licensed surveyors. The mutation plans are submitted as AutoCAD files (DWG format). In a mutation plan, the parcels can be split, merged or a combination hereof. After a quality control procedure of the Survey of Israel and approval of Land Registry (including assignment of new parcel numbers), the changes are included in the BNKL and also registered of the Land Registry (Ministry of Justice). The parcel and gush tables in the BNKL database contain the current representations, while history is maintained via the archive of mutation plans ('Talar') and historic parcels and blocks ('Gush') are moved to different tables.

The Land Administration Domain Model (ISO-TC211 2012, van Oosterom, Lemmen and Uitermark 2013) provides an international standardization of the key concepts of land administration. LADM covers both the survey, cadastral map and land registry (legal) information; see Figure 5. There are several good reasons to consider adopting LADM when (re)developing a cadastral database, and to name a few: collective experience of experts from many countries, meaningful data exchange (within country/SDI-setting or between countries/states), integrated 2D and 3D representation of spatial units, supports both formal and informal rights (RRRs), and explicitly models the links between the essential land information data (as in cadastral map or land registry) to source documents, both spatial (survey) and legal (title, deed). More motivation to consider LADM implementations was discussed at 5th LADM workshop (Kalantari, Rajabifard, Urban-Karr and Dinsmore 2013, and Thompson 2013). As a first step in the direction of LADM, an initial mapping between the key concepts of BNKL and LADM is given in Table 1.

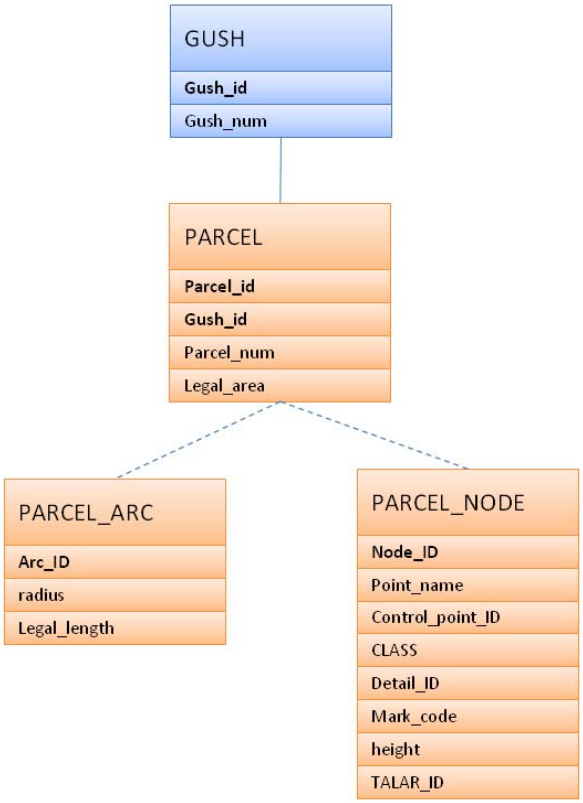

Figure 4. The key classes, tables in the database (Source: slides from Moshe Yaniv as send by Yaron Felus on 26 January 2014)

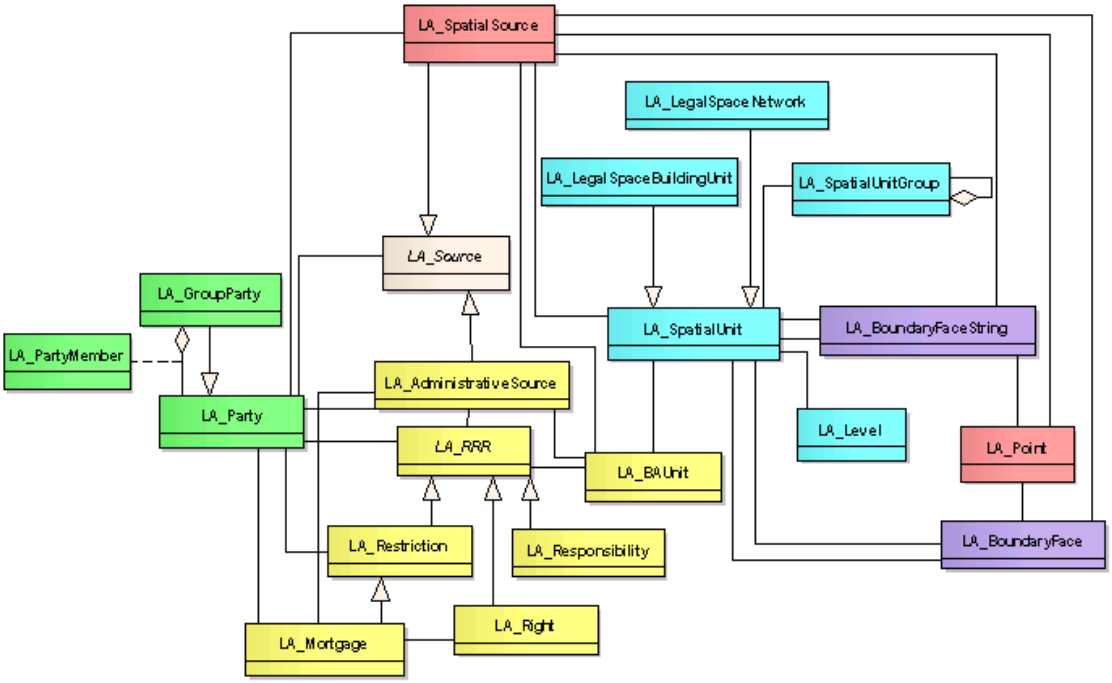

Figure 5. The classes of the LADM (ISO-TC211 2012).

Table 1. An initial mapping between the key concepts of BNKL and LADM.

BNKL	**LADM**	**remark**
Gush	LA_SpatialUnitGroup	
Parcel	LA_SpatialUnit	
Parcel_arc	LA_BoundaryFaceString	
	LA_BoundaryFace	No 3D currently in BNKL
Parcel_node	LA_Point	
Talar	LA_SpatialSource	
	LA_BAUnit	Not explicit in BNKL
	LA_RRR	In scope of Land Registry
	LA_AdministrativeSource	In scope of Land Registry
	LA_Party	In scope of Land Registry

3.2. Towards an initial LADM country profile for Israel

Using the mapping as given in table 1, it is possible to develop an initial LADM country profile for Israel reflecting current registration practice. It would be good to also include the information from the Land Registry into this national model. The fact that different organizations are involved in maintaining their own part of the model is a separate issue. Actually, it is very good to make the relationships explicit and clear as these are crucial in the Information Infrastructure in a country, in which multiple organizations maintain and provide related (source) information. Land administration can be considered a key component of a country's eGovernment (van Oosterom, Groothedde, Lemmen, van der Molen and Uitermark, 2009).

Some other considerations w.r.t. future Cadastral registration in Israel and the content of a future integral LADM country profile:

- full versioning/ history support for all features (inheriting from LADM's VersionedObject),
- storage in a topological structure (and polyline or circular arc boundaries with left and right references to parcels),
- maintain relevant quality and other meta-data, according to ISO TC211 standards as also incorporated in LADM,
- integrated 2D and 3D parcels (or spatial units) according to LADM, which is not too different from the 3D sub-parcel concepts as developed in Israel (but allow a 3D parcel to cross multiple surface parcels),
- explicit linking within the model (and database) between the source documents and information of cadastral map (and land registry),
- explicit linking between parcels (spatial units) and related rights (RRRs) and persons (parties), this to be implemented in Israeli setting via the SDI in order to enhance consistency (this type of integrated information service is also what society will expect in the near future from government in this domain), and
- adding the concept of BAUnit (or basic property unit), which consists of multiple spatial units (parcels) with same right and parties attached.

Chapter 4.
Conclusion

After recapturing the past activities in Israel towards support 3D representations in the cadastral database, analysing international developments towards operational 3D Cadastre developments, focussing on specific Israeli 3D issues, studying the current Israeli cadastral procedures (land model and database), and putting this in the perspective of the international standard of the LADM, it is now recommended to implement an operational 3D cadastral database. It is wise to first create an operational level/ fitting prototype. For short term implementation, it is best to apply state of the art technology; e.g. Oracle spatial today supports to 3D volumetric geometry (solid or polyhedron) and web-based technology for dissemination of 3D data (Sivan 2013). For more advanced functionality, start/continue/participate in research; e.g. 3D topology structure and perhaps even 4D representations (deep integration of 3D space and time) as proposed 5D Greece-Israel innovation project proposal.

While introducing 3D (without interfering with exiting 2D representations), also aim for LADM (ISO 19152) compliance by developing a country profile covering the whole domain (including land registry). The actual implementation within the Survey of Israel (of the spatial part of LADM) should be considered when significant system maintenance/ upgrade is planned. Several new aspects as modelled in LADM such as full versioning/ temporal, including digital source documents, integrated 2D/3D can then be added. It is wise to model more 3D cadastral registration options (real world cases potentially benefiting from 3D) than initially implemented. This gives indication of future growth path (and speed of using the additional 3D options/ extensions depends on needs of society and vision of SoI). During the development (of model and system) is it important to limit the scope to (2D and 3D) cadastral objects, but relate to other relevant geographic objects (topography, pipelines&cables, buildings, addresses, etc) via SDI. These other objects will very often be the reason for registering the 3D cadastral object so it is crucial that these two (physical and legal object) are well aligned.

Besides developing a new model, supporting 3D parcels and developing the technology, it is important to realize that there are also very important legal and organizational aspects to be considered. Main organizational partners are on one side the land registry (especially when also considering to register apartments, condominiums in 3D) and on the other side the: licensed surveyors (creating the new 2D and 3D representations). As the existence and identity of cadastral parcel depends on/ is defined by the RRRs as maintained by the Land Registry, this is a key connection. In relation with the licensed surveyors clear guidelines for submission of 3D mutation (survey) plans must be made. This will then enable more automated validation to check validity (e.g. non-overlapping issues).

3D cadastral registration is part of whole 3D spatial development life cycle in 3D consisting of many steps of which the order may differs per country (van Oosterom 2013): develop and register zoning plans in 3D, register (public law) restrictions in 3D, design new spatial units/objects in 3D, acquire appropriate land/space in 3D, request and provide (after check) permits in 3D, obtain and register financing (mortgage) for future objects in 3D, survey and measure spatial units/objects (after construction) in 3D, submit associated rights (RRRs)/parties and their spatial units in 3D, validate and check

submitted data (and register if accepted) in 3D, store and analyze the spatial units in 3D, and disseminate, visualize and use the spatial units in 3D. While considering the whole life cycle of spatial development, it is good to focus on own aspect: 3D parcels in Cadastre registration (Survey of Israel is key player).

Israel was among the first countries in the world, it is advised to present the renewed ambition again at premium international platform: the FIG 3D Cadastres workshop, 9-11 November 2014. The Survey of Israel may then receive feedback from other countries on the planned developments and at the same time learn more about the latest 3D Cadastre developments in other countries.

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Haim Sandberg (2003). Three-Dimensional Partition and Registration of Subsurface Space. In: Israel Law Review, Volume 37, 1, 2003, pp. 119-167.

Haim Sandberg (2014). Developments in 3D horizontal land sub-division in Israel: Legal and urban planning aspects. In abstract book Planning, Law and Property Rights (PLPR) 2014 Conference, Technion, Haifa, Israel, 10-14 February 2014, page 75.

Uri Shoshani, Moshe Benhamu, Eri Goshen, Shaul Denekamp and Roy Bar (2004). Registration of Cadastral Spatial Rights in Israel – A Research and Development Project. In proceedings FIG Working Week 2004, Athens, Greece, May 22-27, 2004.

Uri Shoshani, Moshe Benhamu, Eri Goshen, Shaul Denekamp and Roy Bar (2005). A Multi Layers 3D Cadastre in Israel: A Research and Development Project Recommendation. In proceedings FIG Working Week 2005 and GSDI-8.

Shlomi Sivan (2013). 3D-GIS in the Cloud. The future of GIS. In proceedings FIG Working Week 2013, Abuja, Nigeria.

Kean Huat Soon (2012). A Conceptual Framework of Representing Semantics for 3D Cadastre in Singapore. In proceedings 3rd International Workshop on 3D Cadastres, 2012, Shenzhen, pp. 361-379.

Jantien Stoter, Hendrik Ploeger and Peter van Oosterom (2013). 3D cadastre in the Netherlands: Developments and international applicability. In: 3D Cadastres II, special issue of Computers, Environment and Urban Systems, Volume 40, July 2013, pp. 56-67

Nur Amalina Zulkifli, Alias Abdul Rahman and Peter van Oosterom (2013). Developing 2D and 3D Cadastral Registration System based on LADM: illustrated with Malaysian Cases. In proceedings 5th Land Administration Domain Model Workshop, September 2013, Kuala Lumpur, pp. 447-464.

Annex A.
Slides ‘3D Cadastres’

presentation at the Survey of Israel, Tel Aviv, 9 February 2014

Survey of Israel
המרכז למיפוי ישראל

3D Cadastres

9-2-2014

Peter van Oosterom, based on joint work with:
Chrit Lemmen, Jantien Stoter, Henrdrik Ploeger

Meeting on 3D Cadastre at the Survey of Israel
Tel Aviv, 9 February 2014

Content overview

→ TU Delft background

- Introduction
- FIG working group, international overview
- 3D in ISO 19152
- Deep integration 3D and time
- Netherlands developments
- Some other countries

Delft University of Technology
Key Figures 2011

Number of students		Staff		Output	
Total student body	19.500	Total staff	5.655	PhD theses	319
of which bachelors	10.900	Academic staff	3.375	Scientific publications	5.840
of which masters	6.300	of which Professors	437	Master's degrees awarded in 2011	1.989
of which PhD students	2.300	Support staff	2.280	Bachelor's degrees awarded in 2009	1.902

Some history

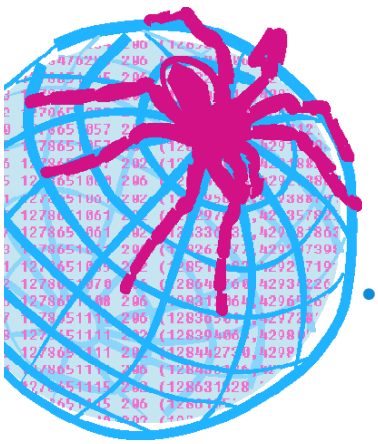
- 1842: Founded by King Willem II as 'Royal Academy'
- 1864: 'Polytechnic school' status, with Lewis Cohen Stuart first professor-director (chair Mathematics-Geodesy)
- 1926: Wim Schermerhorn, professor Surveying, Leveling & Geodesy first prime minister after World War II, and established ITC (International Training Centre for Aerial Survey) in Delft
- 1937: Felix Vening Meinesz part-time lector Gravity Measurements (1939 he became extraordinary professor Geodesy)

- 1948: Start Geodesy education (before Surveying part of Civil Eng)
- 2002: Converted to MSc (no own BSc)
- 2005: MSc Geodetic Engineering renamed to MSc Geomatics
- 2012: New - MSc Geomatics (for the Built Environment)
  - Track Geoscience and Remote Sensing in CE/AES

International Rankings: Times Higher Education (THE)

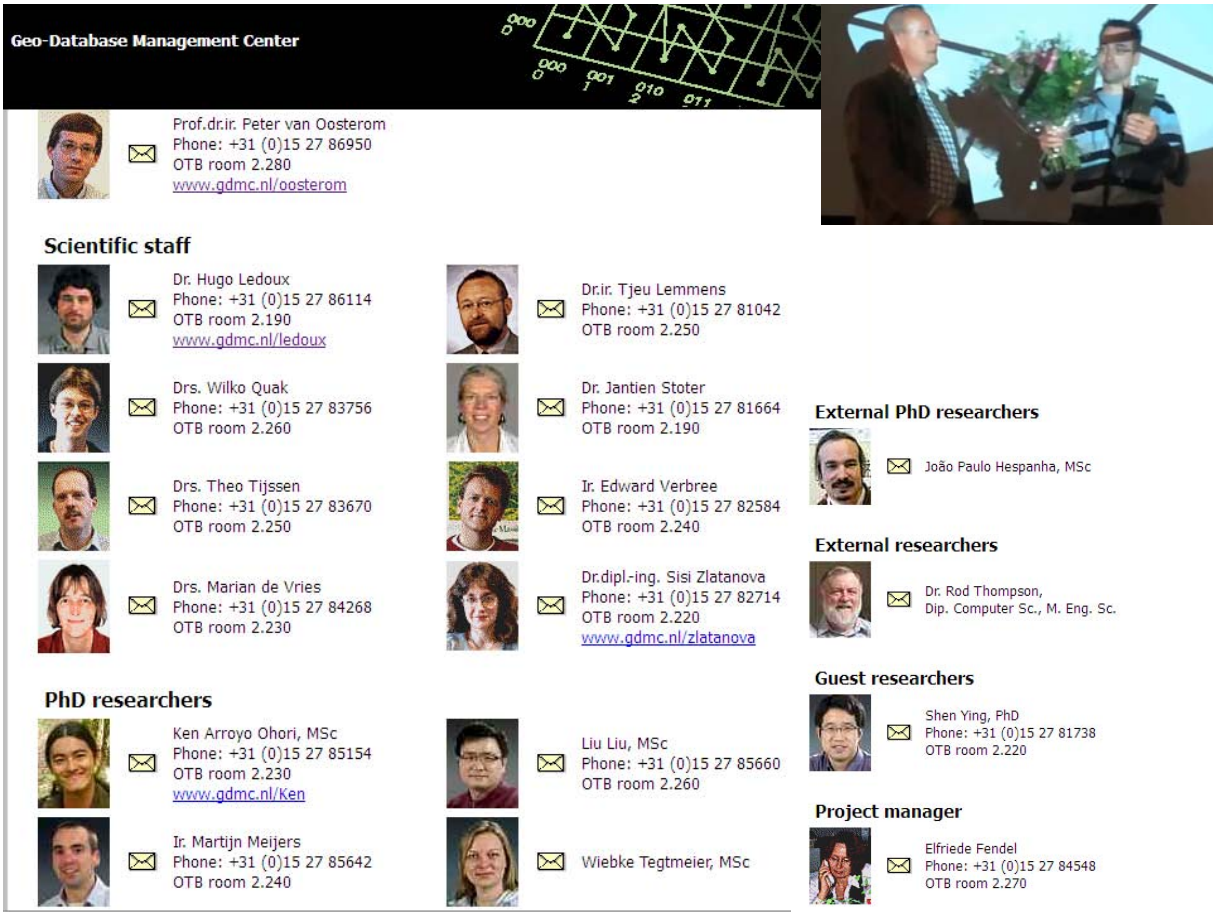
- THE Rankings 2013, overall:
  TU Delft #69 (Technion #201)
- THE Rankings 2013, Engineering and Technology:
  TU Delft #23 (Technion #69)
- World Reputation Rankings 2013:
  TU Delft #51 (Technion not in top 100)
  First in Netherlands, third in continental Europe
- Source: http://www.timeshighereducation.co.uk

Scientific/technological focus of the GIS technology research



- Central research topic geo-DBMS/ 5D super model as 'glue' between:
  - 3D spatio-temporal modeling
  - Computational geometry (generalization)
  - Distributed GI processing
  - Mobile GIS (LBS)
  - Knowledge engineering
- Geo-ICT 'tool research' confronted with 2 application themes:
  - Crisis Management (leader Sisi Zlatanova)
  - Spatial Information Infrastructure (leader Jantien Stoter)

Ambition: top 1(3) geo-DBMS University in the world

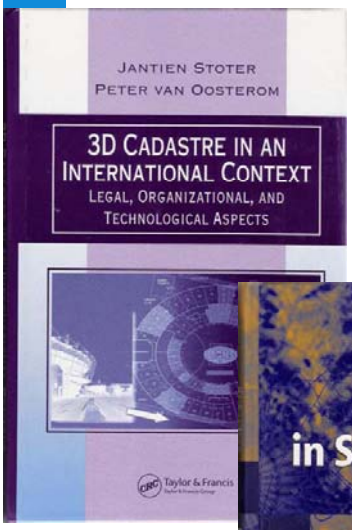


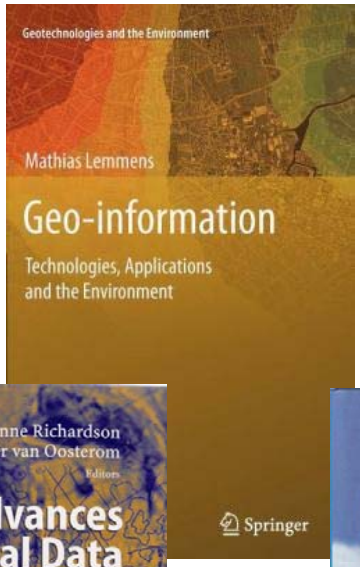
International activities, besides projects

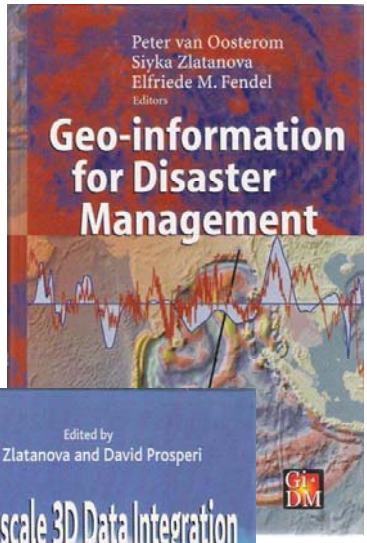
- INSPIRE: member of drafting team data specification (DT DS) and thematic working group Cadastral Parcels TWG CP→ implementing rules finished (others nearly finished; e.g. land-use)
- INSPIRE concerns 34 types of data sets, 27 countries with 22 languages (and more influence; e.g. Iceland, Norway and Switzerland are also involved)

- ISO TC211: founder/editor of ISO 19152 Land Administration Domain Model (LADM) with Chrit Lemmen/Harry Uitermark
- Chair of the 2010-2014 Joint working group (WG) of FIG commissions 3 and 7 on 3D Cadastres
- International Society for Photogrammetry and Remote Sensing (ISPRS), Chair of WG IV/7, 3D Indoor Modelling and Navigation
- Open Geospatial Consortium (OGC), Chair of IndoorGML
- Global Spatial Data Infrastructure Association (GSDI), Chair of WG Legal and Socio-economic Issues
- Chair of EuroSDR commission Data Specifications

Books…

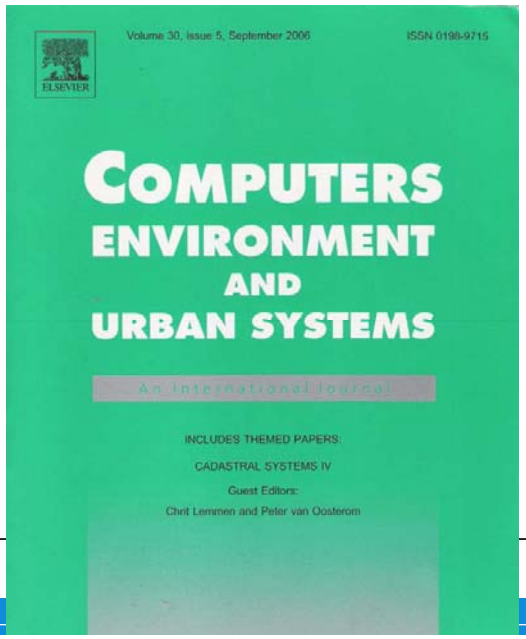






TUDelft

Journals (various editor roles)



Geo-information Education TU Delft

- Bachelor Education
  1. National geo-information minor (half year part of Bachelor)
- Master Education
  1. MSc Geomatics (for the Built Environment)
  2. MSc GIMA (Geo-Information Management and Applications) by four NL Univ's: Delft, Wageningen, Utrecht, Twente (ITC)
  3. Track Geoscience and Remote Sensing in Civil Engineering (and also in Applied Earth Sciences)
- PhD Education (all GI research directions, among which)
  1. Geo-information technology
  2. Geo-information governance

2012: MSc Geomatics (for the Built Environment)

Core programme:

GM.1 Sensing Technology for the Built Environment
GM.2 Geographical Information Systems and Cartography
GM.3 Positioning and Location Awareness
GM.4 3D Modelling of the Built Environment
GM.5 Spatial Decision Support for Planning and Crisis Management
GM.6 Geo DataBase Management Systems
GM.7 Geo Web, Sensor Networks and 3D-GeoVisualisation Technology
GM.8 Geo Datasets and Quality
GM.9 Geo-information Organisation and Legislation

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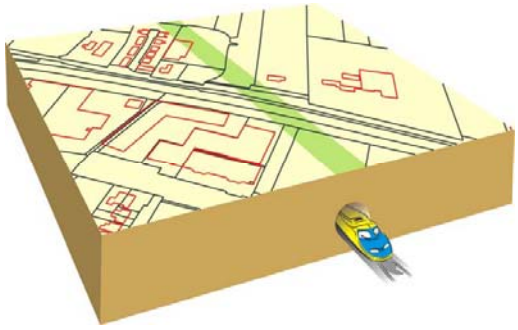
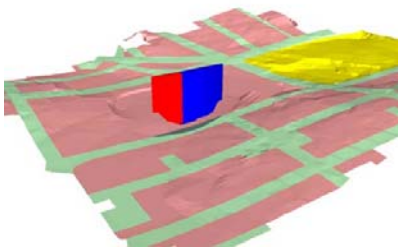
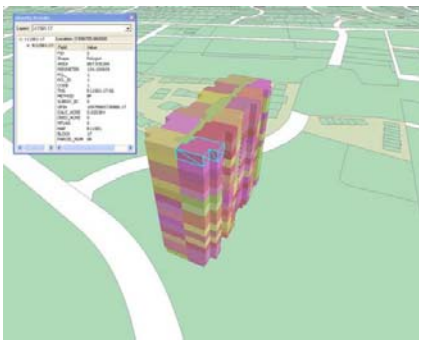
Introduction







2D registration for a 3D world?

Today's practice:
Queensland Australia

Airspace sold

STATE cabinet has approved the sale of airspace over the South Bank rail corridor, which will allow planned offices to extend over the rail lines.

Premier Peter Beattie and Transport Minister Steve Bredhauer said the sale fuelled a new era in Brisbane city development.

"Mirvac and South Bank Corporation approached the Government proposing to buy this airspace because Mirvac wants extra floor space for offices it plans to build on an adjacent lot," Mr Beattie said.

TU Delft

Happening in Singapore…

Upward looking Singapore looks below for room to grow

NOVEL SOLUTION: It may build interconnected cities with shopping malls and transport hubs, writes *Calvin Yang*

Singapore ***has been building upward, with apartment structures reaching as high as 70 stories****, but the demand for land is* ***pushing it to build underground****.*

SINGAPORE, with a little less land mass than New York City, is running out of room for its 5.4 million people.

The city-state has built upward — with apartment buildings reaching as high as 70 stories — reclaimed underused properties for housing and pushed out coastlines for more usable land.

But as one of the world's most crowded cities, and with projections for 1.5 million more people in the next 15 years, Singapore's options are as limited as its space.

So Singapore is considering a novel solution: building underground to create an extensive, interconnected city, with shopping malls, transport hubs, public spaces, pedestrian links and even cycling lanes.

"Singapore is small, and whether we have 6.9 million or not, there is always a need to find new land space," said Zhao Zhiye, the interim director of the Nanyang Center for Underground Space at Nanyang Technological University. "The utilisation of underground space is one option for Singapore."

Height restrictions imposed on areas around air bases and airports have prevented developers from building taller projects. And there is a limit to how much land can be reclaimed from the ocean — so far it accounts for a fifth of Singapore's space, but it is vulnerable to rising sea levels caused by climate change.

The squeeze has led to the closing of several old estates and military camps to make way for residential and industrial development.

Building underground is not new in Singapore. About 12km of expressways and about 80km of transit lines are below ground. Underground drainage systems and utility tunnels are common features beneath the urban landscape.

Now Singapore is going further, beginning work on a huge underground oil bunker called Jurong Rock Caverns. When this is completed, it will free up about 60ha of land, an area equivalent to six petrochemical plants.

Another project on the drawing board is the Underground Science City, with 40 interconnected caverns for data centres and research and development labs that would support the biomedical and life sciences industries. The science centre, with an estimated 20ha to be situated 30 stories below a science park in western Singapore, would house as many as 4,200 scientists and researchers.

"A lot of facilities can go underground if you fully utilise the underground space," Zhao said.

"In the beginning there might be a psychological issue, but as long as we have proper lighting and proper ventilation, gradually people can overcome the idea of working and living underground."

Subterranean projects can be three to four times as costly as surface projects because of higher construction costs and the need for extensive soil investigations.

In a recent blog post, Khaw Boon Wan, Singapore's national development minister, pointed to extensive pedestrian passageways and shopping malls in Japan and Canada.

He cited the possibilities in Singapore "of creating underground transport hubs, pedestrian links, cycling lanes, utility plants, storage and research facilities, industrial uses, shopping areas and other public spaces here".

"The earlier we begin this process, the faster we will learn and the easier it would be for us to realise these plans." NYT

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International Federation of Surveyors

- Initial FIG working group 3D Cadastres 2002-2006 (International Federation of Surveyors, founded 1878 NGO)
- 3D Cadastres sessions at every FIG WW or congress since

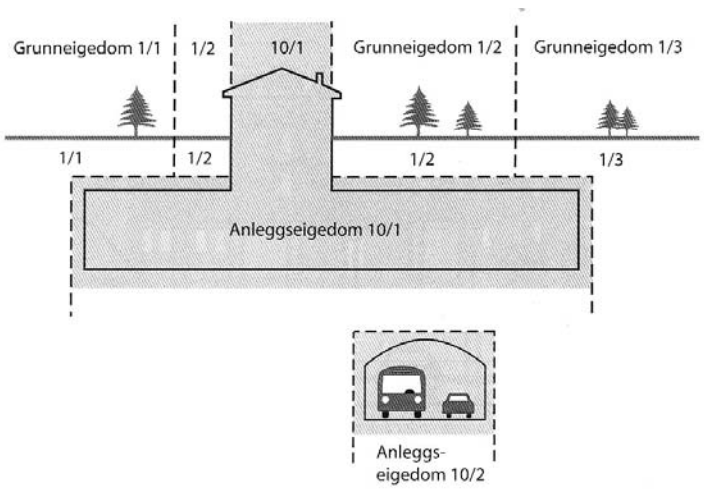
- Working group 3D Cadastres 2010-2014, scoping questions:
  1. What are the types of 3D cadastral objects? Related to (future) constructions (buildings, pipelines, tunnels, etc.) any part of the 3D space, both airspace or subsurface?
  2. 3D Parcels for infrastructure objects, such as long tunnels, pipelines, cables: divided by surface parcels or one object?
  3. For representation of 3D parcel, has legal space own geometry or specified by referencing to existing topographic objects

FIG Working group objectives

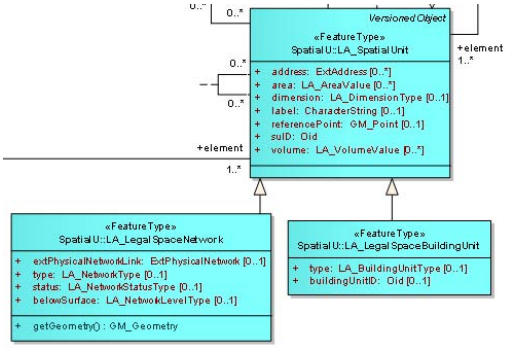
- Common understanding of terms and issues involved; ISO 19152 Land Administration Domain Model: LADM with 3D

- Guidelines/checklist for implementation of 3D-Cadastres: 'best practices' legal, institutional and technical aspects

Note: 3D Parcels in broadest sense: land & water spaces, both above & below surface.



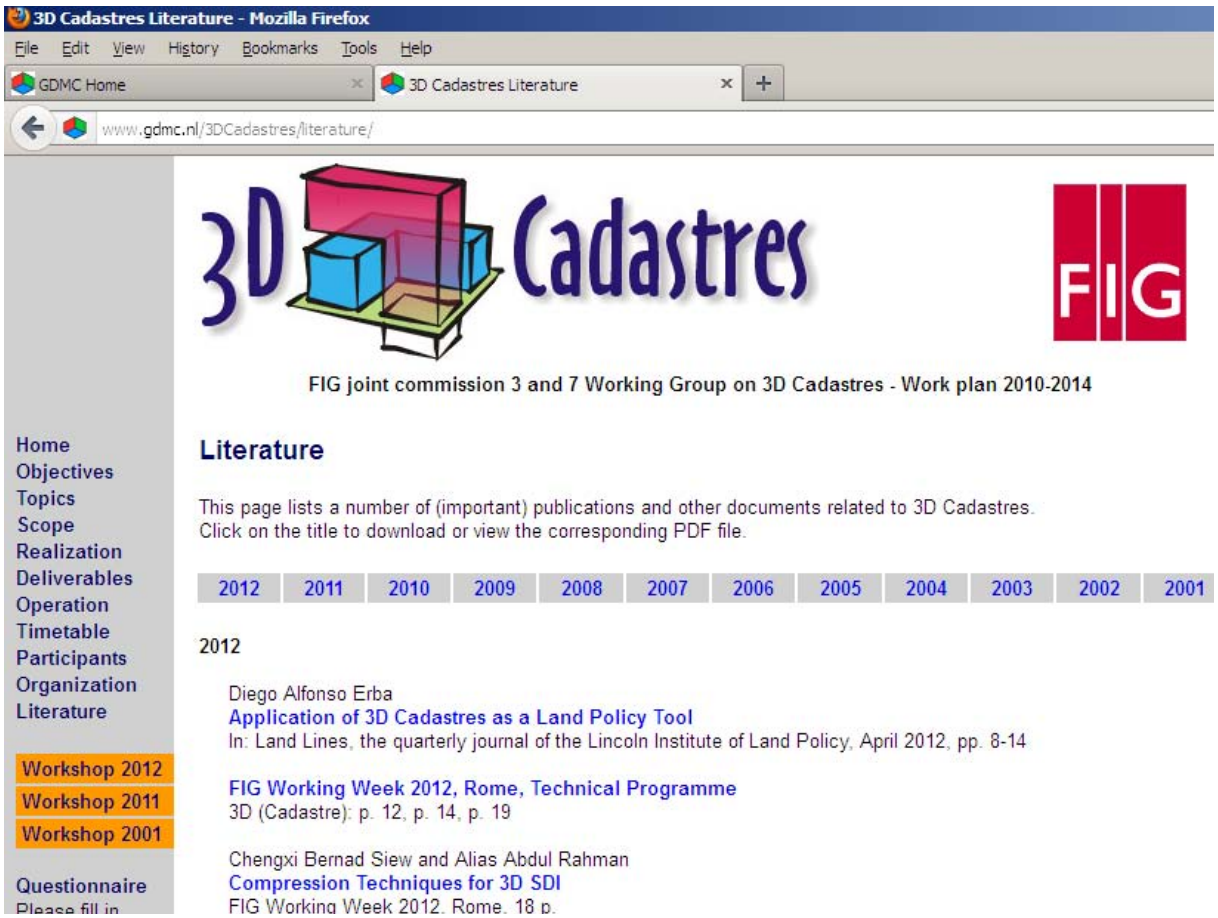
Topics

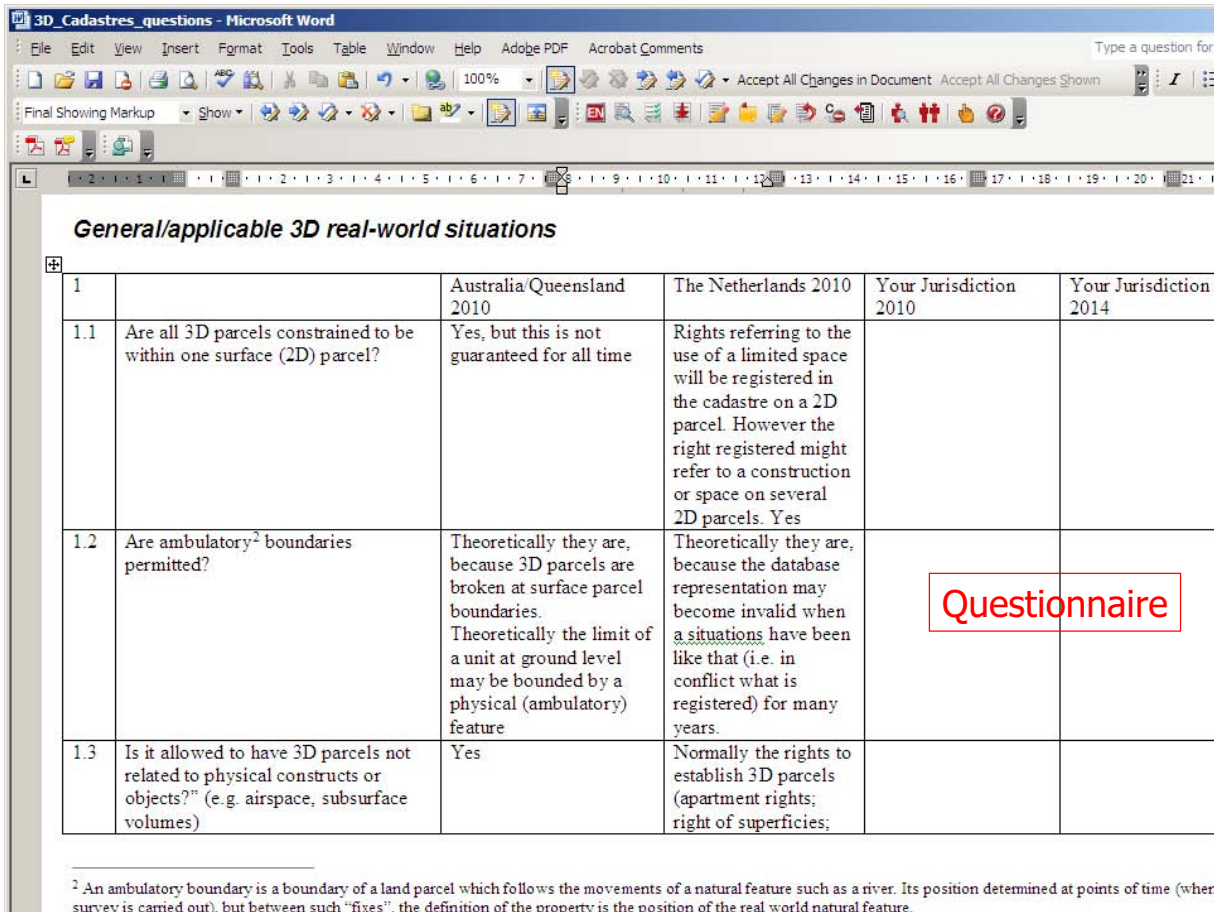


- 3D-Cadastres and models: role of earth surface, 3D parcels open at top and bottom, topology structure, relative height,…
- 3D-Cadastres and SII: legal objects (cadastral parcels and associated rights) and their physical counterparts (buildings or tunnels) result into two different, but related registrations
- 3D-Cadastres and time: partition of legal space into 4D parcels: no overlaps or gaps in space of time
- 3D-Cadastres and usability: graphic user interface (GUI) for interacting with 3D cadastral data; e.g. Google Earth

Deliverables

- 2010: creation of web-site and interest-group www.gdmc.nl/3DCadastres (inc. literature)
- 2010: initial questionnaire status 3D Cadastres
- 2011: 2nd workshop on 3D-Cadastres (16-18 nov, Delft)
- 2011-13: 3D Cadastres session at FIG working weeks
- 2012: 3rd workshop on 3D-Cadastres (25-26 oct, Shenzhen)
- 2014 : final questionnaire status 3D Cadastres
- 2014: presentation of the results FIG-congress


3D Cadastres Literature - Mozilla Firefox
File Edit View History Bookmarks Tools Help
GDMC Home
3D Cadastres Literature
www.gdmc.nl/3DCadastres/literature/
3D Cadastres
FIG
FIG joint commission 3 and 7 Working Group on 3D Cadastres - Work plan 2010-2014
Home
Objectives
Topics
Scope
Realization
Deliverables
Operation
Timetable
Participants
Organization
Literature
Workshop 2012
Workshop 2011
Workshop 2001
Questionnaire
Literature
This page lists a number of (important) publications and other documents related to 3D Cadastres.
Click on the title to download or view the corresponding PDF file.
2012 2011 2010 2009 2008 2007 2006 2005 2004 2003 2002 2001
2012
Diego Alfonso Erba
Application of 3D Cadastres as a Land Policy Tool
In: Land Lines, the quarterly journal of the Lincoln Institute of Land Policy, April 2012, pp. 8-14
FIG Working Week 2012, Rome, Technical Programme
3D (Cadastre): p. 12, p. 14, p. 19
Chengxi Bernad Siew and Alias Abdul Rahman
Compression Techniques for 3D SDI
FIG Working Week 2012, Rome, 18 p.

