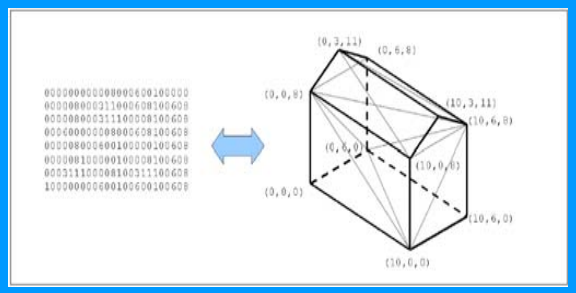
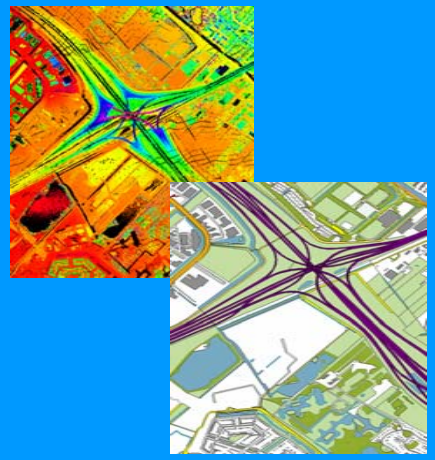
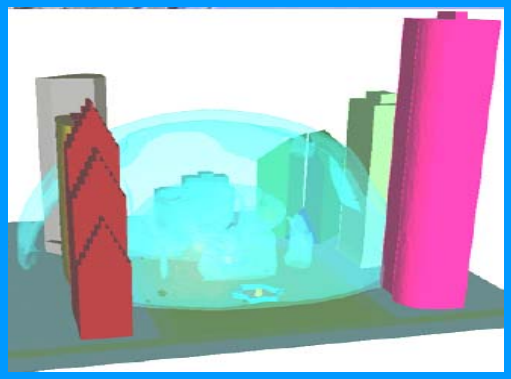
3D Topography



