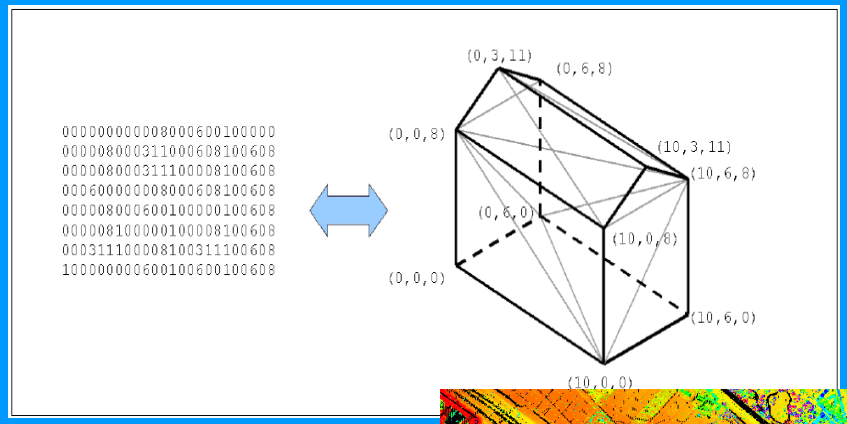
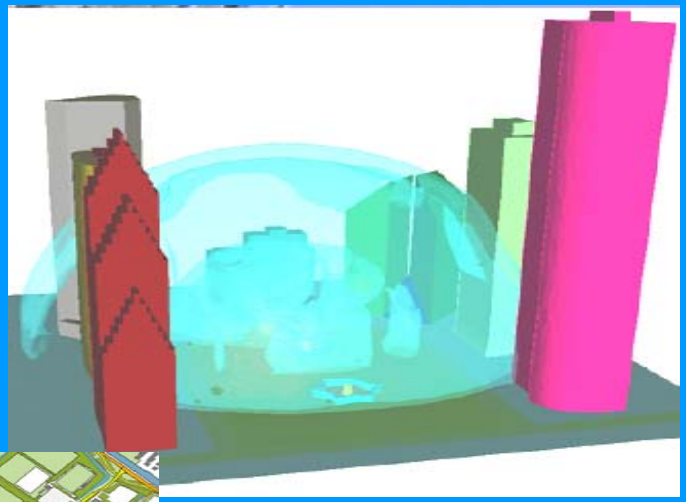
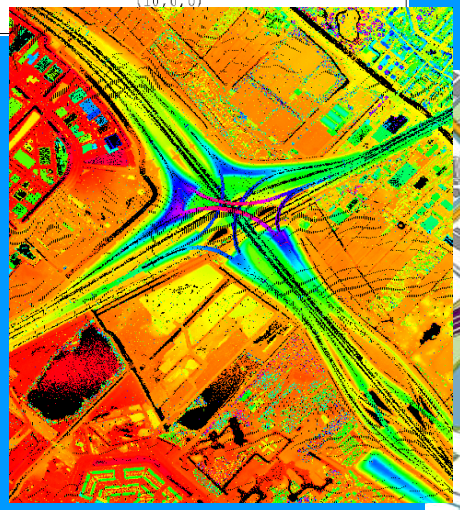
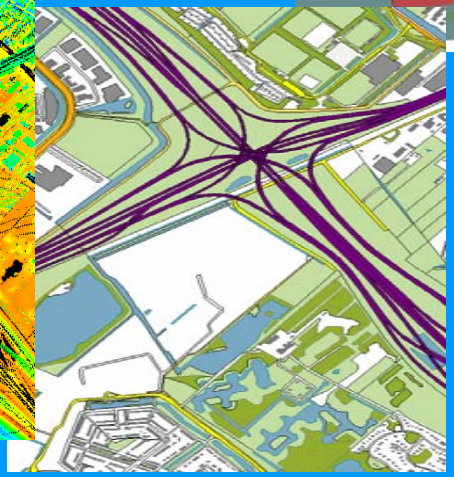
3D Topography









Peter van Oosterom, project leader (TU Delft)

Agenda

- Project goal
- Facts and figures
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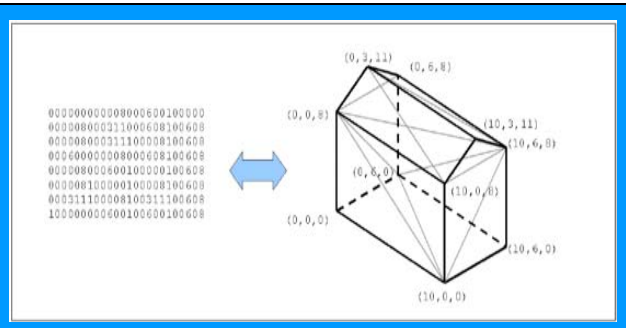
Project Goal

- Enforce major break-through in the application of 3D Topography in corporate ICT environments due to structural embedding of 3D methods and techniques

