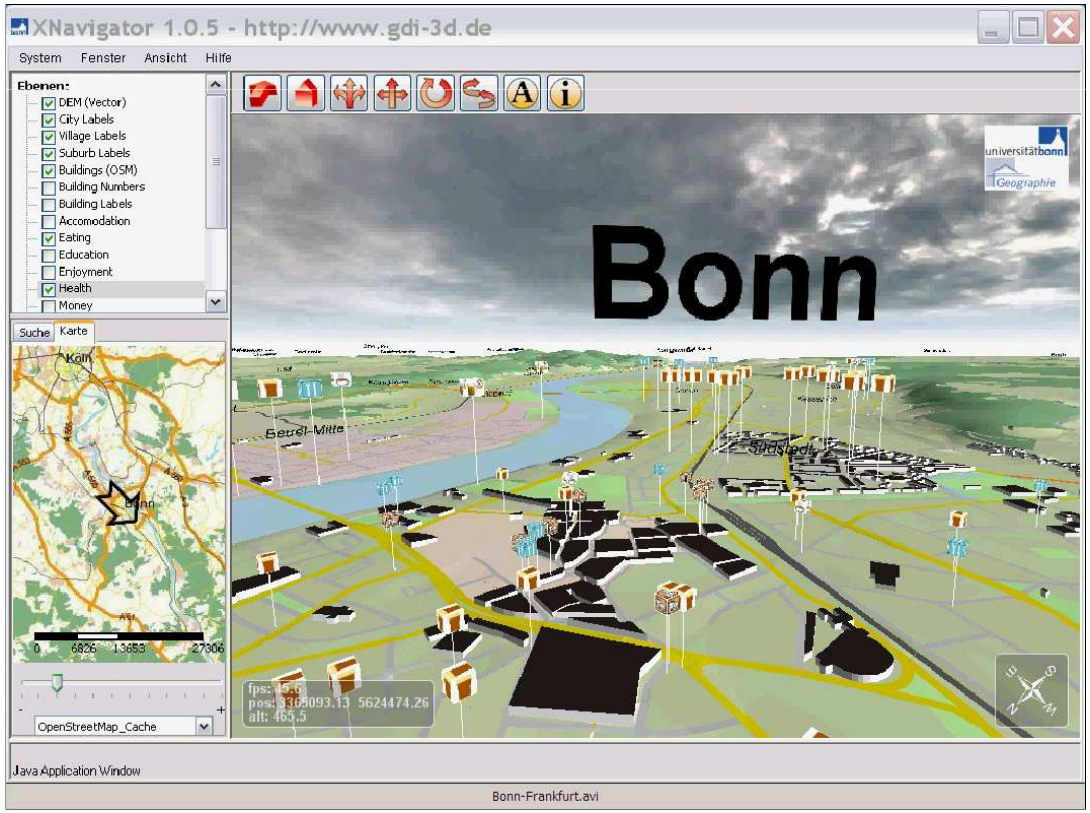
OpenStreetMap 3D

interoperable processing and visualisation of high volume spatial data sets on the Web



