Spatial aspects and multiple dimensions within LADM

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(joint work Christiaan Lemmen, Rod Thompson, João Hespanha and Harry Uitermark)

LADM from Research to Implementation - Land Administration Domain Modelling at a threshold, 6 July 2012, Rotterdam, the Netherlands
Content overview

1. Spatial Aspects LADM
2. Third Dimension
3. Adding Time
Land Administration Domain Model
ISO 19152 (LADM)

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

- Started within the FIG in 2002
  (International Federation of Surveyors, founded 1878 NGO)

- FIG proposed LADM to ISO/TC211, January 2008
  (parallel voting in ISO TC211 and CEN TC287)

- Includes **integrated 2D and 3D support**
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."

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.
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
Land Administration Domain Model

Welcome to the LADM Wiki!

The collaborative environment for posting and discussing ISO/TC 211 Geographic Information - Land Administration Domain Model.


Available Information

- IsoDocuments
- UmiModels
- CountryProfiles
- LadmPublications
- ImplementationMaterial

If you want to add material (and do not have an account for this Wiki), send email to "P.J.M.vanOosterom@tudelft.nl".
Content overview

1. Spatial Aspects LADM
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Today’s solution: 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.
Dynamic 3D world

No country has 3D Cadastre
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, 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

• closed GM_curve

3D LA_SpatialUnit in layer 2 not broken by layer 1 boundaries (LA_FaceStrings)
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Integration of 3D+time: 4D Cadastre

- In addition to spatial (3D) aspect, rights, restrictions and responsibilities include a temporal aspect.
- To be able to manage the dynamics in land administration the time (fourth) dimension must be handled as well.
Conceptual Cadastre Basis

Partition: no gaps or overlaps in the parcelation on which the rights 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
River is moving over time and legal Boundary follows (true 4D)
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
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

- $t_0$
- $t_1$
- $t_2$
- $P_1$
- $P_2$
- $P_3$
- $P_4$
- $P_5$

Axes:
- $x$
- $y$
- Time
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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→ FIG 3D-Cadastres working group
International Federation of Surveyors (FIG) 3D-Cadastres working group

- 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.
Third International FIG Workshop on 3D Cadastres
Developments and Practices • Shenzhen, China
25 - 26 Oct, 2012

Venue & Accommodation

The workshop will take place in Shenzhen, one of the modern and developed cities of P.R.China.
The venue of the workshop will be the Pavilion Hotel in Futian District, Shenzhen (see Google map).

The Pavilion Hotel (Shenzhen)
4002 Huaqiang Road North, Shenzhen, China
Phone: +86-755-82078888
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
### General/applicable 3D real-world situations

<table>
<thead>
<tr>
<th></th>
<th>Australia/Queensland 2010</th>
<th>The Netherlands 2010</th>
<th>Your Jurisdiction 2010</th>
<th>Your Jurisdiction 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Are all 3D parcels constrained to be within one surface (2D) parcel?</td>
<td>Yes, but this is not guaranteed for all time</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Are ambulatory(^2) boundaries permitted?</td>
<td>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</td>
<td>Theoretically they are, because the database representation may become invalid when situations have been like that (i.e. in conflict what is registered) for many years.</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Is it allowed to have 3D parcels not related to physical constructs or objects? (e.g. airspace, subsurface volumes)</td>
<td>Yes</td>
<td>Normally the rights to establish 3D parcels (apartment rights; right of superficies;</td>
<td></td>
</tr>
</tbody>
</table>

\(^2\) 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 (when survey is carried out), but between such “fixes”, the definition of the property is the position of the real world natural feature.
3D Cadastres

FIG joint commission 3 and 7 Working Group on 3D Cadastres - Work plan 2010-2014

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

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

Chengxi Bernad Siew and Alias Abdul Rahman
Compression Techniques for 3D SDI
Working group organisation

- Position within FIG: inter-commission activity between commissions 3 and 7

- Interested in participation?

- Contact chair WG 3D-cadastres: Peter van Oosterom, TU Delft
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