- So: more than ad-hoc model visualization
- Two international top-ups:
  - RGI-011A: model comparison
  - RGI-011B: tetrahedron network computation

Agenda



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Facts and figures - Partners

- TU Delft
- ITC
- Topografische Dienst Kadaster
- Rijkswaterstaat – Adviesdienst Geo-informatie en ICT
- Oracle USA & NL
- NedGraphics CAD/GIS B.V.
- Stuurgroep AHN

Facts and figures – Added

- RGI-011A, 3D model comparison:
  - TU Vienna (Andrew Frank)
  - City University London (Jonathan Raper)
  - University College London (Paul Longley)
  - University of Glamorgan (Chris Gold)
  - Sweco (private company) Sweden (Ludvig Emgård)
  - Queensland Government (Rod Thompson)
- RGI-011B, tetrahedron computation:
  - Weierstrass Institute for Applied Analysis and Stochastics, Berlin (Hang Si)

Facts and figures - Management

- Consortium-wide meeting two times per year (prepared agenda, elaborated meeting notes with clear action points,…)
- Smaller meetings: more often as required
- One KPMG accountant statement for whole consortium (not easy with many partners)
- Professional project management support for reporting (TUD/OTB, Elfriede Fendel)

Facts and figures – Budget

- RGI-011, 3D topography:
  899,836 Euro
- RGI-011A, 3D model comparison:
  198,136 Euro
- RGI-011B, tetrahedron computation:
  97,620 Euro

Facts and figures – Period

- RGI-011, 3D topography:
  Period 11-01-2005 – 31-12-2008
- RGI-011A, 3D model comparison:
  Period 01-01-2007 – 31-12-2008
- RGI-011B, tetrahedron computation:
  Period 01-09-2007 – 01-09-2008

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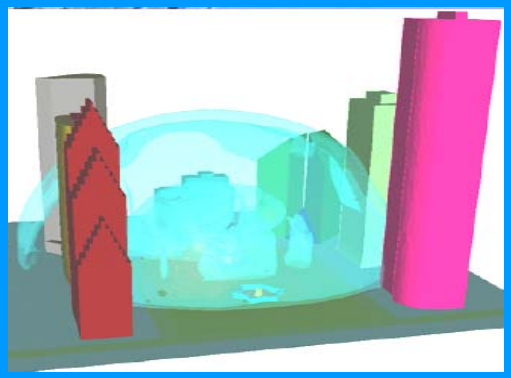

Position within RGI/NGII

- Many indications of growing need of 3D topography as part of NGII framework data
- Our project analyses 4 use-cases: (Municipality Den Bosch, Google Earth at RWS, Lekdijk dike control, TOP10NL) support this
- Same is true at international level, both from demanding side (e.g. INSPIRE) and research side (→ top-ups)

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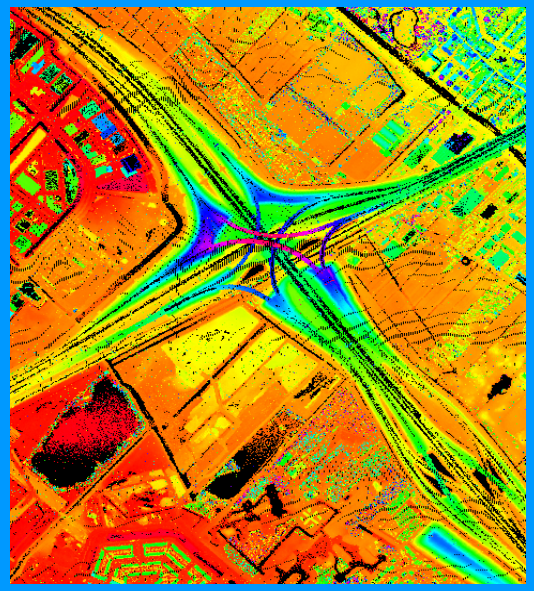


Approach and status

Project work packages:

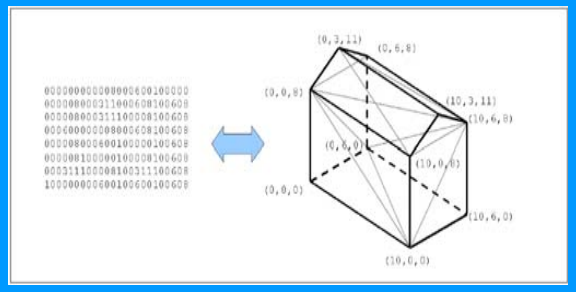
1 User requirements of 3D topographic data and systems