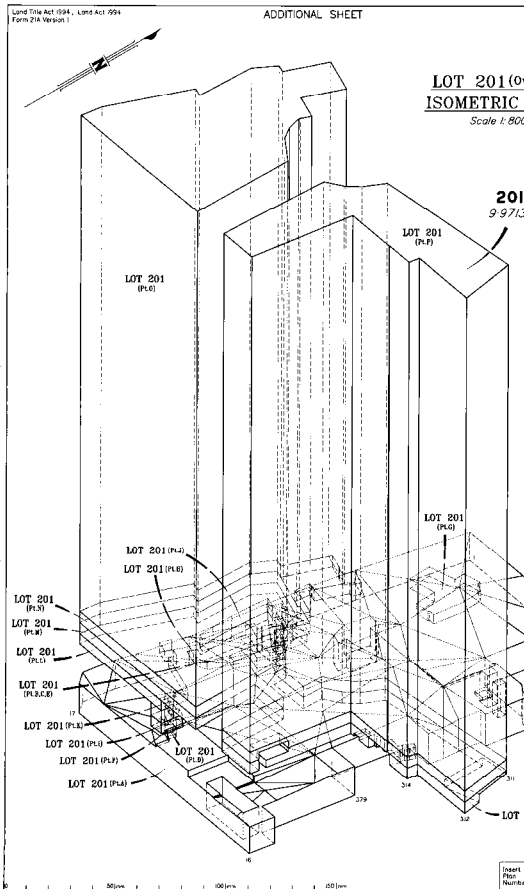

3D_Cadastres_questions - Microsoft Word
File Edit View Insert Format Tools Table Window Help Adobe PDF Acrobat Comments
Type a question for
Accept All Changes in Document Accept All Changes Shown
Final Showing Markup Show
General/applicable 3D real-world situations
1 | Australia/Queensland 2010 | The Netherlands 2010 | Your Jurisdiction 2010 | Your Jurisdiction 2014
1.1 | Are all 3D parcels constrained to be within one surface (2D) parcel? | Yes, but this is not guaranteed for all time | Rights referring to the use of a limited space will be registered in the cadastre on a 2D parcel. However the right registered might refer to a construction or space on several 2D parcels. Yes
1.2 | Are ambulatory[2] boundaries permitted? | Theoretically they are, because 3D parcels are broken at surface parcel boundaries. Theoretically the limit of a unit at ground level may be bounded by a physical (ambulatory) feature | Theoretically they are, because the database representation may become invalid when a situations have been like that (i.e. in conflict what is registered) for many years.
1.3 | Is it allowed to have 3D parcels not related to physical constructs or objects?" (e.g. airspace, subsurface volumes) | Yes | Normally the rights to establish 3D parcels (apartment rights; right of superficies;
Questionnaire
[2] An ambulatory boundary is a boundary of a land parcel which follows the movements of a natural feature such as a river. Its position determined at points of time (wher
survey is carried out), but between such "fixes", the definition of the property is the position of the real world natural feature.

Design of questionnaire

- Difficult to design clear questionnaire for abstract topic 3D Cadastres (quite abstract, everybody has own interpretation)
- Questionnaire starts with introduction notes, including formal and informal definition of 3D parcel: 'spatial unit against which (one or more) unique and homogeneous rights (e.g. ownership right or land use right), responsibilities or restrictions are associated'
- Important distinction between 3D physical and 3D legal object
- Questions grouped into 9 thematic blocks (next slide)
- Two blank columns: status 2010 and expectation 2014
- Two example set of answers (Queensland/Australia, Netherlands)
- Questionnaire distributed among members of FIG working group 3D Cadastres (via commissions 3 and 7) and still open

Thematic blocks of questions

1. General/applicable 3D real-world
2. Infrastructure/utility networks
3. Construction/building units
4. X/Y Coordinates
5. Z Coordinates/height repr.
6. Temporal Issues
7. Rights, Restrictions & Responsib.
8. DCDB (Cadastral Database)
9. Plans of Survey, incl. field sketch



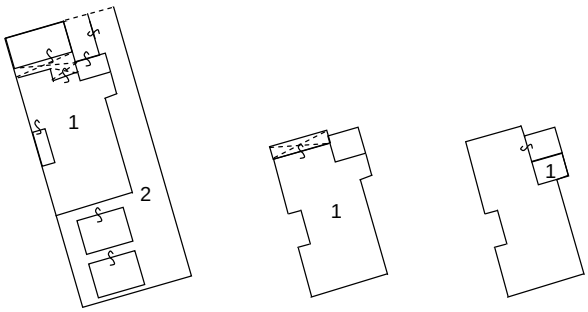
Analysis of responses

- 37 FIG completed questionnaires received (Argentina, Australia, Austria, Bahrain, Brazil, Canada, China, Croatia, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, India, Indonesia, Israel, Italy, Kazakhstan, Kenya, Macedonia, Malaysia, The Netherlands, Nepal, Nigeria, Norway, Poland, Russia, South Korea, Spain, Sweden, Switzerland, Trinidad and Tobago, Turkey, and United Kingdom) → on website www.3dcadastres.nl

- Nearly all jurisdictions (except Poland & Nepal) allow registration of 3D parcels, in practise often (limited to) apartments
- Despite efforts concept '3D cadastre/parcel' still ambiguous
- Hardly any responses for 2014, some exceptions: Switzerland, Denmark, Israel, Bahrain, Russian Federation,…
- Completed questionnaires give overview of the different systems: organizational, legal, technical

Registration of 3D parcel in cadastral database

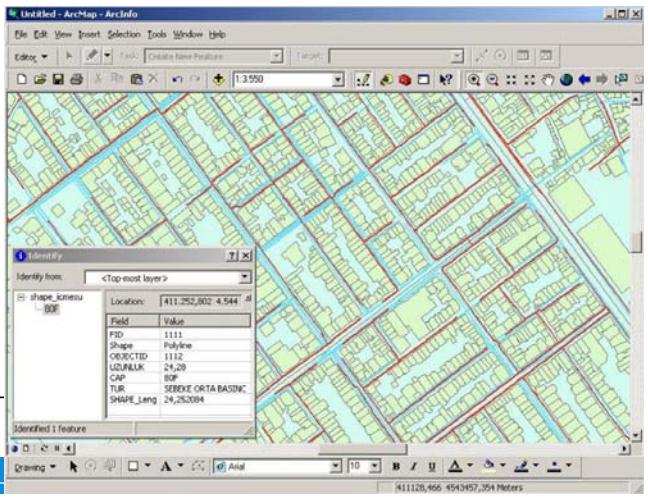
- Did not exist in any country in 2010…
- 'Floor plans' boundaries per floor and are in public register
- Reference to 3D parcel from 2D map Australia, Cyprus, Croatia, Norway and Sweden
- Italy has separate 'Cadastre of Buildings' with 3D
- Spain converts floor plans to 3D parcels (with 3m height)



Cable and pipeline networks

- Specific type of 3D object: below/above over several land parcels
- Netherlands, Switzerland, Kazakhstan, Russia (limited practise) and Canada allow registration of right spaces related to networks
- Others are developing this: Denmark, Hungary, Israel and Italy
- Some countries have separate 'utility' maps/ registrations (Victoria/Aus, Croatia)

- Last group: no registration or very limited registration; e.g. in Turkey only high voltage power lines (but other networks at level of municipality; e.g. Istanbul →



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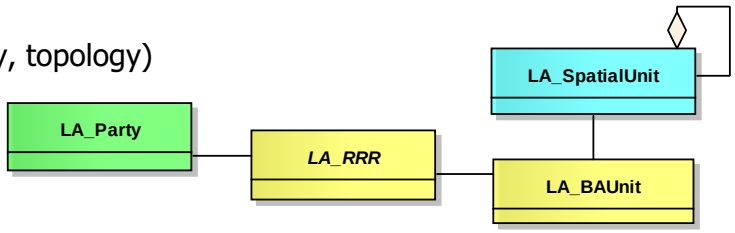
Land Administration Domain Model ISO 19152 (LADM)

- Model includes:
  - Spatial part (geometry, topology)
  - Extensible frame for legal/admin parts

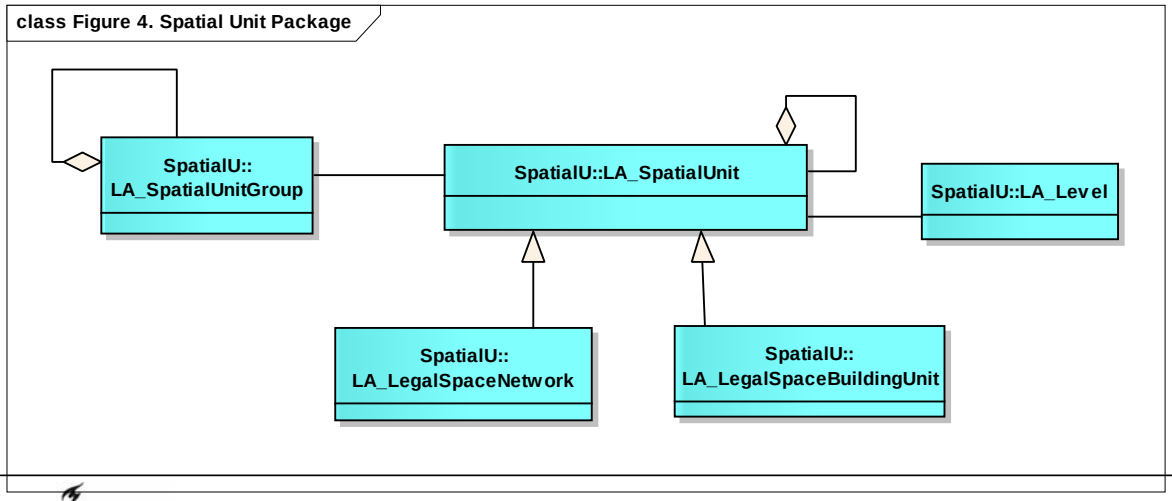


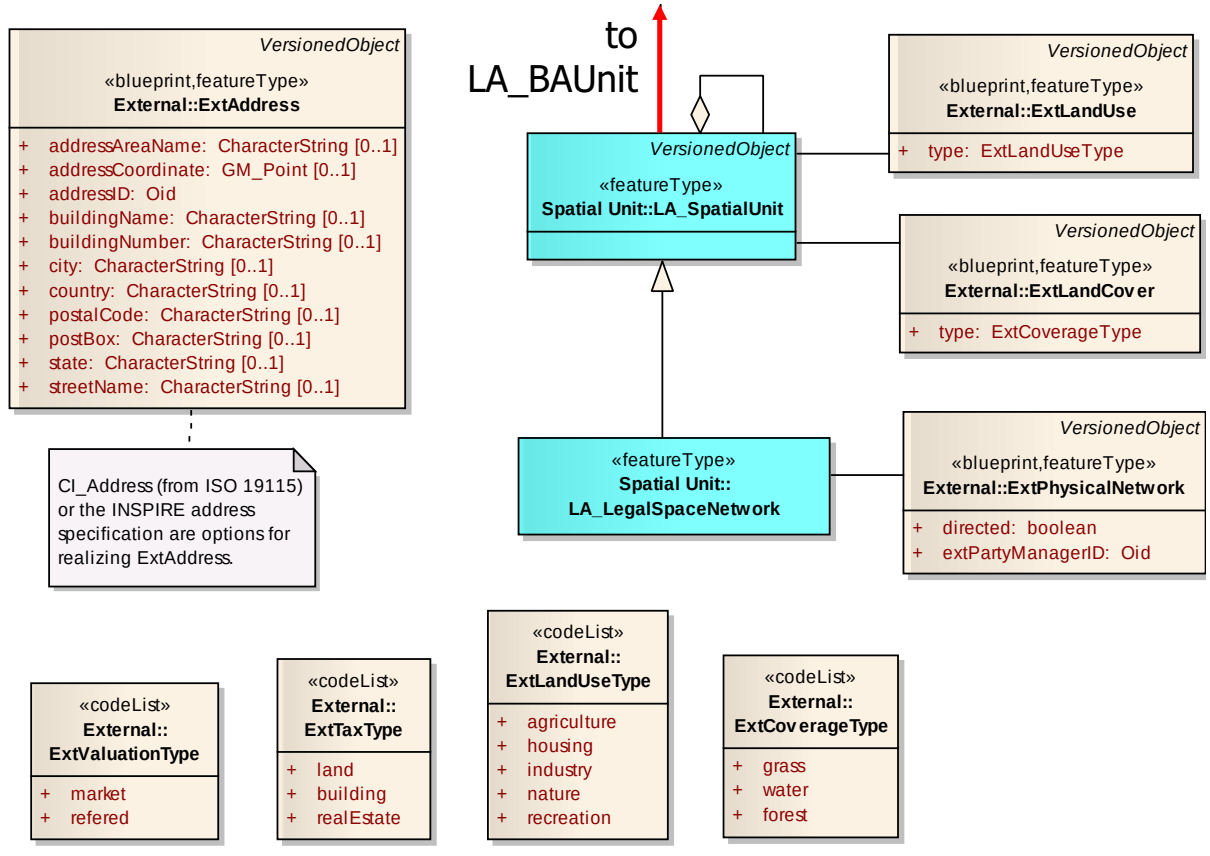
- Stared within the FIG in 2002
- FIG proposed LADM to ISO/TC211, January 2008 (parallel voting in ISO TC211 and CEN TC287)
- Includes integrated 2D and 3D support

ISO/TC 211
Geographic information/Geomatics

LA_SpatialUnit (alias LA_Parcel)

- LA_SpatialUnit specializations: network, building unit
- organized in LA_Level based on structure or content
- 5 types: point, text (unstructured) line, polygon, and topology
- 2D and 3D integrated without complicating 2D



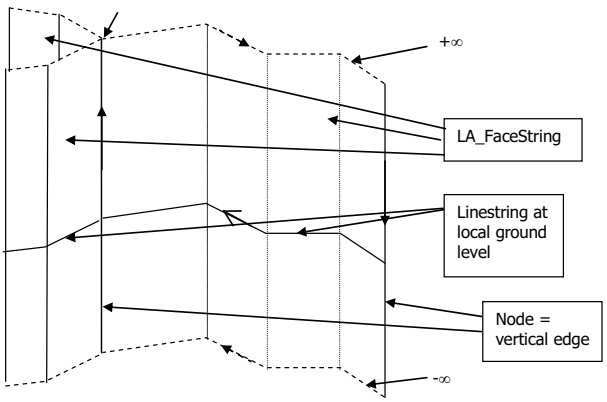


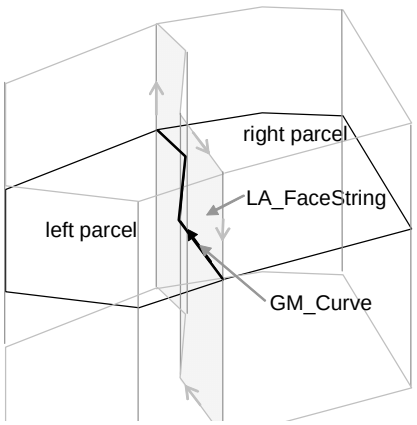
Spatial Units in 3D

- Extend the equivalent concept from 2D to 3D
  → 3D parcels are in areas of highest land values
- Sharing of surfaces between 3D parcels
  where lines would be shared in 2D
- point-line-area becomes point-line-area-volume
- Challenges:
  1. Majority of parcels is in 2D and should not be lost
     → integrate 2D/3D
  2. 3D parcels can be unbounded (up/down) according to National law
     → does not fit in ISO 19107 (spatial schema), so alternative needed

2D parcels and their 3D interpretation

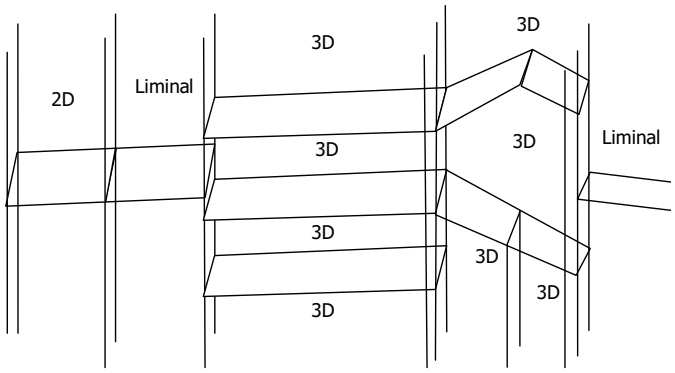
- Observation: 2D description implies 3D prismatic volume
- 2D polyline (GM_curve) implies string of vertical faces



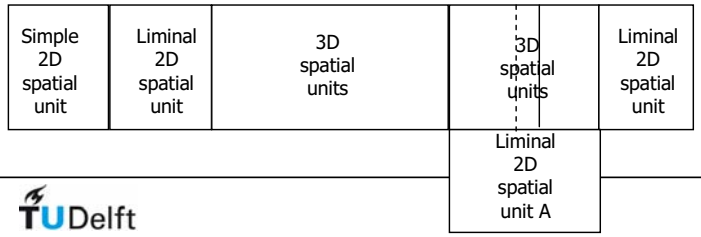


2D and 3D Integration

- between 2D and 3D spatial unit transition via liminal spatial units

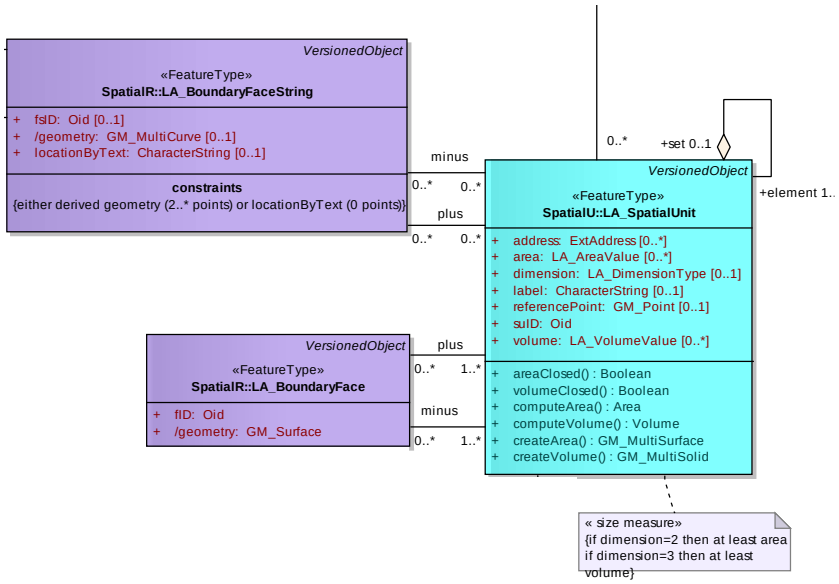


- Liminal spatial units are 2D parcels, but are stored as 3D parcels
- Liminal spatial units are delimited by a combination of LA_BoundaryFace and LA_BoundaryFaceString objects



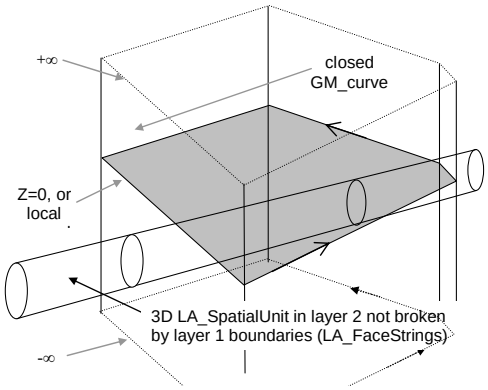
2D and 3D integration

- 2D polyline (GM_curve) implies string of vertical faces: LA_BoundaryFaceString
- true 3D described with arbitrary oriented faces: LA_BoundaryFace



The 3D use of LA_Level

- organization based on content or structure:
  - example 1, content-based: one layer with 'primary' (strongest) rights, another layer with rights that can be added/subtracted (e.g. restrictions)
  - example 2, structure-based: one layer with topologically structured parcels (one part of the country), another layer with (unstructured) line based parcels (other part of country)
- can also be used in 3D context: one layer 'normal' parcels, another layer with subtracted 3D parcels
- based on independence principle
- each country design own levels



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4. Deep integration 3D and time
5. Netherlands developments
6. Some other countries

Deep integrating 3D space and time: 4D Cadastre Example

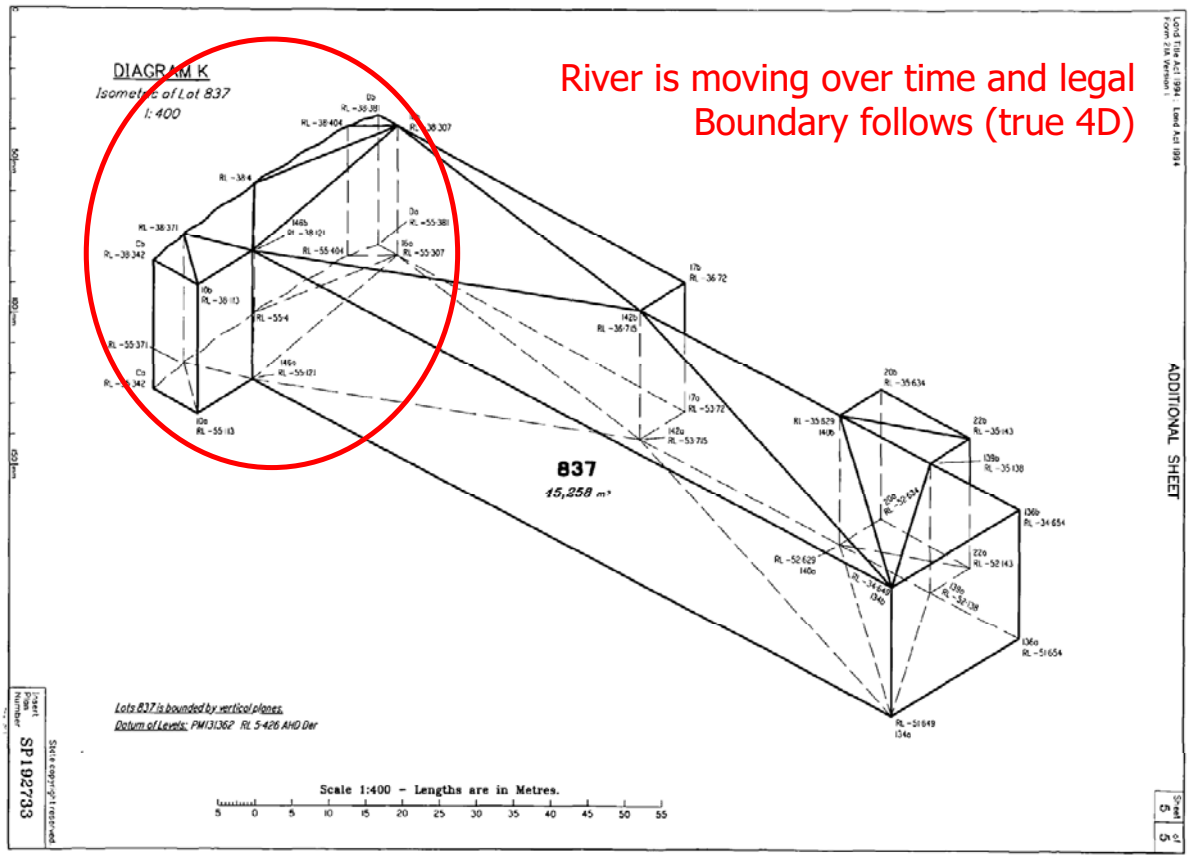
Partition: no gaps or overlaps in the parcelation on which the rights (e.g. ownership) are based

2D: a planar partition of the surface

3D: a partition of space with no overlaps or gaps

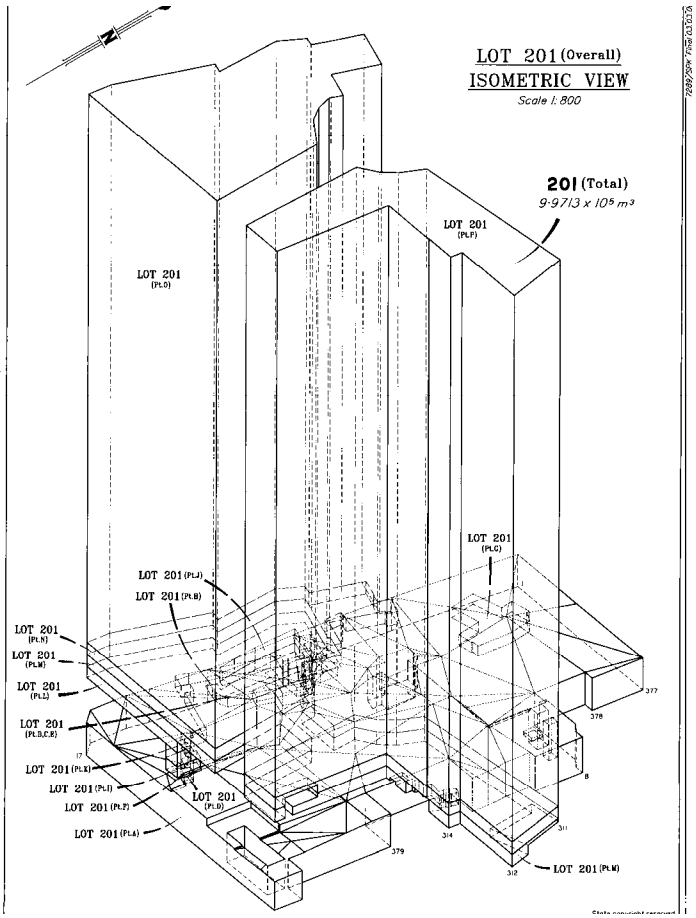
4D: no overlaps or gaps in the rights, not only in space but also in parallel the time dimension

3D Tunnel registration in Queensland



More cases: Timesharing

- 3D volumetric survey plan (apartments)
- Timesharing of 40 units/week: 40*52 shares
- Timeshare can be traded, mortgaged, etc.
- 3D+time=4D

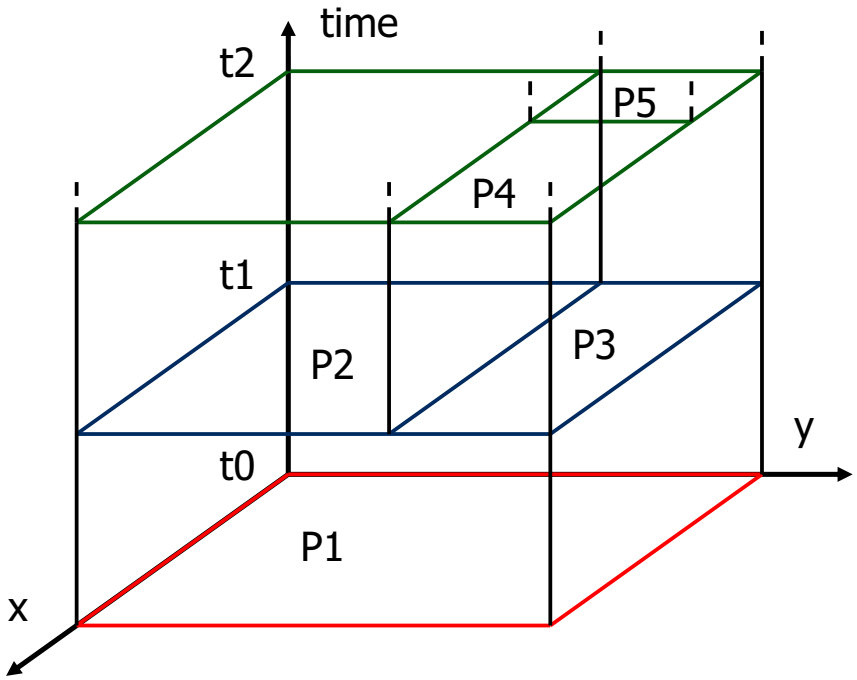


TUDelft

4D cadastre: separate space and time or an integrated attribute?

- Advantages of separate attributes:
  1. Already able to represent all cases
  2. Supported by state-of-the art technology
  3. Temporal aspect is more than just one dimension
- Advantages of integrated 4D data type:
  1. optimal efficient 4D searching
  2. Parent-child becomes topology neighbor query in time

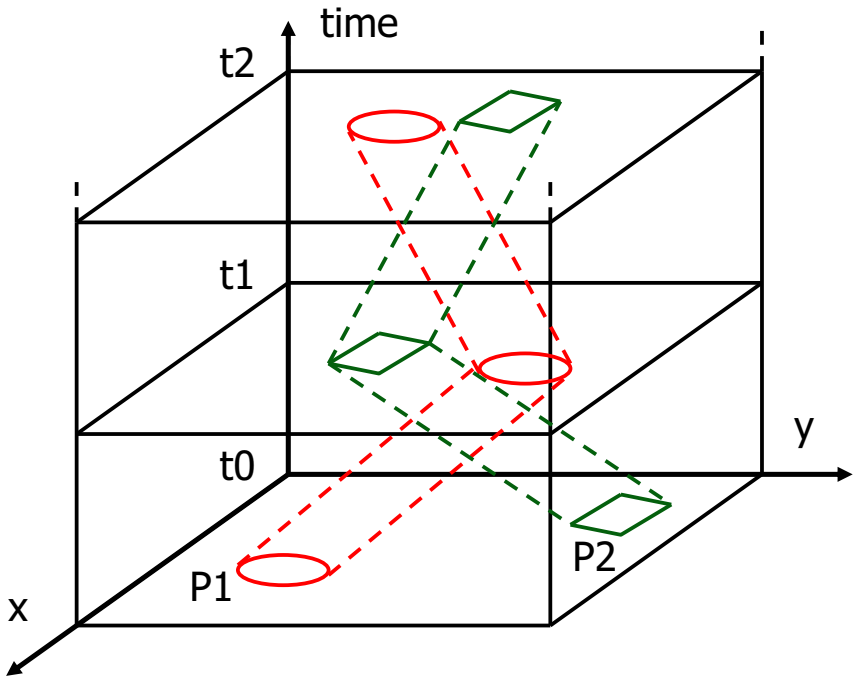
Subdivision of parcels



4D data type advantages (cont.)

- Advantages of integrated 4D data type:
  1. optimal efficient 4D searching
  2. Parent-child becomes topology neighbor query in time
  3. Foundation of full (4D) partition: no overlaps or gaps in space and/or time
  4. 4D analysis: do two moving cattle rights have spatio-temporal overlap/touch

Moving cattle



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3D Cadastre in the Netherlands

- Several studies have been carried out in the past decade
- Now actual implementation
  within legal, institutional, organisational context

Why now?

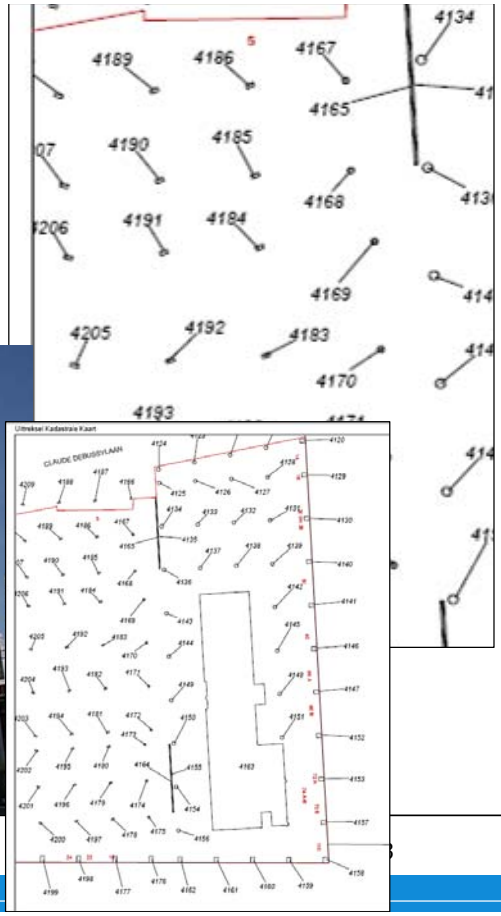
- Technically it has become possible to accept 3D drawings
- Practice has asked for support

Background

- Main registration entity is 2D parcel
- Although it is possible to
  establish property rights
  with 3D boundaries
- Case 1: one object, superficies
- Note parcel fragmentation

Case 2

- Land by municipality
- Two 3D objects, long lease:
  1. Parking garage
  2. Office tower on 80 pillars
- Note again parcel fragmentation



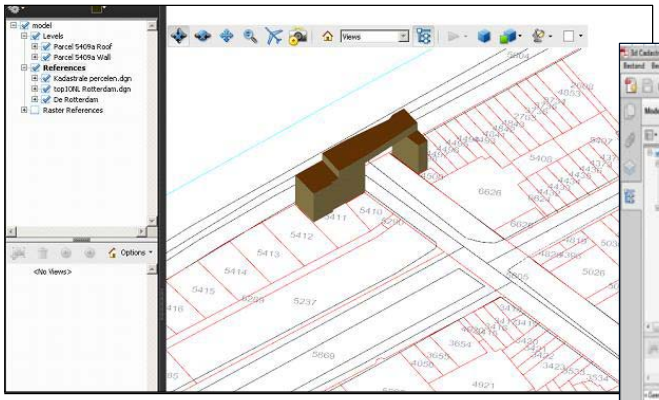
Findings from the case studies (many more than now presented)

- Registration and publication of rights on 3D property is possible with the traditional 2D approach

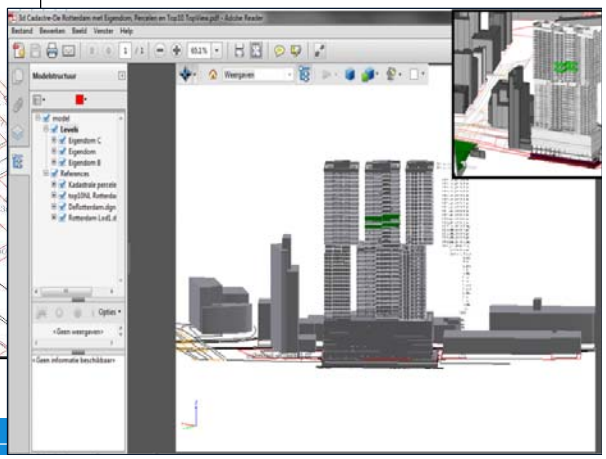
- But:
  1. Registration is not clear:
     Hard to understand if more than one object/part is involved
  2. Objects are divided over several parcels:
     Hard to maintain

Phase I

- No dramatic change
- Principle: refuse "fragmented parcel creation"
- Require a registration of 3D representation that reflects the space to which right applies
- 3D PDF (is already possible!)