Alexander Zipf

Chair of Cartography

Department of Geography

University of Bonn

www.geographie.uni-bonn.de/karto/

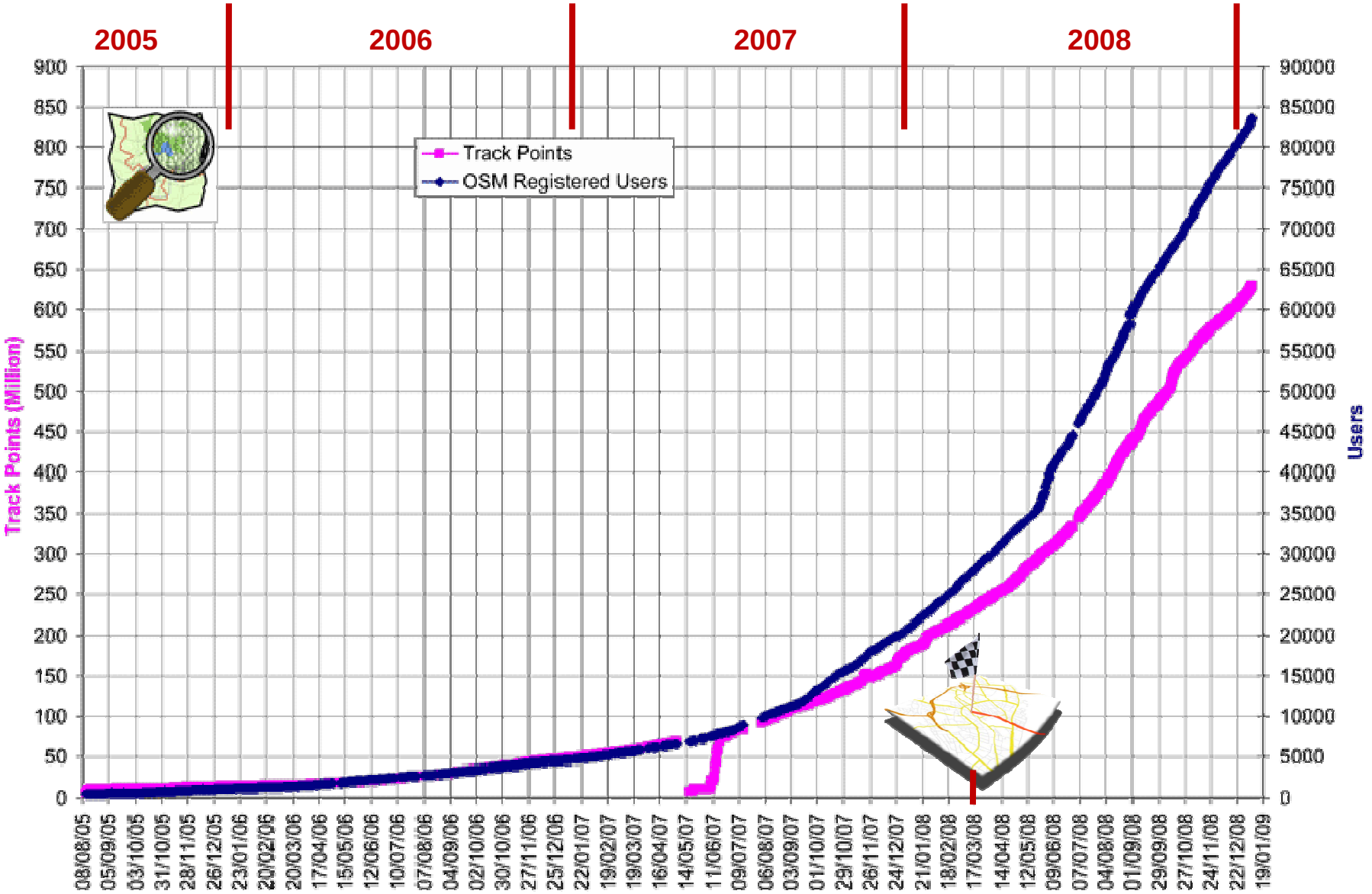
www.osm-3d.de

www.gdi-3d.de

www.nrw-3d.de

Growth of OpenStreetMap

GDI3D



OSM-3D Research questions

GDI3D

- Use potential and quality of user-generated data
- Scalability of concepts and services developed in GDI-3D
- Integration of user-generated content into interoperable geodata infrastructures

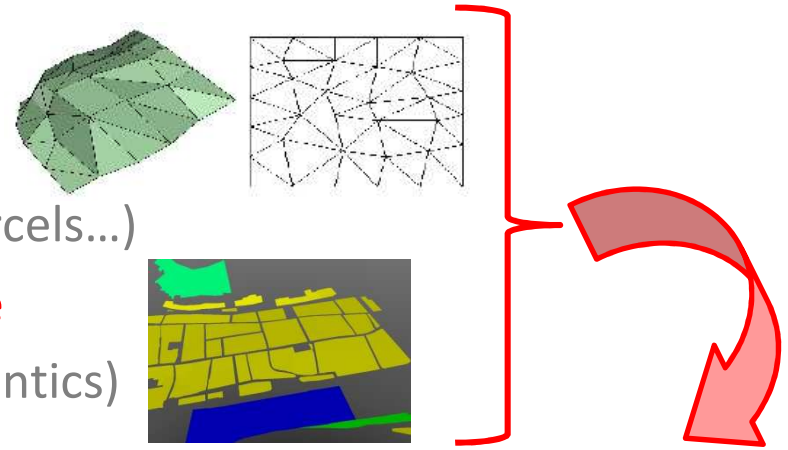
- Development of state-wide GDI-3D prototype
- Provide interoperable platform for 3D city and landscape models
- Evaluation of cartograhic principles in3D