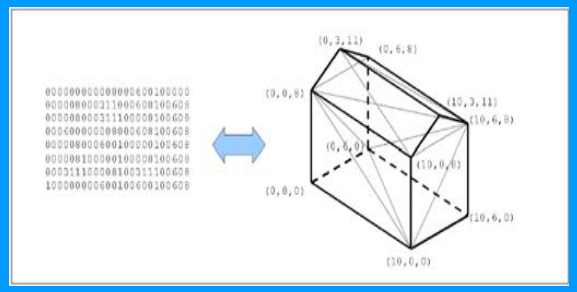


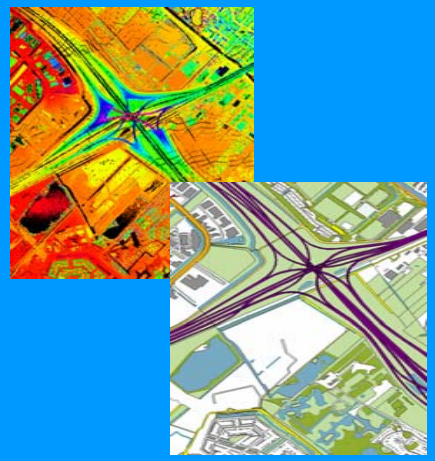


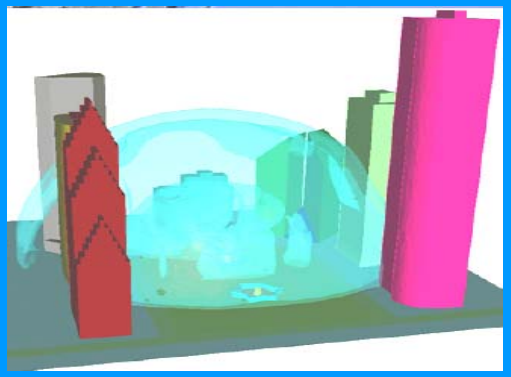
Friso Penninga TU Delft

Sander Oude Elberink ITC Enschede

3D Topography





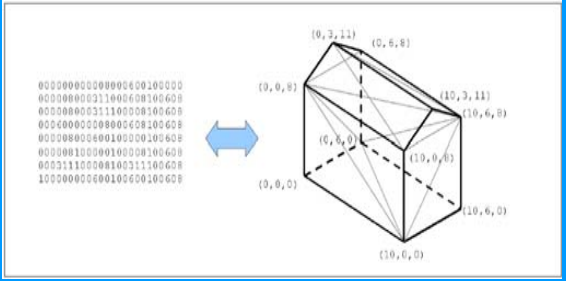


3D data modelling

3D data acquisition

3D DBMS Analysis

3D Topography

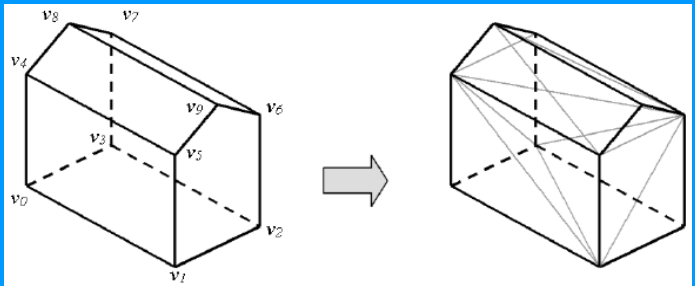


Objective: develop a data structure capable of handling large data volumes and offers support for querying, analysis and validation.

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

3D data modelling

3D Topography



$$S_{31} = \langle v_0, v_1, v_3, v_4 \rangle \qquad \partial S_{31} = \langle v_1, v_3, v_4 \rangle - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle$$
$$S_{32} = \langle v_1, v_2, v_3, v_6 \rangle \qquad \partial S_{32} = \langle v_2, v_3, v_6 \rangle - \langle v_1, v_3, v_6 \rangle + \langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle$$
$$S_{33} = \langle v_1, v_3, v_4, v_6 \rangle \qquad \partial S_{33} = \langle v_3, v_4, v_6 \rangle - \langle v_1, v_4, v_6 \rangle + \langle v_1, v_3, v_6 \rangle - \langle v_1, v_3, v_4 \rangle$$
$$S_{34} = \langle v_1, v_4, v_5, v_6 \rangle \qquad \partial S_{34} = \langle v_4, v_5, v_6 \rangle - \langle v_1, v_5, v_6 \rangle + \langle v_1, v_4, v_6 \rangle - \langle v_1, v_4, v_5 \rangle$$
$$S_{35} = \langle v_3, v_4, v_6, v_7 \rangle \qquad \partial S_{35} = \langle v_4, v_6, v_7 \rangle - \langle v_3, v_6, v_7 \rangle + \langle v_3, v_4, v_7 \rangle - \langle v_3, v_4, v_6 \rangle$$
$$S_{36} = \langle v_4, v_6, v_7, v_8 \rangle \qquad \partial S_{36} = \langle v_6, v_7, v_8 \rangle - \langle v_4, v_7, v_8 \rangle + \langle v_4, v_6, v_8 \rangle - \langle v_4, v_6, v_7 \rangle$$
$$S_{37} = \langle v_4, v_5, v_6, v_8 \rangle \qquad \partial S_{37} = \langle v_5, v_6, v_8 \rangle - \langle v_4, v_6, v_8 \rangle + \langle v_4, v_5, v_8 \rangle - \langle v_4, v_5, v_6 \rangle$$
$$S_{38} = \langle v_5, v_6, v_8, v_9 \rangle \qquad \partial S_{38} = \langle v_6, v_8, v_9 \rangle - \langle v_5, v_8, v_9 \rangle + \langle v_5, v_6, v_9 \rangle - \langle v_5, v_6, v_8 \rangle +$$