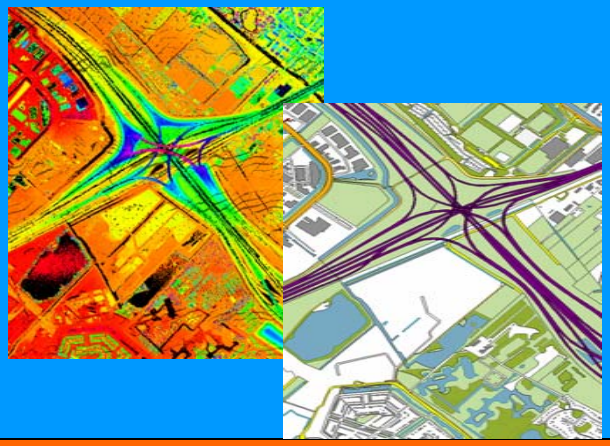
2 3D topographic data model

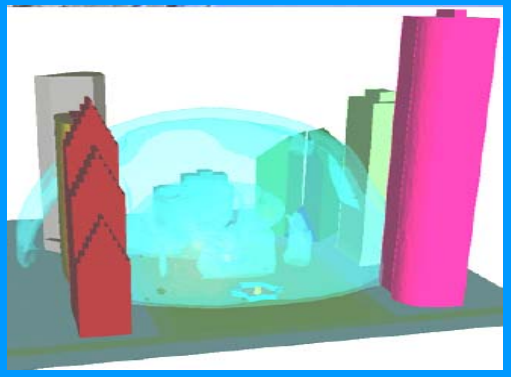
3 3D conversion and acquisition techniques

4 3D DBMS and analysis

5 Knowledge distribution and communication





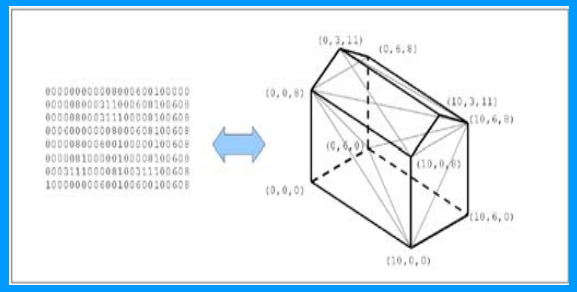


3D data modelling

3D data acquisition

3D DBMS Analysis

3D data modelling (1/2)

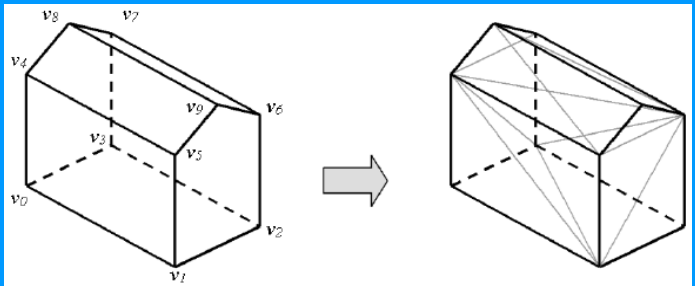


Objective: develop a data structure capable of handling large data volumes and offers support for querying, analysis and validation.

Model characteristics:
- full 3D decomposition of space;
- apply a tetrahedron structure;
- based on Poincaré simplicial homology as mathematical foundation.

Main researcher: Friso Penninga (TUD)

3D data modelling (2/2)



$S_{31} = \langle v_0, v_1, v_3, v_4 \rangle$ $\partial S_{31} = \langle v_1, v_3, v_4 \rangle - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle$

$S_{32} = \langle v_1, v_2, v_3, v_6 \rangle$ $\partial S_{32} = \langle v_2, v_3, v_6 \rangle - \langle v_1, v_3, v_6 \rangle + \langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle$

$S_{33} = \langle v_1, v_3, v_4, v_6 \rangle$ $\partial S_{33} = \langle v_3, v_4, v_6 \rangle - \langle v_1, v_4, v_6 \rangle + \langle v_1, v_3, v_6 \rangle - \langle v_1, v_3, v_4 \rangle$

$S_{34} = \langle v_1, v_4, v_5, v_6 \rangle$ $\partial S_{34} = \langle v_4, v_5, v_6 \rangle - \langle v_1, v_5, v_6 \rangle + \langle v_1, v_4, v_6 \rangle - \langle v_1, v_4, v_5 \rangle$

$S_{35} = \langle v_3, v_4, v_6, v_7 \rangle$ $\partial S_{35} = \langle v_4, v_6, v_7 \rangle - \langle v_3, v_6, v_7 \rangle + \langle v_3, v_4, v_7 \rangle - \langle v_3, v_4, v_6 \rangle$

$S_{36} = \langle v_4, v_6, v_7, v_8 \rangle$ $\partial S_{36} = \langle v_6, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_6, v_8 \rangle - \langle v_4, v_6, v_7 \rangle$

$S_{37} = \langle v_4, v_5, v_6, v_8 \rangle$ $\partial S_{37} = \langle v_5, v_6, v_8 \rangle - \langle v_4, v_6, v_8 \rangle + \langle v_4, v_5, v_8 \rangle - \langle v_4, v_5, v_6 \rangle$

