NCG-KNAW + GIN Studiemiddag 'Geo-informatie kent geen tijd?'

17 September 2009
Universiteitsbibliotheek Universiteit Utrecht, De Uithof, Boothzaal
(dagvoorzitter: Peter van Oosterom, TU Delft)

History of the Subcommission 'Geo-Information Infrastructure'

- In '04 an NCG task group started, in Mar'06 the "Rapport Ruimtelijke basisgegevens 2010" was published, advise (a.o.) create new subcomm.
- Created Jun'07 (together with Subcommission Core Spatial Data, chair Vosselman)
- Both proceed from the Subcommission Geo-Information Models (GIM) from Nov'88-Jun'07, chair Molenaar/Bregt
- Reflects the growing importance of this part of the research field within the NCG.

Previous NCG (GIM) seminars

- Seminar Core Spatial Data, Delft'08
- Studiedag Sensor web enablement, Utrecht'07
- Studiedag Geo-information and computational geometry, Utrecht'05
- Seminar Standards in Action, Delft'04
- Studiedag GeoMetaMatica, Utrecht'04
- Themamiddag 3D Models and Applications, Delft'03
- Studiedag Europese GIS-projecten met o.a. INSPIRE, Utrecht'03
- Geo-norm(ale) studiedag, Wageningen'02
- Seminar Time in GIS, Apeldoorn'00

AGGN: GIS en TIJD 6 juni 2006 bij het KNMI

- Principes van temporale aspecten in GIS
  Peter van Oosterom (TU-Delft)
- Toepassing van tijd in weersystemen
  Frans van der Wel (KNMI)
- Mesttransporten gevolgd in de tijd
  Rogier van Dam (LNV/AID)
- Gebruik van tijd in ArcInfo 9.2
  Jeroen van Winden (ESRI-NL)

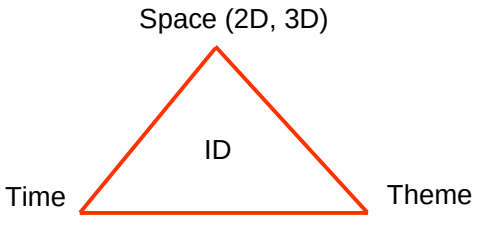
Overview

- Temporal principles
- Cadastral model
- 3D+time = 4D

Discrete or continuous change?

- Object model (vector) might be better suited for discrete changes; note there are exceptions (tracing moving objects)
  → man-made objects
- Field model (raster) might be better suited for continuous changes; sampling both in space (x,y) en time (t)
  → natural phenomena
- Process modeling: natural/continuous domain
- In this presentation focus on object model

Space-Time-Theme triangle



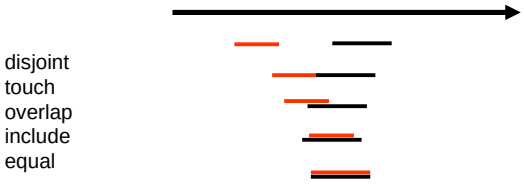
2D space + time → 3D
3D space + time → 4D

Some time concepts

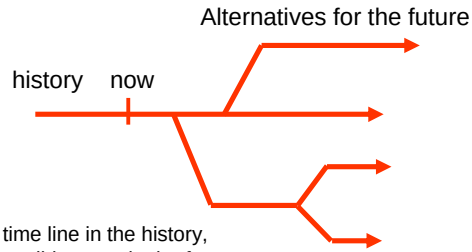
- Smallest time unit chronos
- Moment in time → point on time line
- Special moment = now (always move on)
- Time interval = between two moments
- Frequency (of patterns, reoccurring events)

Time topology

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



More time lines



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

Which time in the model?