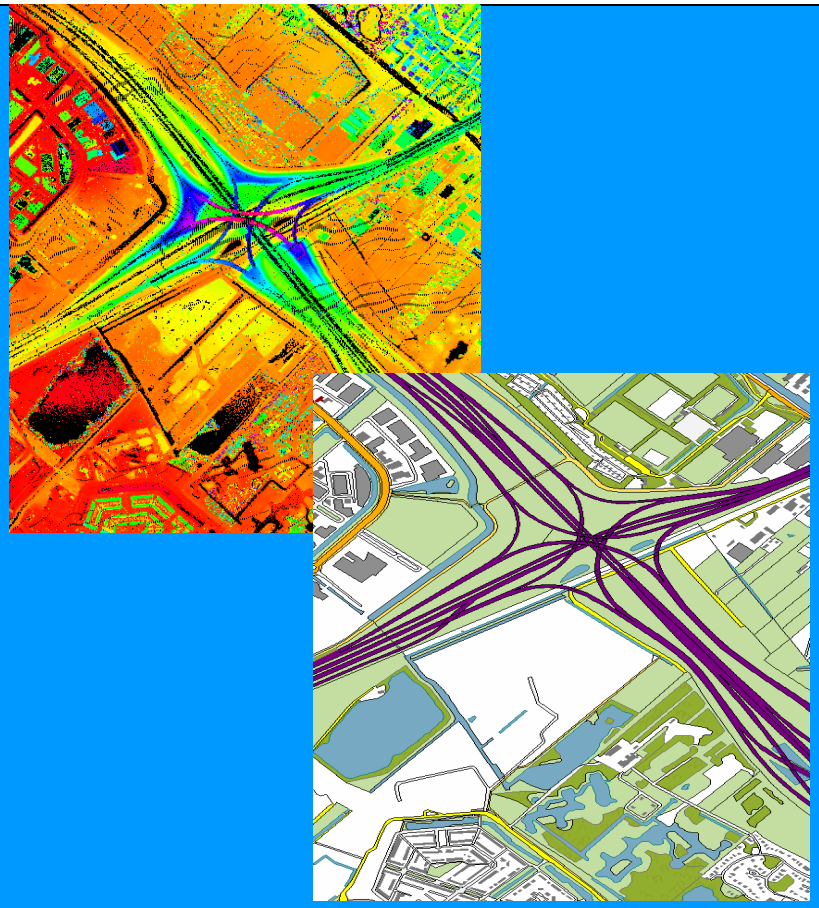
$$C_3 = \quad - \langle v_0, v_3, v_4 \rangle + \langle v_0, v_1, v_4 \rangle - \langle v_0, v_1, v_3 \rangle + \langle v_2, v_3, v_6 \rangle + \langle v_1, v_2, v_6 \rangle - \langle v_1, v_2, v_3 \rangle - \langle v_1, v_5, v_6 \rangle - \langle v_1, v_4, v_5 \rangle - \langle v_3, v_6, v_7 \rangle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