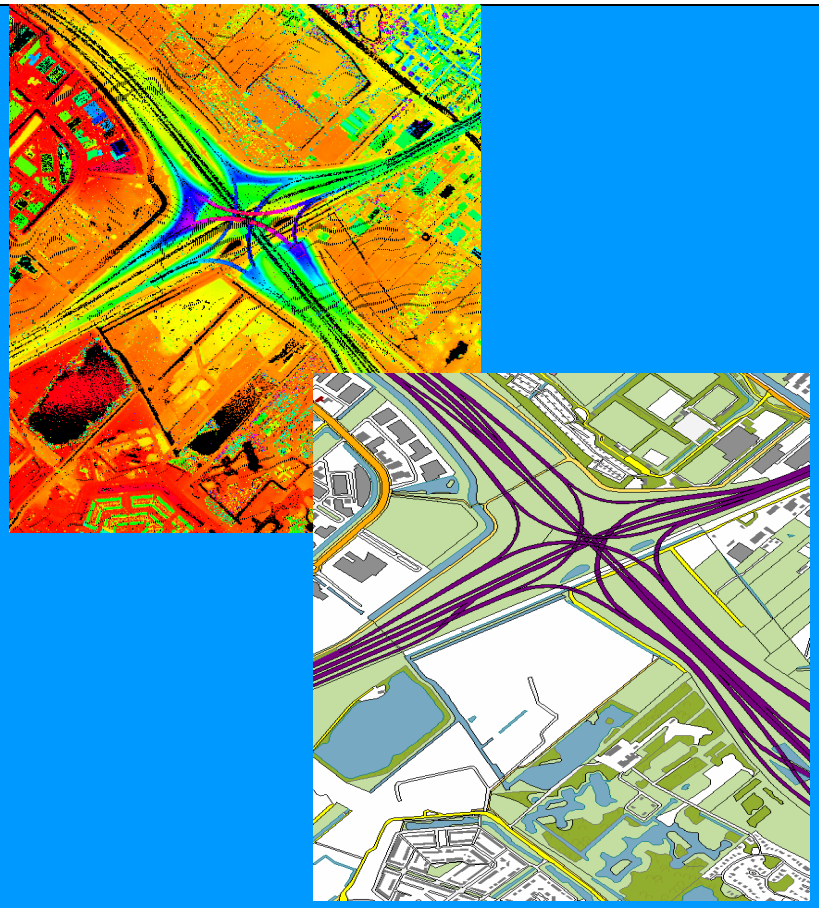
$S_{38} = \langle v_5, v_6, v_8, v_9 \rangle$ $\partial S_{38} = \langle v_6, v_8, v_9 \rangle - \langle v_5, v_8, v_9 \rangle + \langle v_5, v_6, v_9 \rangle - \langle v_5, v_6, v_8 \rangle +$

$C_3 =$ $- \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle + \langle v_2, v_3, v_6 \rangle +$
$\langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle - \langle v_1, v_5, v_6 \rangle - \langle v_1, v_4, v_5 \rangle - \langle v_3, v_6, v_7 \rangle$
$+ \langle v_3, v_4, v_7 \rangle + \langle v_6, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_5, v_8 \rangle +$
$\langle v_6, v_8, v_9 \rangle - \langle v_5, v_8, v_9 \rangle + \langle v_5, v_6, v_9 \rangle$

Results:

- a new innovative approach to 3D data modelling;
- validation and analysis through topology
- reduces data storage (stored in one single-column table!);
- no explicit updates of topology and less dimensional simplexes;
- full control over orientation;
- based on a solid theoretical foundation (100 years old math).

3D data acquisition (1/3)



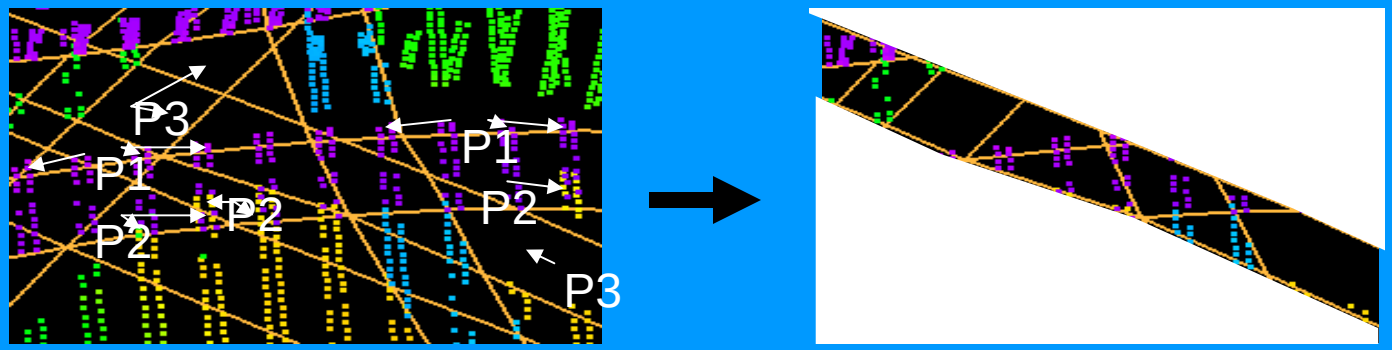
Objective: develop an automated 3D data acquisition method, by integrating laser altimetry data with 2D GIS data.