- When it happened in the real world
- Observed in the reality (date photo)
- Included in the database (system)
- Last checked in reality
- Signature/registration/postmark time
- When error (in historic data set) discovered and corrected (two moments)
- Display time (to user on screen/map)
- …

Data granularity related to time

Course, more redundancy

Fine, less redundancy

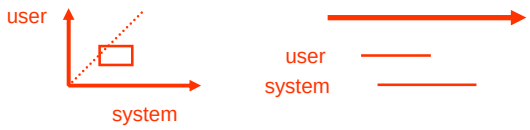
- Map or universe (whole data set); e.g. current topographic maps or aerial photography (every 6-years)
- Object class; e.g. future topographic map (roads every 2-years)
- Object instance; e.g. cadastral map
- Attribute level; e.g. ground water level a point location

Time at object (record) level

- Most common alternative
- Can be well implemented
- Alternatives:
  - State orientation: every object extended with some time attributes (tmin and tmax)
  - Event orientation: store/document the changes (which attr, why, when)
- Main questions:
  - give map at moment t
  - give changes in map between t1-t2

Bi-temporal model

- Two types of time:
  - Valid time (user or real world time)
  - System time (transaction or DBMS time)
- At object level, state oriented
- Results in a 2D rectangle (or 4D point)



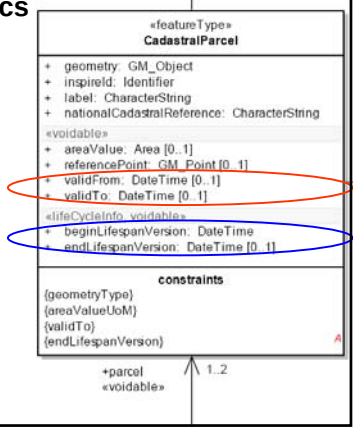
INSPIRE data specs

(as published 16 sept'09)

Bi-temporal model
for cadastral parcels

Valid time

System time



Time visualization

- Show snapshot at moment t1
- Show changes over interval t1-t2
- Show two snapshots besides each other at resp. t1 and t2
- Show animation from t1 to t2 (absolute or relative time steps)
- Show time as the 3rd dimension
- Show temporal events as cartographic symbols (color change rates, mark locations with changes with symbol,…)

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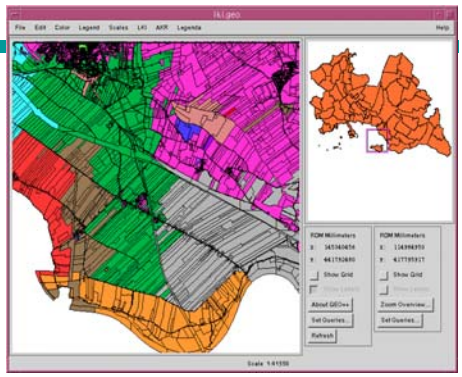
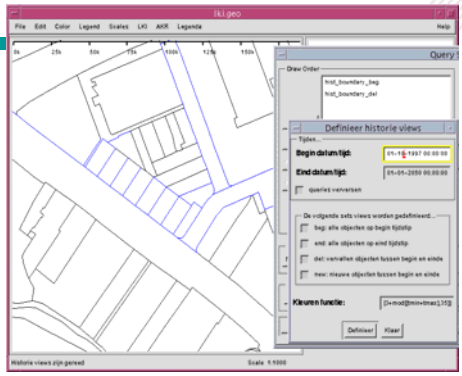
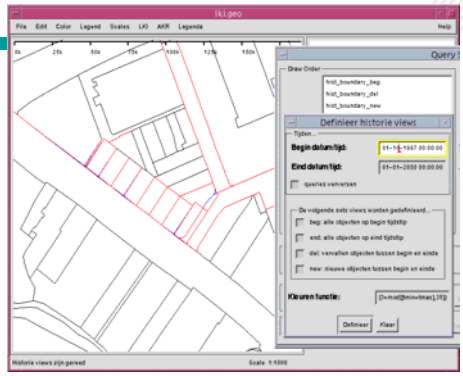
Deletion time color coded



Deleted boundaries in blue...



New boundaries in red…



Unique object identifiers

- Normally every object has an unique object identifier (oid)
- In temporal system, many versions of the same object (with the same oid) may exist
- To identify every object-version in time and space: key = oid+tmin
- Less good alternative: key = oid+tmax
- When referring from one object to another, only use oid-part of key

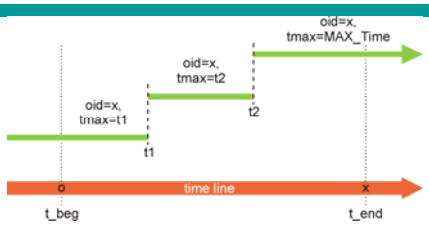
Time at object level

- Every record gets system tmin and tmax.
- *Insert* record: tmin=check-in time, tmax=maxint.
- *Delete* record: tmax=check-in time.
- *Update* record: make new version with tmin=check_in time, tmax=maxint and for old version tmax=check_in time (same value!).
- Easy to get map at time moment *t* and also easy to produce update file over time period *t1-t2*.