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 modelling

3D Topography



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

3D data acquisition

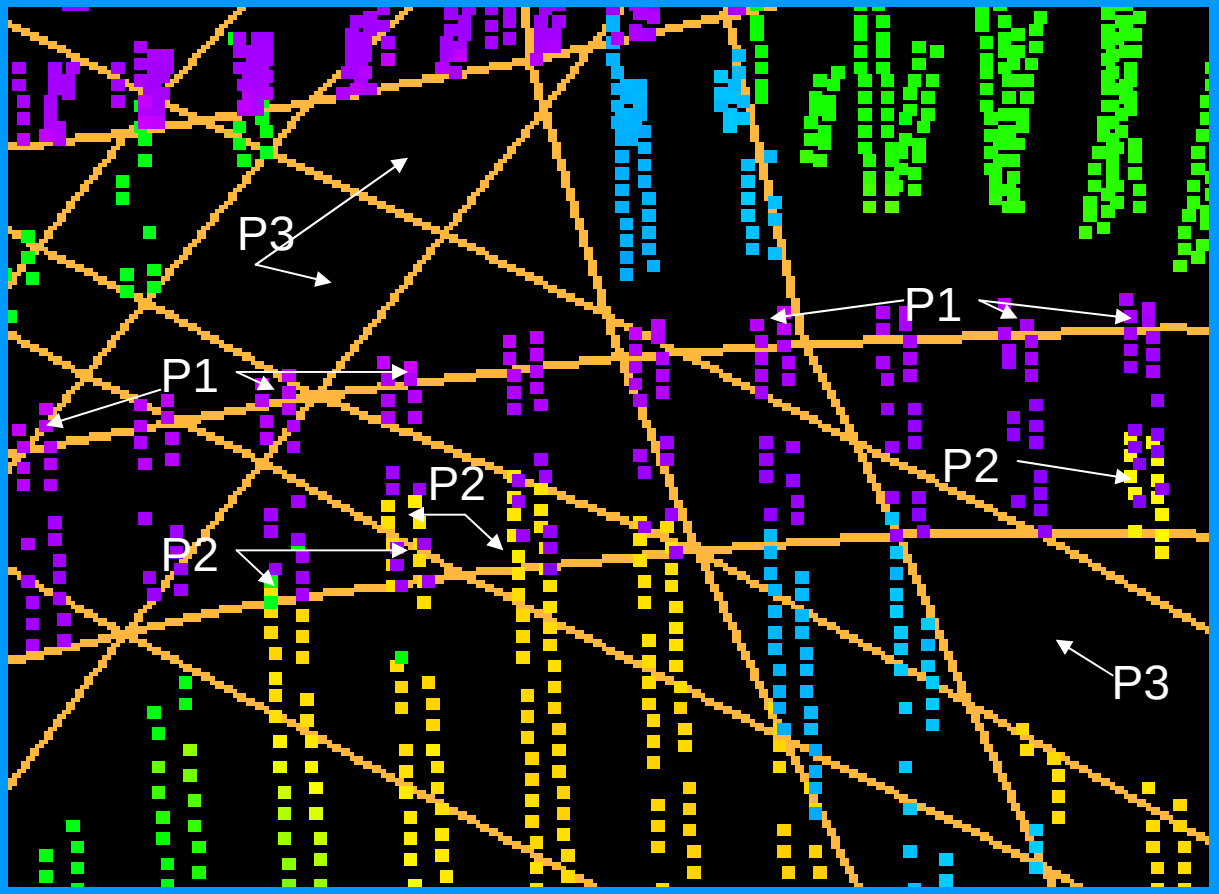
3D Topography

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.