Courtesy of Kees van Prooijen, Bentley



Phase I in more detail

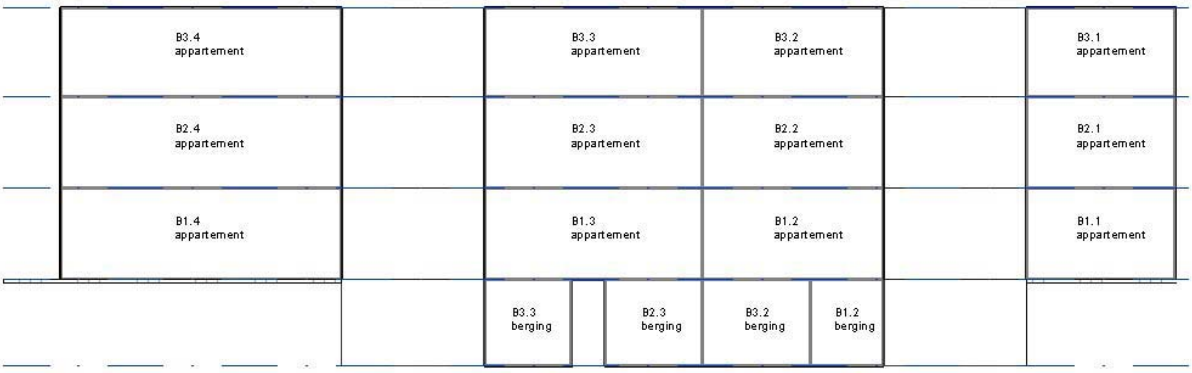
- Notification of 3D registration in cadastral map
- Projection 3D representation in separate layer (LA_Level)
- Link to 3D drawing
- Original 2D parcels can be kept (have own LA_Level)
- No 3D parcel in a 3D cadastral map
- Requirements/guidelines for 3D drawing

Requirements for 3D PDF

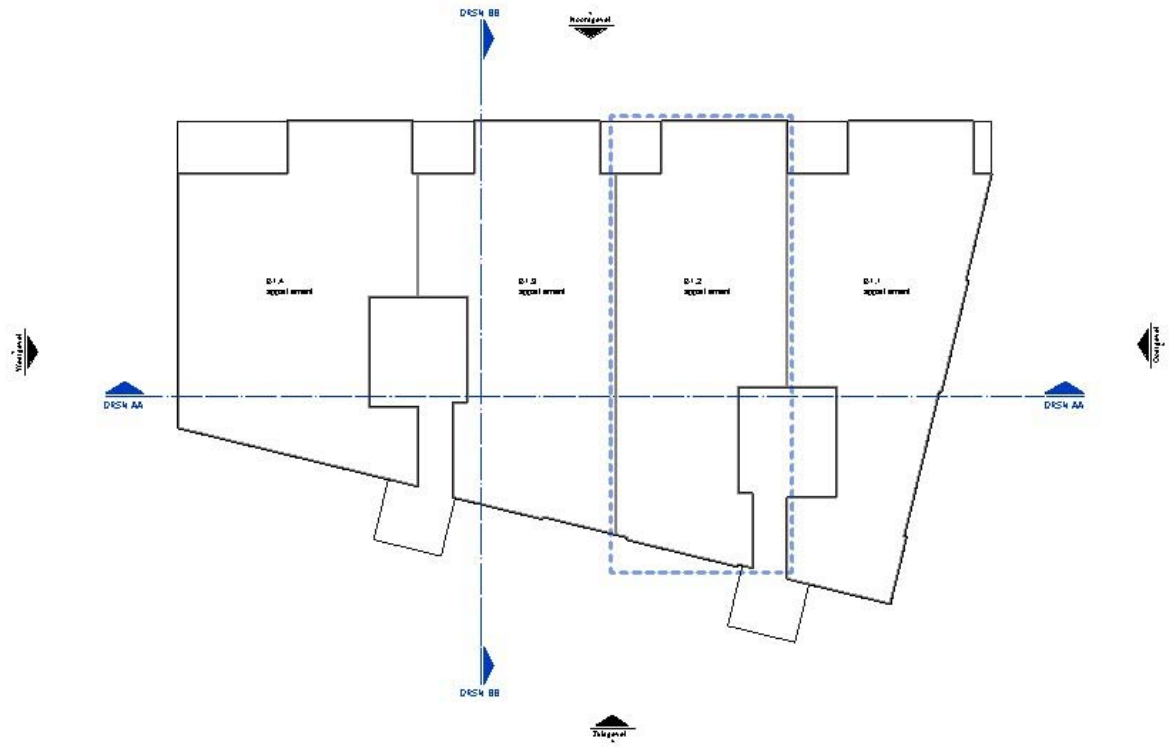
- 2D ground parcels that overlap with legal volumes
- 3D (graphical) description of legal space:
  - 3D extent and overlap with ground parcels
- Legally required 2D cross sections with accompanying annotations
- Objects needed for reference/orientation in 3D environment:
  - large scale topography
  - 2D geometry of buildings
  - 3D constructions and earth surface (with ground parcels) as reference
- Length/area measures of the legal space
- Volume of the legal space
- Z: 3D PDF should identify origin in local coordinates (and relate this to national height datum)

Example 3D PDF by a company: VDNDP Bouwingenieurs

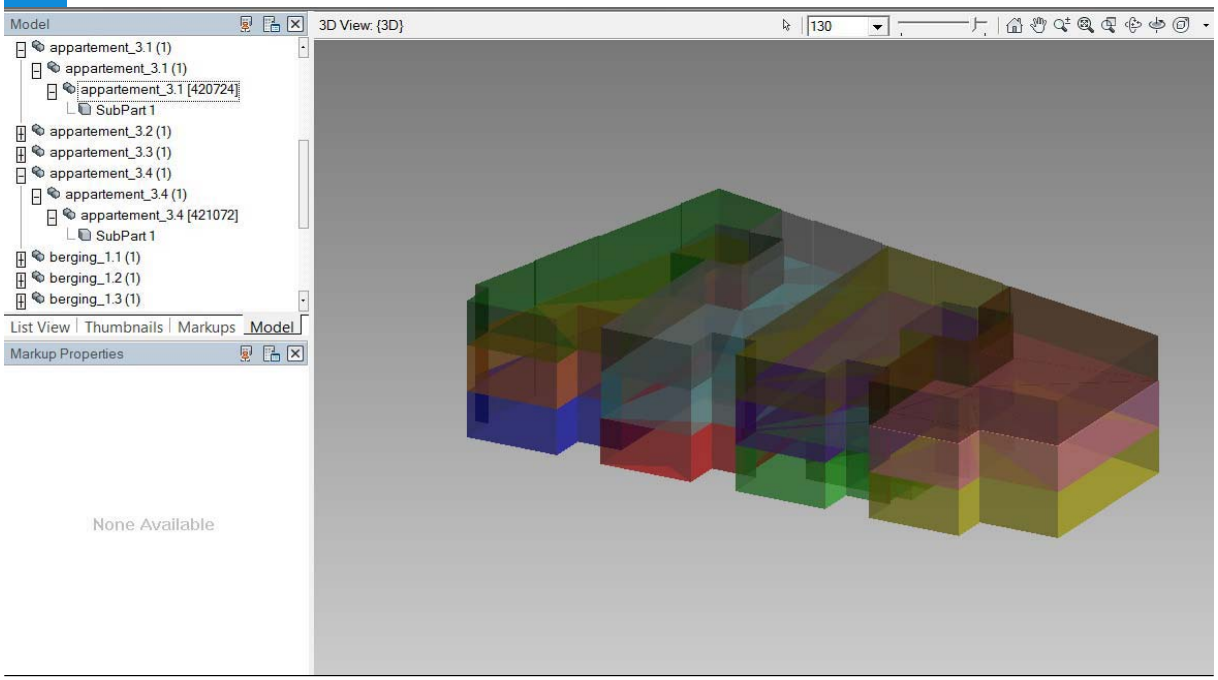
Vertical cross section



Floor plan of 1st floor



3D legal spaces



Additional requirements, phase I

- Footprint and projection on earth surface in cadastral map
- Unique identification is not possible, therefore preliminary id's
- No 3D data can be submitted for registration:
  1. as long as the 3D space can be visualised in a 3D PDF, the representation is accepted
  2. topological structure not possible, but one 3D PDF could show separate legal volumes; e.g. neighbours in apartment complex
  3. quality of the 3D representations cannot be checked

Next, Phase II

- Obligatory in specific situations
- Still related to one or more ground parcels
- A 3D graphical representation is always required
- based on ISO standard LADM and full integration 2D/3D (LA_BoundaryFace and LA_BoundaryFaceString)

- 3D data itself: XML-encoding (CityGML, LandXML, IFC?)
- Kadaster checks on geometry, topology, overlap:
  - Requirements for allowed geometries

- Possible to establish legal space that overlaps several ground parcels with own identification

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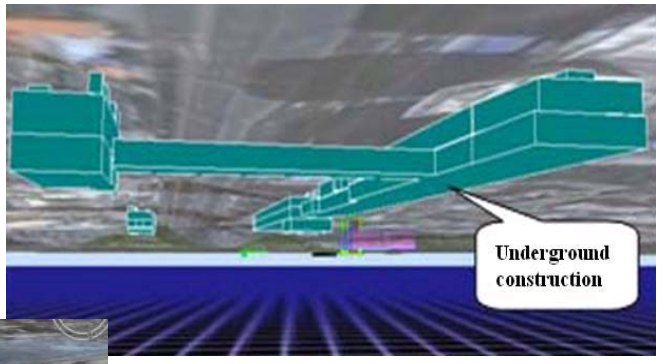
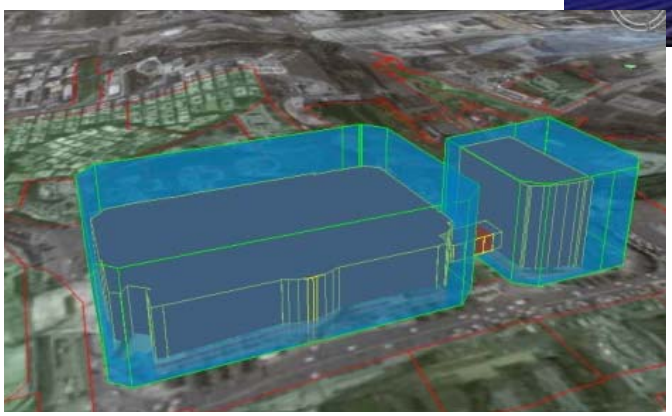
Some other countries

- China
- Russian Federation
- Malaysia
- Australia (operational, but in DCDB)
- Scandinavian countries (operational, but in DCDB)
- Switzerland (ongoing study)
- Bahrain (being constructed)
- Singapore (tender on-going)

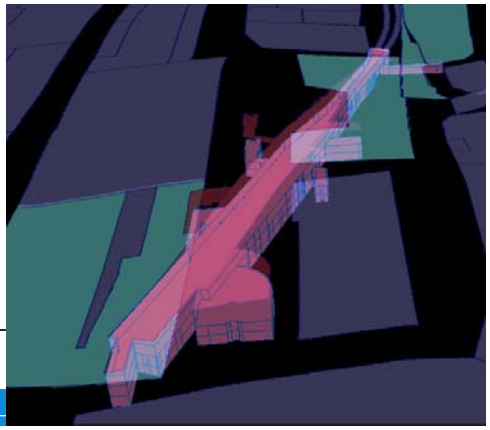
Shenzhen China



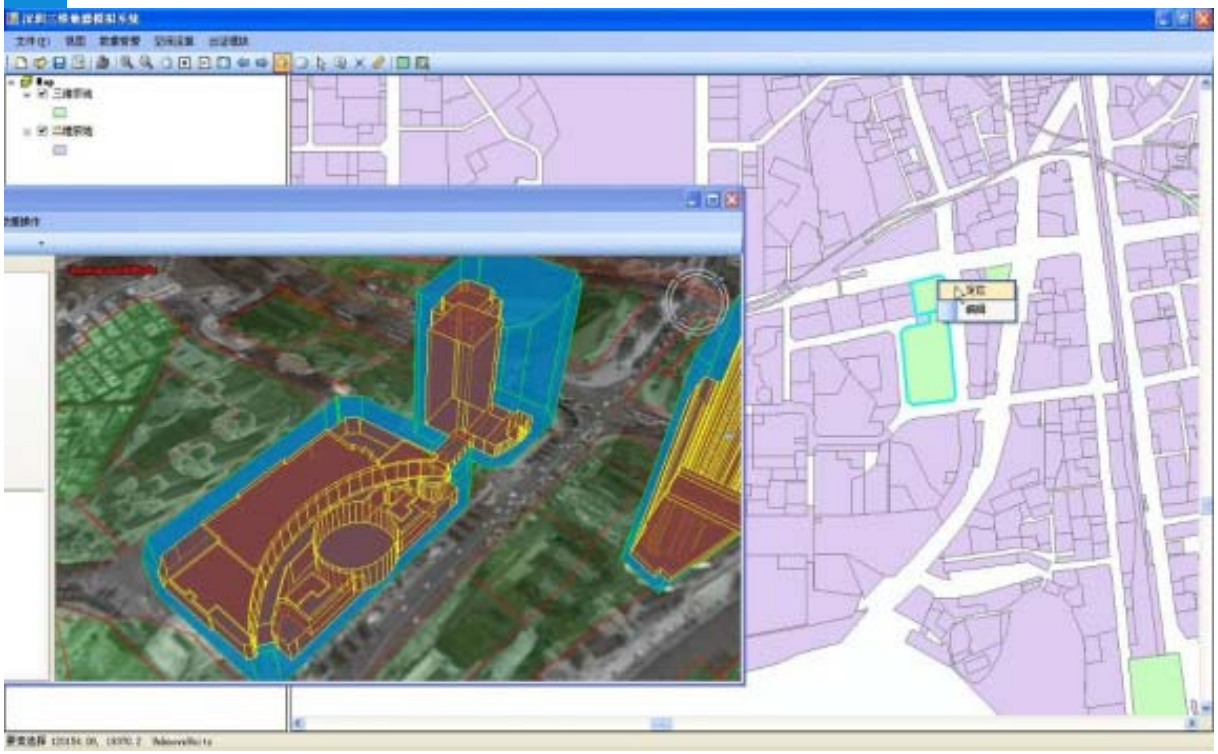


Legal space (blue), buildings (brown)

Subsurface metro, 3 levels



2D and 3D Cadastral data (Shenzhen)



Demo's of 3D Cadastre, 2012 workshop Changchun and Shenzhen

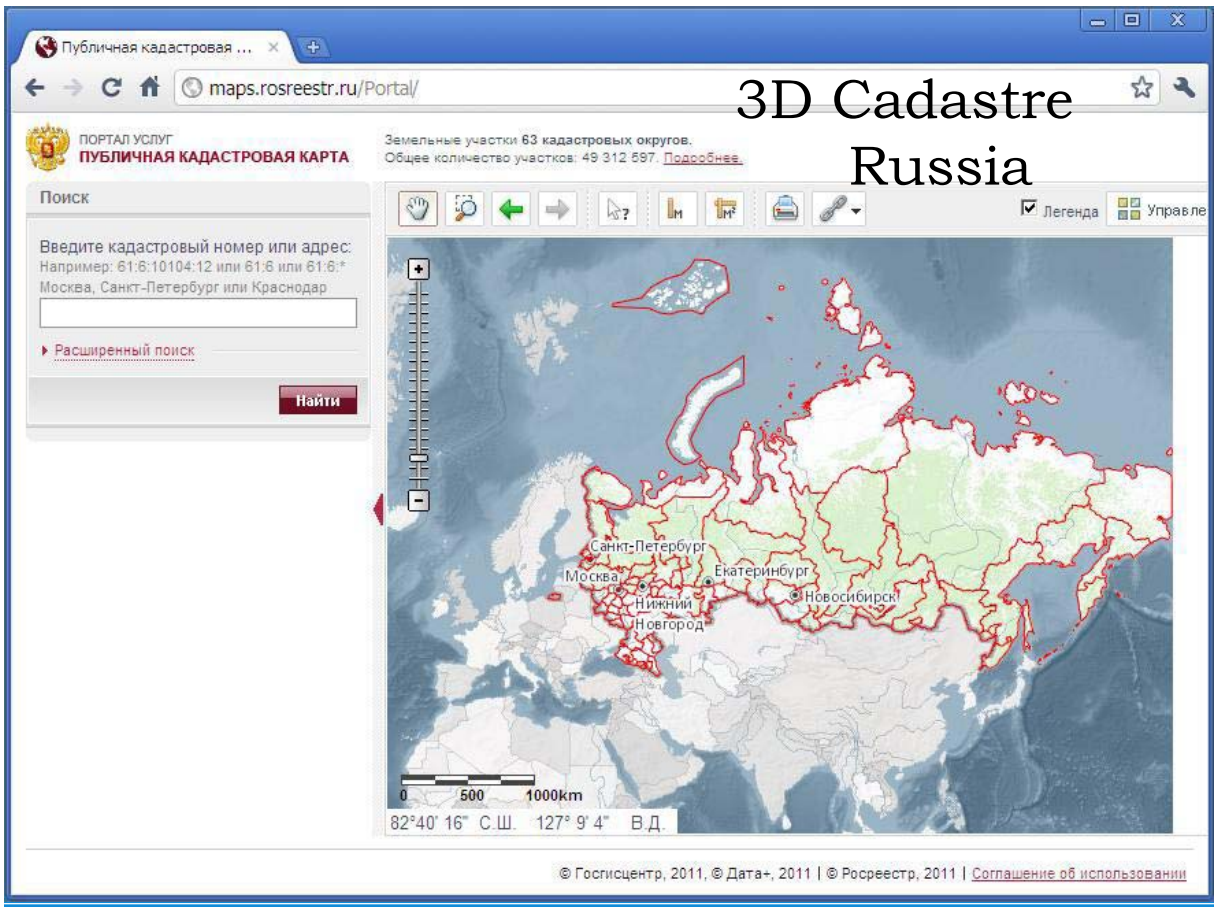
Relevant publications

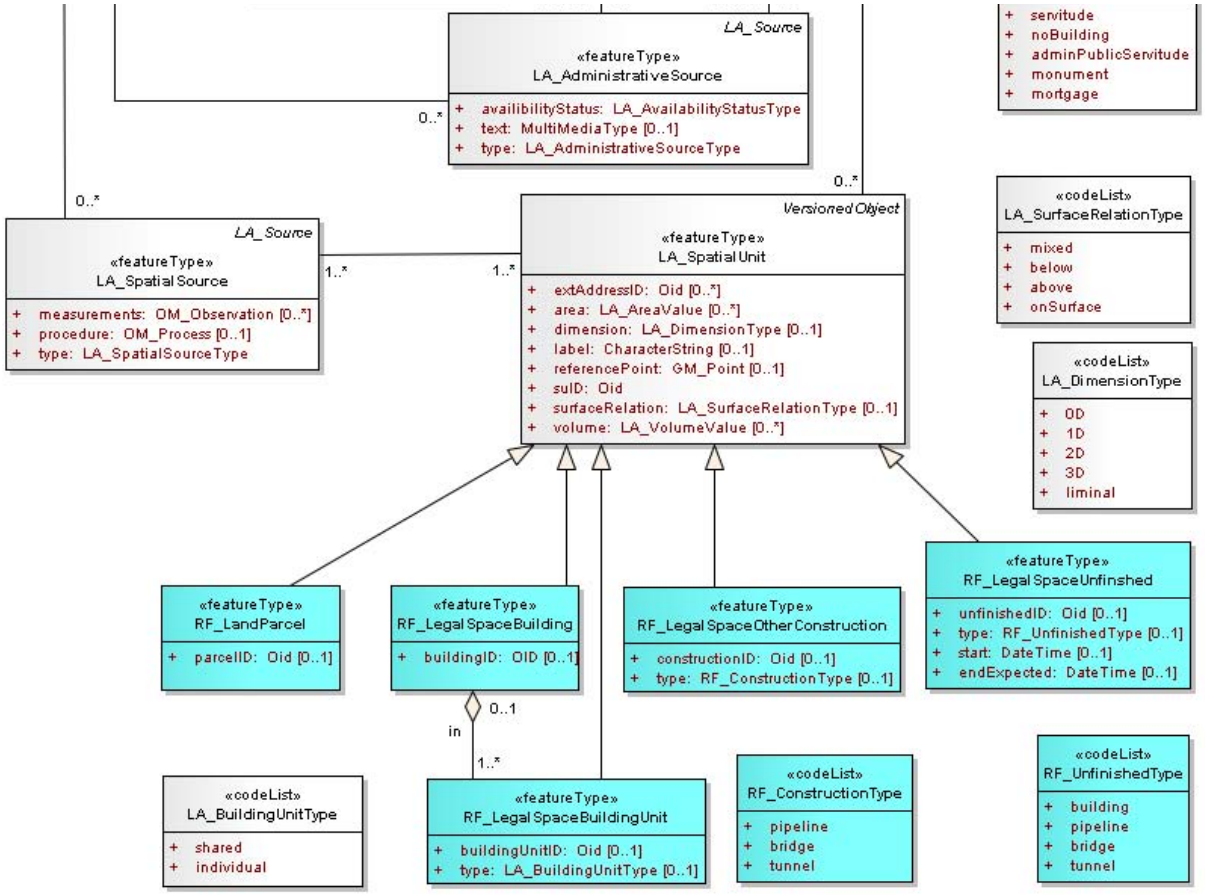
3D Cadastre, Shenzhen (in FIG 3D Cadastres 2011 workshop):

- A Multi-jurisdiction Case Study of 3D Cadastre in Shenzhen, China as Experiment using the LADM (by Renzhong Guo, Shen Ying, Lin Li, Ping Luo and Peter van Oosterom)
- Design and Development of a 3D Cadastral System Prototype based on the LADM and 3D Topology (by Shen Ying, Renzhong Guo, Lin Li, Peter van Oosterom, Hugo Ledoux and Jantien Stoter)

LADM:

- Integration of Land and Housing in China: First Analysis of Legal Requirements for LADM Compliance (by Yuefei Zhuo, Zhimin Ma, Christiaan Lemmen and Rohan Bennett), FIG LADM 2013 workshop

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+ text: MultiMediaType [0..1]
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+ noBuilding
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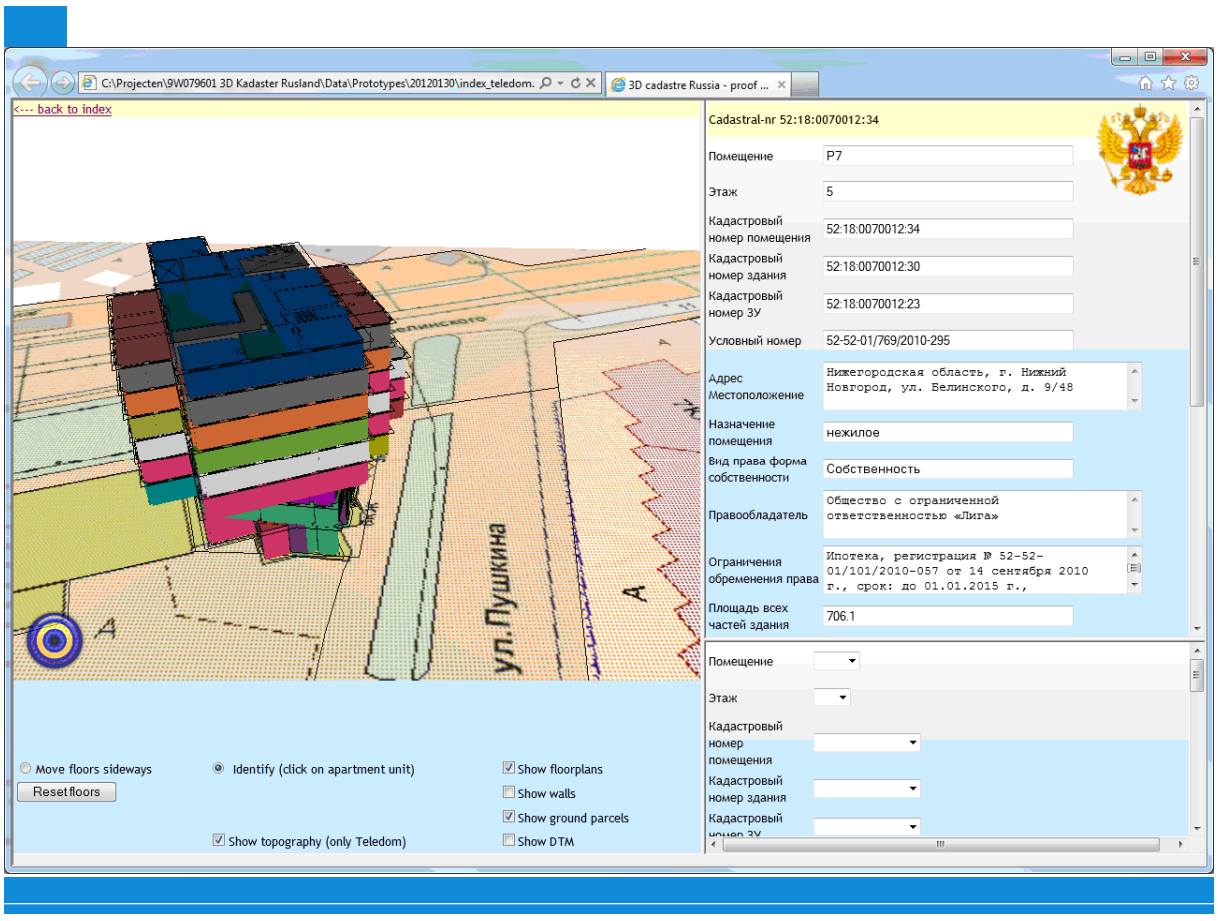
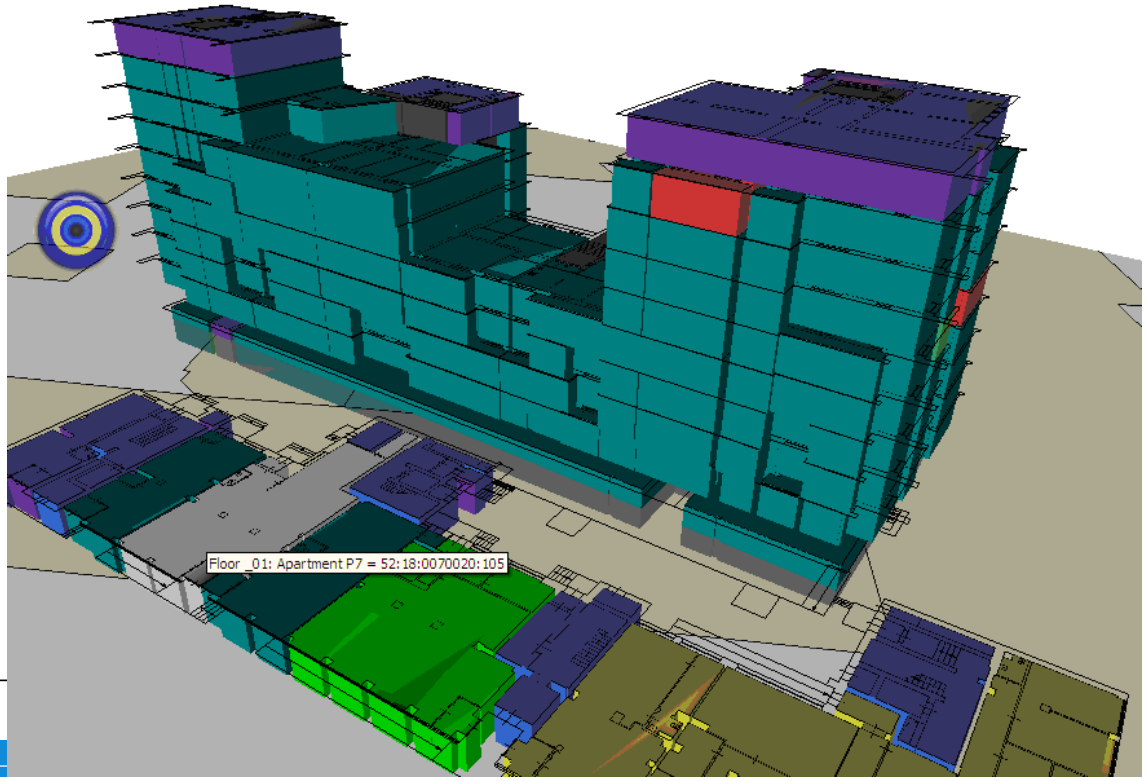
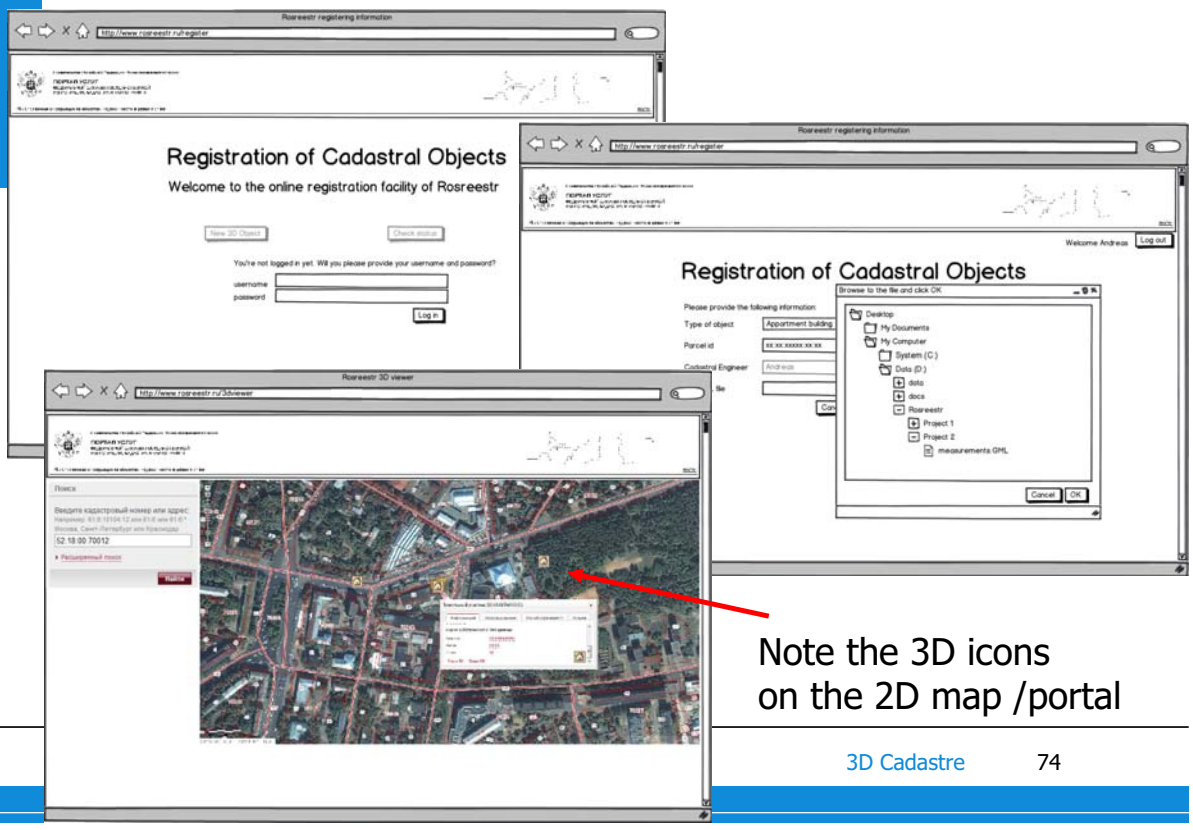

<--- back to index
Cadastral-nr 52:18:0070012:34
Помещение
P7
Этаж
5
Кадастровый номер помещения
52:18:0070012:34
Кадастровый номер здания
52:18:0070012:30
Кадастровый номер ЗУ
52:18:0070012:23
Условный номер
52-52-01/769/2010-295
Адрес Местоположение
Нижегородская область, г. Нижний Новгород, ул. Белинского, д. 9/48
Назначение помещения
нежилое
Вид права форма собственности
Собственность
Правообладатель
Общество с ограниченной ответственностью «Лига»
Ограничения обременения права
Ипотека, регистрация № 52-52-01/101/2010-057 от 14 сентября 2010 г., срок: до 01.01.2015 г.,
Площадь всех частей здания
706.1
ул. Пушкина
Move floors sideways
Identify (click on apartment unit)
Reset floors
Show floorplans
Show walls
Show ground parcels
Show DTM
Show topography (only Teledom)

Slide-out interface (look inside)



Registration mock-up



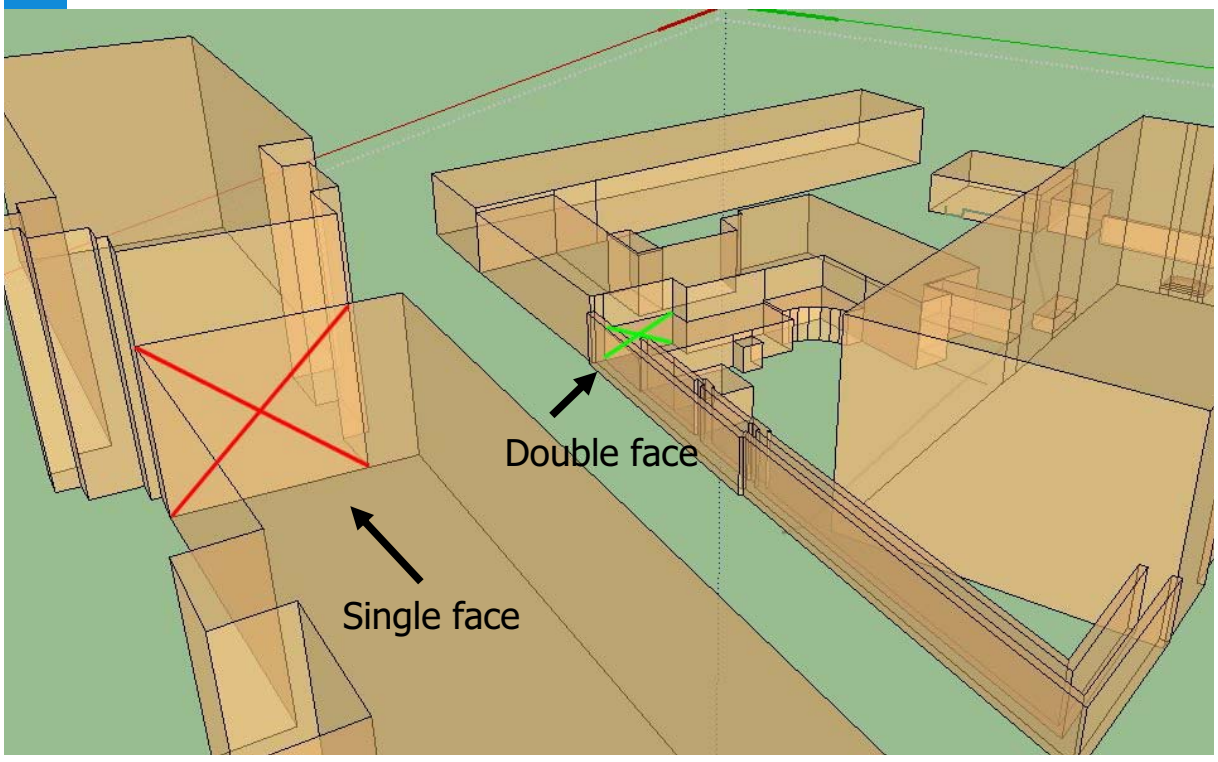
Note the 3D icons
on the 2D map /portal

Russian 3D cadastre prototype

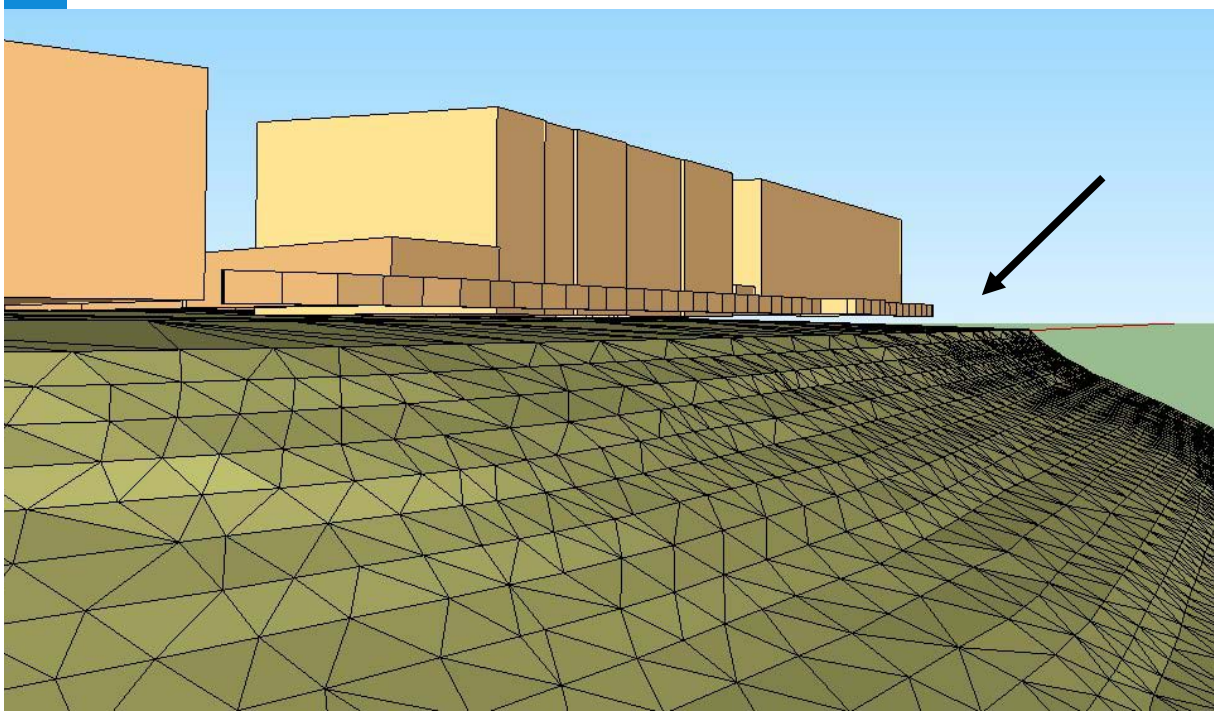
- Prototype focused on
  - Visualization of the three selected cases
  - Web dissemination of 3D cadastral objects and related admin
  - Added reference objects DTM, walls of buildings, scanned map,…
  - Spatial interaction with data in 2D/3D environment
  - Selection based on admin conditions