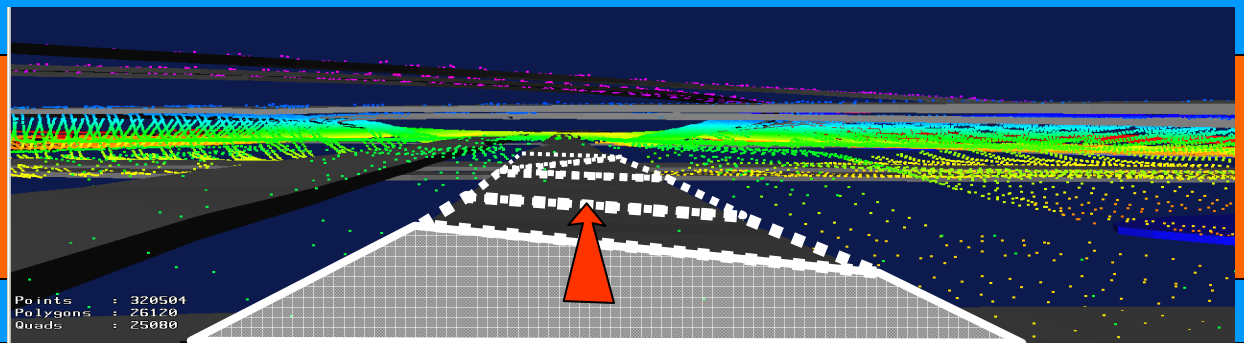
Main researcher: Sander Oude Elberink (ITC)

3D data acquisition (2/3)

3D acquisition algorithm:

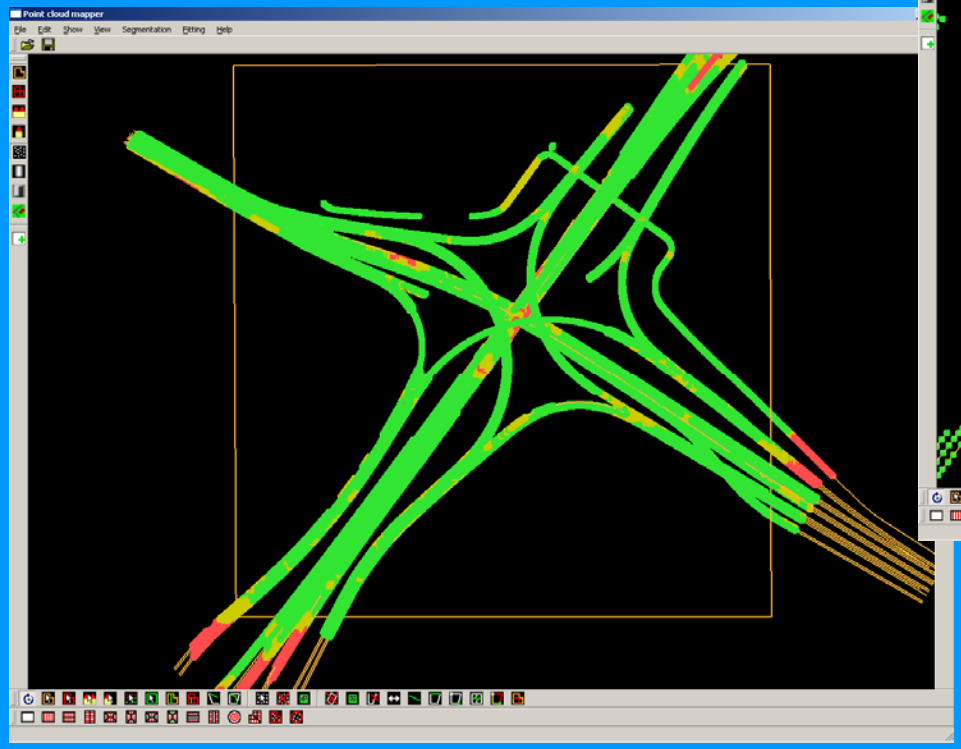
- segmentation based filtering of small objects in laser data;
- assigning laser data to map data in a sophisticated map and laser growing & fusion algorithm;
- integrating object knowledge to produce horizontal lakes and smooth roads;
- additional 3D boundaries have automatically been reconstructed to allow the reconstruction of 3D objects.