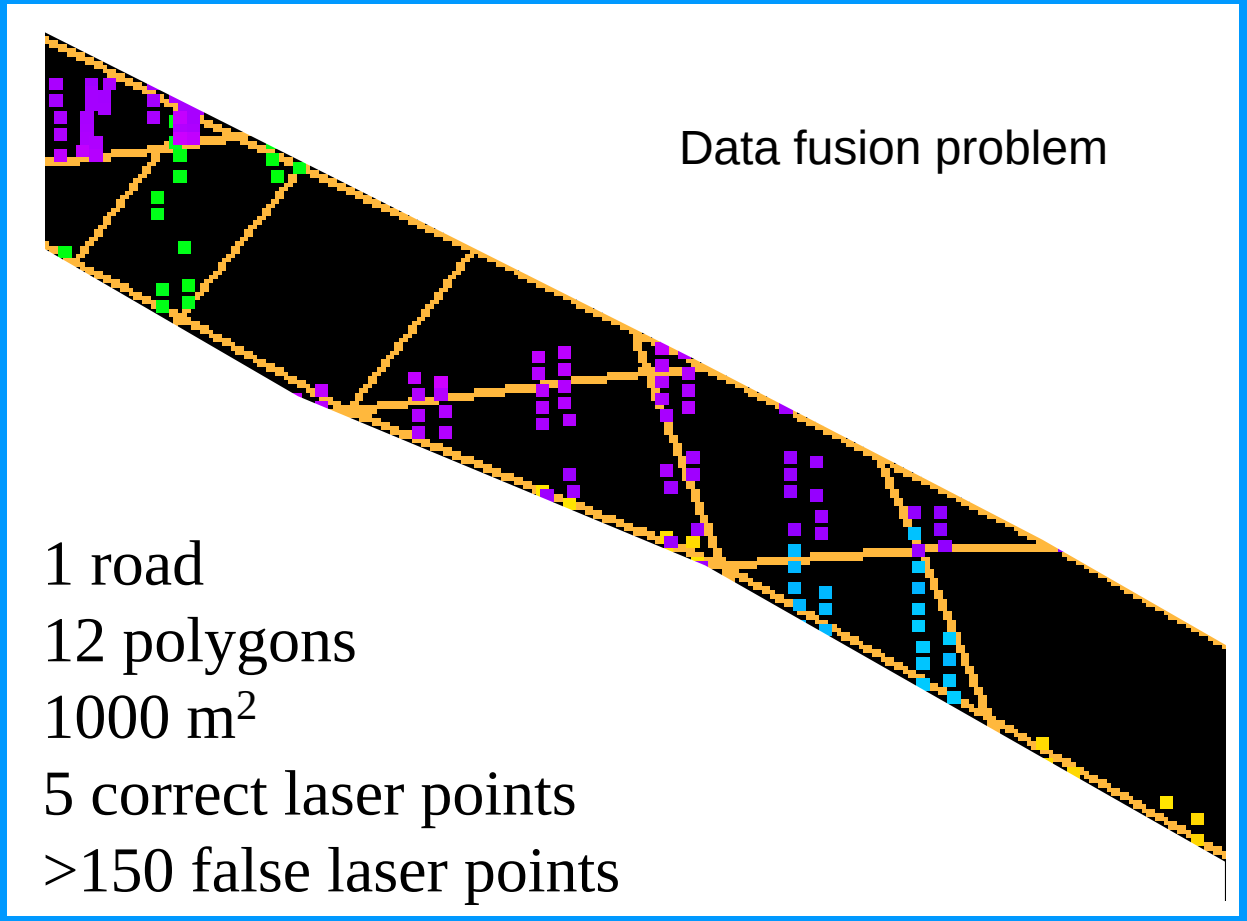
3D data acquisition

3D Topography



3D data acquisition

3D Topography

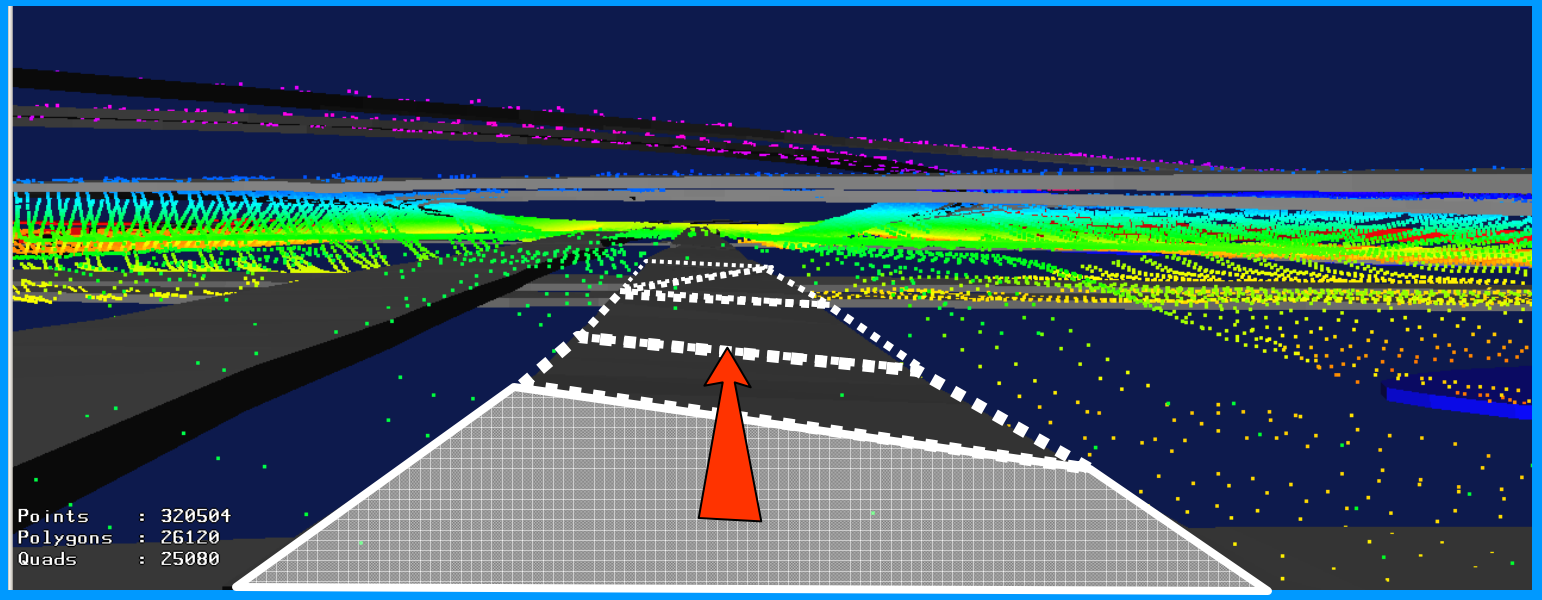


1 road
12 polygons
1000 m^2
5 correct laser points