Delivery of update files

- Avoid shipping of full copies all the time
- Store previous delivery, compute difference (old method within Cadastre) or use time model (new method)
- Types of update deliveries:
  - Interval or two points in time
  - Only relevant attributes A1, A2, …A3: yes/no
- 4 combinations possible

All changes over time interval (including temporary versions)



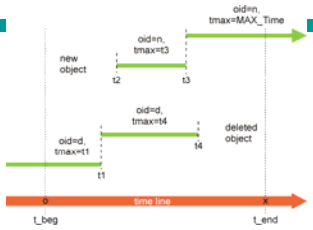
delete

```
select * from line l where
    t_beg < l.tmax and l.tmax <= t_end;
```

new

```
select * from line l where
    t_beg < l.tmin and l.tmin <= t_end;
```

Only changes comparing 2 points in time (excl. temporary versions)



delete

```
select * from line l where
    t_beg < l.tmax and l.tmax <= t_end
                   and l.tmin <= t_beg;
```

new

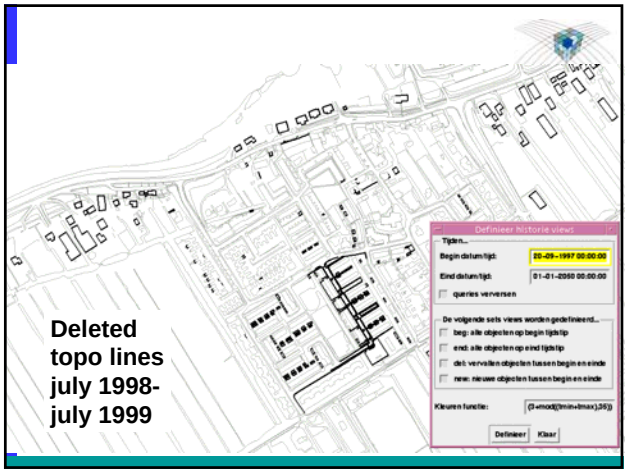
```
select * from line l where
    t_beg < l.tmin and l.tmin <= t_end
                   and t_end < l.tmax;
```


Billing topographic map

- Joined ownership of large scale topo map;
- Billing based on the number of mutations;
- Different types of mutations defined: delete, new hard/soft topo, (non)concentrated, ...;

```
create table topo_line
   (id int, line iline(50),
   tmin int, tmax int);   /* history */

create table municip
   (m_code char(5), pgon long polygon);
```

Deleted topo lines july 1998- july 1999

Overview

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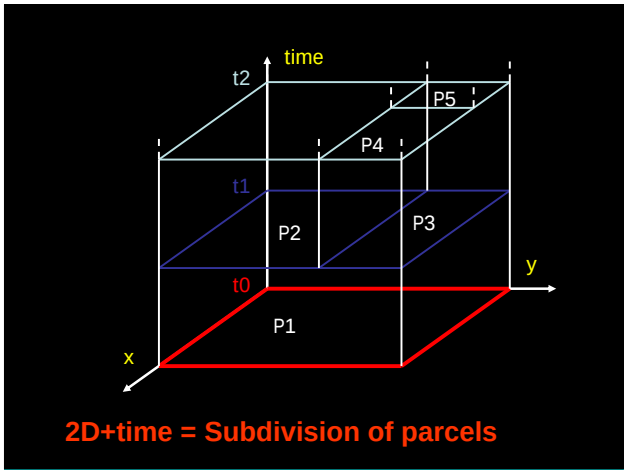
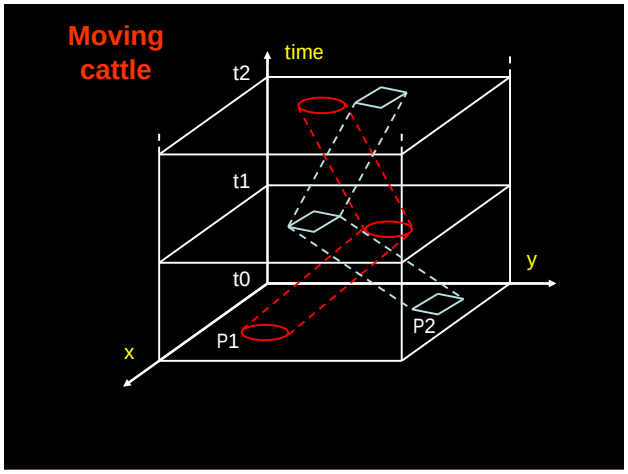