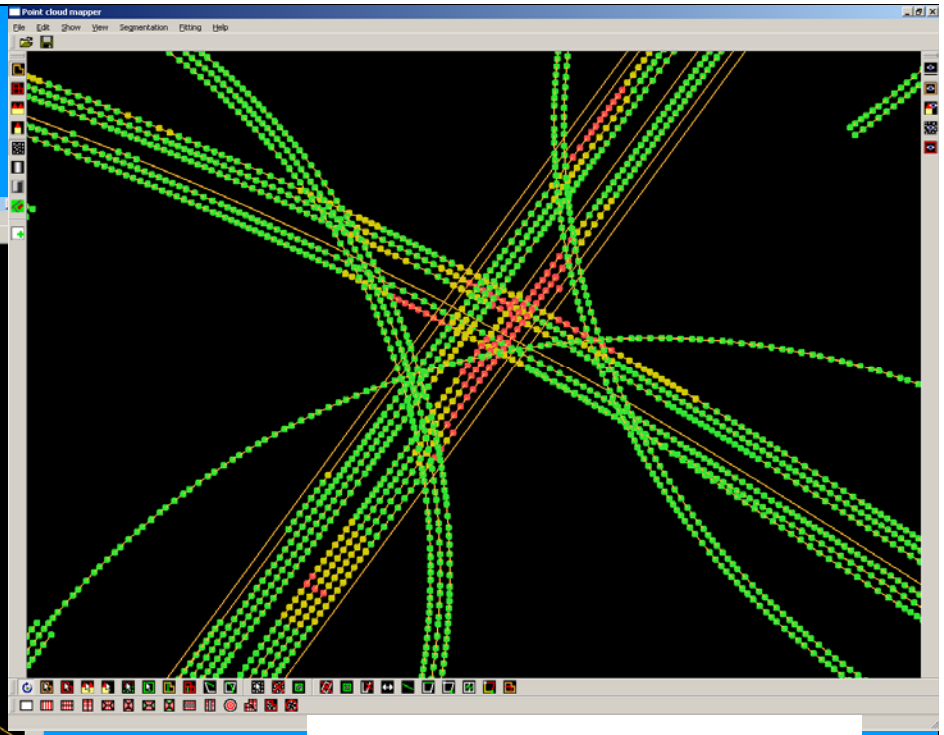




3D data acquisition (3/3)

Quality check





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0.2 – 0.5 m yellow
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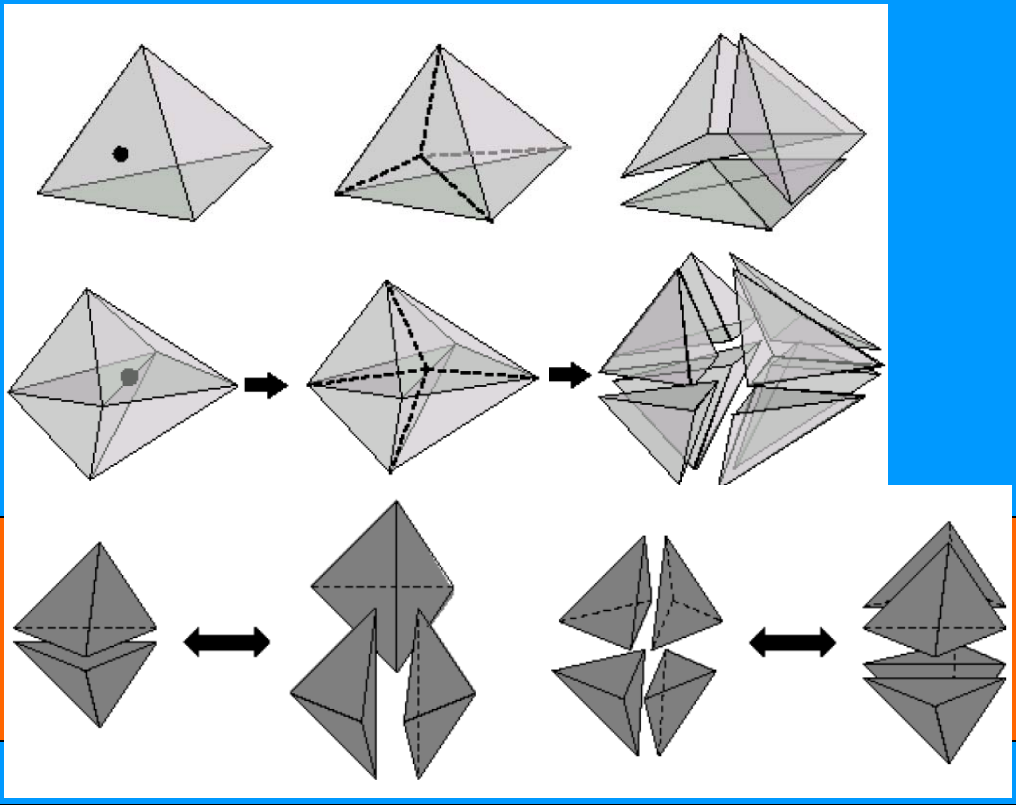
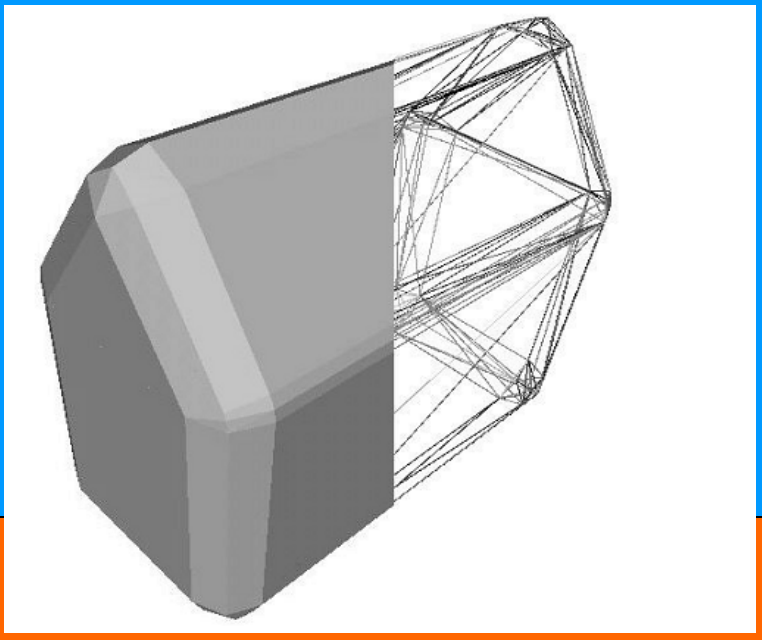
Quality check: compare with accurate DTB