>150 false laser points

3D data acquisition

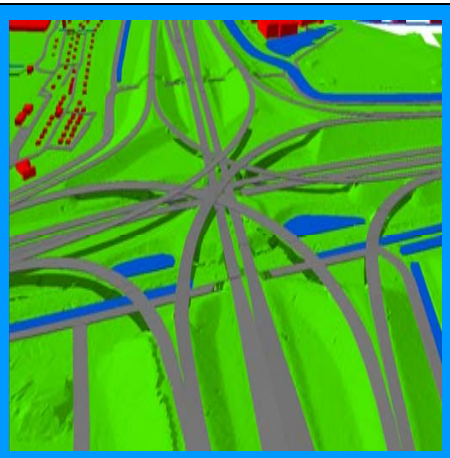
3D Topography

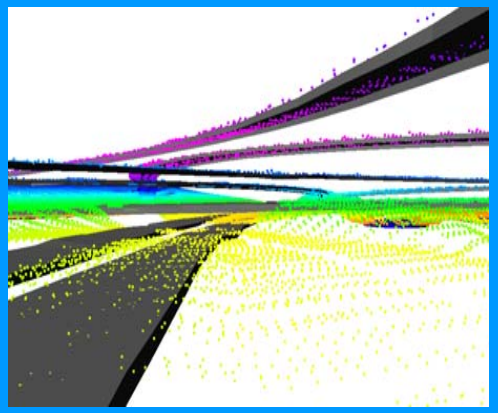
Data fusion solution:
Combined map & laser growing