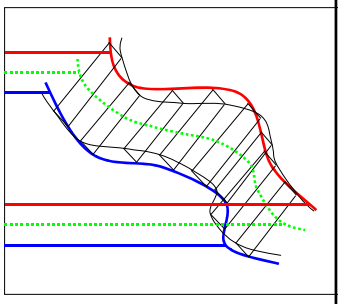
2D+time = Subdivision of parcels

Moving cattle

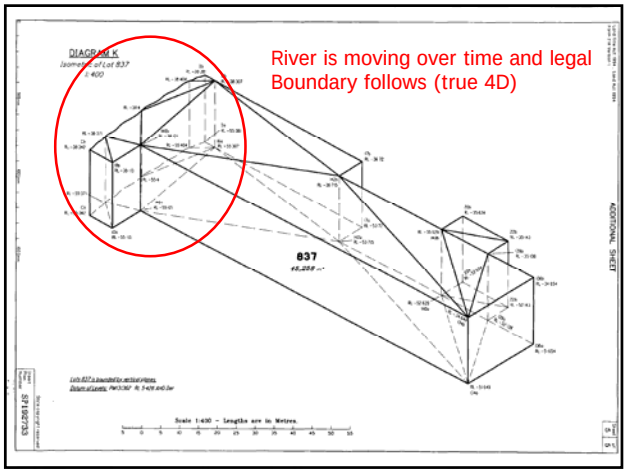


3D+time= 4D, Case 1: dynamic objects

- 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)

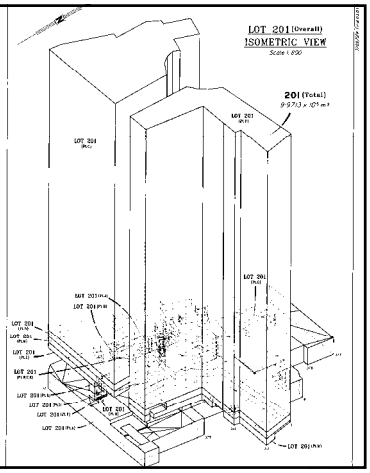


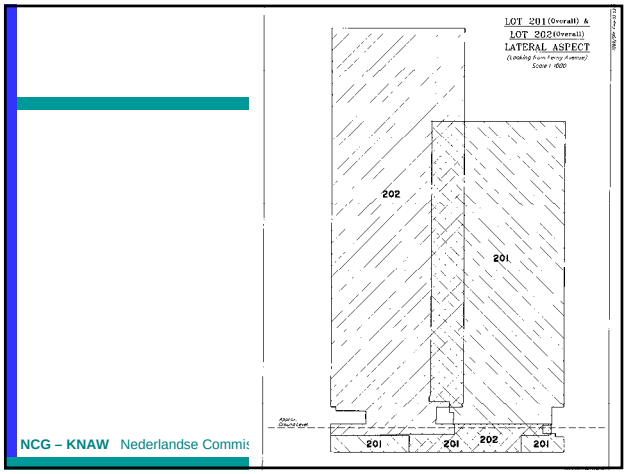
3D Tunnel in Queensland



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

4D: separate space and time attributes 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

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

Programma vandaag

14.00 Temporele standaarden in GIS-bestanden (NEN3610, OGC, TOP10NL, ISO 19108),
Wilko Quak (TU Delft)

14.30 Historische data, mogelijkheden en moeilijkheden bij geografisch onderzoek,
Elger Heere (Universiteit Utrecht)

15.00 Pauze

15.30 Tijd: basisingrediënt van meteorologische en klimatologische gegevens,
John van de Vegte (KNMI)

16.00 Archeologie en GIS, geodata in verleden en toekomst,
Milco Wansleeben (DANS)

16.30 Borrel