# 4D Land Administration Solutions in the Context of the Spatial Information Infrastructure

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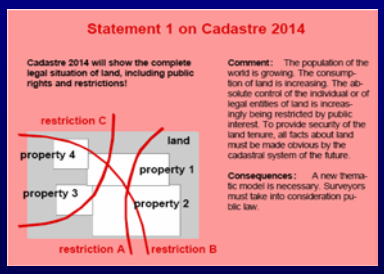
- Introduction
- 4D Land Administration
- Registration of utilities
- Spatial Information Infrastructure
- Case study
- Conclusion



## Introduction, Need for 4D LA

- **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**

- **The Bathurst Declaration (UN ve FIG, 1999):** "most land administration systems today are not adequate to cope with the increasingly complex range of rights, restrictions and responsibilities in relation to land."

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## Conceptual Basis of 4D Land Administration

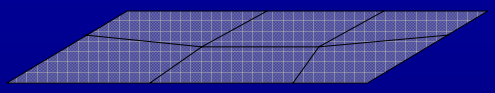
- **Partition: no gaps or overlaps in the parcelation on which the rights are based**

2D: a planar partition of the surface

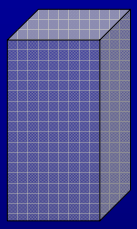
3D: a partition of space with no overlaps or gaps

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

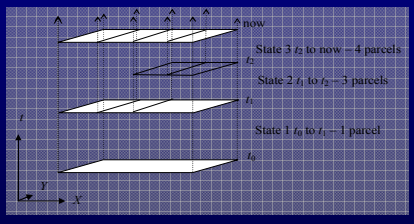
## Implementation of 4D Land Administration



2D: partition of the surface based on a 2D topology with faces, edges and nodes



3D: partition of space based on a complete 3D topological structure based on volumes, faces, edges and nodes




4D: use a 4D space-time topological structure

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# Registration of utilities

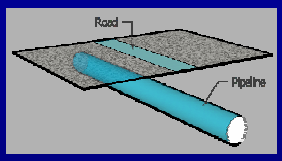
Why utilities?

- Main objects in LA with 4D characteristic
- Utility networks can cross many parcels
- Current LA systems have shown limitation to manage utilities
- Different applications in practice in different LA systems
  - not registered
  - registered as separate real property
  - registered as restrictions with their own geometry




# Registration of utilities in Turkey

- Underground objects are considered to be movable
- Many utility networks are located under public lands (e.g. roads)



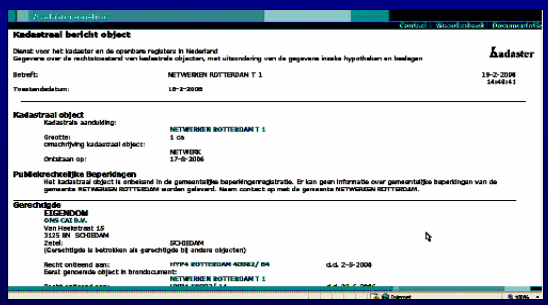

1. Limited rights are used to entitle the owner of the utility to space above or below the surface parcel
2. The person who holds a utility network is also the owner of the surface parcel

# Registration of utilities in The Netherlands

- Technical registration: the registration of the geometry, in order to avoid damage to the utility
- Legal registration: the registration of the utility network as an object of property rights.

Dutch Supreme Court in 2003: underground networks are real estate objects

Dutch Civil Code was modified in 2007: "a network … constructed in, on or above the land of an other person, is owned by the competent constructor"


Kadastraal bericht object

Kadaster

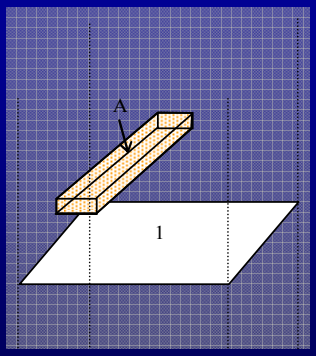
Kadastraal object

Publiekrechtelijke Beperkingen

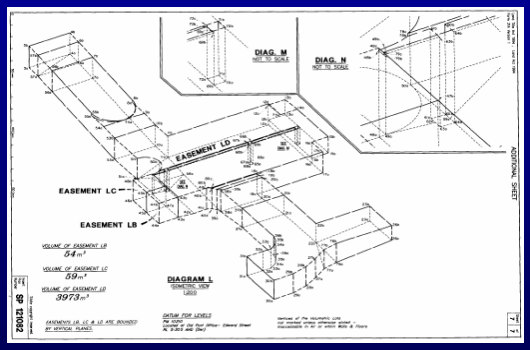
Gerechtigde

**A registered telecominaction network in the Netherlands cadastre**

## Registration in 3D: Queensland case




A 3D easement "A" as a secondary interest in a 2D parcel "1"




Example of volumetric survey plan for easement

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# SII

Why SII?

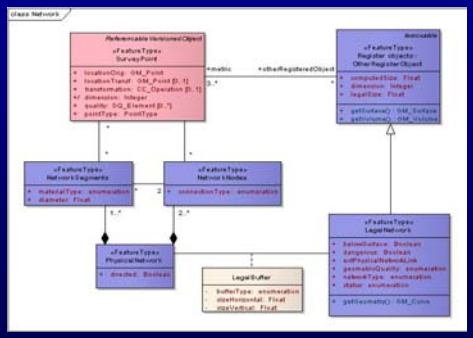
Refer from the LA system to 3D descriptions in external building and network registrations.