3D data acquisition

3D Topography



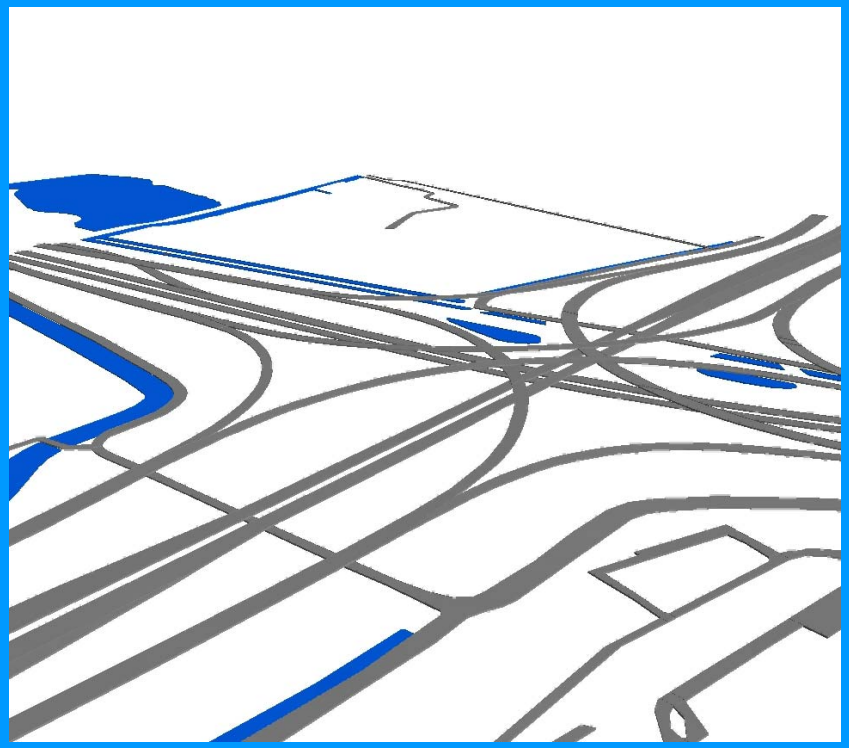


BeeldbankVenW.nl

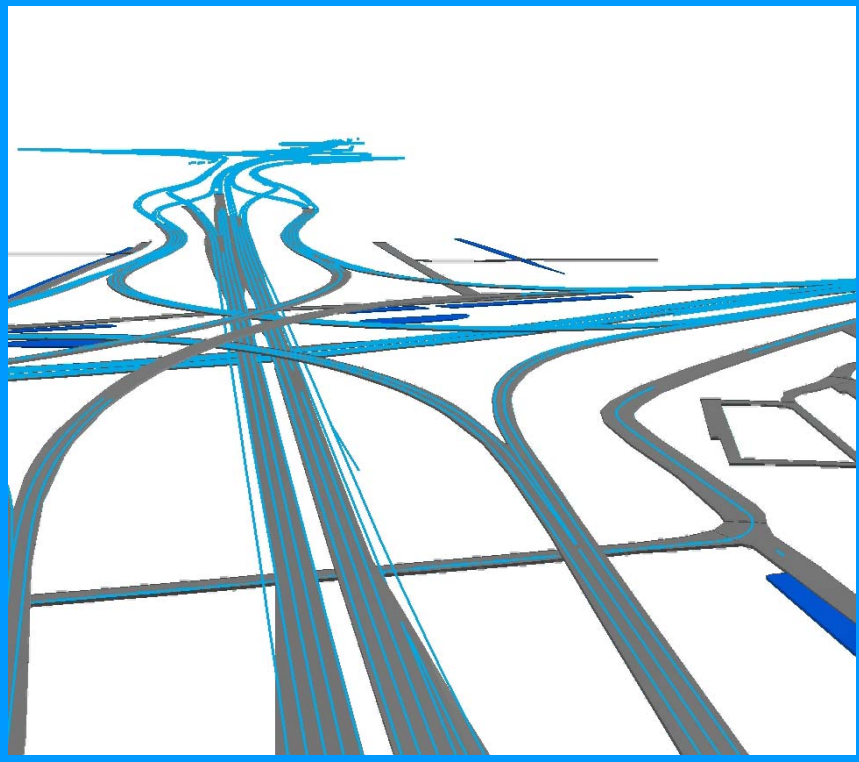
3D data acquisition

3D Topography

Results



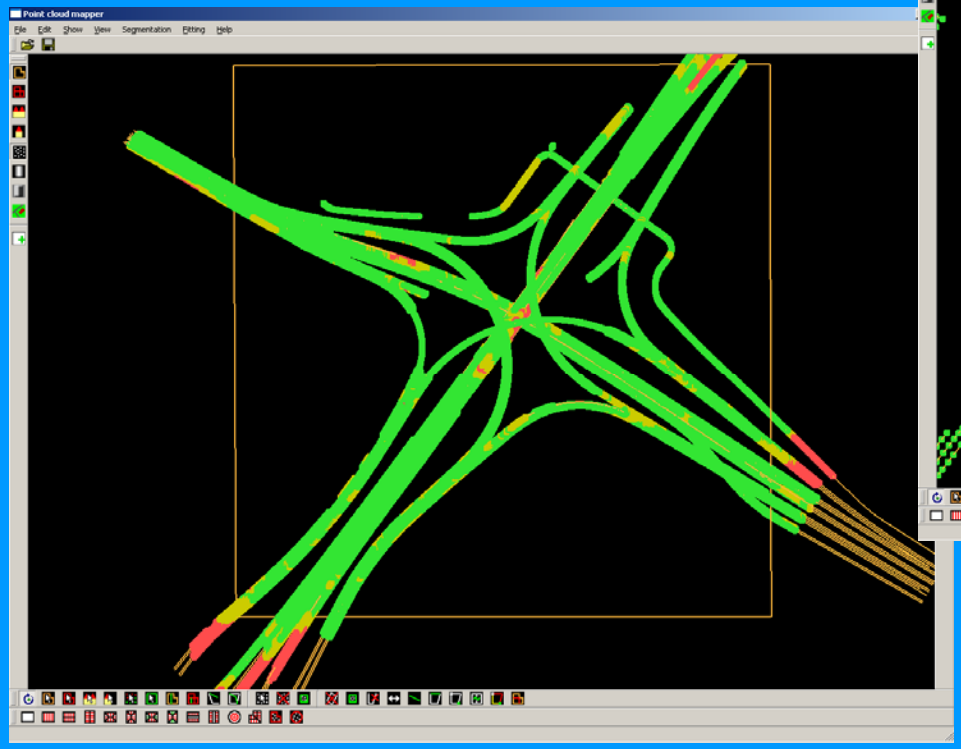