3D DBMS analysis

Updating and querying the DBMS with 3D data
Compare TEN structure to alternative (top-up RGI-011A)
Initial computing and updating TEN (top-up RGI-011B)

Types of operations: buffer, overlay, topology, metric (volumes, distance),…





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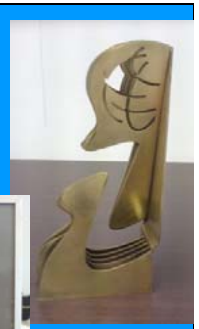
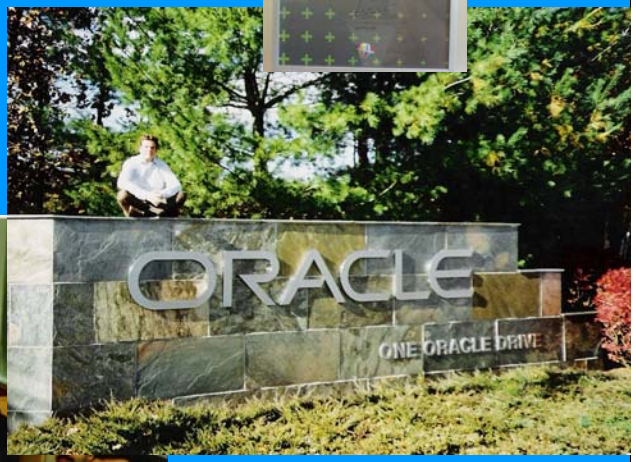
Results, successes

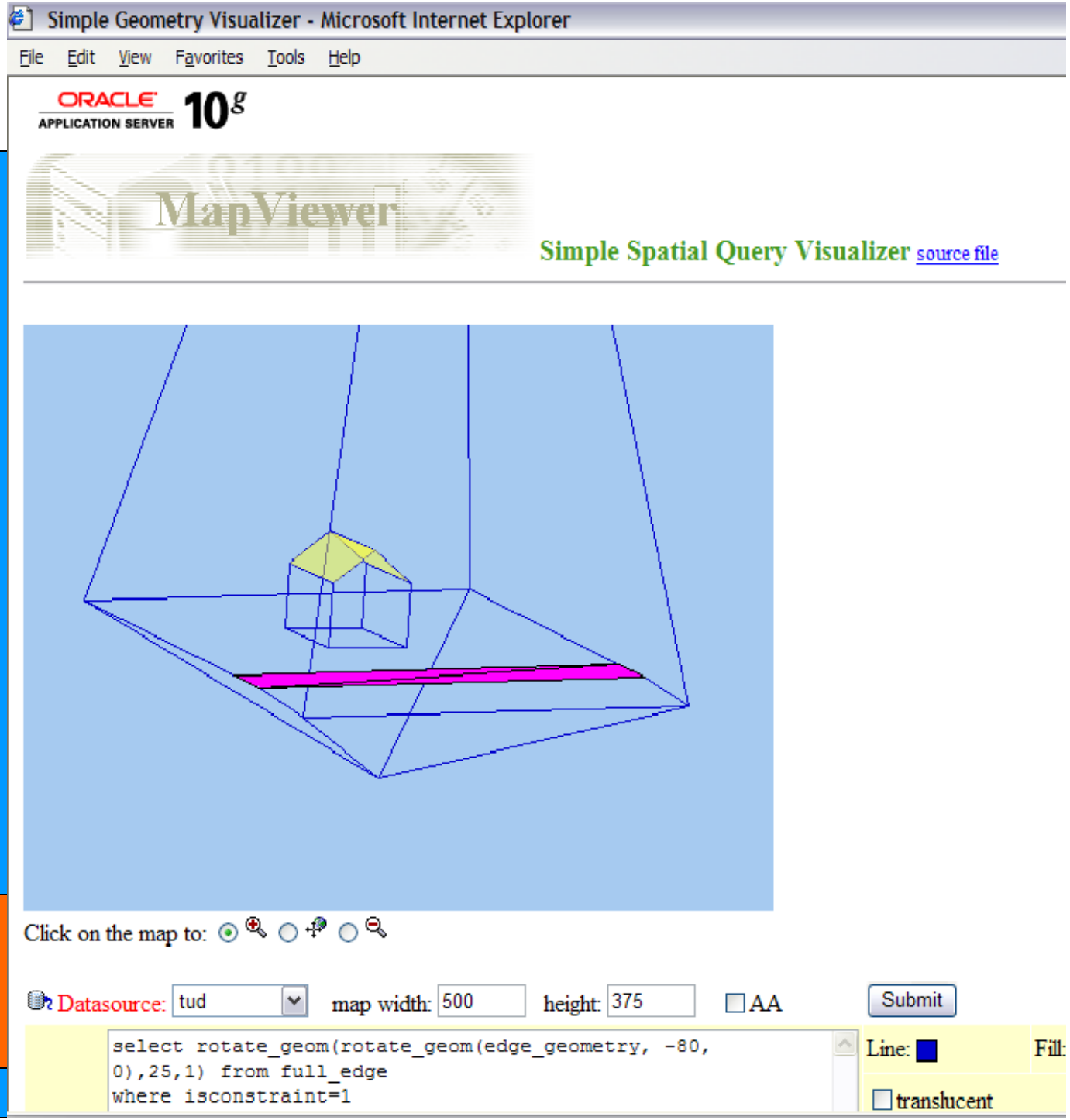
- Geo-Innovation award, category Science
- Geo-Info prize best paper
- Oracle 11g with functionality
- Automated reconstruction Prins Clausplein
- TUD campus test data
- TEN prototype