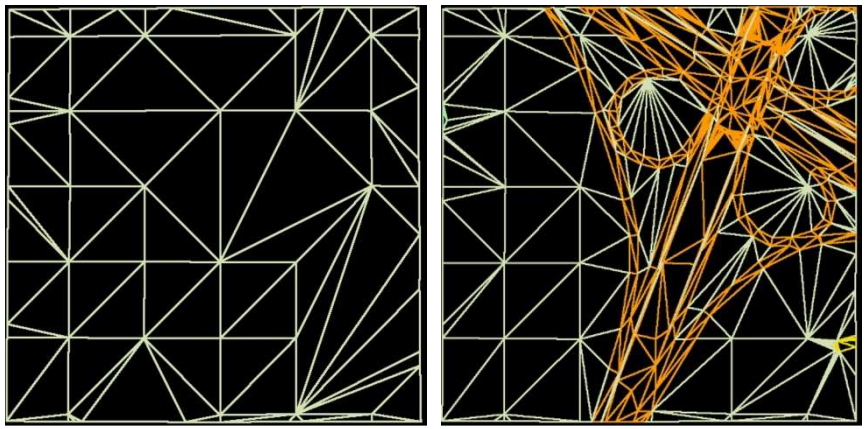
Generating 3D landscape models

GDI3D

Integrate heterogeneous data sources:

- 3D buildings (city model)
- digital elevation models (DEM)
  - triangulated 3D points
- Landuse (streets, water, forest, parcels…)
  - 2D vector data with landuse type
  - aerial / satellite images (no semantics)
- other objects
  - trees, signs, street furniture
  - landmarks, POIS, …