Quality check

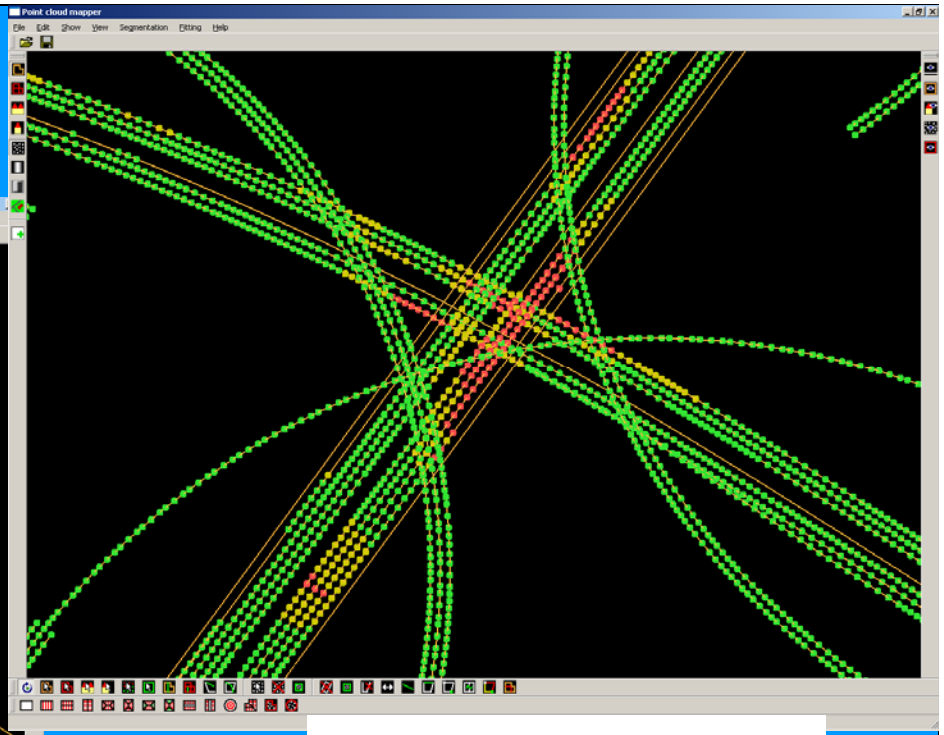


3D data acquisition

3D Topography

Quality check





<0.2 m green
0.2 – 0.5 m yellow
>0.5 m red

3D data acquisition

3D Topography

www.gdmc.nl/3Dtopo

Contact: Peter van Oosterom