- Excluded from prototype/pilot, but needed:
  1. Initial registration (use of required format)
  2. Data validation (check input data quality)
  3. Data storage and management (in DBMS)

3D cadastral objects not in solid group → non-trivial to correct



Buildings partially floating in air (case gas pipeline)

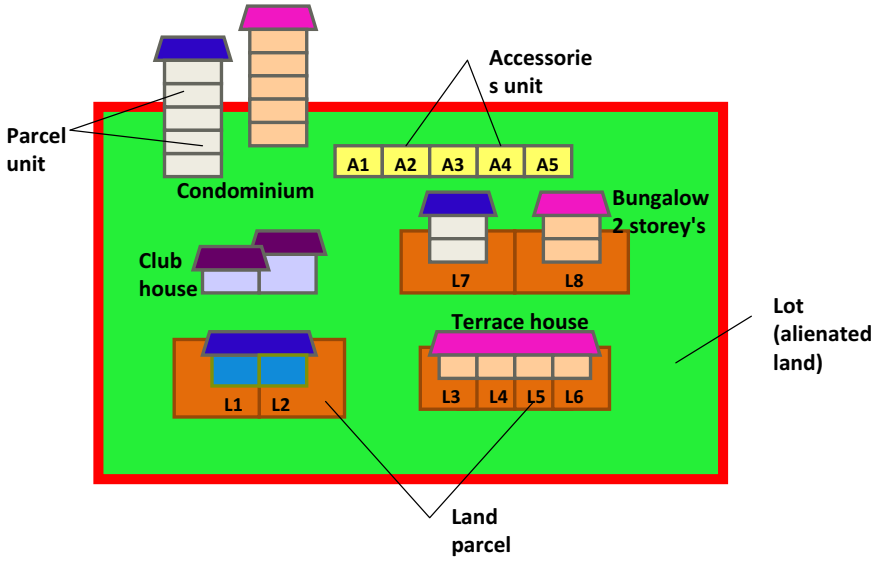


Validator

- (Automatic) check 3D cadastral object before input
- Use proper data management (right data type in DBMS) during storage
- Check for potential conflicts with other 3D objects (or columns implied by 2D surface parcel)
- Should 3D cadastral objects be connected (indirectly) to earth surface, i.e. must be reachable

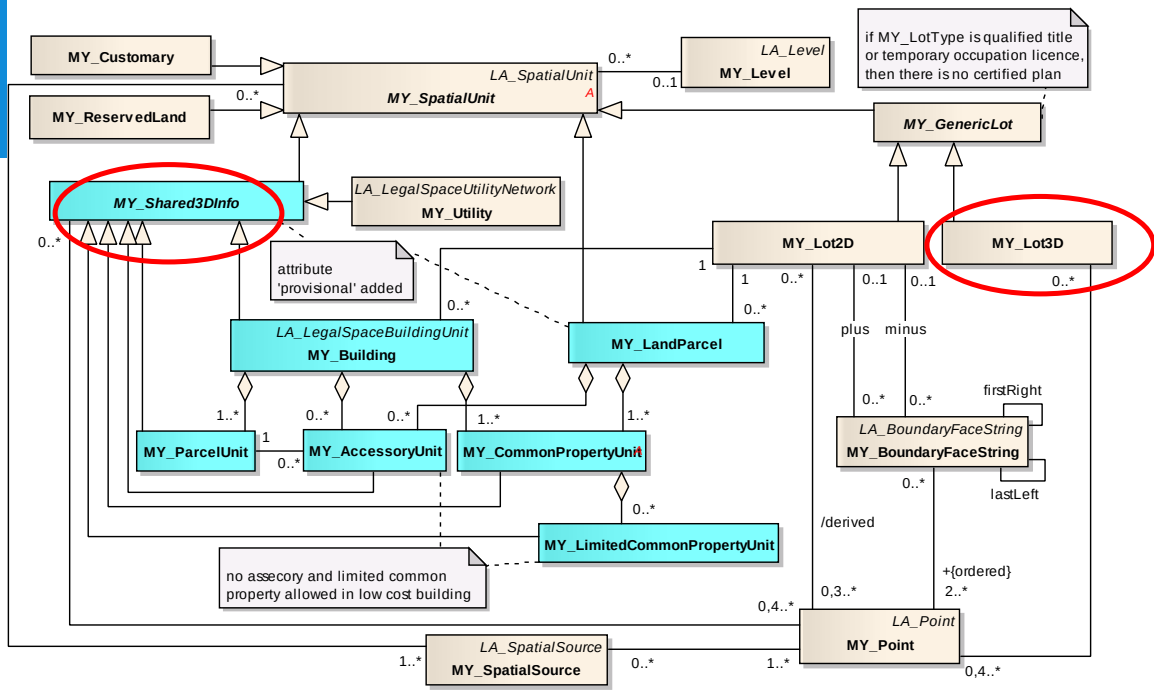
- Check spatial aspects (flat faces, partition of space)
- Check consistency between spatial – legal/admin data
- Check legal/admin attributes, proper transfer of rights between involved parties

Malaysia: integrated 2D and 3D



Various cadastral objects related to strata titles in context of one lot

Spatial data modelling based on LADM



Implementation

- Convert conceptual model (UML class diagram) into technical model, decide on indexing, exact data types, references/id's, topology, history/versions,…

- Database Oracle spatial: MDSYS.SDO_GEOMETRY type
- Malaysian country profile: 2D topology structure for land parcel
- Managing 2D and 3D spatial object, Oracle Spatial supports storage for 3D points, lines and polygons
- MY_BoundaryFaceString represent 2D cadastral object
  → polyline, GTYPE=2002
- MY_Shared3DInfo represent 3D cadastral objects
  → multipolygon method, GTYPE=3007

3D Cadastral object

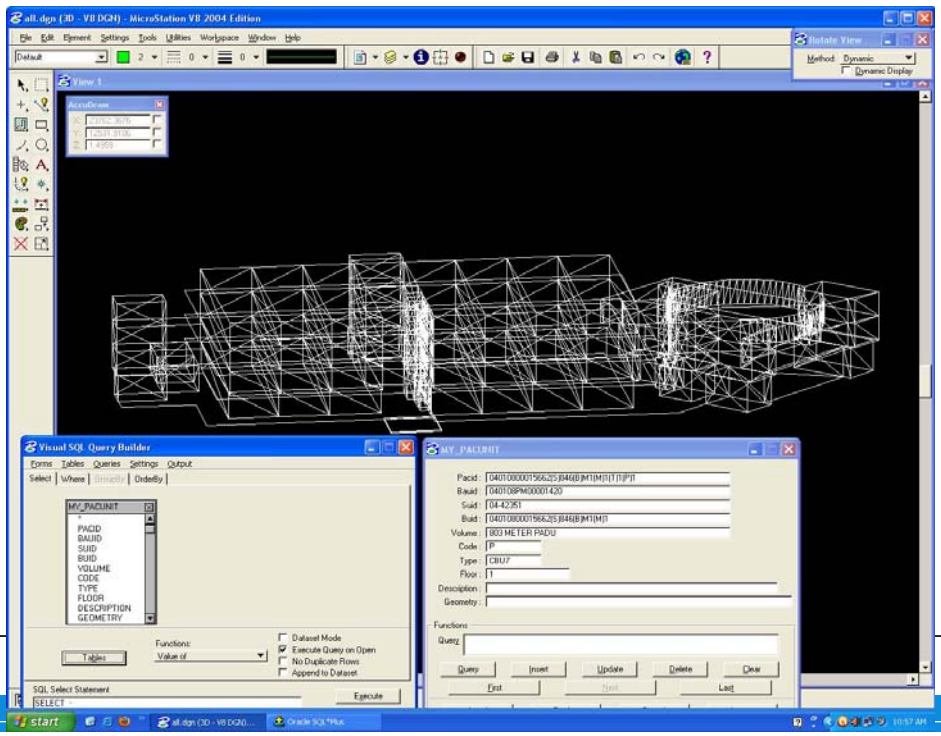


FIG 2014 congress, unofficial programme 3D Cadastres

- Transition of Property Registration from Paper to 2D to 3D – A Case Study from Bahrain (Kashram Ammar et al.)
- 3D Laser Scanning to Detect Property Encroachment (Khoo Victor H. S. et al., Singapore)
- Developing a 3D Digital Cadastral System for New Zealand (Gulliver Trent et al.)
- Let's Talk About land and property information in 3D: What Should The Future Look Like? (Rajabifard Abbas et al., Australia)
- Germany on the Way to 3D-Cadastre (Gruber Ulrich et al.)
- Development of Structure-based Topology of 3D Spatial Databases for Storing and Querying 3D Cadastre Cases (Aditya Trias, Indonesia)

FIG 2014 congress, continued…

- Developing Infrastructure Framework to Facilitate the Malaysian Multipurpose 3D Cadastre (Liat Choon Tan et al.)
- The Development of 3D City Model for Putrajaya MPC Database (Chee Hua Teng et al., Malaysia)
- Review and Assessment of Current Cadastral Data Models for 3D Cadastral Applications (Aien Ali et al., Australia)
- A Geometric-Topologic Exemplification for 3D Cadastre (Duncan Edward et al., Malaysia)
- Towards Malaysian LADM Country Profile for 2D and 3D Cadastral Registration System (Zulkifli Nur Amalina et al.)
- Integration of Data from Real Estate Cadastre, Register of Utility Networks and Topographic Database Based on LADM and CityGML Standards (Góźdź Katarzyna et al., Poland)

Content overview

1. Introduction
2. FIG working group, international overview
3. 3D in ISO 19152
4. Deep integration 3D and time
5. Netherlands developments
6. Some other countries

→ Conclusion

Conclusion

- Besides legal and technological aspects, 3D Cadastre implementation in specific country requires communication with stake holders (surveyors, notary, banks, government agencies, public), and taking (scoping) decisions

- Educate future data providers, help them with practical rules/ guidelines and tools for proper description of 3D cadastral objects:
  - What to do with wall or ceilings?
  - What horizontal and vertical reference system to use?
  - What to do with pipelines crossing multiple parcels?
  - What to do with curved surfaces (non-horizontal/vertical)?
  - What to do with partial (un)bounded objects
  - When can 3D Cadastral Unit exist (specific rules or not; e.g. relation to construction or connection to Earth surface)?

Cost of realizing 3D Cadastral system

- Some cadastral organizations estimate limited cost for realization as often: 3D data will originate from outside
- But registration guidelines are crucial

- Possible sources:
  1. Survey in 3D
  2. Old floor plan upgraded to 3D volumes
  3. New architecture design (CAD) directly in 3D

- In all cases:
  1. Agree on submission format (LADM, encoding CityCML/LandXML/..)
  2. Rules for valid 3D objects
  3. Automated checking as much as possible

Intention often more than 3D Cadastre ...full life cycle in 3D

Involved steps (order differs per country):

1. Develop and register zoning plans in 3D
2. Register (public law) restrictions in 3D
3. Design new spatial units/objects in 3D
4. Acquire appropriate land/space in 3D
5. Request and provide (after check) permits in 3D
6. Obtain and register financing (mortgage) for future objects in 3D
7. Survey and measure spatial units/objects (after construction) in 3D
8. Submit associated rights (RR)/parties and their spatial units in 3D
9. Validate and check submitted data (and register if accepted) in 3D
10. Store and analyze the spatial units in 3D
11. Disseminate, visualize and use the spatial units in 3D

Further development

- 3D Cadastre is here to stay and #implementations increase
- Often renewal in combination with LADM conformance
- In 3D even more need to connect to other registrations via SDI: buildings, tunnels, cables/pipelines, terrain elevation, etc. (physical and legal 3D objects should be aligned)

- FIG 3D cadastres working group continues for term 2014-2018
- Most of the earlier topics remain
- However, emphasis on following topics:
  1. Experiences of operation 3D Cadastral systems (law, organization, technology)
  2. 3D Cadastre in mega-cities, often in Latin-America (Brazil, Mexico), Asia (China, Malaysia, Korea, Singapore) and Africa (Nigeria)
  3. 3D Cadastre usability studies, web-dissemination and 3D cartography

Next 3D Cadastres workshop

- 4th International FIG 3D Cadastre Workshop, 9-11 November 2014 (in cooperation with the 3D GeoInfo Conference, 11-13 November 2014)

- Tentative timetable:
  1. 30 June 2014: Extended abstract (500-1000 words)
  2. 7 September 2014: Author notification
  3. 9 October 2014: For accepted submissions, final version full paper
  4. 9-11 November 2014: Workshop

Acknowledgements

- This research is supported by the Dutch Technology Foundation STW, which is part of the Netherlands Organisation for Scientific Research (NWO) and partly funded by the Ministry of Economic Affairs, Agriculture and Innovation (Project codes: 11300 and 11185)

- Thanks to the SoI organizers for the invitation to give this presentation and providing the opportunity be involved in the Israel 3D Cadastre development (Consulting Agreement Contract No 8000179)

Questions?

Peter van Oosterom

TU Delft

Annex B.
Slides ‘Land Administration Domain Model (LADM, ISO 19152)’

presentation at Survey of Israel, Tel Aviv, 10 February 2014

Survey of Israel
המרכז למיפוי ישראל

Land Administration Domain Model (LADM, ISO 19152)

10-2-2014

Peter van Oosterom, based on joint work with:
Chrit Lemmen and Harry Uitermark

Meeting on LADM at the Survey of Israel
Tel Aviv, 10 February 2014

Motivation LADM
Generic benefits of standards

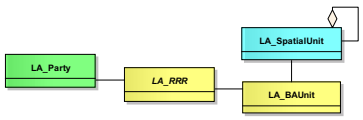
- Standardization condition for interoperability, use parts together (meaningful exchange of data and building SDI)
- Standardization quality enhancing (based on knowledge and experience of global community)
- Standardization cost effective (components do fit better, industry+open source solutions)

ISO ISO/TC 211
Geographic information/Geomatics

Motivation LADM
Geo-information/land admin aspects

- Within ISO geo-information/geomatics is responsibility of TC211 (Technical Committee)
- Earlier TC211 standards domain neutral: basics for geometry, topology, temporal aspects, reference systems, metadata, …
- LADM is first domain specific standard within TC211
  → meaningful (inter)national communication between professionals
- Allows efficient design/development of ICT systems
- Note: standardization itself not new in our field, was already applied in analogue times, both for spatial/survey and admin/legal docu (However, ICT requires more strict approach and detect errors)

Motivation LADM
Reasons to apply LADM



- LADM collective experience of experts from many countries (FIG)
- LADM is based on consensus and adopted by ISO (and CEN)
- LADM allows meaningful data exchange: 1. within country, SDI-setting (other types of data), 2. between countries/states (same type)
- LADM covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons, etc.
- LADM focuses on information, not on process/organization aspect
- LADM is modular (packages) and extensible → country profiles
- LADM allows integrated 2D and 3D representation of spatial units
- LADM supports both formal and informal RRRs
- LADM links essential land information data to source documents, both spatial (survey) and legal (title, deed)

LADM compliance will seldom be main reason for new system in country
→ every system needs upgrades: consider becoming LADM compliant!

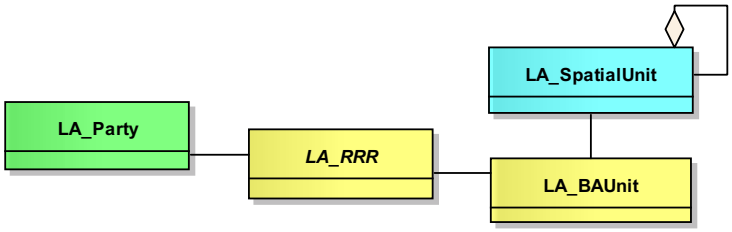
Motivation LADM
Expressed at 5th FIG LADM workshop

- Some quotes from Kalantari (et al, 2013):
  1. International compliance
  2. Cross jurisdictional data exchange
  3. Upgrading or new versions for existing systems
  4. Existing institutions ('do fit in well')
  5. Semantic Compliance (definition of key concepts)
  6. Structural Compliance (agreed model patterns)
  7. Feedback and improvements (during standard development, and after)
  8. Capacity building (LADM included in various curriculums).

- Thompson (2013) added: LADM provides excellent growth path from text, sketch and point parcels to full topology and 3D (and same range of options available in administrative side of model)

- LADM workshop slides (and papers) available at http://isoladm.org

Contents



What is needed in a domain model?

- A mechanism to access more data than only from a single source, stored in a variety of locations
- Unambiguous definitions of the contents, to avoid overlap, enable re-use and maintain consistency
- Shareable semantics of fundamental parts, a domain vocabulary, ontology
- Spatial and non spatial data
- Extensible base to capture specific applications, specialisations

- Thus: standards for the domain, based on domain independent basic geoinformation standards (ISO TC211 family)
- Boundary of a domain model and links to related domain models within the Spatial Information Infrastructures (SII=Geoweb)

Standardization in Land Adminastration?

- Supposition: there are huge differences between cadastral and land registry systems

- However, look at the common area's:
  - Standardized Model (adaptable, extensible)
  - Avoid "re-inventing the wheel"
  - Enable involved parties to communicate

- Lack of a shared set of concepts and terminology in the Land Administration Domain
  → FIG, Washington 2002: Proposal for Domain Model

- Note FIG = International Federation of Surveyors (founded 1878 NGO)

Land Administration Domain Model ISO 19152 (LADM)

- Model includes:
  - Spatial part (geometry, topology)
  - Extensible frame for legal/administrative part
- Object-orientation → expressions in UML
- Model Driven Architecture (MDA)
- FIG proposed LADM to ISO/TC211, January 2008

ISO 19152 (=LADM) Scope

- Reference model (abstract, conceptual schema)
- Land/water, below/above surface
- Basic classes:
  1. parties,
  2. rights, responsibilities, restrictions,
  3. spatial units (incl. spatial sources and spatial representations)
- Terminology enabling communication
- Shared description of formal or informal practices
- Basis for national & regional profiles (application schema)

Besides ISO TC211 countries some persons noticed the LADM

•Doug Batson, on behalf of the U.S. State (Foreign Office) and Defense Departments
→ visited Delft a few times to discuss the LADM

•Clarissa Augustinus, Chief, Land, Tenure and Property Administration Section, UN-Habitat, Nairobi Kenya
→ invitation to present LADM in UN-Habitat Expert Group Meeting 'Innovative land tools and urban cadastre' (on-going cooperation)

U.S. State and Defense Departments and Land Administration !?!?

- Re-examining reconstruction and stability in post-conflict countries
- Open call to staff to suggest solutions
- Doug Batson's (U.S. Board on Geographic Names) suggestion to apply land administration was selected
- After investigations he noticed the LADM and does want to apply this tool
- After visit to Delft, he went 'on a mission' to Afghanistan → result report

UN-Habitat: United Nations Human Settlements Programme

- Mandate: To promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all
- Close cooperation in context of the 8 Millennium Development Goals with World bank, FAO, UNDP,.. (objectives o.a. development and poverty eradication)
- Goal 7: Ensure environmental sustainability,
  Target 11: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers

Land and the Habitat Global Campaign for Secure Tenure (started 2000)

Why does UN-Habitat 'believe' in land administration?

Insecure tenure:

- inhibits investment in housing
- hinders good governance
- undermines long term planning
- distorts prices of land and services
- reinforces poverty and social exclusion
- impacts most negatively on women and children

Land and Economic Development: Hernando de Soto

- Trendsetting Hernando de Soto: The Mystery of Capital
- Why is capitalism in the western world successful and not elsewhere
- Incompetence to produce capital
- Problem: properties informal

TUDelft

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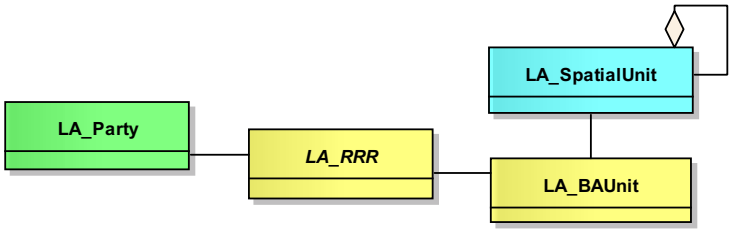

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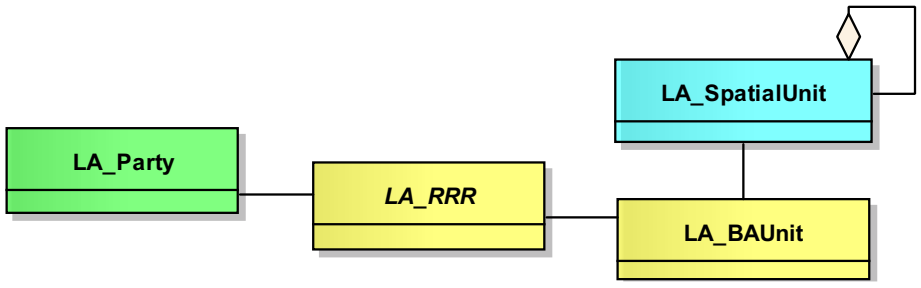
3. Instance level diagrams
4. External
5. Administrative/legal
6. Possible legal extension
7. Spatial units
8. 3D representation
9. Survey
10. Standardization process
11. Conformance testing
12. Standard maintenance
13. Conclusion

Requirements, support for:

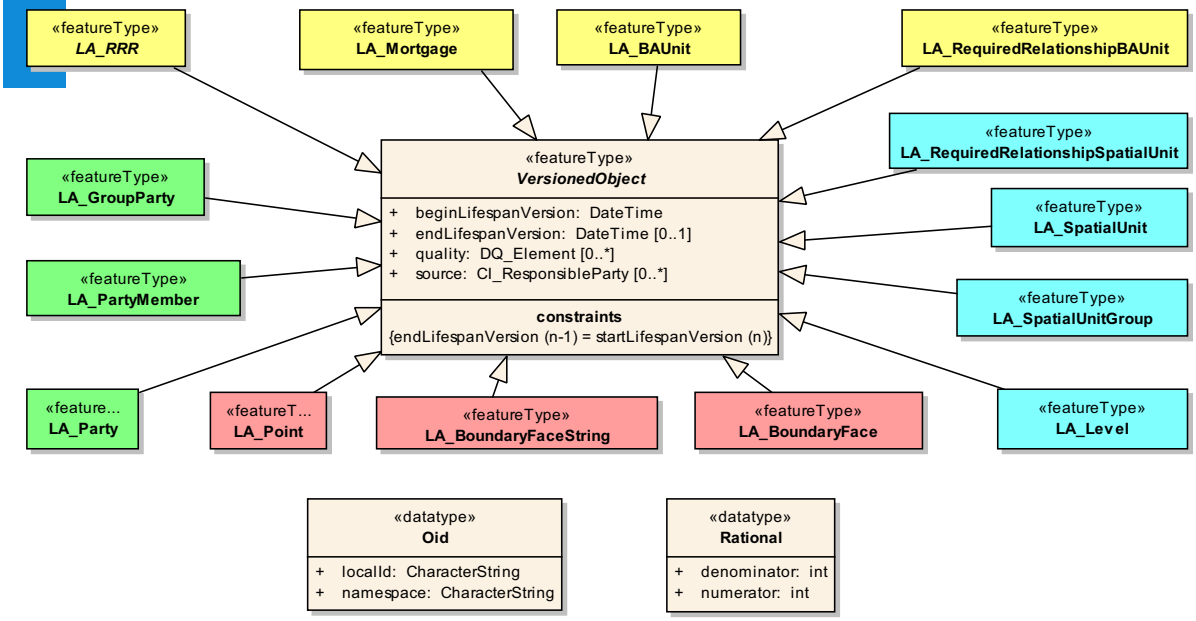
1. Continuum of land rights
2. Continuum of parties
3. Continuum of spatial units
4. Basic Administrative Units (or Basic Property Unit)
5. A range of data Acquisition methods
6. A range of authentic source documents
7. Transparency
8. History
9. Different organisations
10. Keep data to the source (within SDI)
11. Existing standards
12. Reference system
13. Identifiers
14. Marine Cadastres, 3D Cadastres
15. Quality

ISO 19152 core in action
Land Administration Domain Model

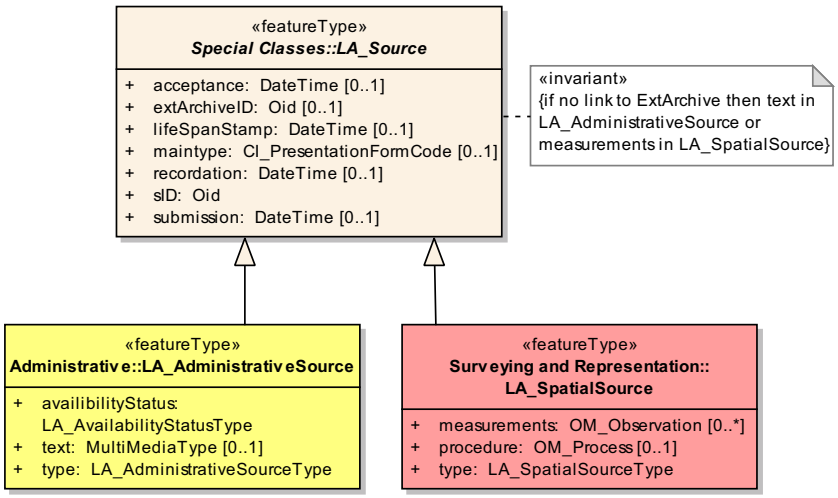
- LA_Party Peter has LA_RRR ownership on LA_BAUnit Peter's estate consisting of 2 LA_SpatialUnit parcels (with same LA_RRR)
- LA_BAUnit stands for Basic Administrative Unit

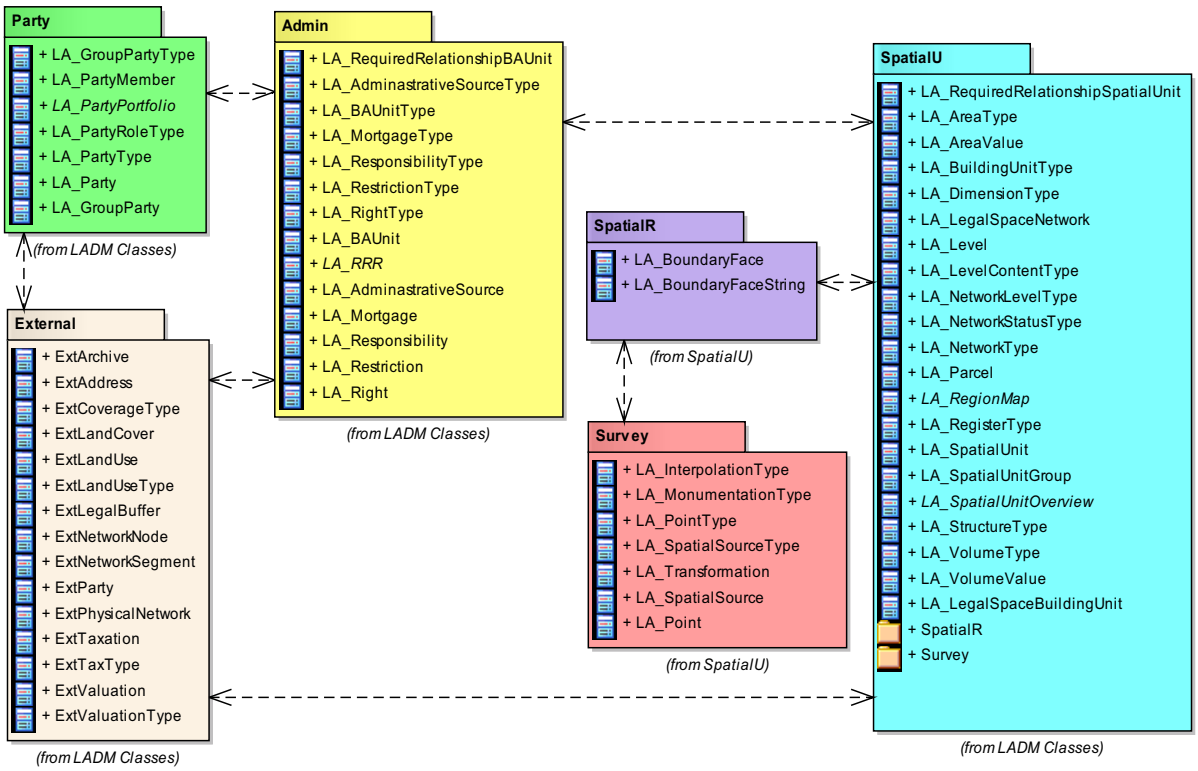


Full version management → inherit from VersionedObject



Administrative and Spatial Sources

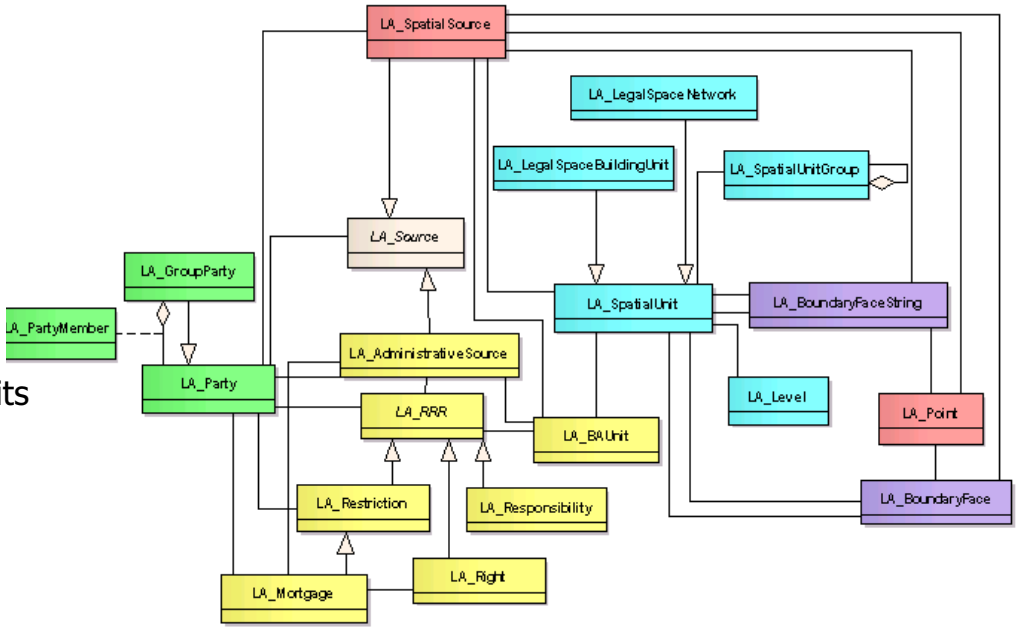




LADM Diagram

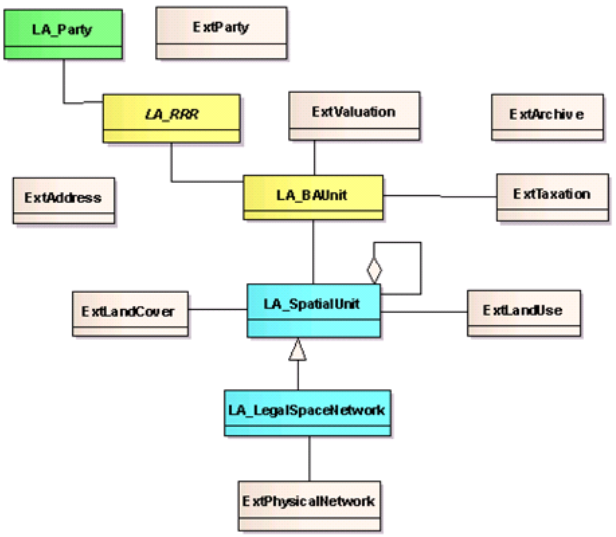
- Parties
  → green
- RRRs
  → yellow
- Spatial Units
  → blue
- Surveying
  → pink
- Mapping
  → violet

RRR supports
all land rights



LADM and external classes

- Determine scope LA
- Apply SDI thinking
- Link to external registrations:
  - Address
  - Party (person)
  - Valuation
  - Taxation
  - LandCover
  - LandUse
  - PhysicalNetwork (utility
  - …



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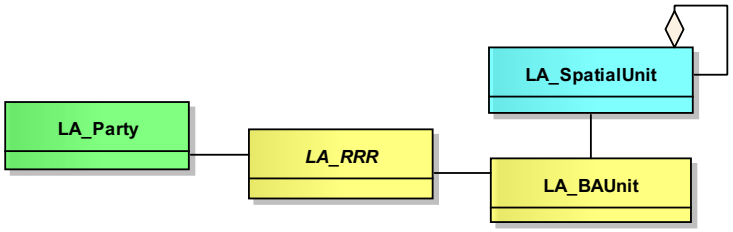


Instance level diagrams

- A comprehensive set of informative examples (using instance level classes) is available in Annex C of ISO 19152
- 39 different LA cases described in short text and illustrated with instance level diagram
- Advantage of instance level diagram is that it is less abstract than class level diagrams, i.e. easier to understand

Some of the LADM case, Annex C

- C2: Spatial units with customary right
- C3: Serving parcel provides access to four parcels, and serving parcel is not public, but commonly owned by four neighbouring parcels
- C8: Timeshare ownership for the month of February
- C9: Restriction not to change building because of monument status
- C20: Responsibility to clean the ditches
- C21: Right to use road on somebody else's property
- C23: Restriction area ("it is not allowed to build within 200 metres of fuel station") with its own geometry
- C29 Spatial unit with one owner, with building from different owner
- C33: Norwegian categories of basic property units
- C36: Grazing rights of pastoralists in Kenya
- C37: Customary rights in Ghana
- ....

ject Case C10

Figure C.10 — Mortgage on ownership, bank included as party

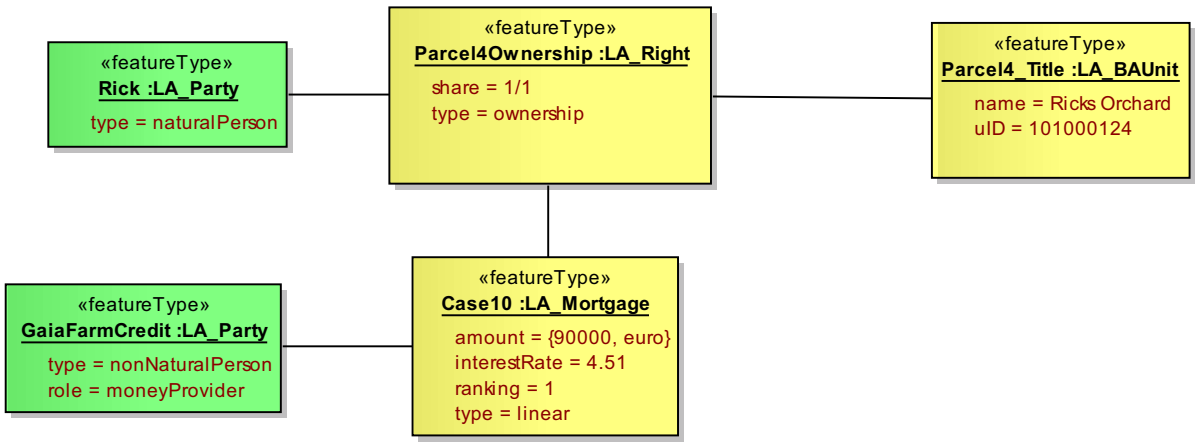
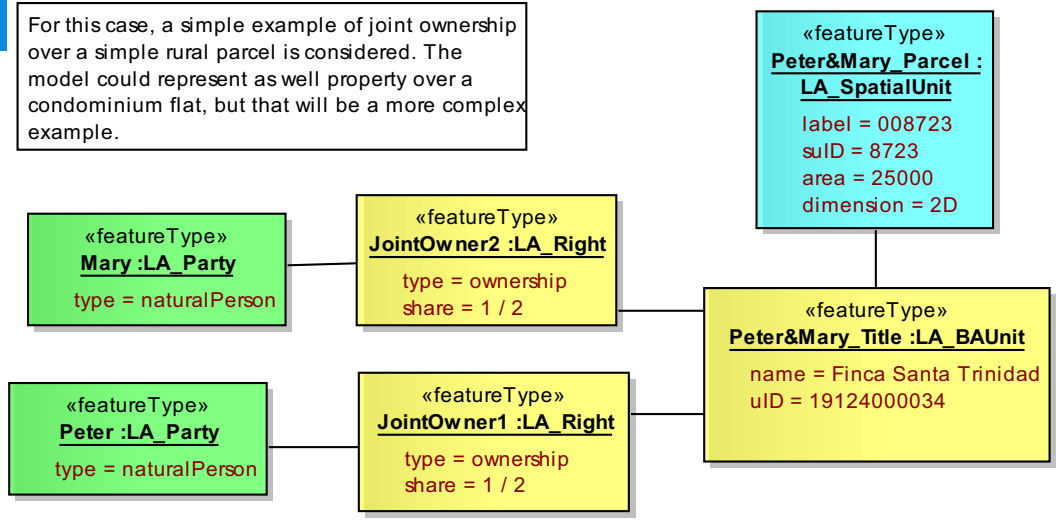


Figure C.30 — A married couple owns a property with equal shares

For this case, a simple example of joint ownership over a simple rural parcel is considered. The model could represent as well property over a condominium flat, but that will be a more complex example.



