Aspects of a 4D Cadastre: a first exploration

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Agenda

1. Introduction
2. Temporal aspect of Cadastre
3. Core Cadastral Domain Model
4. 4D Cadastre cases
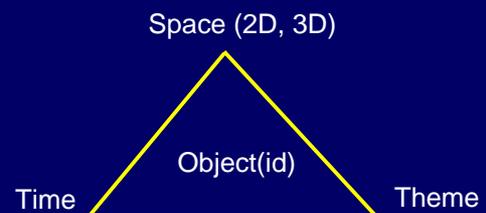5. Discussion and conclusion

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Introduction, 4D Cadastre

- The dynamic nature of the people-land relationship: transactions
- Rights with temporal element: leases, time-shares, mineral concessions, season bound rights (grazing, picking, hunting, ...), nomadic passing, ...
- Recording of history (who was owner in 1981?, what were the changes between 2004-2006?, ...)
- Registration process several steps, which take time

- In addition to 3D geometric parcel descriptions

Space-Time-Theme triangle

Space (2D, 3D)

Object(id)

Time   Theme

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Functionality in a temporal GIS (Langran, 1993)

- Inventory: complete description
- Analysis: explain, exploit, forecast
- Updates: supersede outdated info with new
- Quality control: monitor and evaluate new data (consistent with old data)
- Scheduling: identify threshold states, which trigger predefined actions (buy)
- Display: generate maps or tables of a temporal process

Some time concepts

Time line

history   now   future

- Smallest time unit chronos
- Moment in time → point on time line
- Special moment = now (always move on)
- Time interval = between two moments
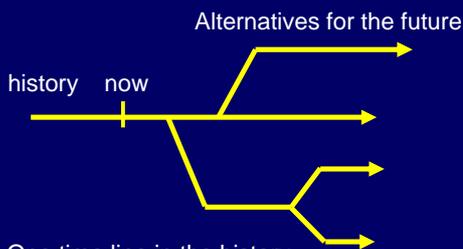- Frequency (of patterns, reoccurring events)

Time topology

- Between two points: before, equal, after
- Between two intervals:

disjoint
touch
overlap
include
equal

More time lines

Alternatives for the future

history   now

One time line in the history,
but possibly many in the future
(not so simple topology…)

Three 'types' of time in cadastral database

1. Database Time (history of updates, update in progress)
2. Legal Event Time (history of ownership, pre-registration/planned subdivision)
3. Variation of the right with time (99 year lease, future rights, periodic tenure, boundary defined by moving river, moving rights: e.g. grazing right)
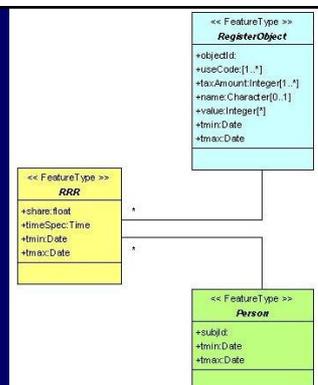
- These types are largely independent

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Core Cadastral Domain Model

- Generic model
- Supports: 2D/3D (3D columns defined by 2D parcels minus 3D volumes)

- Mixed event and state based modeling
- All objects tmin/tmax
- Right has timeSpec

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+objectId:
+useCode:[1..*]
+taxAmount:Integer[1..*]
+name:Character[0..1]
+value:Integer[*]
+tmin:Date
+tmax:Date

<< FeatureType >>
RRR
+share:float
+timeSpec:Time
+tmin:Date
+tmax:Date

<< FeatureType >>
Person
+subjId:
+tmin:Date
+tmax:Date

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Case 1: dynamic objects

- river meandering: parcel boundary moves over time
- parcel is surveyed at t1 (blue) and t2 (red)
- based on 'physics': possible locations boundary between t1-t2 (green)
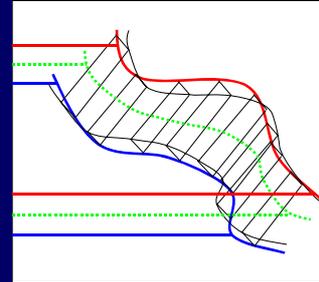
Case 2: Timesharing