Results

- First TEN structure in DBMS
- Simple toy world



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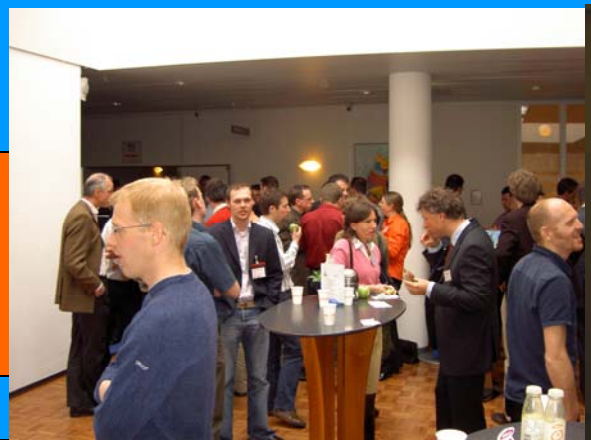
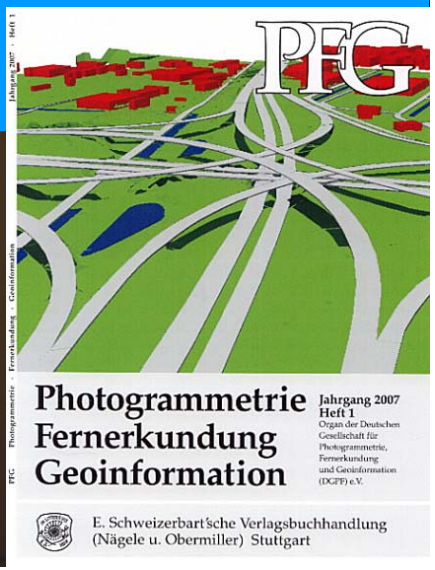
Relevance scientific/society

- So far: 17 conference papers, 6 professional publications, 6 reports and still counting!
- 1 accepted paper for peer-reviewed journal
- Upcoming event: 3D geoinfo07 al Workshop on 3D Geo-Information: Requirements, Acquisition, Modelling, Analysis, Visualisation 12-14 December 2007, Delft, the Netherlands
- Workshop User requirements 3D Topography (April 2006):

  (in Dutch, about 80 attendants, good press coverage)





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Future perspective

- 3D geoinfo07 workshop: forum for international discussion
- 11 December 07: international top-up day: comparison 3D approaches with TU Delft campus model
- Top-up Rod Thompson, December 07 PhD defense
- Spring 2008: PhD defense on 3D modelling (first RGI PhD?)
- 2009: PhD defense on 3D acquisition
- more publications in the pipeline: PhD-theses, peer-reviewed journals, international conferences

Overall perspective:

3D topography project delivers promising, relevant results according to both planning and budget!

3D Topography

www.rgi-otb.nl/3dtopo
www.3D-GeoInfo-07.nl

Contact: Peter van Oosterom