C.1 — A leaseholder (Joe) and an owner (Fruit Co)

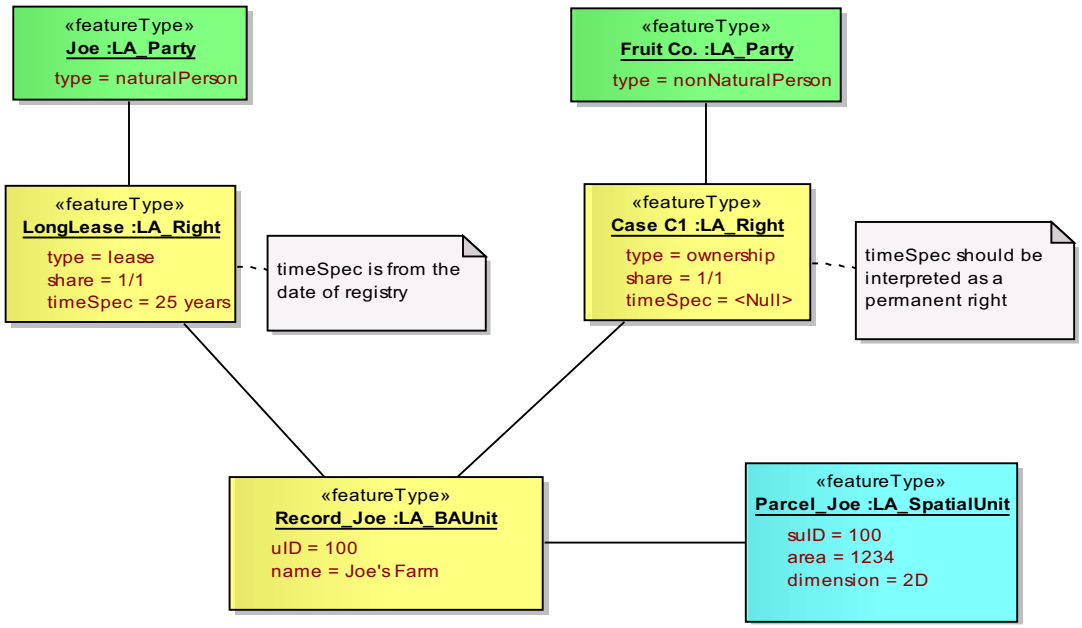


Figure C.5 — A group party holds an ownership right on a parcel

bject Case C5

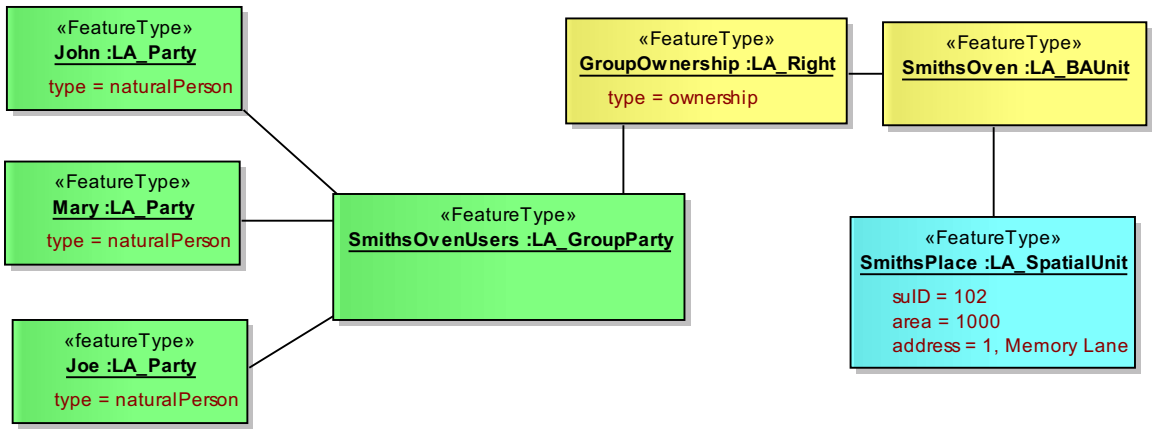
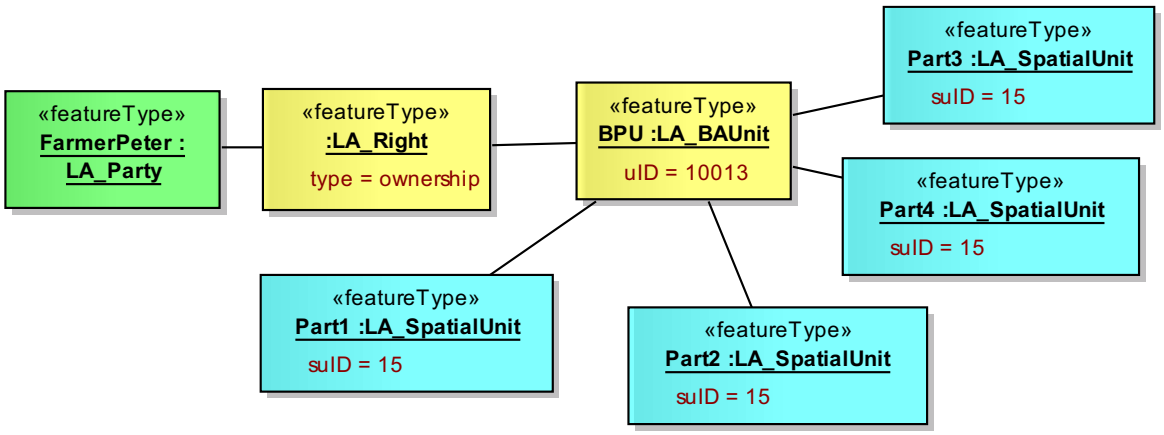


Figure C.17 — Owning a basic property unit with several spatial units

bject Case C17



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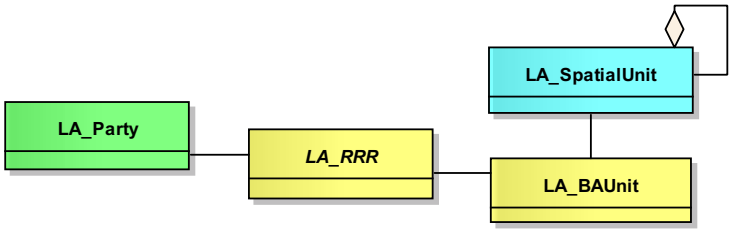


External classes (Domains)

- Archives
- Taxation
- Valuation
- Parties
- Addresses
- Land cover
- Land use
- Utility networks

→ Related, but outside the scope of LADM

Spatial Information Infrastructure

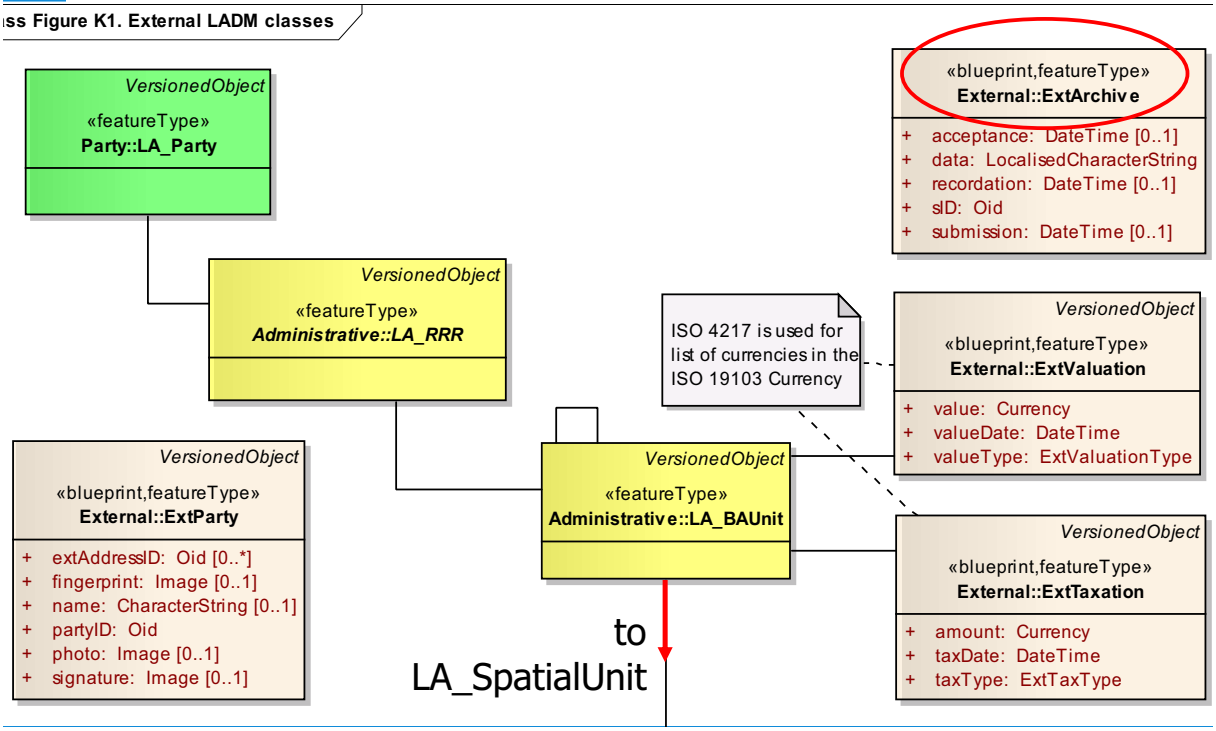
- Standards needed as users are at unknown distance
  → ISO LADM (and CEN)
- Network of related information sources, blueprints for
  → Address, Building, Party, Network, LandUse, …
- Remote users might need/refer to historic version
  → All object classes need to be versioned objects

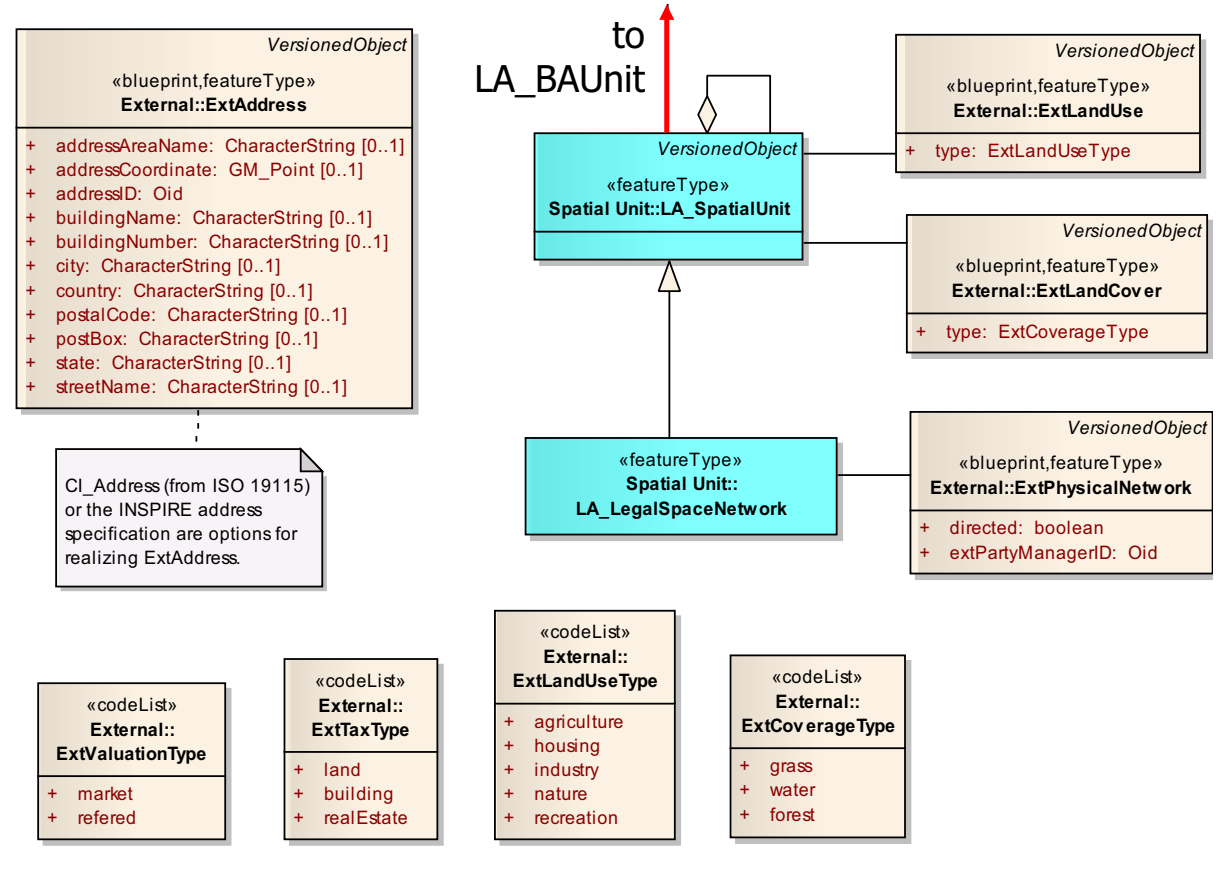
- Maintain consistency: subscription on update warnings
- Legal counterparts of physical objects
- Information assurance (contracts)

- In LADM, external classes as <<blueprint>> and expected to be defined in more detail elsewhere (other standard)

External classes as <<blueprints>>

ss Figure K1. External LADM classes





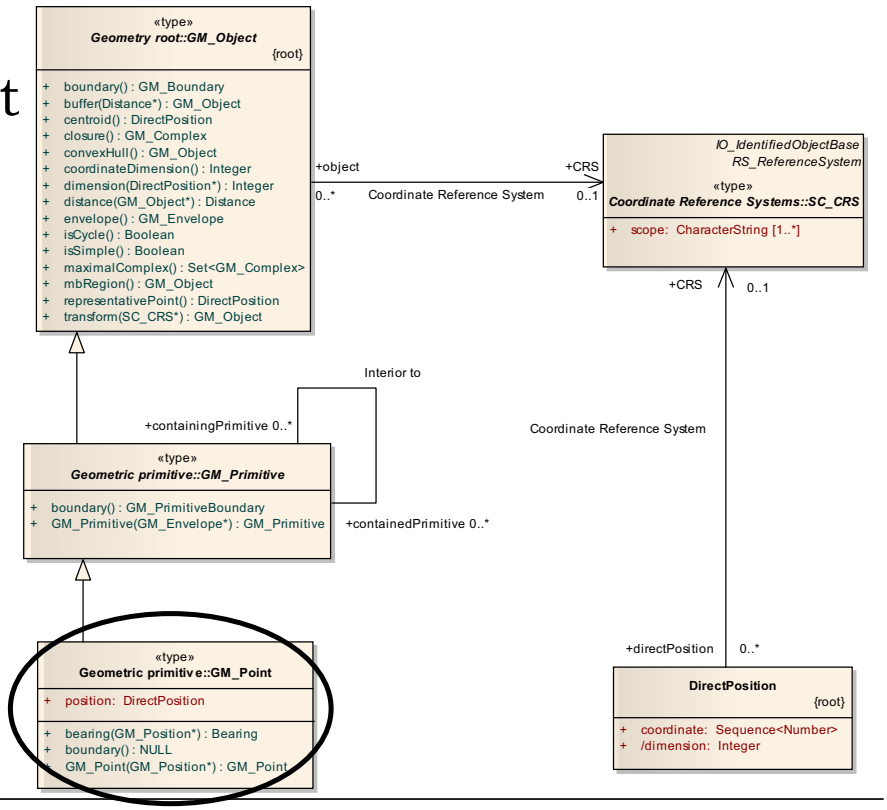
Relationships ISO/TC211 family

- ISO/IS 19103 Conceptual Schema Language
- ISO/IS 19107 Spatial Schema
- ISO/IS 19108 Temporal Schema
- ISO/IS 19111 Referencing by Coordinates
- ISO/IS 19115 Metadata
- ISO/IS 19156 Observations and Measurements (O&M)

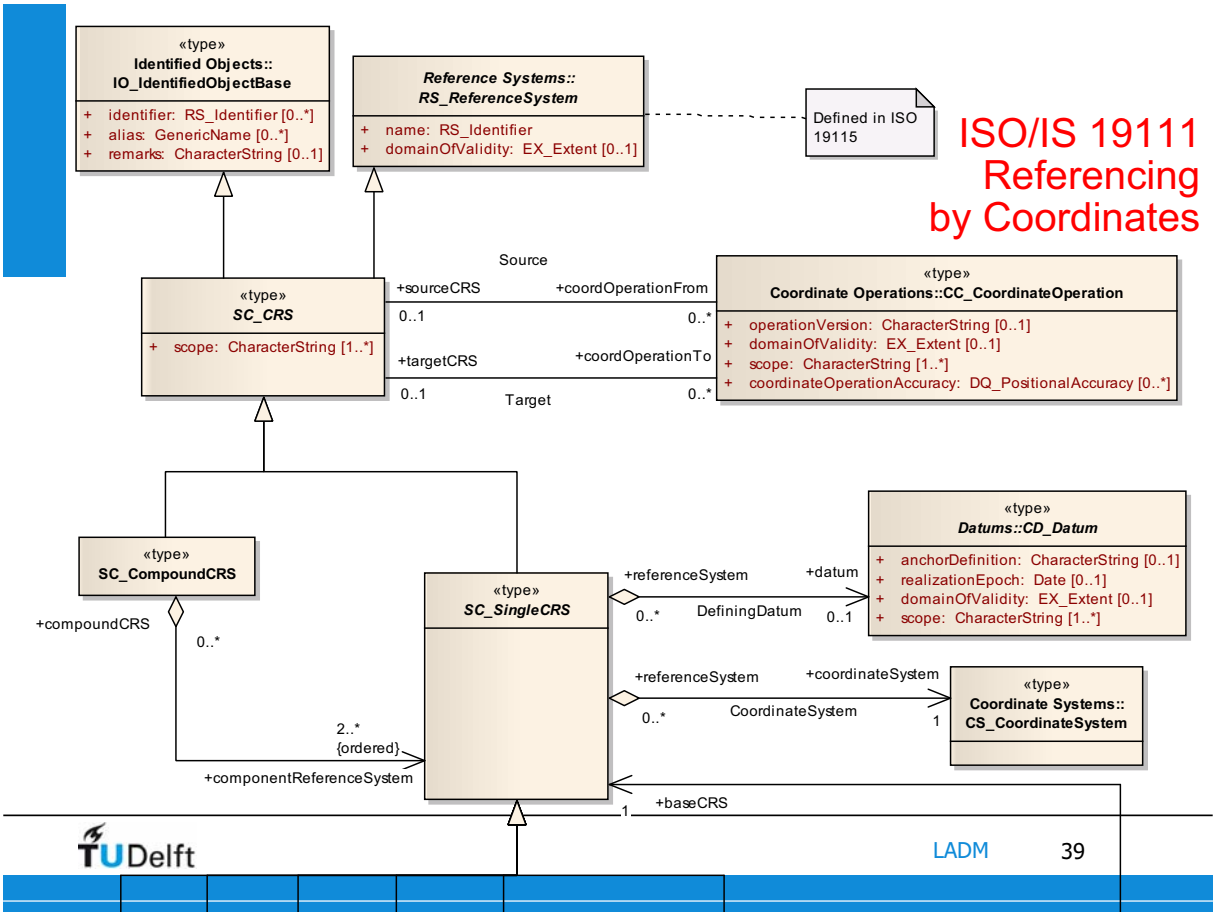
- UoM, Area, Volume (19103)
- GM_Point (19107)
- Coordinate Reference System (19111)
- DQ_Element (19115)
- OM_Observation & OM_Process (19156)

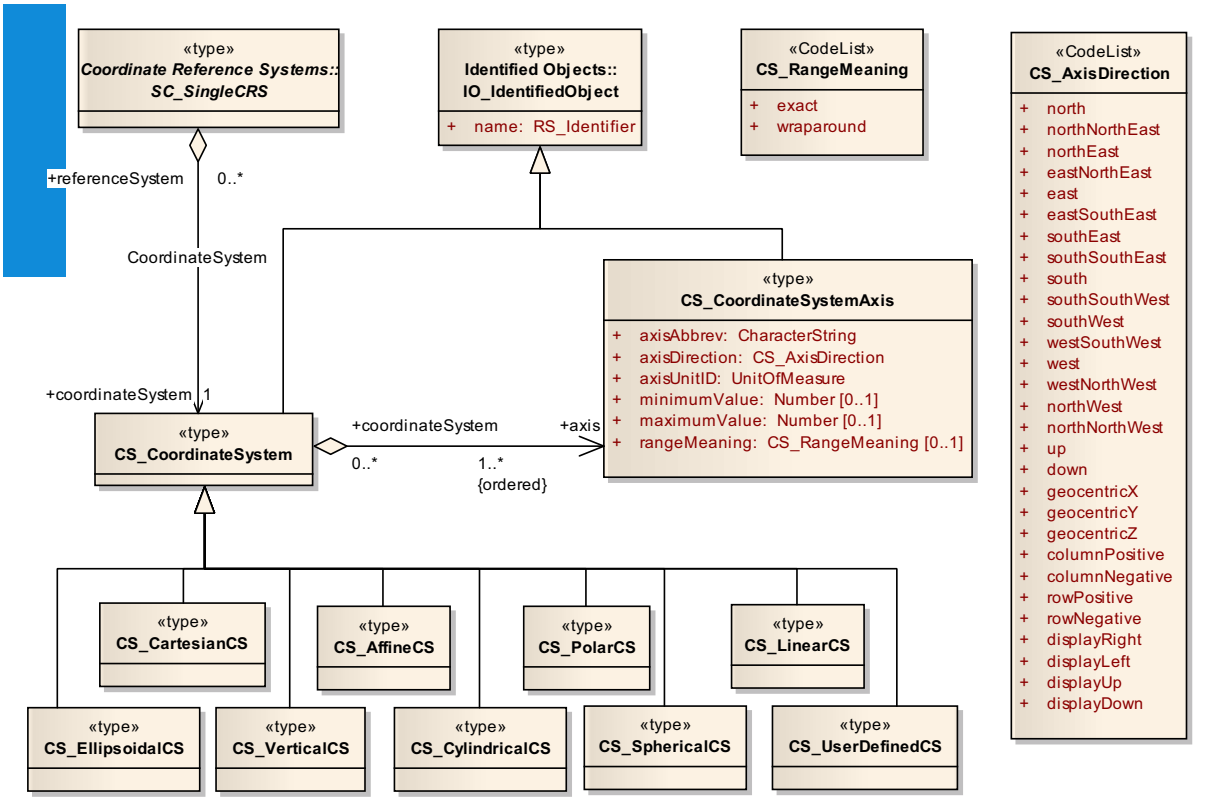
GM_Point

- Part of large model: ISO 19107
- Many (inherited) methods
- One attribute DirectPosition
- Note SC_CRS (ISO 19111)



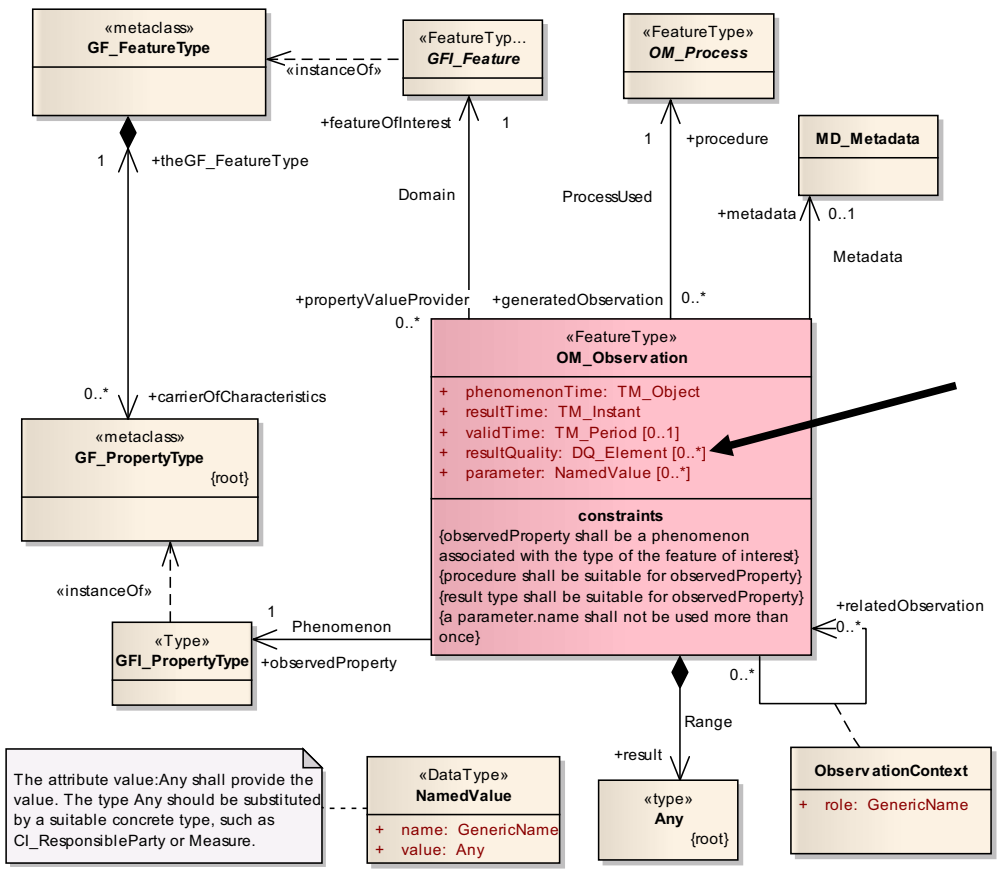
ISO/IS 19111 Referencing by Coordinates



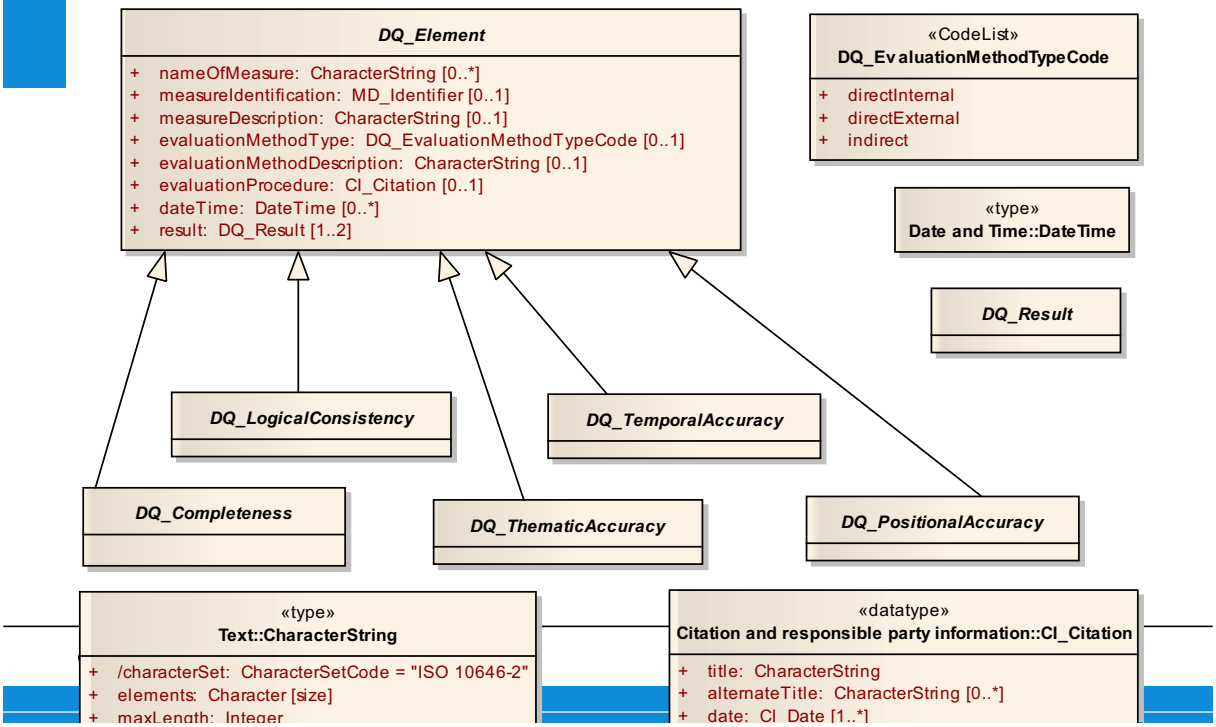


Observations and Measurements

- In LA_SpatialSource attribute "measurements" is of type OM_Observation (as defined in ISO 19156) and contains the actual source survey data
- In LA_SpatialSource attribute "procedure" is of type OM_Process and documents the actual survey procedure



DQ_Element (ISO 19115)



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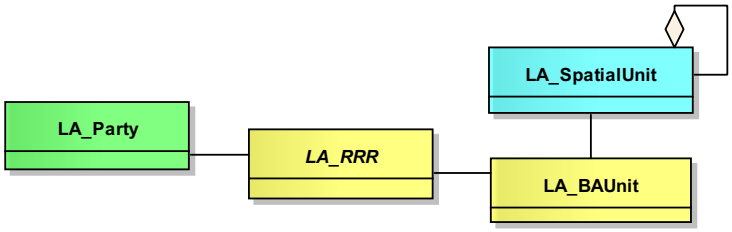

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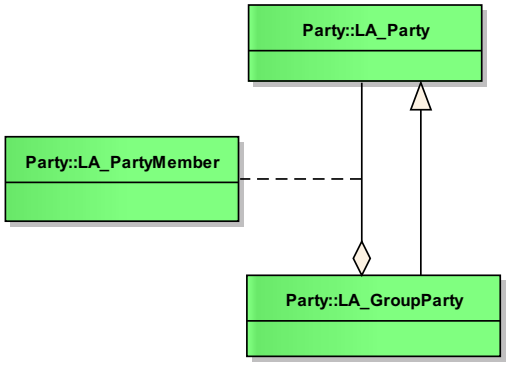
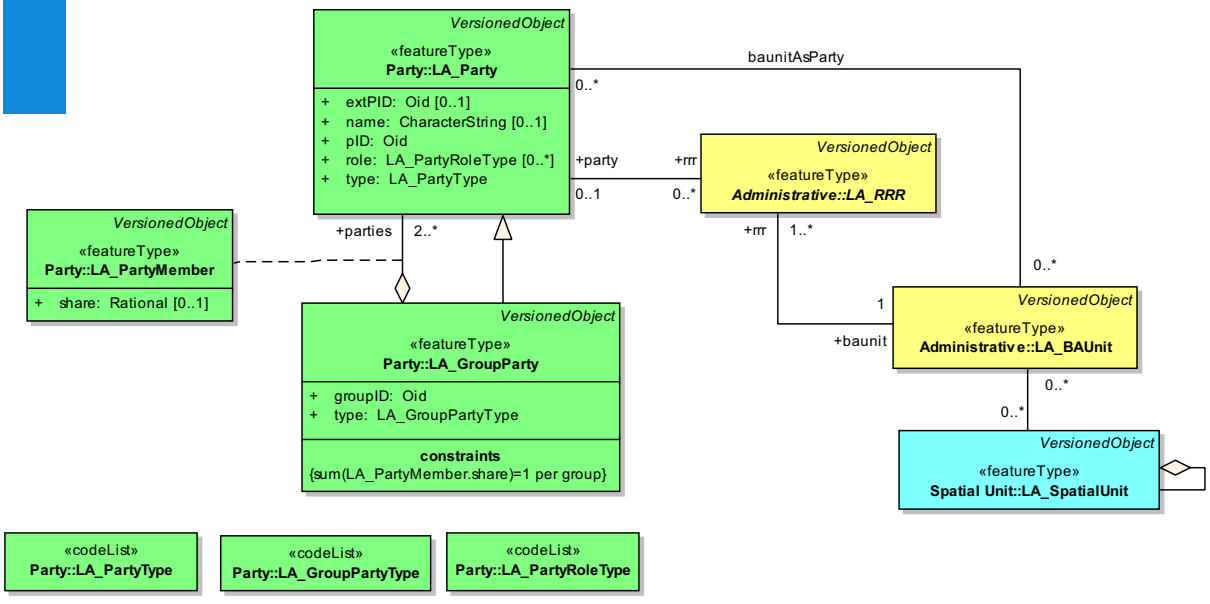
LADM: Party

- Parties can be natural or non natural: private, gov, groups, BAUnit,..
- Surveyor, farmer, notary, money provider are included, role types of the Party class



LADM: Party, some details



Some rights and restrictions

(from Sweden, Ireland, Germany, the Netherlands and Portugal)

Possibility of reverter *Easement* *B.P. right*
Freehold covenant
Beschränkte persönliche Dienstbarkeiten
Ownership *Erbbaurecht*
Grunddienstbarkeit *Gemensamhetsanläggningar*
Servidão de Estilicio
Wayleave *Profít á pendre*
Niessbrauch
Erfdienstbaarheid
Servitut
Bearbetningskonsession *Building lease*
Rentenschuld
Right of entry or re-entry *Vruchtgebruik*
Leasehold *Detaljplan*
Mortgage
Emphyteusis *Opstal* *Grundschuld*
Reallast *Usufruct* *Erfpacht* *Lien* *Right of pre-emption*

Diversity, even with common roots

(Zevenbergen, 6 july'12 at LADM workshop, Rotterdam)

Property rights, including land rights, very diverse, even in Europe

- Of course its language has its own words for 'similar notions', even two jurisdictions with shared language have often different wordings
- EU Lisbon treaty: 'The Treaties shall in no way prejudice the rules in Member States governing the system of property ownership' (art.345)
- Core right, esp. ownership, rather similar, but..
  - more customary rights very diverse (although number of effected parcels might not be that large), even in Europe
  - individual possession of flats extreme diverse (own part of building, co-own whole building, special cooperation, stocks in company, ..)