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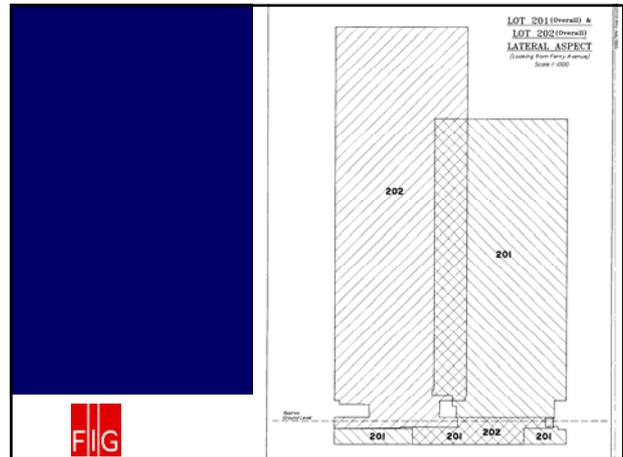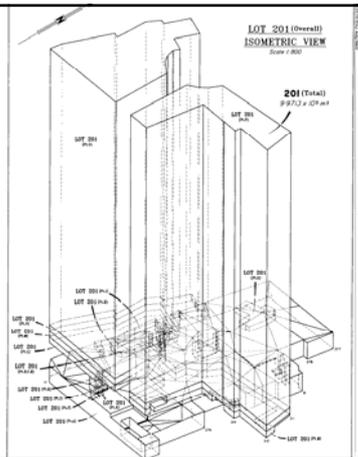
Case 3: Registration of Utilities

- In 2003: Dutch Supreme Court judged telecom networks are immovables → cadastral registration
- Important 3D aspect (below/above surface)
- Temporal aspect (besides transactions/mortgages) includes registration of planned network elements
- Networks change in time: they are renewed, extended or shortened

- Note difference physical network and legal network

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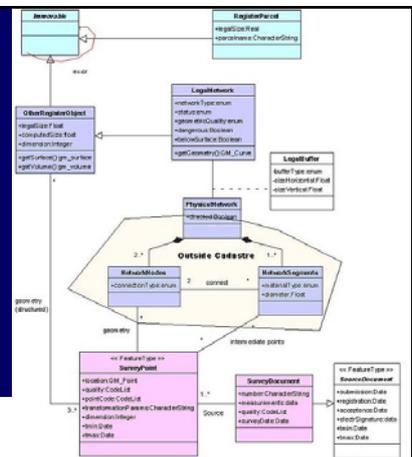
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4D cadastre: separate space and time attributes or an integrated attribute?

- Advantages of separate attributes:
  1. Already able to represent all cases (CCDM)
  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
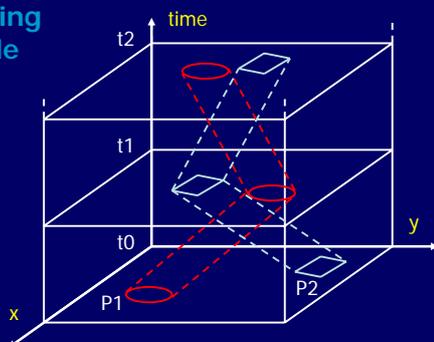

Subdivision of parcels
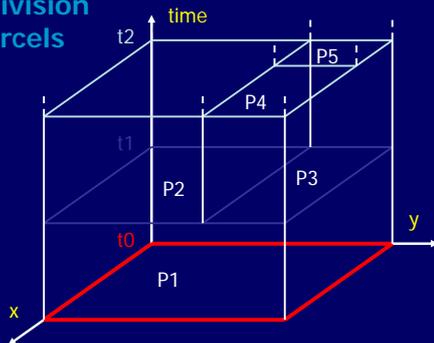
4D data type advantages (cont.)

- 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

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Moving cattle

Conclusion

- Medium-long term: 4D data type is solid foundation
- Might even be cheapest approach as no special cases have to be considered (for 3D space and temporal), but legal, organizational, technical aspects have to be further investigated

- 4D data type is not there yet and current separate 3D+time attributes are sufficient for presented cases
- Time has always been an important aspect of cadastral registration, and deserve further attention in system development (standards) → performance improvement