Standardization?

Standardization enables involved parties to communicate each other describing digital data and services.

# SII – Standardization

The Land Administration Domain Model (LADM) is an attempt to achieve standardisation in the area of LA data



Conceptual model of LADM for registration of utility network represented in UML

- The geometry and topology (2D and 3D) are based on the ISO/TC 211 standard classes.
- The LADM only covers the 'legal space'
- The LADM covers both event and state based temporal modeling to model temporal changes

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# Case Study


Study area together with building data set

A case study was performed

to organize utility networks in a database management system (DBMS)

to access the data from GIS/CAD applications

to visualize the data in 3D

Data sets
- pipelines
- cables
- cadastral parcels
- buildings with elevation information
- terrain height points

# Case Study-Implementation in DBMS

3D coordinates for 2D parcels were obtained in order to relate the parcel data set to the underground networks.

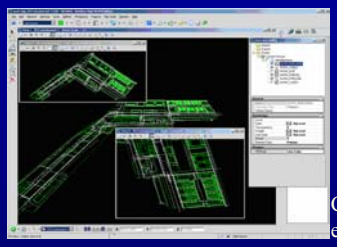
Data sets were implemented in Oracle Spatial (OS)

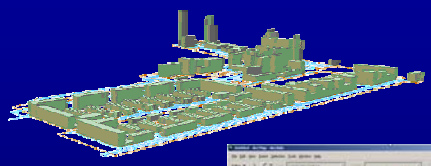
- Geometry model: (SDO_GEOMETRY) of OS
- Tables were created to store information of utilities
- Metadata was maintained in OS
- Spatial index was created on the tables

Content of Pipeline table in OS

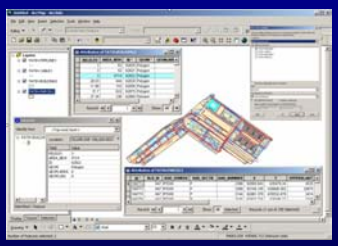
| Column Name | Datatype | Description |
|---|---|---|
| IDBUIS | NUMBER(11) | Primary Key |
| AANTAL | NUMBER(11) | Pipeline Number |
| IDBEHEERDE | NUMBER(11) | Owner number |
| IDPRODUCT | NUMBER(11) | Material |
| IDSPANNING | NUMBER(11) | Pressure |
| IDSTATUS | NUMBER(11) | Status |
| PIB | NUMBER(11) | Licence number |
| AANVULLEND | CHAR(50) | Additional |
| STEUNTEKST | CHAR(50) | Support text |
| TMIN | VARCHAR(7) | Build date |
| TMAX | VARCHAR(7) | Deleted date |
| GEOM | MDSYS.SDO_GEOMETRY | Gtype=3002 (3D line) |

# Case Study-Access/Visualization from CAD/GIS





CAD application for 3D data edit and visualization

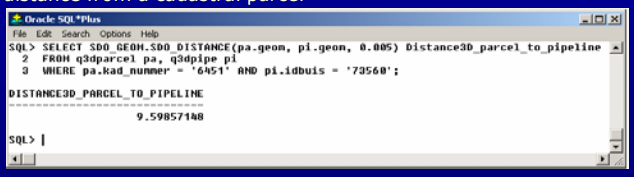


GIS applications for 3D visualization and spatial query

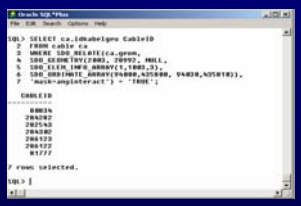
3D data on Google Earth (Red line is an underground cable)

# Case Study-Query in DBMS

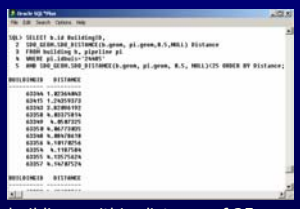
‘’what is the vertical distance between a parcel and pipeline’’ or ‘’is a pipeline at a particular distance from a cadastral parcel’’



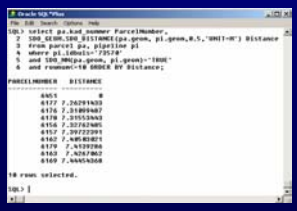

Query in OS11g: Distance parcel-pipe in 3D



Underground cables in a given region



buildings within distance of 25 meters from a pipeline



10 nearest parcels to a specific pipeline

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# Conclusion

- 4D LA can benefit from SII. In this way, geometry of objects remains at their original source while this information can be accessed from LA to register legal space of these physical objects
- The difference between legal and physical objects should be recognized
- Adjustments in land administration are necessary to apply this solution. Legal and organizational aspects have to be further investigated.

# Conclusion (cont.)

- From technical point of view, implementation can be realized with two approaches
  - •use a 4D space-time topological structure (medium-long term)

This approach guarantees the consistency
4D topological structures are not yet available in the current software packages, R&D is needed

  - •store space and time information separately

no guarantee for consistency
additional constraints can be put the model to obtain the partition

- In this study, extension of LADM for utilities was applied to case. The case study has shown that separate 3D+time attribute are sufficient for the selected case.