Legal Families in Europe

Newman and Thornley (1996)

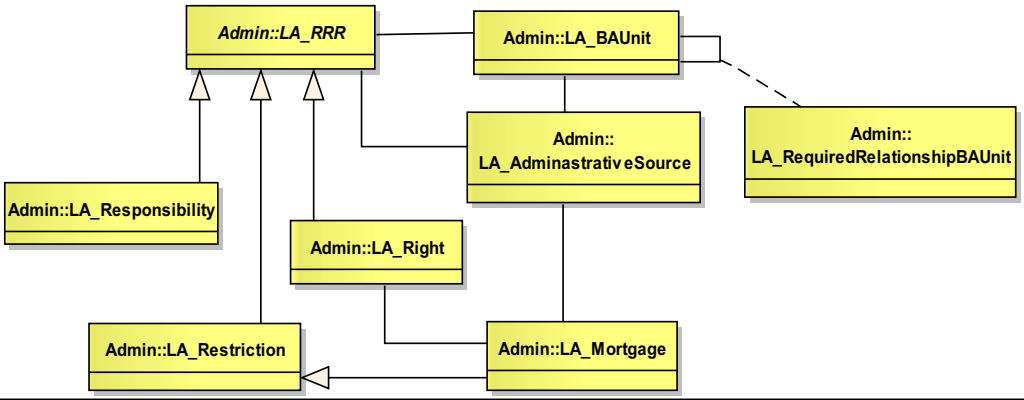
Diversity, some common elements

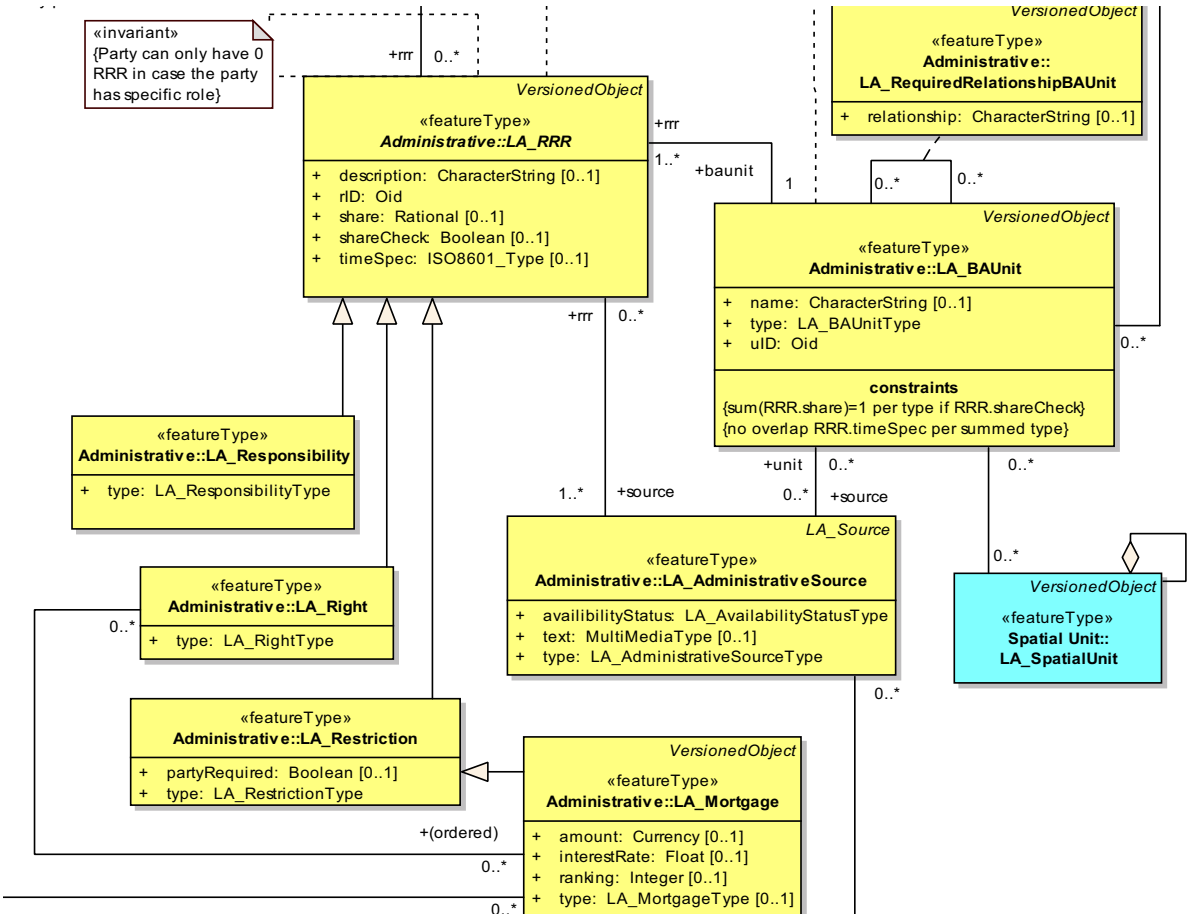
- Land Rights rather limited, even ownership
- Layered rights (leasehold), secondary rights (usufruct)
- Restrictions and responsibilities

- One person's right, is the neighbors burden; e.g. servitude
- Rights that are linked to another right (not to be separated)
- Stake in group rights; e.g. joint facilities, which can not be separated from the main right
- Mortgage (hypotec) on any other strong rights

LADM: Administrative (legal)

- RRR (Right Restriction Responsibility) has associations with Party (Person) and Basic Administrative Unit (and indirectly to SpatialUnit)
- RRRs are based on legal documents or decisions
- A RRR can be temporal:
  - Long lease (or ownership for limited time)
  - Nomadic behavious/Hunting rights during certain seasons
  - Time-sharing (mon-fri:X, sat-sun:Y)



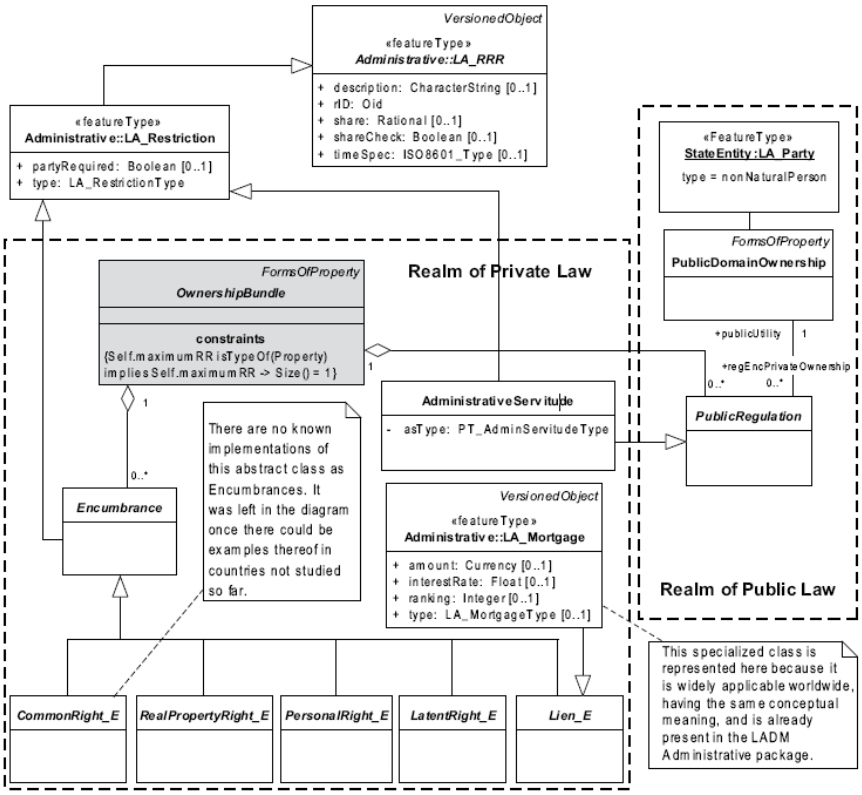


Annexes to ISO 19152

- Annex A (normative) Abstract Test Suite
- Annex B (normative) 2D and 3D Representations of Spatial Units
- Annex C (informative) Instance Level Cases
- Annex D (informative) Country Profiles
- Annex E (informative) Spatial Units and Spatial Profiles
- Annex F (informative) Legal Profiles
- Annex G (informative) The LADM and INSPIRE
- Annex H (informative) The LADM and LPIS
- Annex I (informative) STDM
- Annex J (informative) Code lists
- Annex K (informative) External Classes
- Annex L (informative) Interface Classes
- Annex M (informative) Modelling Land Administration Processes
- Annex N (informative) History and Dynamic Aspects
- Annex O (informative) LADM and other ISO/TC 211 Standards

Annex F (informative) Legal profiles

- Restrictions (Figure F.2)



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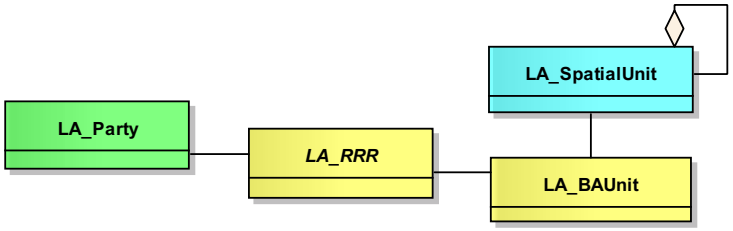


Quote from page 14 of PhD-thesis Jesper M. Paasch

- "A research hypothesis was established stating that

  it is possible to categorize real property rights and public regulations influencing real property ownership, regardless of their origin in different legal systems."

- Spacing and coloring added
- PhD thesis-title:
  Standardization of Real Property Rights and Public Regulations
  (KTH Stockholm, September 2012)

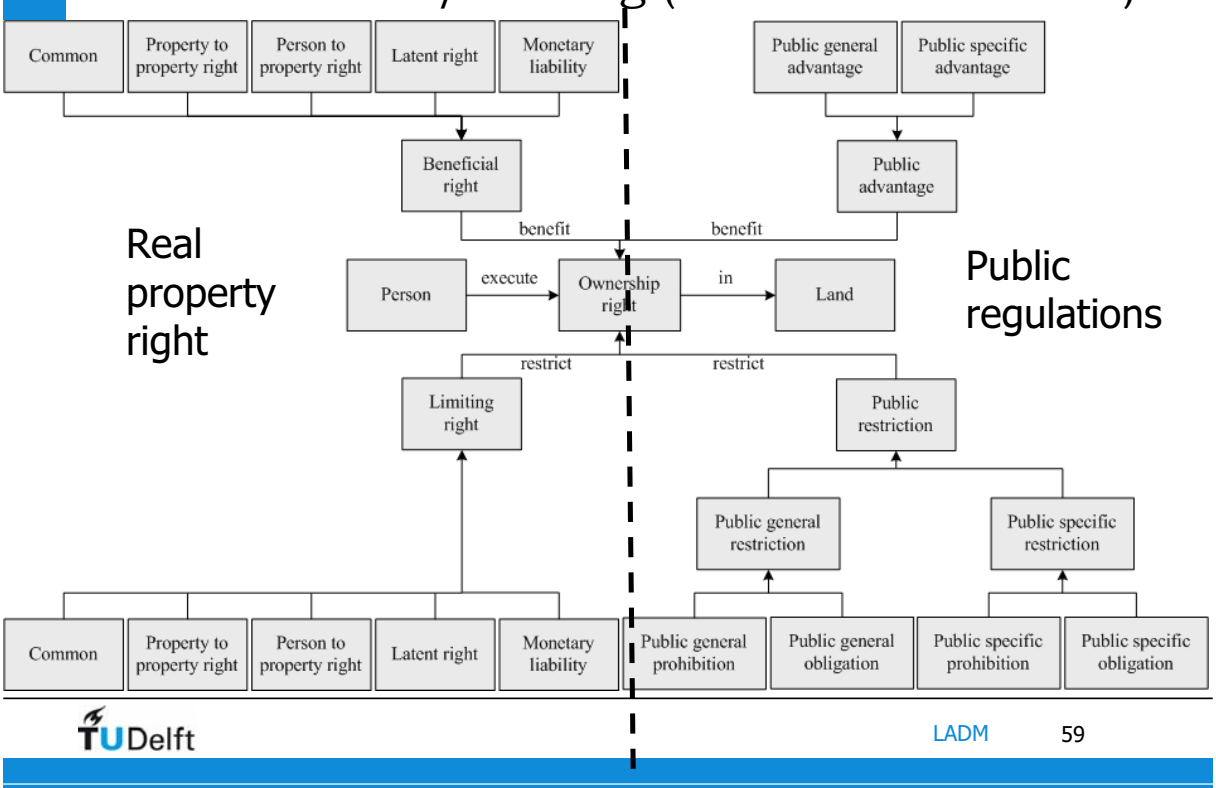
The LADM provide a rather coarse classification

- Right
  "action, activity or class of actions that a system participant may perform on or using an associated resource"
- Restriction
  "formal or informal obligation to refrain from doing something"
- Responsibility
  "formal or informal obligation to do something"

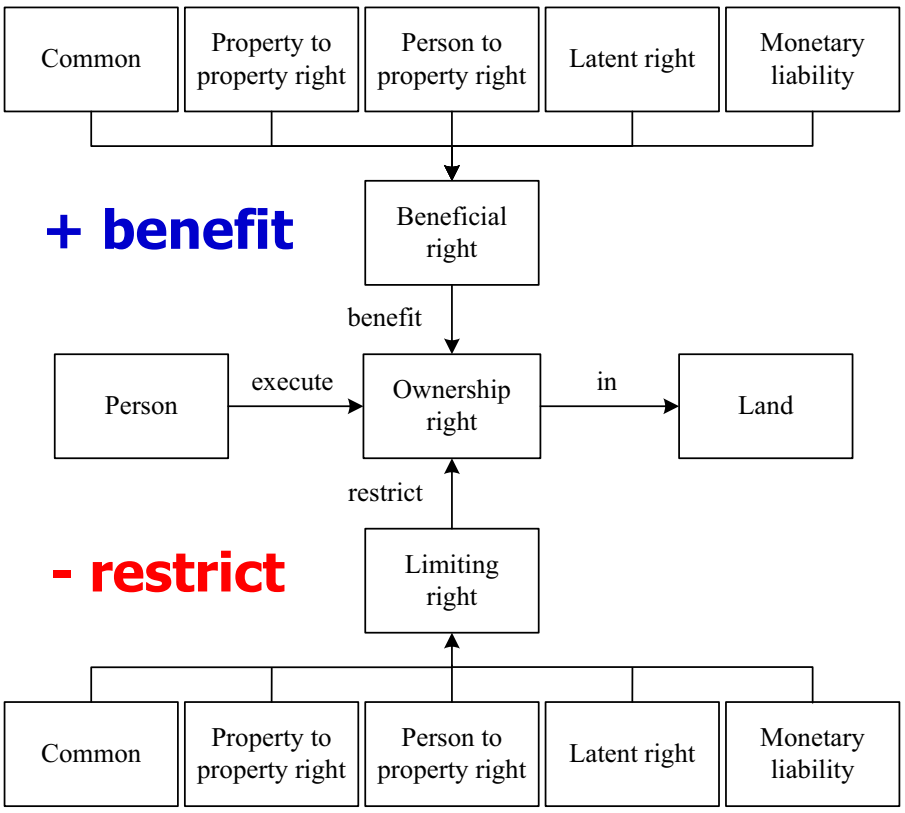
Legal Cadastral Domain Model (LCDM)

- A more detailed classification of rights, restrictions and responsibilities than LADM
- Based on how they influence ownership ← central concept
- *PhD-thesis Jesper Paasch (KTH, September 2012)*
  Standardization of Real Property Rights and Public Regulations – The Legal Cadastral Domain Model

Warning: temporarily non-LADM notation/naming (PhD-thesis Paasch)



Real property right classes

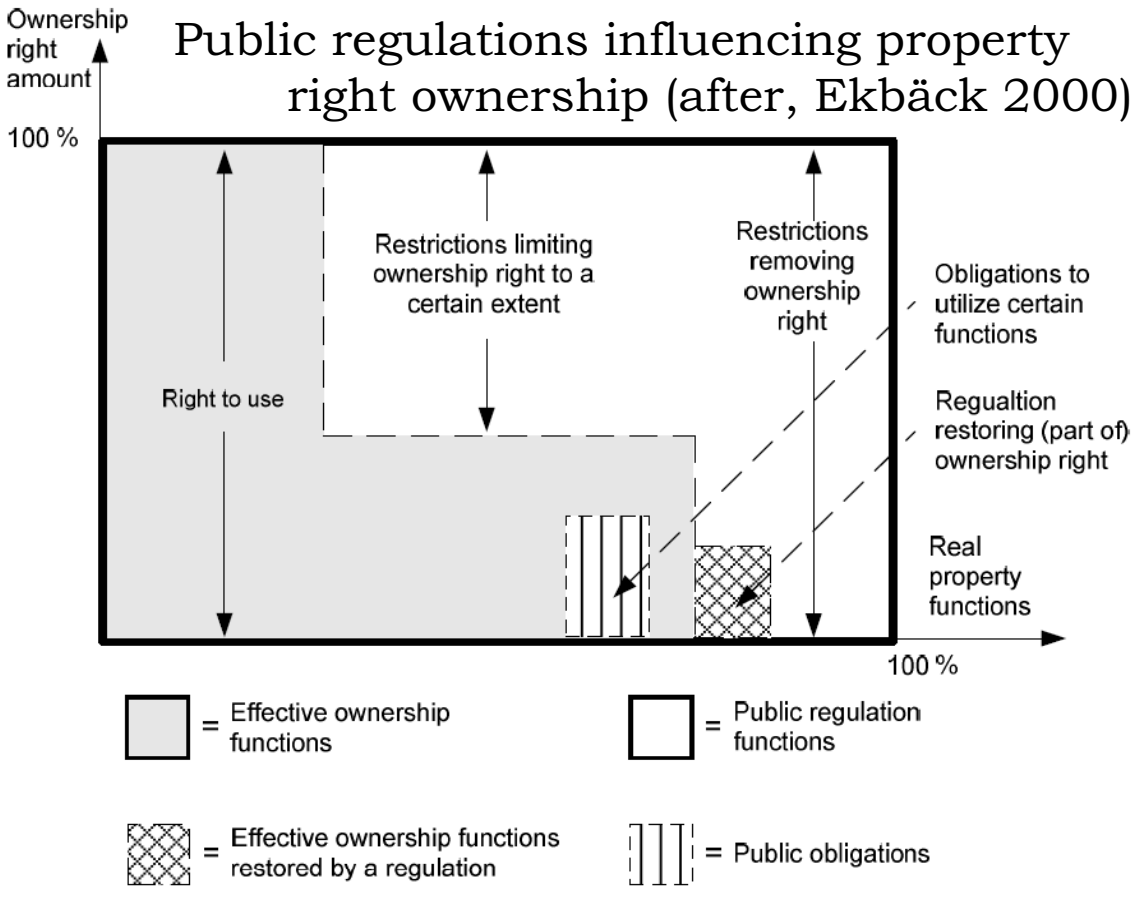


Private interests in LCDM are divided into five groups, examples

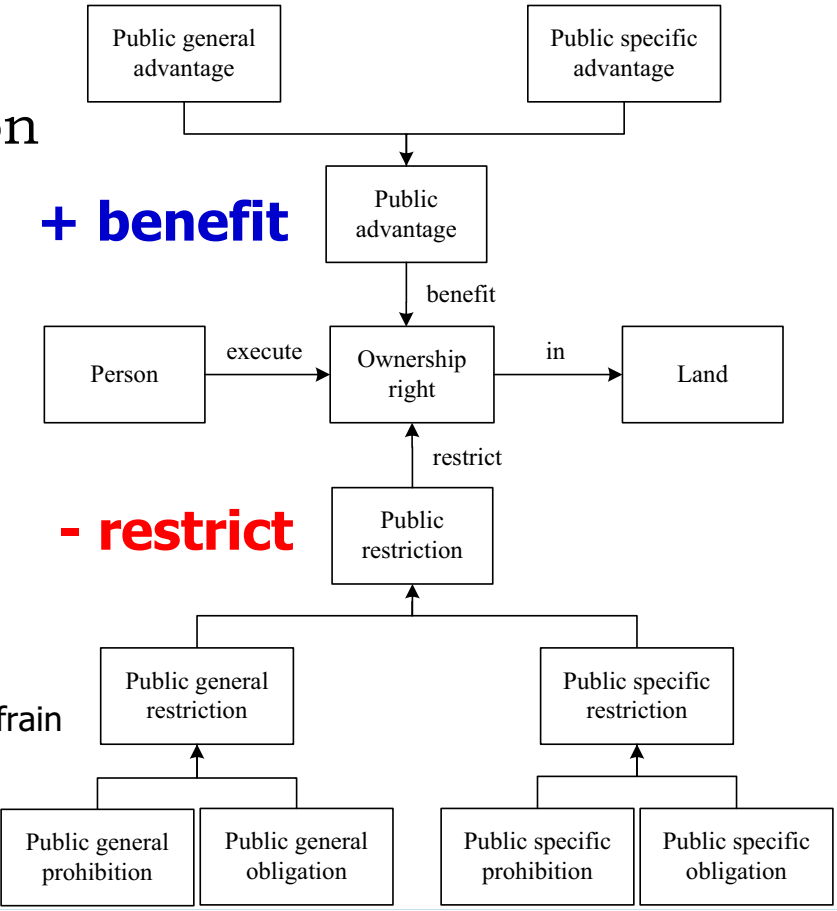
1. Common
   → e.g. be a property jointly owned by other properties
2. Property to property right
   → e.g. an easement
3. Person to property right
   → e.g. a personal use right
4. Latent right (is a right not executed yet)
   → e.g. a pre-emption right
5. Monetary liability (is a financial claim)
   → e.g. a mortgage.

Full definitions are provided in PhD-thesis Paasch

Public regulations influencing property right ownership (after, Ekbäck 2000)



Public regulation classes



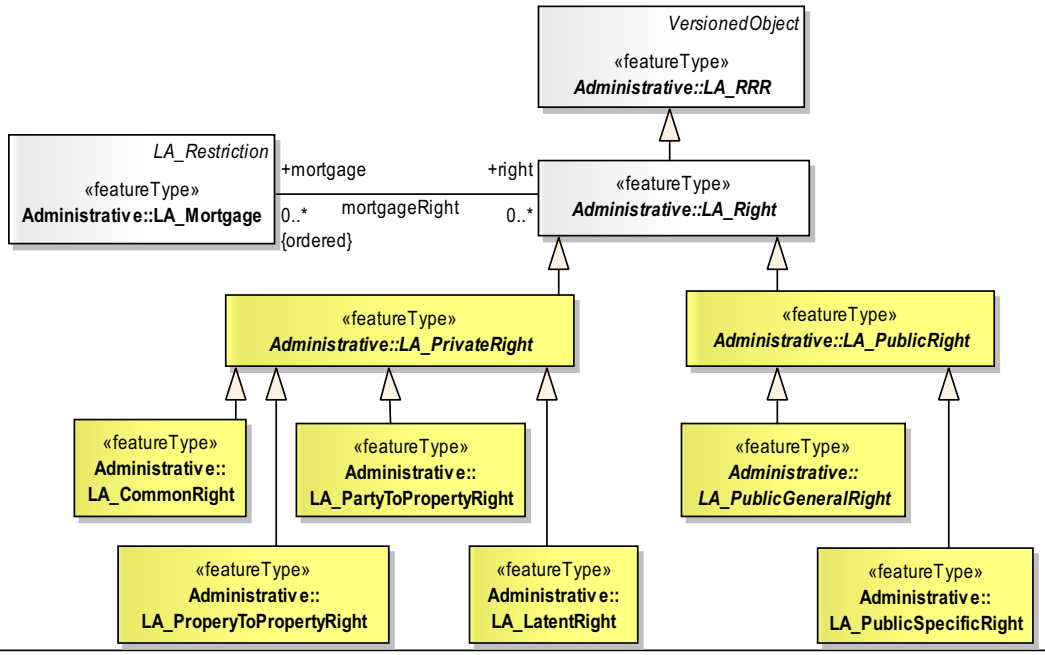
- General: regulation at class (type) level
- Specific: regulation by decision at instance (set) level

- Obligation: must do
- Prohibition: must refrain

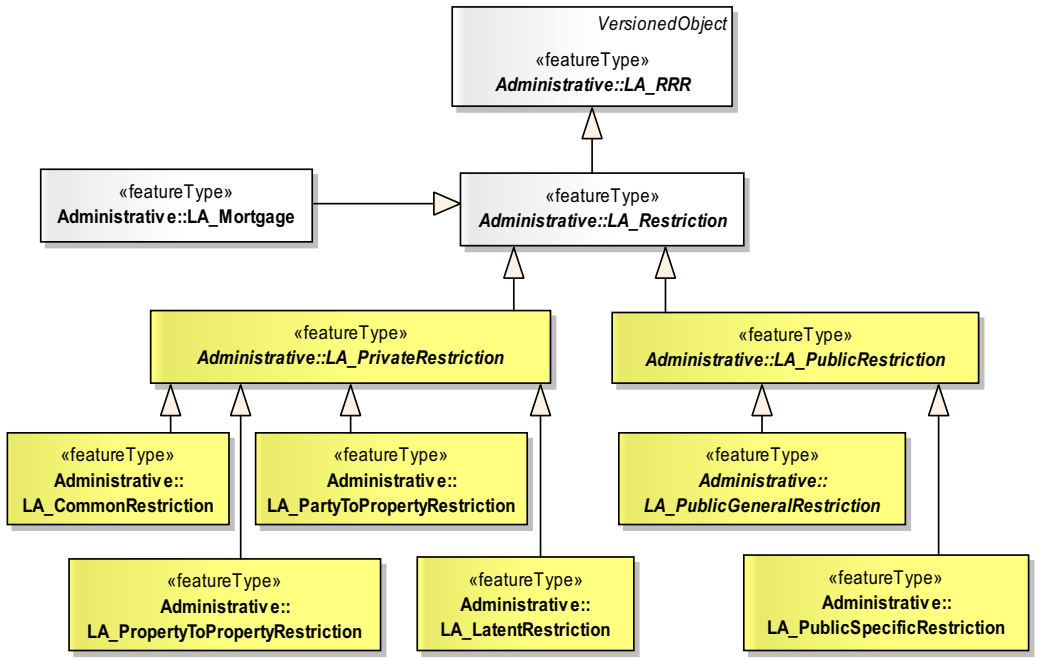
LADM Legal Profile

- Based on the Legal Cadastral Model Classification
- LCDM naming aligned with LADM terminology
- Monetary liability mapped to LA_Mortgage (more broad interpretation)
- Modeled in UML class diagrams
  Note the use of *abstract* and concrete classes

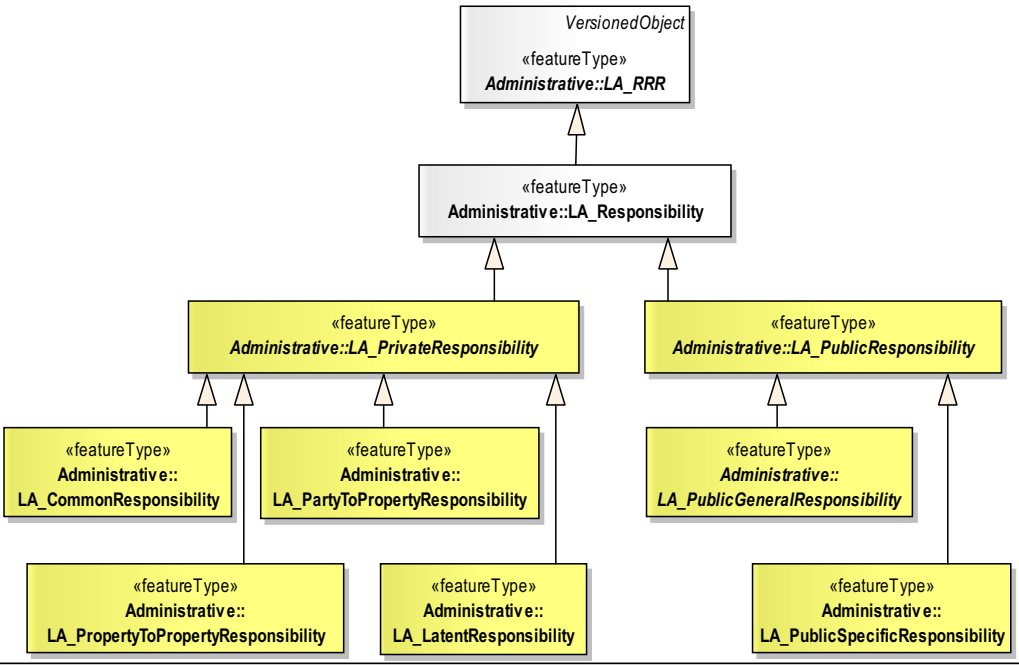
LA_Right extended profile for privately and publicly imposed rights



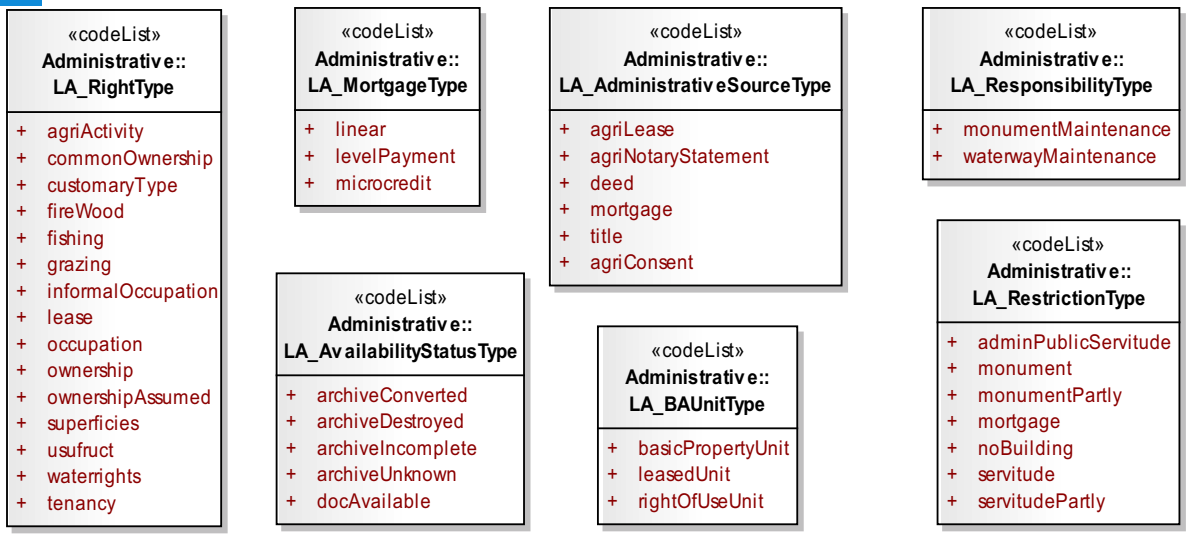
LA_Restriction extended profile for privately and publicly imposed restrictions



LA_Responsibility extended profile privately and publicly imposed responsibilities



LADM's current code lists for Administrative Package (annex J.2)



Code lists need further structuring and formalization

- Should there for every of the 6 leaf and 2 non-leaf subclasses of LA_Right be separate code lists?
- Same questions for LA_Restriction and LA_Responsibility?
- Can code lists inherit from corresponding parent code lists?
- How to add country specific code list values (related to the standard code list values)?
- How to deal with country profiles in which standard code list are not applicable?

- For code lists related to the *abstract leaf* classes:
  these code list values encode public (general) regulations!

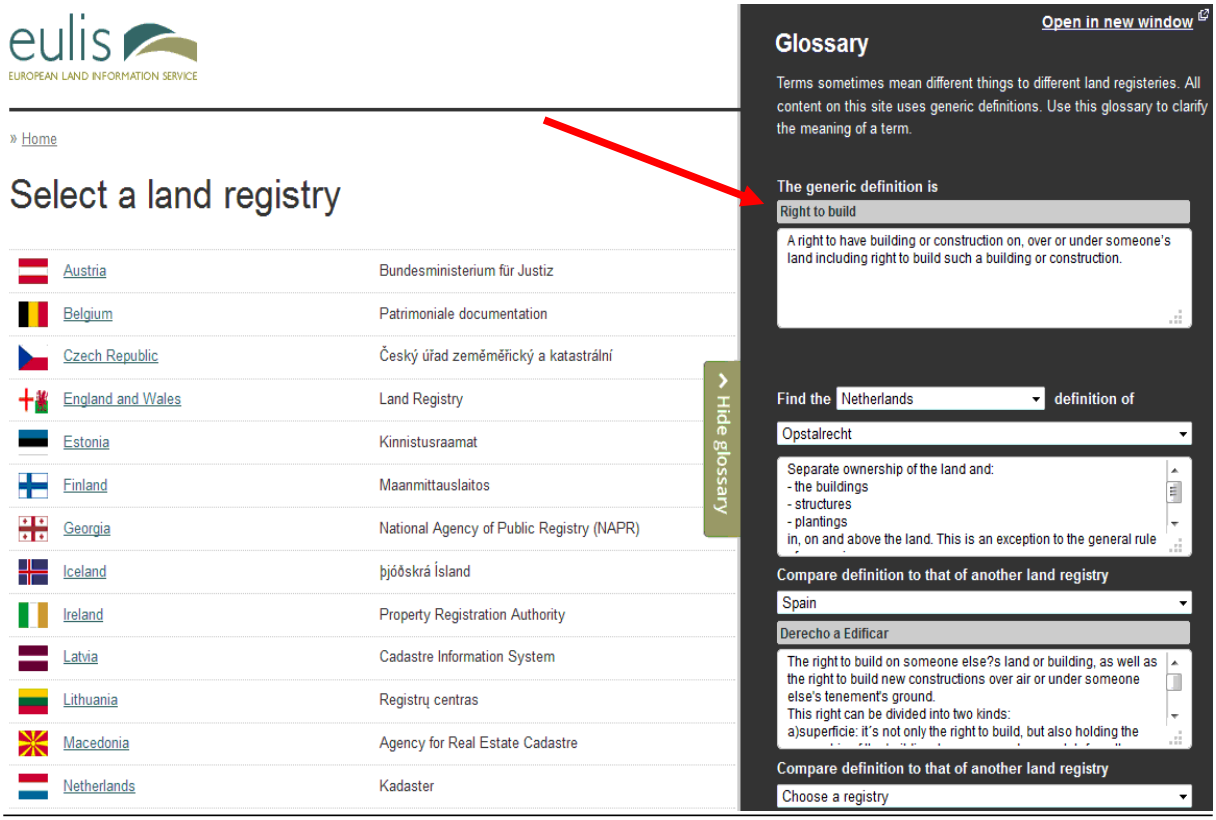
Legal refinement: New LADM classes or extend LADM code lists ?

- More and more new LADM classes (as presented) and also more proposed; e.g. LA_RRR: LA_CustomaryRight
  as previously proposed in (Hespanha, 2013)

- Or extend LADM code lists with more types of rights?
  1. Tenancy
  2. Grazing
  3. Trusteeship
  4. "Terra nullius" (customary lands without owners)
  5. …

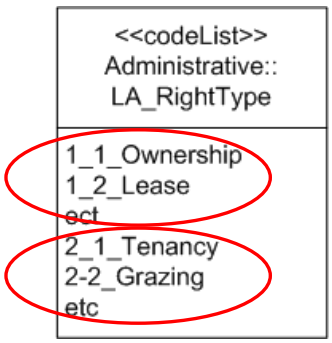
  based on (Alden Willy, 2013)

- 'Formal' definitions of code list values needed; example from European Land Information Service, EULIS (http://eulis.eu)



Example of formal and non-formal rights code list

Hierarchy in the code list values is a way to better define the values.



Formal

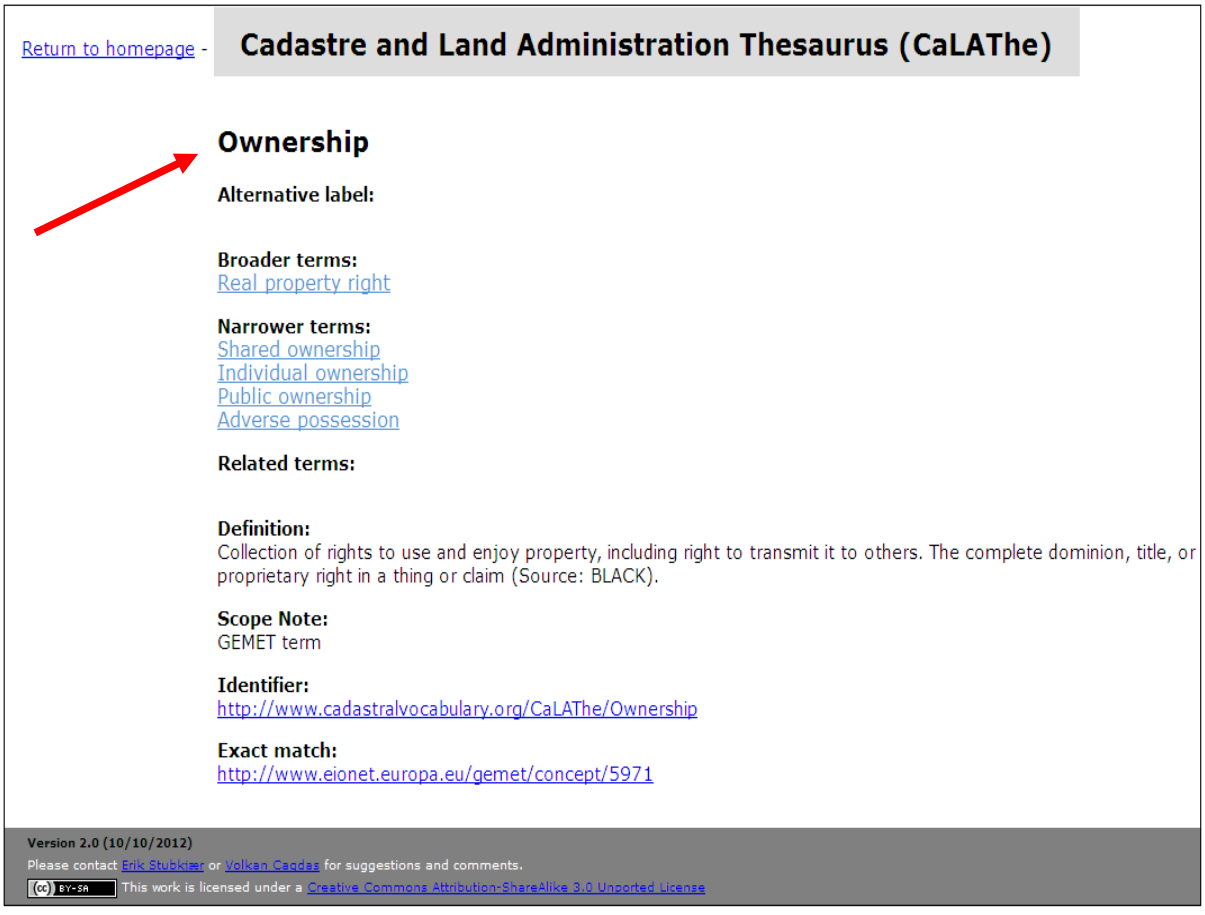
Non-formal

(FAO)

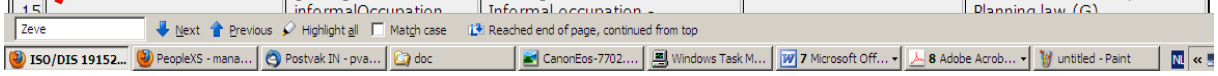
National identification can be done according to ISO 3166-1 country codes

Semantic technologies

- Semantic technologies (ontology, etc.) can be used to further provide explicit meaning to code list values in more refined manner than just a hierarchy
- RDF (Resource Description Format) vocabulary SKOS (Simple Knowledge Organization System) has semantic relations between concepts; such as: broader, narrower, related, closeMatch, exactMatch, broadMatch narrowMatch, relatedMatch,...
- SKOS example 'Cadastre and Land Administration Thesaurus' (CaLAThe by Erik Stubkjær and Volkan Cagdas), LADM related/inspired; http://cadastralvocabulary.org/



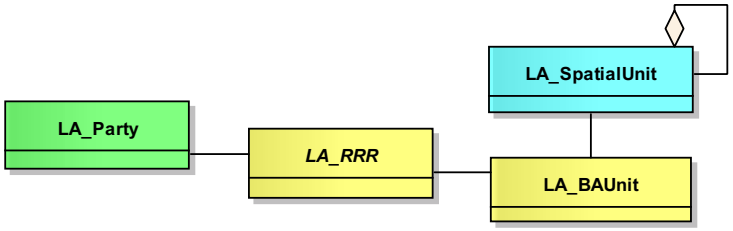
	Terms of the ISO/DIS 19152 LADM **Administrative package**		Draft CaLAThe terms based only on LADM terms	CaLAThe thesaurus terms (ver.1) and related thesauri A: AGROVOC agricultural vocabulary G: GEMET Thesaurus I: INSPIRE Spatial Data Themes O: Cycorp's OpenCyc S: STW Thesaurus for Economics	
	Primary terms	Secondary terms: Attributes and Enumeration and code list terms		Adopted terms (+ alternative labels)	New terms (+ alternative labels)
1	LA_BAunit		Basic administrative unit ~	Property unit ~ (Basic administrative unit)	(Real estate (S))
2 3 4 5	LA_BAUnitType	basicPropertyUnit leasedUnit propertyRightUnit	Basic administrative unit type ~ Basic property unit - Leased unit - Property right unit -	Property unit type ~	Servient property unit Dominant property unit
6	LA_RRR		Right, restriction and responsibility -		Law (S)
7	LA_Right		Right -		Real property right
8 9 10 11 12 13 14 15	LA_RightType	agriActivity commonOwnership customaryType firewood fishing grazing informalOccupation	Right type - Agricultural activity - Common ownership ~ Customary right ~ Firewood - Fishing - Grazing - Informal occupation -	Shared property ~ Customary law ~	Legal basis (G) (Formal right Real estate law (S) Individual ownership Public ownership (A) Party share Condominium right Timeshare ownership Planning law (G)



International legal refinement possible

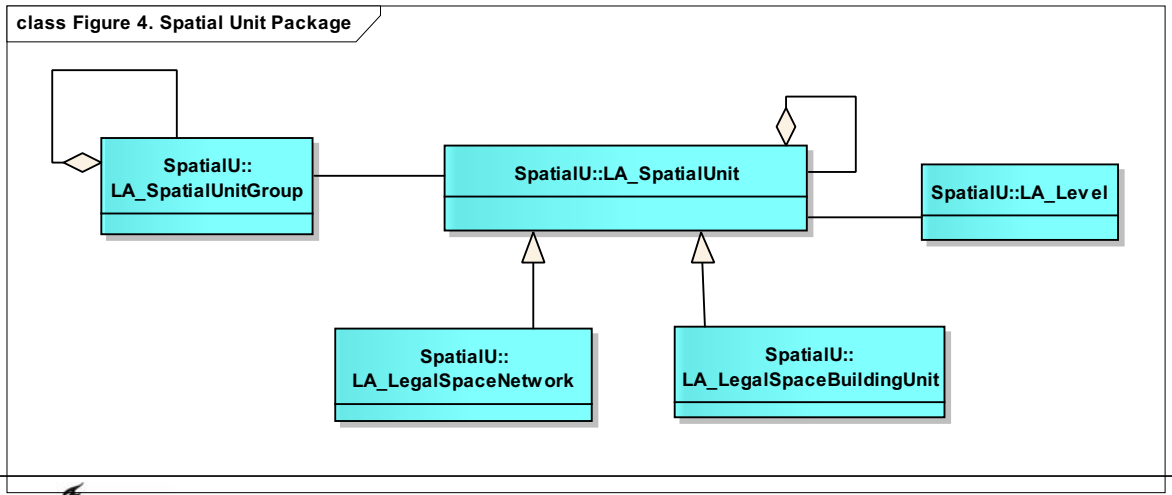
- The extended model is suitable for classification of real property rights and public regulations (at least in Western legal systems), based on the case study results
- The model should be further tested in other legal systems
- Applying the "correct" terminology is important and an ongoing
- Code lists with values for types of rights, restrictions and responsibilities need further structuring and formalization
- LCDM does extend the LADM standard and has been integrated

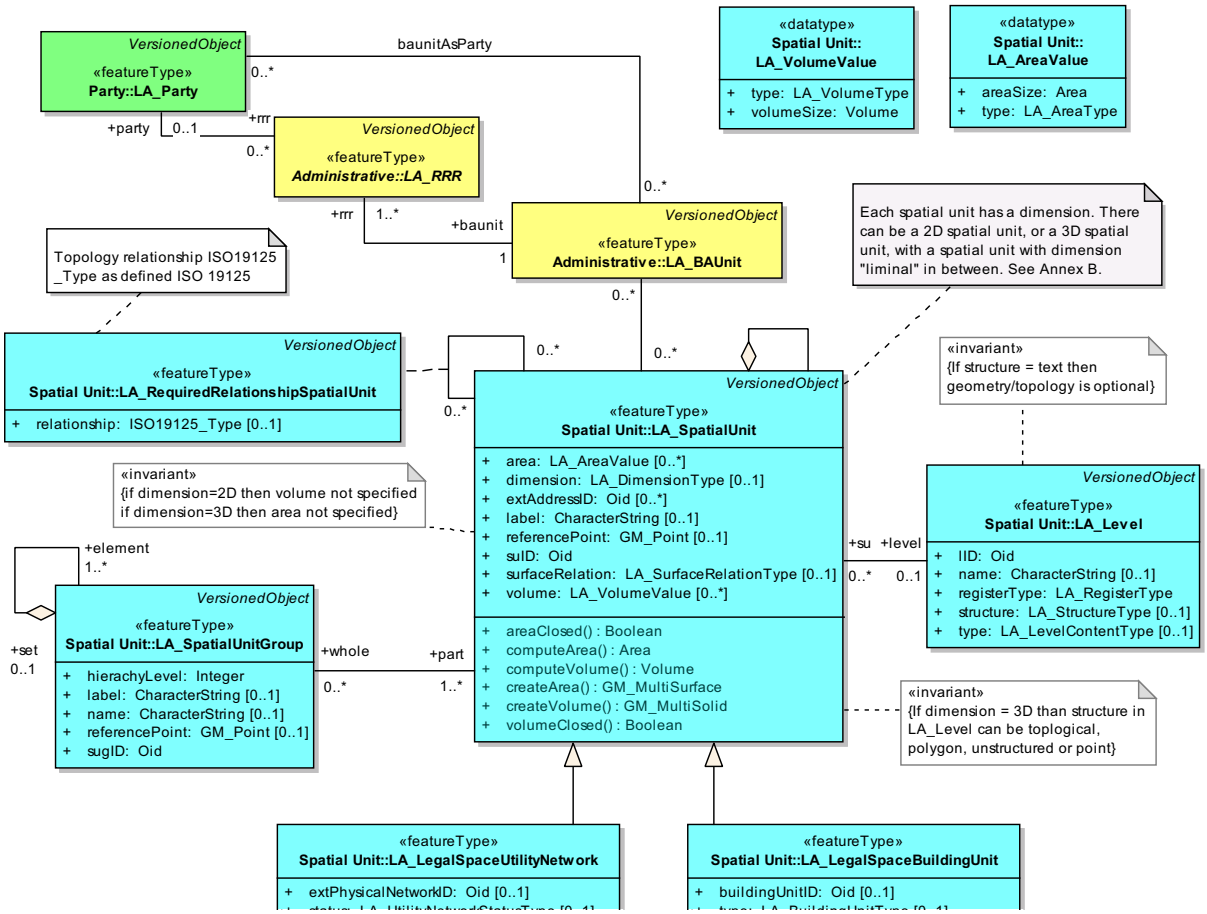
Contents



LA_SpatialUnit (alias LA_Parcel)

- LA_SpatialUnit specializations: network, building unit
- organized in LA_Level based on structure or content
- 5 types: point, text (unstructured) line, polygon, and topology
- 2D and 3D integrated without complicating 2D





Text-Based Spatial Unit

"beginning with a corner at the intersection of two stone walls near an apple tree on the north side of Muddy Creek road one mile above the junction of Muddy and Indian Creeks, north for 150 rods to the end of the stone wall bordering the road, then northwest along a line to a large standing rock on the corner of John Smith's place, thence west 150 rods to the corner of a barn near a large oak tree, thence south to Muddy Creek road, thence down the side of the creek road to the starting point."

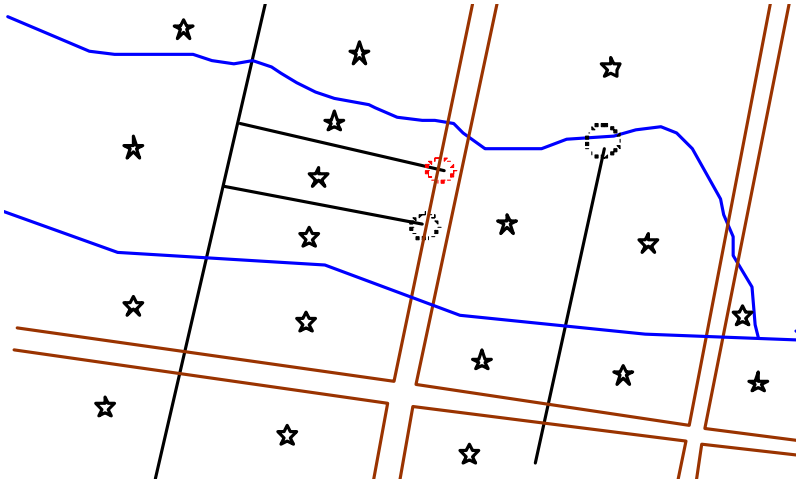
(quoted from: http://en.wikipedia.org/wiki/Metes_and_bounds).

Point-Based Spatial Unit

"*a single coordinate of the centre of the dwelling unit could positively identify that unit, and this may be sufficient for basic recording purposes where the limits of the land holding are for the time being unimportant".*

- An early stage in a system of progressive title improvement, ending in a standard freehold system.
- Identifies a spatial unit, but does not delineate it.
- Provides an address reference point.

Line-Based Spatial Unit

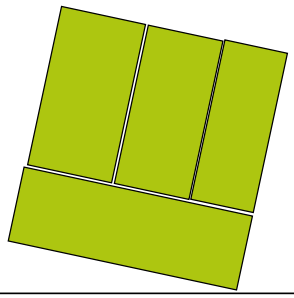


Likewise an early stage in development
Allows misses and overshoots
Still provides a useable "cadastral map" base

Polygon-Based Spatial Unit

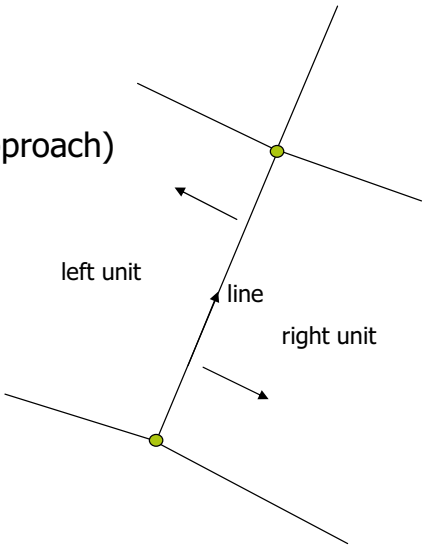
Each spatial unit is recorded as a separate entity (a polygon in 2D).

- No topological connection between neighbouring spatial units (and no boundaries shared),
- Constraints enforcing a complete coverage must be applied by the sending and receiving software
- All lines are represented twice (at least)
- Secondary interests difficult.



Topology-Based Spatial Unit

- Lines are stored once only
- Lines broken at nodes (unlike line-based approach)
- Fast for adjacency
- Tight validation
- Topology is built into the database



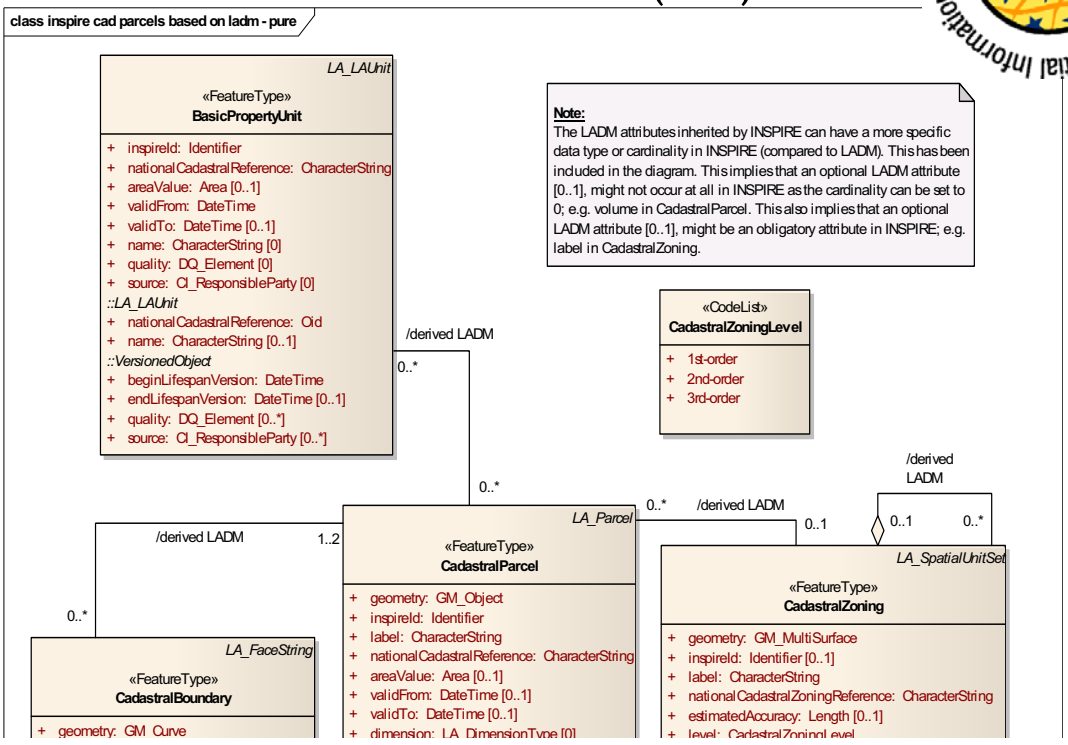
ISO 19152 LADM based INSPIRE cadastral parcels

- Infrastructure for Spatial Information in the European Community
- INSPIRE defines 34 data theme's, of which cadastral parcels is one

- From LADM to INSPIRE:
  1. Selection of relevant classes
  2. Based on inheritance
  3. Add attributes
  4. Add constraints (to refine meaning)

- LADM and INSPIRE cadastral parcels are compatible

INSPIRE Cadastral Parcels (CP)



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Spatial profiles fill-in the options

- Text
- Point
- Unstructured line
- Polygon
- Topology

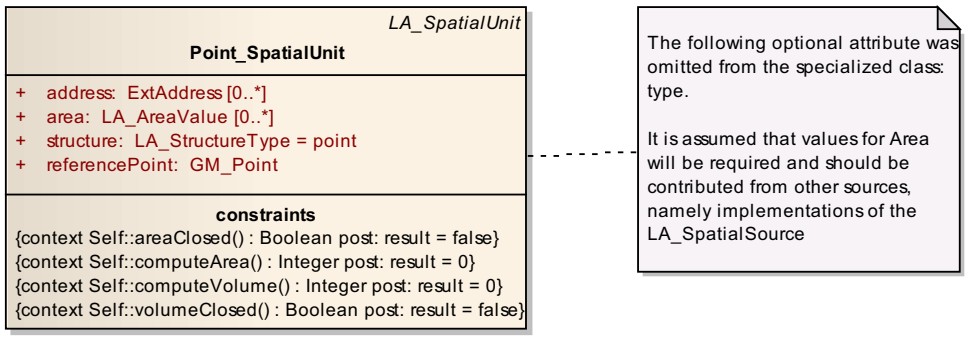
- 2D
- 3D
- Mixed

→ Gives 5 times 3 options (15 in total), now 3 examples

Point based (2D)

The following classes should be omitted

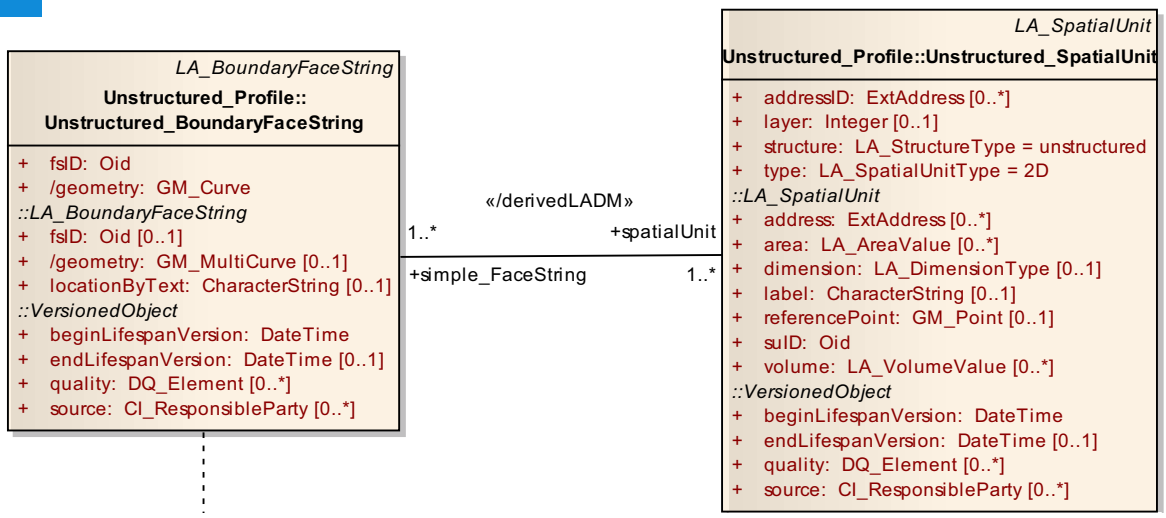
- LA_BoundaryFaceString;
- LA_BoundaryFace



Unstructured line based (2D)

The following classes should be omitted

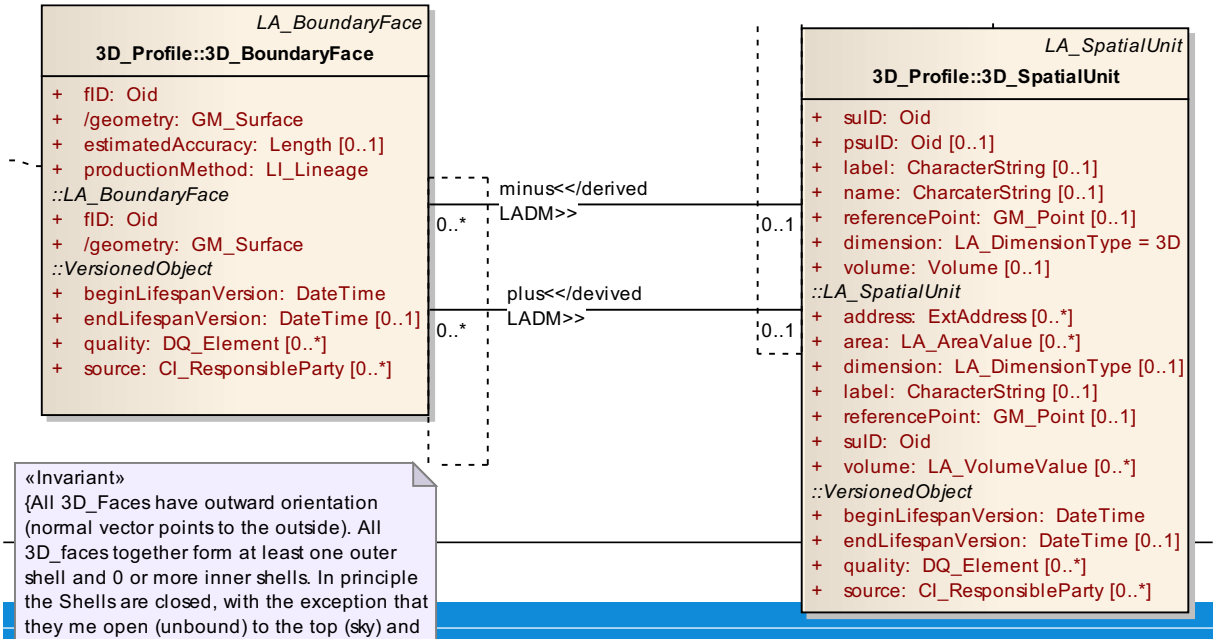
- LA_BoundaryFaceString



Topology based (3D)

The following class is omitted

- LA_BoundaryFaceString



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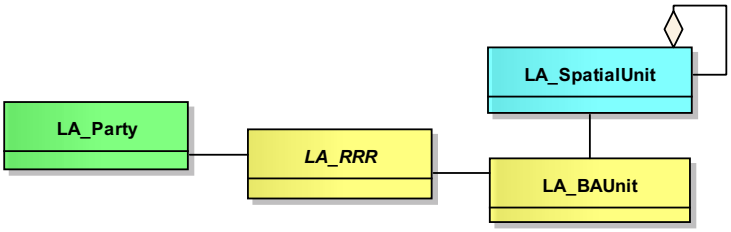
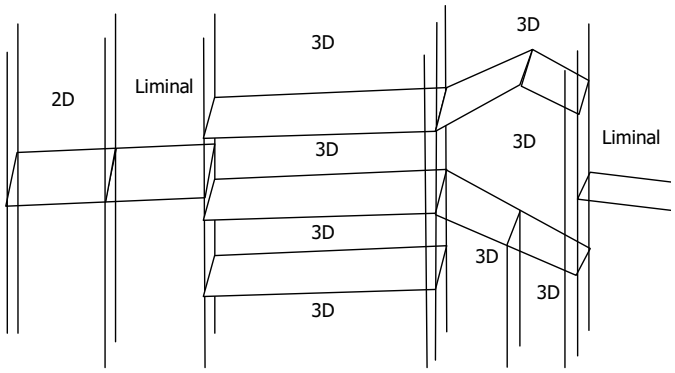
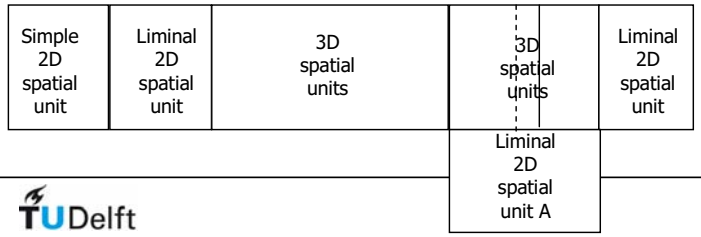


2D and 3D Integration
→ Presentation of yesterday…

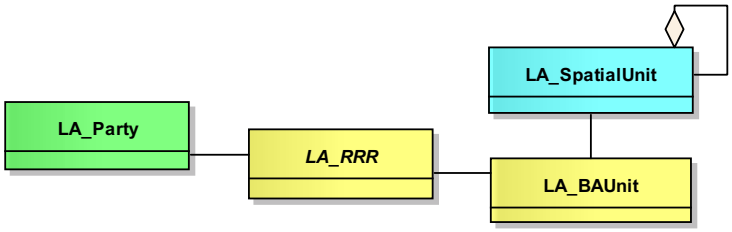
- between 2D and 3D spatial unit transition via liminal spatial units





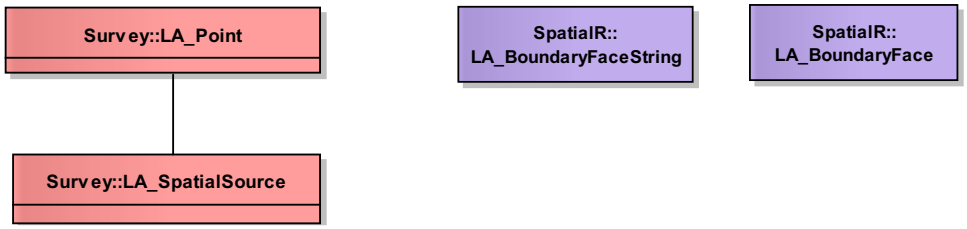
- Liminal spatial units are 2D parcels, but are stored as 3D parcels
- Liminal spatial units are delimited by a combination of LA_BoundaryFace and LA_BoundaryFaceString objects

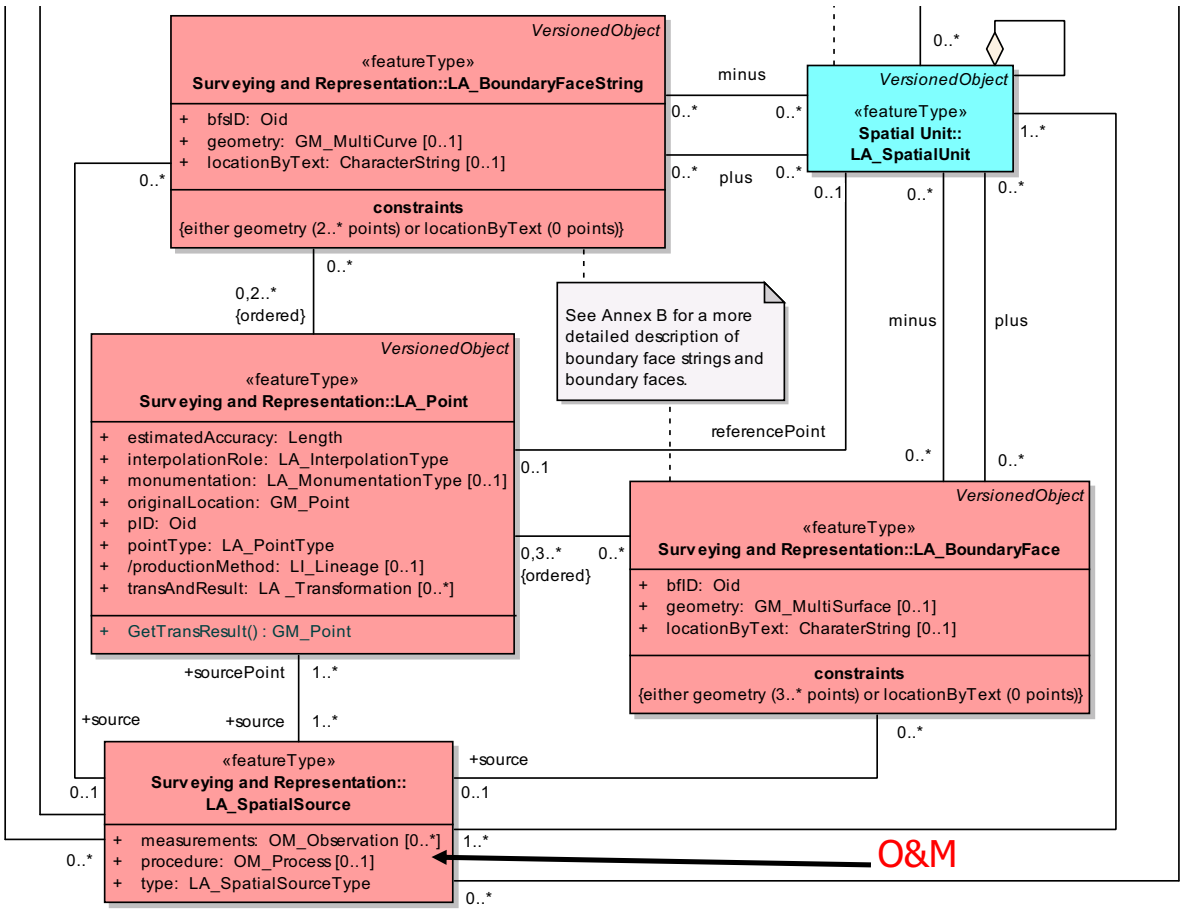
Contents



Spatial Representation and Survey subpackages of SpatialUnit

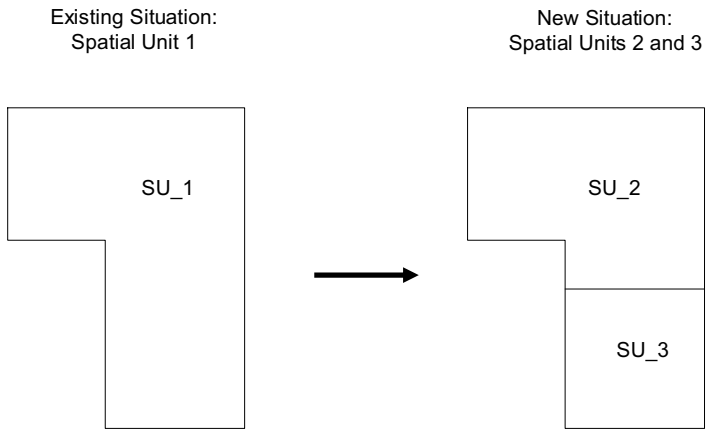
- Geometry, topology of Spatial Units (based ISO 19107)
- Spatial source (based ISO/CD 19156 Observations and Measurements)



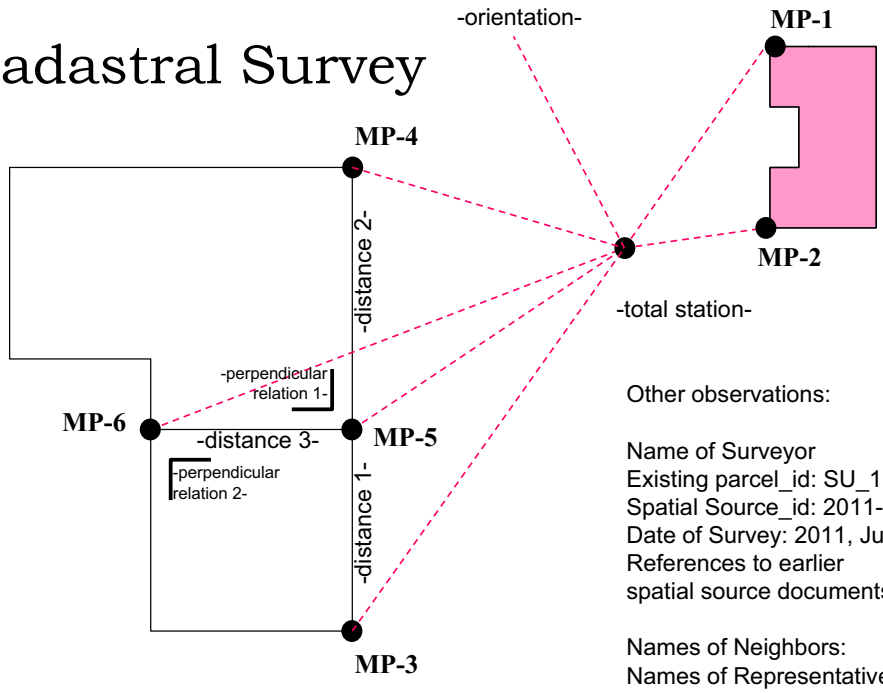


Survey approach

1. Survey, collect measurements
2. Adjust measurements and fit in existing map
3. Create objects



Cadastral Survey



Other observations:

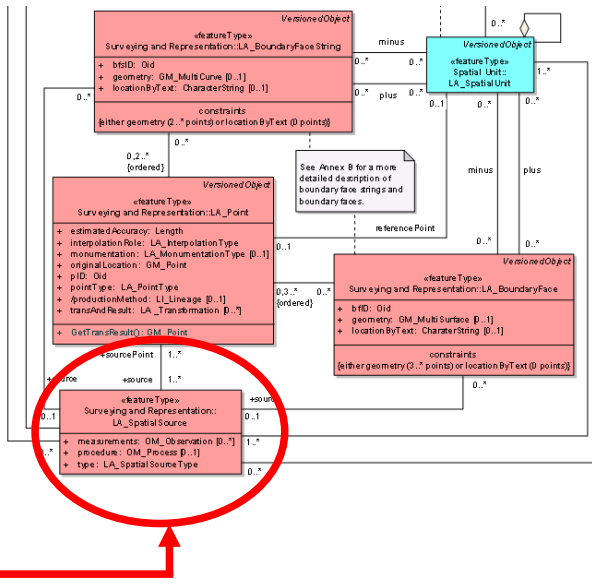
Name of Surveyor
Existing parcel_id: SU_1
Spatial Source_id: 2011-2
Date of Survey: 2011, June 20th
References to earlier
spatial source documents: 2011-1

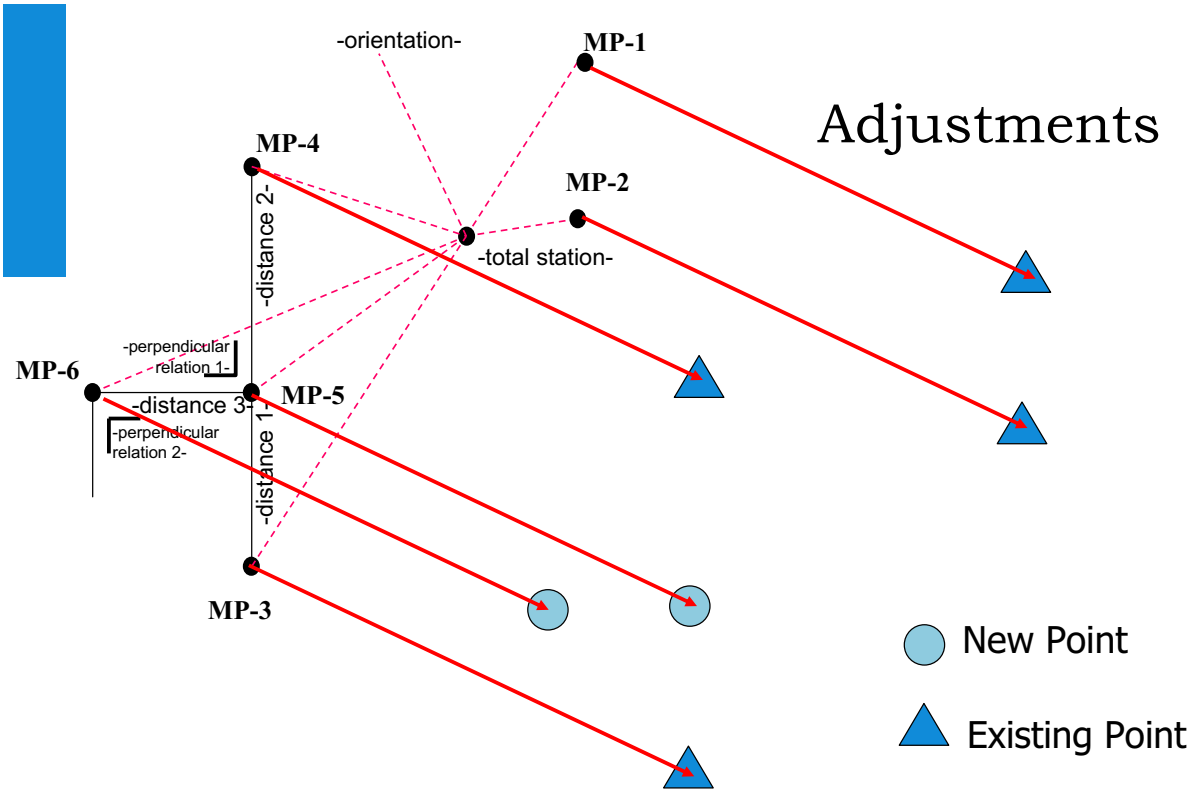
Names of Neighbors:
Names of Representatives: n/a

Agreement Y/N: Y

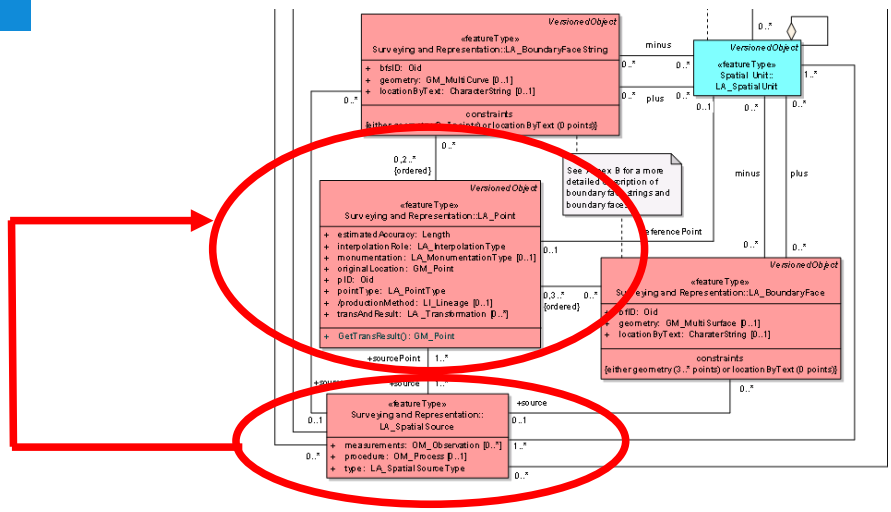
Original O&M into LA_SpatialSource

Direction and Distance Total Station – MP-1
Direction and Distance Total Station – MP-2
Direction and Distance Total Station – MP-3
Direction and Distance Total Station – MP-4
Direction and Distance Total Station – MP-5
Direction and Distance Total Station – MP-6
Existing X,Y (of building corner in database) of MP-1
Existing X,Y (of building corner in database) of MP-2
Existing X,Y (of spatial unit vertex in database) of MP-4
Existing X,Y (of spatial unit vertex in database) of MP-3
Perpendicular relation 1 (MP-4, MP-5, MP-6)
Perpendicular relation 2 (MP-3, MP-5, MP-6)
Distance 1 between MP-3 and MP-5
Distance 2 between MP-5 and MP-4
Distance 3 between MP-6 and MP-5
MP5 and MP6 to be connected to a boundaryfacestring





Adjustment: Original O&M adjusted to Geo DB using existing Points

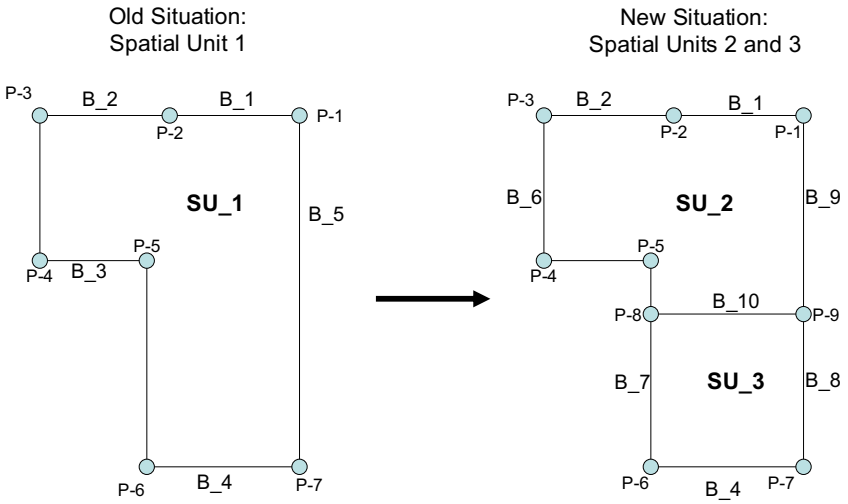


Accuracy Labels can de included now

Storing the observations

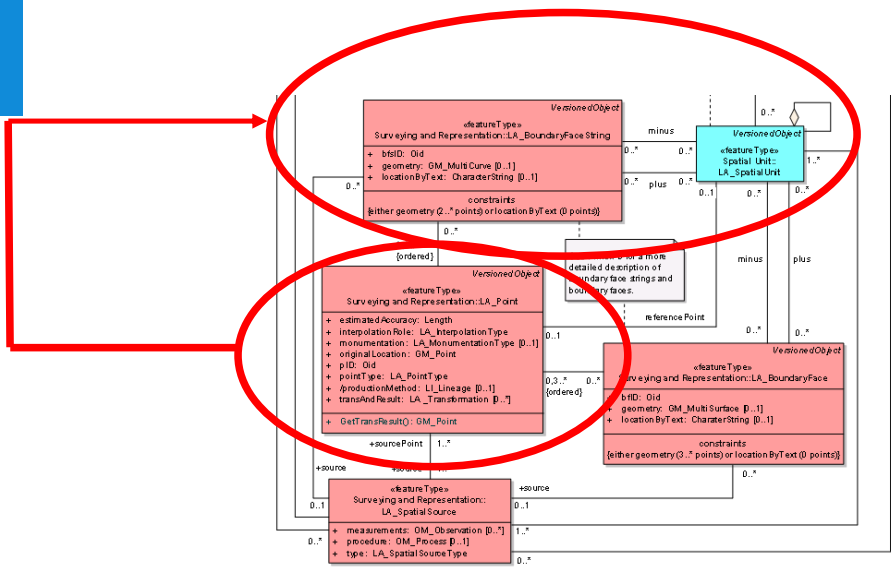
- Stored in LA_SpatialSource: raw data and quality info
- Next calculations: transformations, geodetic adjustments, observations are often redundant (and have small errors); e.g. least squares adjustment computes optimal solution
- Result stored in LA_Point attribute "transAndResult" of type LA_Transformation (which has two parts: 1. transformation of type CC_OperationMethod and 2. transformedLocation of type GM_Point)
- Adjustments can be reiterated (cardinality of attribute "transAndResult" is 0..*)

New Spatial Units created

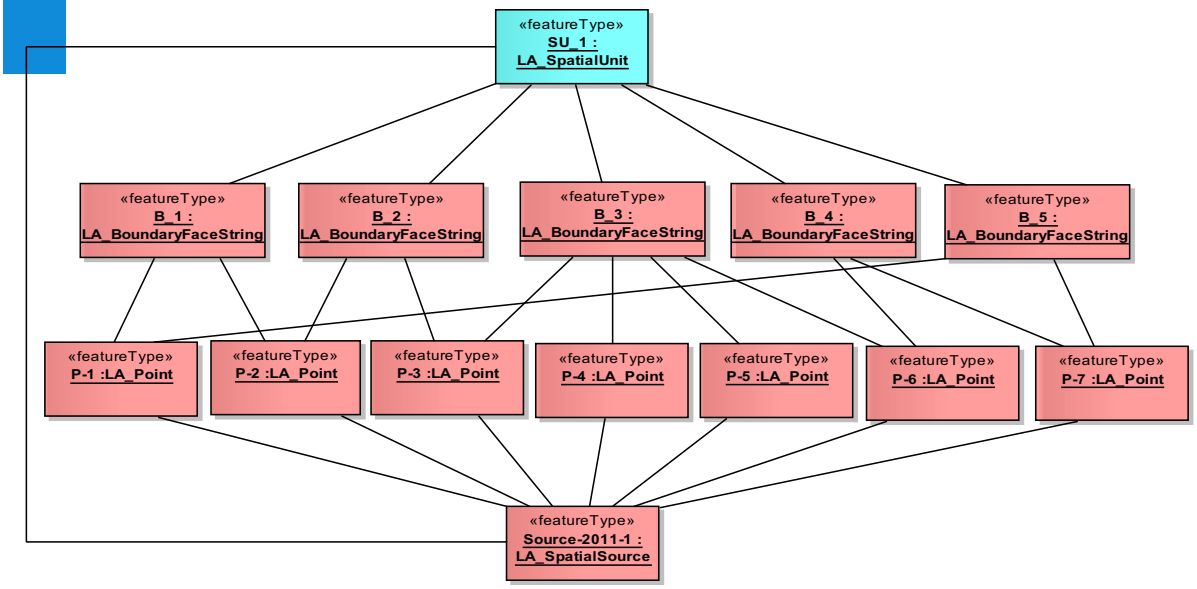


- New LA_Points used to create new LA_BoundaryFaceStrings and these are used to create new LA_SpatialUnits
- All linked in LADM: chain from LA_SpatialSource to LA_SpatialUnit → instance level diagrams before and after split

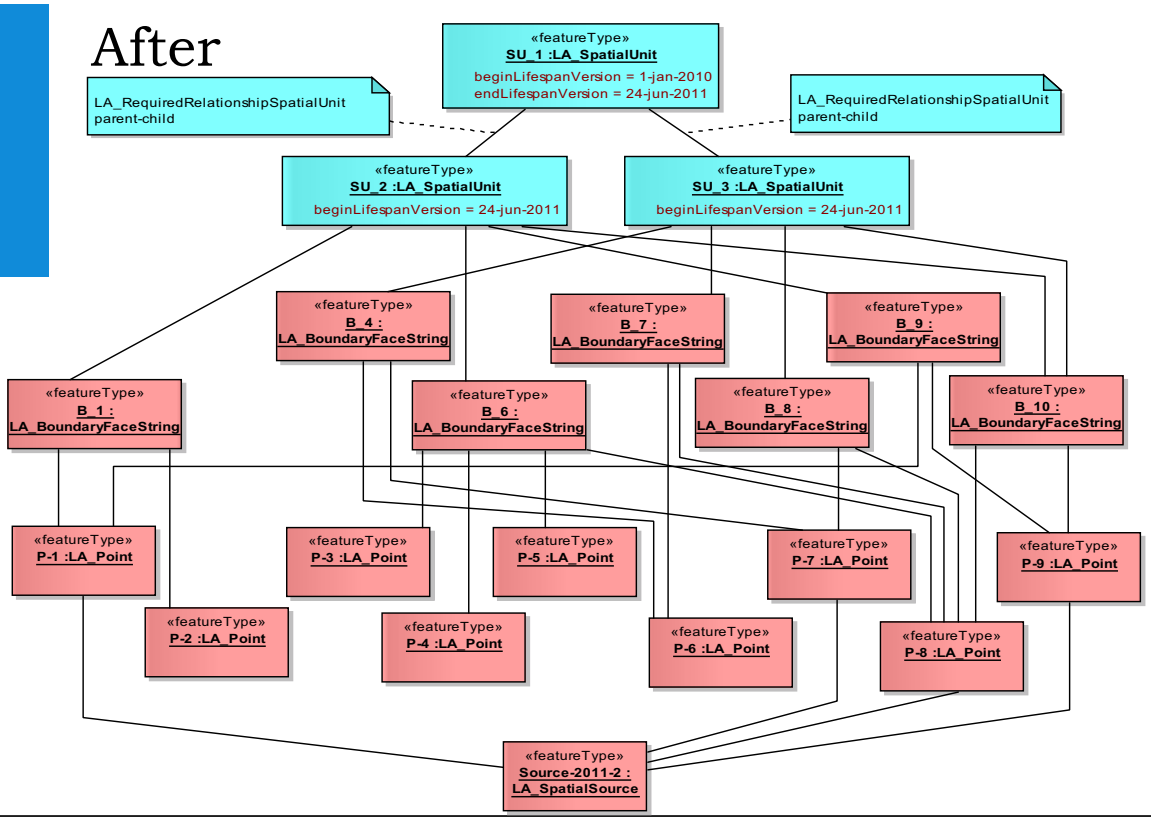
Object Creation



Instance level diagram, before split



After



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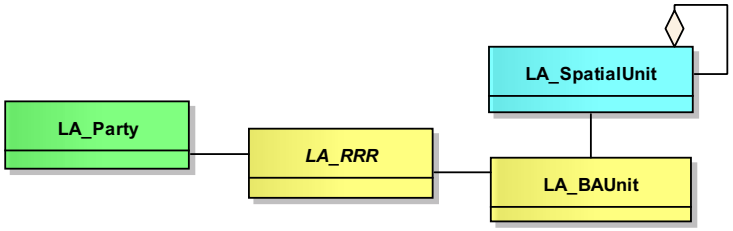


Background ISO TC211

- Over 60 P/O-member countries (participating + observing), including Standards Institution of Israel (SII), O-member
- Liaisons with other organizations; e.g. OGC and FIG
- Over 40 standards, LADM = ISO 19152
- Main phases in standards development process:
  1. Proposal of new work item (NWIP), determination of scope
  2. Development of specifications in Working Drafts (WD) and Committee Draft (CD) in consensus-building processes
  3. Formal approval International Standard (IS), via Draft IS (DIS) and optionally Final Draft IS (FDIS)

ISO TC211 and CEN TC287

- CEN: European Centre for Standardization
- Close cooperation arranged via resolutions, based on overall Vienna agreement between ISO and CEN (FDIS phase obligatory)
- Goal: equal standards
  - existing ISO standards: unique acceptance procedure (UAP), fast
  - new/ongoing standards: parallel voting
- 26 February 2009: CEN TC287 accepted LADM
- Project with CEN – French translation needed

→ parallel voting in ISO TC211 and CEN TC287 on LADM

LADM standardization process

1. Start of LADM (2002 – 2006)
   - from Washington D.C. to Munich
2. Start of Standardization (2006 - 2008)
   - preliminary talks within ISO/TC211
   - the players: FIG, ISO (TC211), CEN (TC287), JRC, UN-HABITAT
   - first proposal & voting
3. Actual standardization (2008 – 2012)
   - NP, WD, CD, DIS, FDIS, IS...

Start of LADM before standardization

Version	*Date*	*Location*
Original idea	April 2002	Washington D.C., USA
0.1	September 2002	Noordwijk, The Netherlands
0.2	March 2003	Enschede, The Netherlands
0.3	September 2003	Brno, Czech Republic
0.4	December 2004	Bamberg, Germany
0.5	April 2005	Cairo, Egypt
0.6	March 2006	Moscow, Russian Federation
1.0	October 2006	Munich, Germany

Start of Standardization (2008)

- Result of NWIP voting (May 2008)
  - 15 'yes' over 6 'no'
  - 10 participants
- Negative votes
  - vote 'no', participate 'yes'
  - influence national legislation?

	Yes	No	Participate?	Comments
Australia (SA)	X		N	
Austria (ON)	X		N	
Canada (SCC)	X		Y	
China (SAC)	X		Y	
Czech Republic (CNI)	X		N	
Denmark (DS)	X		N	
Finland (SFS)		X	N	X
Germany (DIN)		X	Y	X
Italy (UNI)	X		N	
Japan (JISC)		X	N	X
Korea, Rep. of (KATS)	X		N	
Netherlands (NEN)		X	Y	X
New Zealand (SNZ)	X		Y	
Norway (SN)		X	N	X
Russian Fed. (GOST R)	X		N	
South Africa (SABS)	X		N	
Spain (AENOR)	X		Y	X
Sweden (SIS)		X	Y	X
Thailand (TISI)	X		Y	
United Kingdom (BSI)	X		Y	X
USA (ANSI)	X		Y	
Totals (P-members only)	15	6	10	(8)

Via WD to CD

- Voting (October 2009)
  - 22 'yes' to 3 'no'
  - nearly 300 comments from 7 countries...

Member body	Approve	Disapprove	Comments
Australia (SA)	X		X
Austria (ON)	X		
Canada (SCC)	X		X
China (SAC)	X		X
Denmark (DS)	X		
Ecuador (INEN)	X		
Finland (SFS)		X	X
France (AFNOR)		X	
Germany (DIN)	X		
Hungary (NSZT)	X		
Japan (JISC)	X		X
Korea, Rep. of (KATS)	X		
Malaysia (DSM)	X		
Morocco (SNIMA)	X		
Netherlands (NEN)	X		
Norway (SN)	X		
Russian Fed. (GOST R)	X		
Saudi Arabia (SASO)	X		
South Africa (SABS)	X		
Spain (AENOR)	X		
Sweden (SIS)	X		X
Switzerland (SNV)		X	
Thailand (TISI)	X		
United Kingdom (BSI)	X		X
USA (ANSI)	X		
Summary Members (25)	22	3	(7)

To DIS

- Text for DIS
  - submitted in January 2011, for a 5-month vote
  - approved in June 2011: 26 'yes' to 2 'no'
  - with an avalanche of nearly 400 comments!

Country	Approve	Disapprove	Comments
Austria	X		
Canada		X	X
China	X		
Czech Republic	X		
Denmark	X		X
Ecuador	X		
Finland		X	X
France	X		X
Germany	X		X
Hungary	X		
Italy	X		
Japan	X		X
Korea, Republic of	X		X
Malaysia	X		
Morocco	X		
Netherlands	X		
New Zealand	X		
Norway	X		
Poland	X		
Portugal	X		
Russian Federation	X		
Saudi Arabia	X		
Serbia	X		
South Africa	X		X
Spain	X		
Sweden	X		X
Thailand	X		
Turkey	X		
United Kingdom	X		
USA	X		X
Member TOTALS	26	2	(10)

To FDIS

- Voting 30 aug-30 oct'12
  - Very favourable
  - No negative votes
- Some last editorial comments (formally not possible): layout, typo's, inconsistency between text and figure
- Also parallel CEN without no-votes!

Country	Approve	Disapprove	Comments
Australia	X		X
Austria	X		
Canada	X		X
Chile	X		X
China	X		
Czech Republic	X		
Denmark	X		
Ecuador	X		X
Finland	X		
France	X		
Germany	X		
Hungary	X		
Iran	X		
Italy	X		
Japan	X		
Lithuania	X		
Malaysia	X		
Morocco	X		
Netherlands	X		
New Zealand	X		
Norway	X		
Russian Federation	X		
Saudi Arabia	X		
Serbia	X		
South Africa	X		
Spain	X		
Sweden	X		
Thailand	X		
Turkey	X		
United Kingdom	X		
USA	X		
TOTALS	31	0	(4)

International standard (IS) 1 December 2012

- Editing not by project team anymore (TC211), but central ISO secretariat Genève, Switzerland
- Last "Dot your i's and cross your t's", including last FDIS comments
- Three type of comments:
  1. Subtle differences between text, figures and tables
  2. Normative wording; e.g. replace 'should' by 'shall' (ISO rules)
  3. Annex A, ATS was relatively new and main table A.1 and text were not consistent (and small part of text was forgotten; tests for LA_level and LA_RequiredRelationshipBAUnit)
- UML model maintained by TC211 HMMG was updated accordingly

Discussion on the process

- The number of comments grew along the development track...
  - CD: 295 comments (92% accepted)
  - DIS: 398 comments (86% accepted)
  - FDIS: nearly 60 editoral comments (and nearly all accepted)
- Redundancy of information in text, tables, figures and UML-model contributed to the number of comments!
- Nearly 1000 comments → quite cumbersome to manage...
- We did every attempt to resolve comments and negative votes, with the danger that we "tried to please everybody"
  → when one is pleased sometimes the other is disappointed
  → rule: generic (valid for more countries) and improve model

Editorial Committee ISO 19152

- Mr. Antony Cooper, chair
- Mr. Christiaan Lemmen, editor
- Mr. Paul Egesborg, ISO/TC211-WG 7
- Mr. Tomohiko Hatori, Japan
- Mr. Danilo Antonio, UN-HABITAT
- Mr. TaikJin Kim, Korea
- Mr. Christian Lord, Canada
- Mrs. Julie Binder Maitra, USA
- Mrs. Tarja Myllymäki, Finland
- Mr. Peter van Oosterom, The Netherlands
- Mr. Jesper Paasch, Sweden
- Mr. Wim Devos, EC-JRC
- Mr. Harry Uitermark, FIG
- Mrs. Frédérique Williams, France
- Mr. Shawn Silkensen, ISO/TC211-HMMG
- Mr. Marcus Seiffert, Germany

At work…

Published on 1 December 2012..

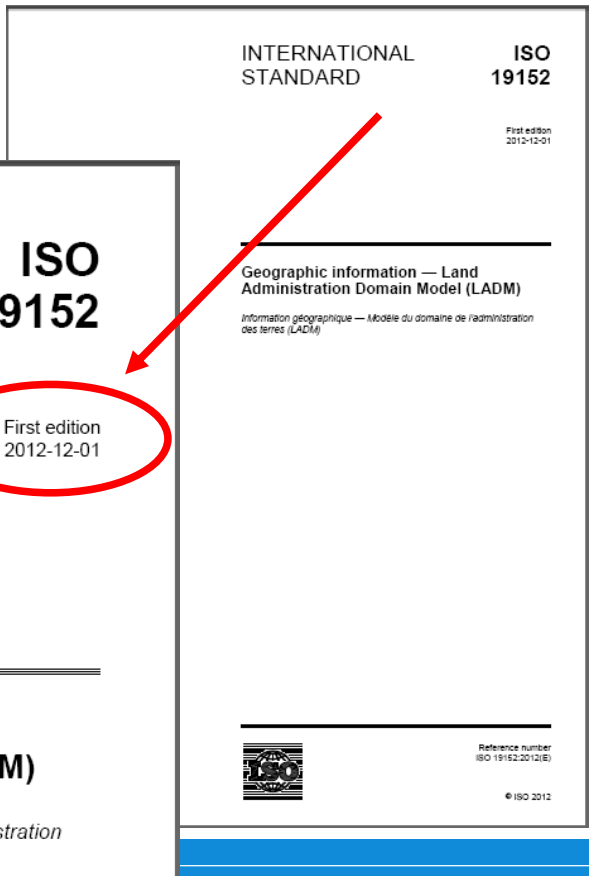
INTERNATIONAL STANDARD

ISO 19152

First edition
2012-12-01

Geographic information — Land Administration Domain Model (LADM)

Information géographique — Modèle du domaine de l'administration des terres (LADM)



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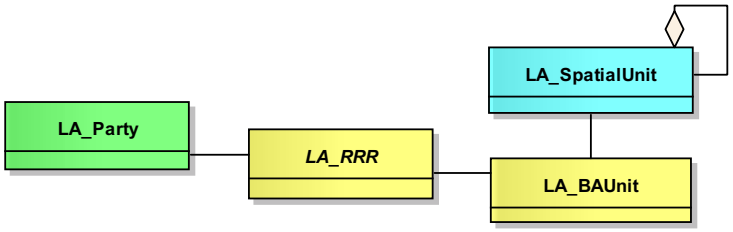
ISO 19152:2012

Geographic information -- Land Administration Domain Model (LADM)

Media and price

Format	Price	Language	
PDF	CHF 210,00	English	Add to basket
Paper	CHF 210,00	English	Add to basket

Contents



Conformance testing at model level (of e.g. country profile)

1. Any system claiming to be ISO19152 conformant, has to pass the Abstract Test Suite (ATS, Annex A)
2. Conformance can be tested per
   - Package: Party, Admin, Spatial Unit, (subpackage) Survey
   - Level: 1=basic, 2=medium, 3=full
3. Three outcomes: conformant, notConformant, notEvaluated
4. Proof of conformance (executing the test)
   - Analyse inheritance between LADM and derived model or
   - Create mapping table between LADM and derived model

Conformance testing packages, levels (1/2)

package	LADM class		Dependencies
-	*VersionedObject*	1	
	LA_Source	1	Oid, (as a minimum one of the specializations must be implemented [LA_AdministrativeSource or LA_SpatialSource]), LA_AvailabilityStatusType
Spatial Unit			
	LA_SpatialUnit	1	VersionedObject, Oid,
	LA_SpatialUnitGroup	2	VersionedObject, Oid, LA_SpatialUnit
	LA_LegalSpaceBuildingUnit	3	LA_SpatialUnit
	LA_LegalSpaceUtilityNetwork	3	LA_SpatialUnit
	LA_Level	2	VersionedObject, Oid
	LA_RequiredRelationshipSpatial Unit	3	VersionededObject, LA_SpatialUnit
Surveying			
	LA_Point	2	VersionededObject, Oid, LA_SpatialSource, LA_PointType, LA_InterpolationType
	LA_SpatialSource	2	LA_Source, LA_Point, LA_Party, LA_SpatialSourceType
	LA_BoundaryFaceString	2	VersionedObject, Oid, LA_Point (if using geometry)
	LA_BoundaryFace	3	VersionedObject, Oid, LA_Point (if using geometry)

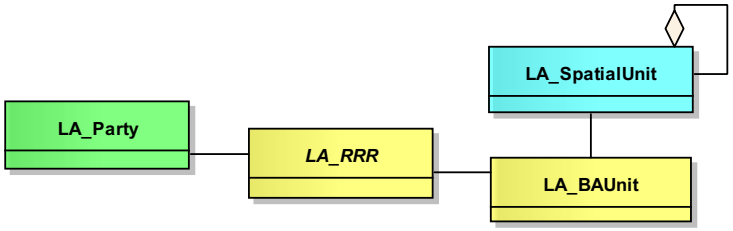
Conformance testing packages, levels (2/2)

package	LADM class		Dependencies
Party			Exist only if Administrative Package is implemented
	LA_Party	1	VersionedObject, Oid, LA_PartyType
	LA_GroupParty	2	Oid, LA_Party, LA_GroupPartyType
	LA_PartyMember	2	VersionedObject, LA_Party, LA_GroupParty
Admin			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
	LA_BoundaryFace	3	VersionedObject, Oid, LA_Point (if using geometry)

Example ATS
A.2.4 Test case identifier: Administrative::LA_Right

a) Test Purpose: if LA_Right is implemented, to ensure that the implementation package under test contains at least one class conformant with the definition of one of the specializations of class LA_Right and has all mandatory attributes and association roles of LA_Right.
b) Test Method: examine the application schema of the implementation under test, including class, attribute(s) and association definitions.
c) Reference: level 1 requirement, see 6.4.2 and 6.4.3.
d) Test Type: Basic.

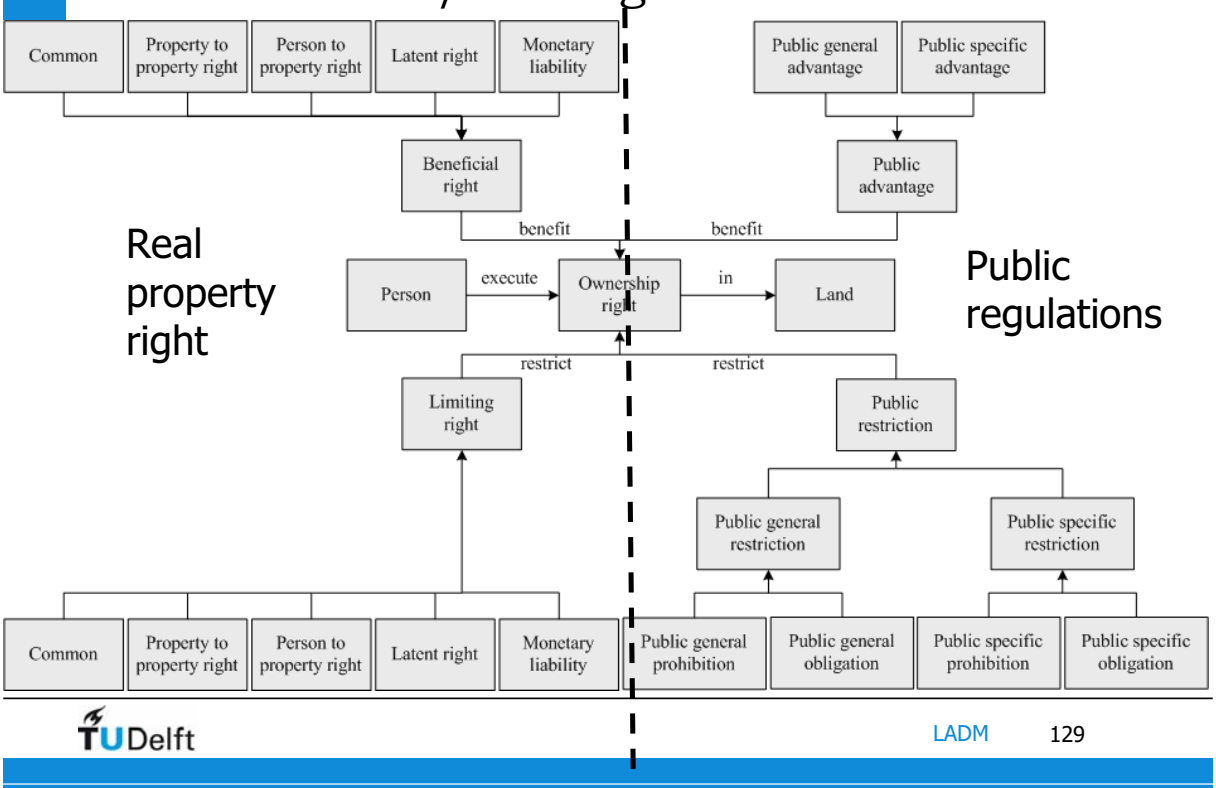
Contents



Standard maintenance

- As the LADM standard is now being used (and read by further eyes) it is inevitable that further issue will arrive
- These can range from:
  1. detecting and correcting simple text error
  2. via omissions
  3. to further extensions of the standard
- E.g. extension of the legal model conform the proposal of Paasch or informative code lists need further structuring and formalization
- Use ISO LADM Wiki for communication http://isoladm.org
- ISO has standardized standard maintenance procedure

Warning: temporarily non-LADM notation/naming



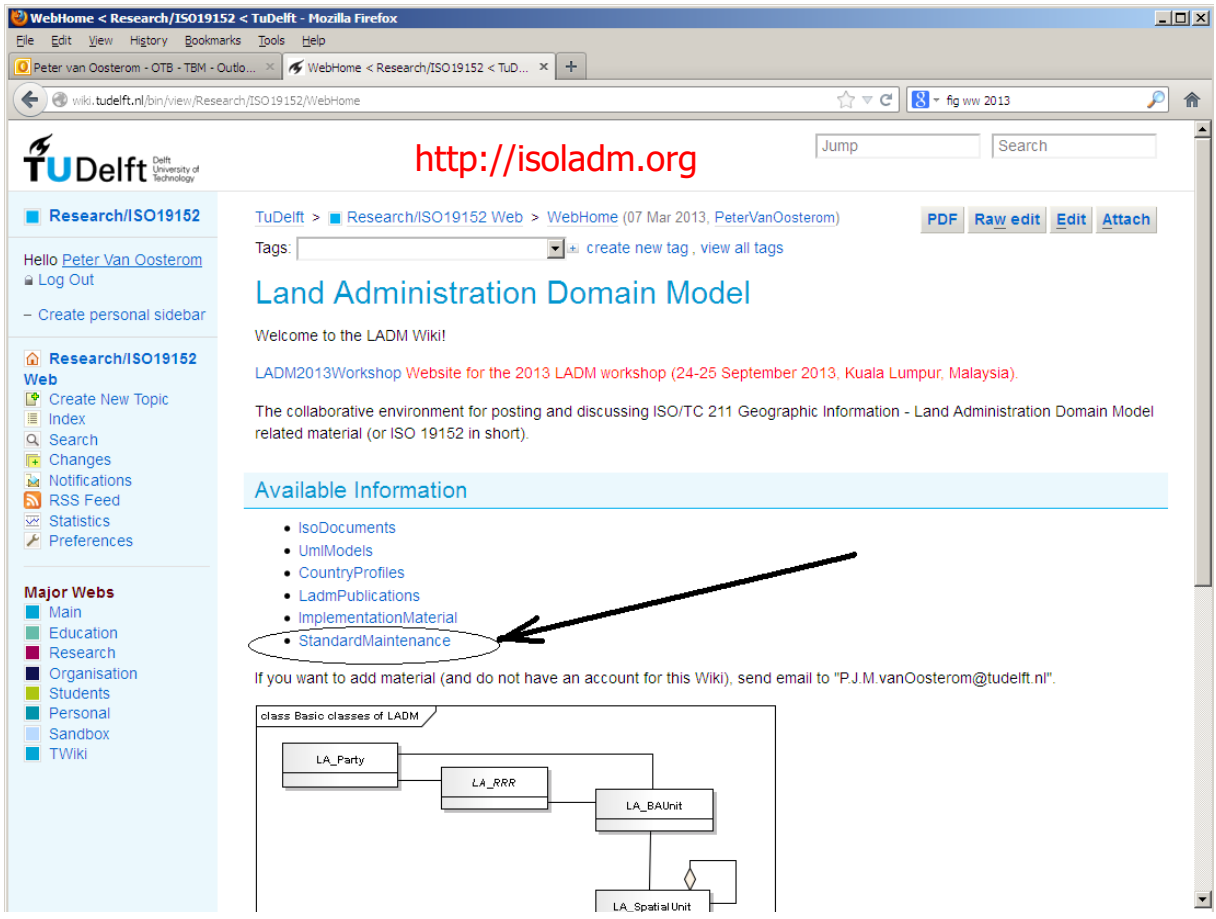
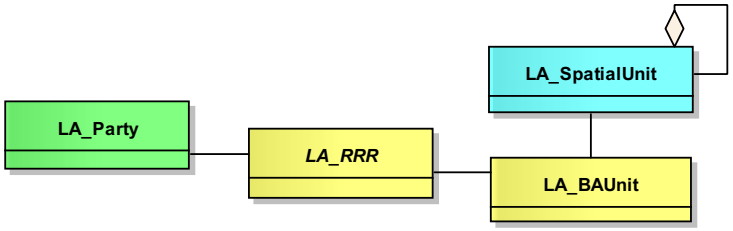


FIG LADM Governance Group

- Conclusion from 5th LADM Workshop (Kuala Lumpur, sept'13): Governance structure is needed.
- Proposal: LADM Governance within FIG to be led by the OICRF - the International Office of Cadastre and Land Records
- Members: ISO 19152 editors, Worldbank, UN Habitat, FAO, FIG comm 3+7, FIG Young surveyors, …

- Activities of LADM governance group:
  1. maintenance of LADM in accordance to ISO requirements
  2. registry for various code lists (and web services for use)
  3. collect and disseminate best practices
  4. plan LADM related events (stand-alone or combined; ISG'13)
  5. check if system (model) is LADM conformant

Contents



LADM Voting Results by ISO/TC 211 P-Members

Voting ISO 19152	New Work Item Proposal 2 May 2008	Committee Draft 12 October 2009	Draft International Standard 27 June 2011	Final Draft International Standard 30 October 2012
Approve:	15	22	26	30
Disapprove:	6	3	2	0
Abstain:	4	4	4	3
Not Voted:	7	3	0	0

Conclusion

- LADM standardizes both administrative (legal) and spatial aspects
- After WD, CD, DIS, FDIS: LADM now IS!
- LADM in parallel by ISO and CEN
- Many country profiles developed in Annex D: Portugal, Queensland (Australia), Indonesia, Japan, Hungary, The Netherlands, Russian Federation, and Republic of Korea
- Consensus process → acceptance by wide community
- Conformance testing

- From conceptual model to technical model (CityGML, LandXML,…)
- Explicit relationship with other domain models <<blueprint>>
- Based on other ISO standards ISO 19107, 19111, 19115, 19156
- Land Administration cornerstone of the SII (Geoweb)

Implementation and use in practice

- Social Tenure Domain Model (STDM) is a specialization of LADM
- STDM is an initiative of UN-HABITAT to support pro-poor land administration, customary and informal land rights are included
- UN-FAO Solutions for Open Land Administration (FLOSS/SOLA) is LADM based
- Integration of LADM with the Land Parcel Information System of the European Commission for subsidies to farmers
- INSPIRE cadastral parcels data set is consistent with LADM
- Country profiles (besides the ones in Annex of standard): Canada, Croatia, Cyprus, Honduras, Poland, Portugal, Malaysia and others

LADM at FIG 2014 congress provisional programme

- Zulkifli Nur Amalina et al.: Towards Malaysian LADM Country Profile for 2D and 3D Cadastral Registration System
- Paradzayi Charles et al.: Investigating the Conformity of the Zimbabwe Land Administration System to the Land Administration Domain Model Standard (ISO 19152)
- Savoiu Ionut Cristian et al.: Land Administration Domain Model: Opportunities for Enhancing Systematic Registration in Romania
- Gonzalez Rhodora et al.: Linking the Land Information Systems in the Philippines Using the LADM as a Global Schema
- Aydinoglu Arif Cagdas et al. (Turkey): Developing Land Registry and Cadastre Base Data Model for Land Management Applications

LADM at FIG 2014 congress (part 2)

- Góźdź Katarzyna et al. (Poland): Integration of Data from Real Estate Cadastre, Register of Utility Networks and Topographic Database Based on LADM and CityGML Standards
- Lemmen Christiaan (The Netherlands): LADM and its Role in Establishing Cadastral Systems
- Kean Huat Soon (Singapore): A Proposed Framework for Achieving High Level Automation in Cadastral Processing
- Zulkifli Nur Amalina et al.: Development of a Prototype for the Assessment of the Malaysian LADM Country Profile
- Bulbul Rizwan: Designing Spatial Component of Pakistan's Cadastral System based on Land Administration Domain Model
- …and probably more (but not mentioning this in title/abstract)

Further development

- LADM is conceptual model → technical model
- Option: collaboration between FIG and OGC: CityGML, LandXML

- Consider complete development life cycle of rural+urban areas:
  - develop and register zoning plans,
  - design new spatial units/objects;
  - acquire appropriate land/space (after financing);
  - request and provide (after check) permits;
  - construct and build; and
  - use, manage and maintain, etc.

  all related to cadastral registration (Parties, RRRs, Spatial Units) and more and more these will involve 3D descriptions.

Conclusion, Spatial part

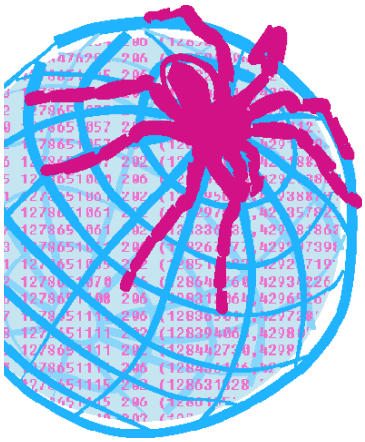
- Spatial Units are the "glue" joining the spatial description of land to the RRR aspects

- Spatial Units are universal in their land administration application (ownership, easement, utilities, building,..)

- Range of representations: text → 3D topology

- Spatial Units based on Source Documents and LA_Points

Conclusion, towards the Geoweb (GII)



- Standardization is a condition for realizing the GII
- Domain models (themes) contain knowledge
- (G)II or SDI is mega-construction
- ISO (TC211) is often the foundation
- ISO 19152 / LADM and INSPIRE cadastral parcel have different scope, but are consistent in their overlap

Acknowledgements

- The 19152 project team
- Iain Greenway for submission proposal to ISO on behalf of FIG
- FIG Council 2007 – 2010, under President Stig Enemark and the FIG Council 2011 – 2014, under President CheeHai Teo and FIG's director Markku Villikka (Finland) for continuous support
- Bjørnhild Sæterøy for advice feeling to be at home in ISO/TC211
- John Herring and Serena Coetzee for support within ISO/TC211
- Rod Thompson contributed in development of 2D-3D aspects
- Clarissa Augustinus and Jaap Zevenbergen with STDM
- Many, many others contributed by developing country profiles, performing reviews, participation in discussions and so on

→ Thank you very much!!!!!

Annex C.
Key concepts and terms in context of realising Israeli 3D cadastre

In (Shoshani, Benhamu, Goshen, Denekamp and Bar 2005) the key concepts and terms are defined in the Israeli context of realising a 3D cadastre and quoted below:

- *'Registration Block:* A defined area, out of a settlement's land, that include a parcel or number of parcels, Spatial Sub-Parcel or number of Spatial Sub-Parcels, spatial parcel or number of spatial parcels. This defined area serves as a surveying and registration unit.
- *Parcel:* A piece of land, which is a part of a Registration Block, registered in the Land Registration Books and defined by its shape, its boundaries lengths and its area, in "First Registration" or registration according to the "Land Registration Ordnance" or in its mutation prepared according to the Survey Ordnance – 1928 or it's regulations.
- *Spatial Parcel:* A volumetric registration unit, which is a part of a Registration Block, defined in above or below surface and created by consolidation of several spatial sub-parcels, defined in the boundaries of the Registration Block.
- *Displacement Distances:* The distances between the project itself and the outer envelope, displaced from the project, by engineering stability, safety and ecological considerations. These "displacement distances" will be specified by a planning authority in a document describing the relationships between the project and its environment as far as the influence of the project and its operation is concerned.
- *Spatial Lot:* A spatial volumetric land unit, defined in a multi layers town planning plan, taking into account the Displacement Distances and is a part of a parcel, before it is registered as a spatial sub-parcel in the Land Registration Books whether construction is permitted there or not.
- *Subterranean Space:* The definition of a space's outline in the subterranean areas, according to a town-plan, without taking into accounts the buildings and cultivated areas upon the surface.
- *Above Terranean Space:* The definition of a space's outline above terrain areas, according to a town-plan, without taking into accounts the buildings and cultivated areas upon the surface.
- *Spatial Physical Object:* Physical object defined in subterranean space or in above terrain space, included in spatial sub-parcel. Its outer boundaries are included in the spatial sub-parcel according to the displacement distances.
- *Spatial Registration Plan:* 3D cadastre registration plan is a digital, 3D and multispaced.
- *Spatial Sub-Parcel:* A volumetric registration unit, defined in above or below surface and which is included within the vertical boundaries of the surface parcel.'