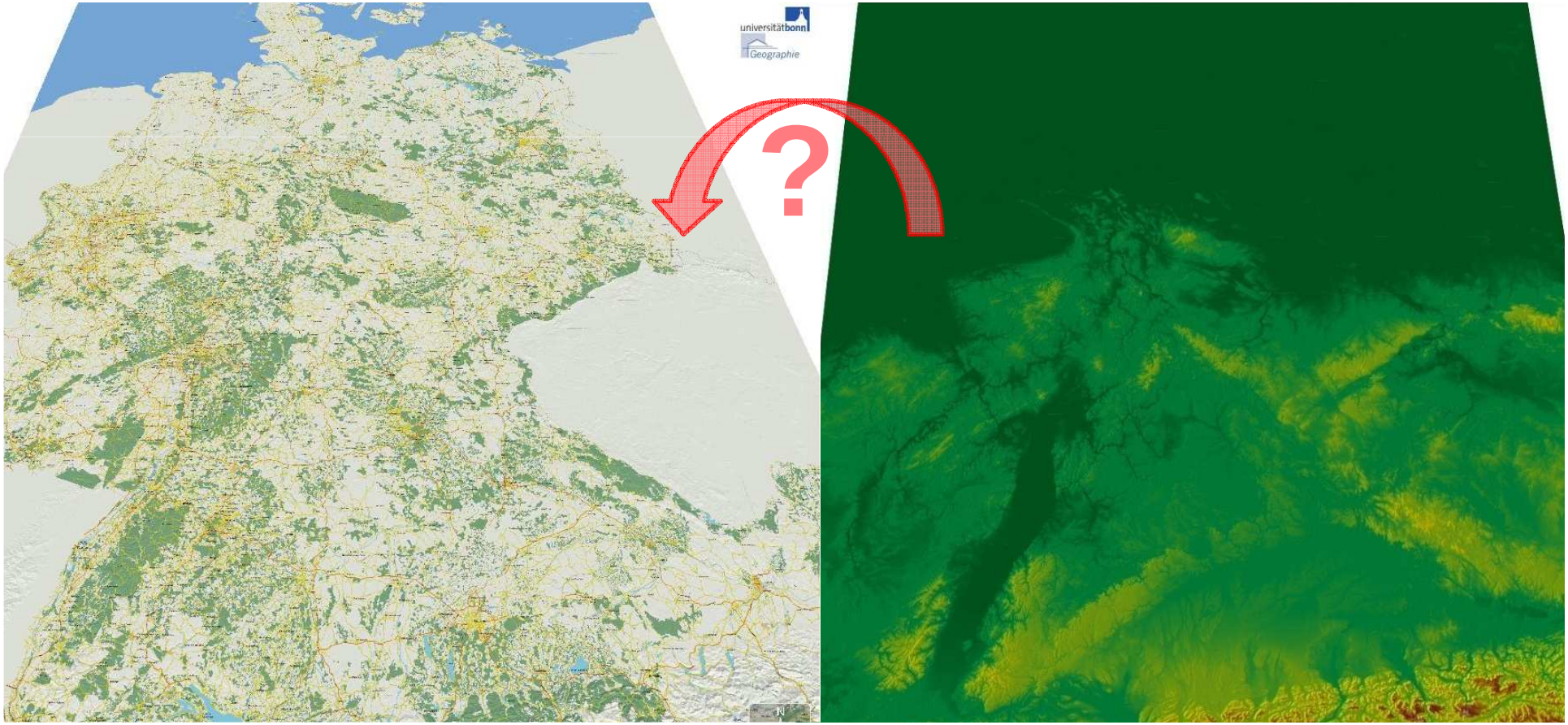




W3DSG ermany 3D - elevation model?

GDI3D

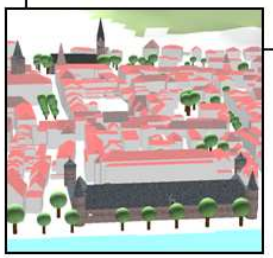
- DEM: SRTM, Shuttle Radar Topography Mission, 2000
  - resolution 90m (+-7m height accuracy in Germany) - FREE



Support for streaming through tiling & view dependent level of detail (LOD)

Map 3D Client
Visualization
Interaction

W3DS
3D City Models



OGC Web3D Service

For each Tile

```
request=GetScene
&bbox={Tile.bbox}
&layers=DEM
```

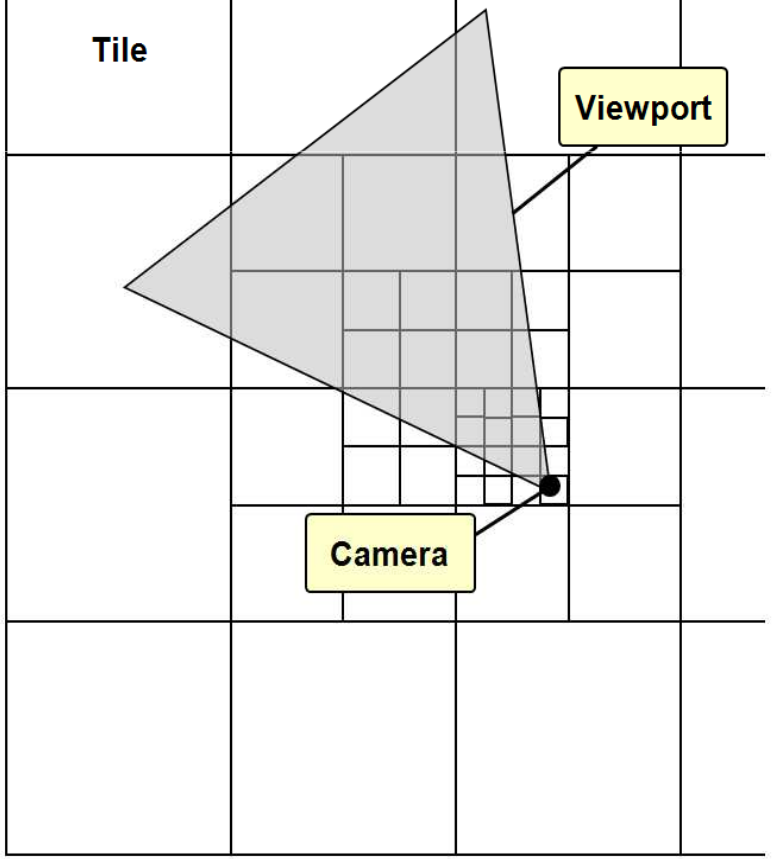
VRML 2.0

```
request=GetScene
&bbox={Tile.bbox}
&layers=Buildings
```

VRML 2.0

⋮

one request
for each layer



Tiling Germany

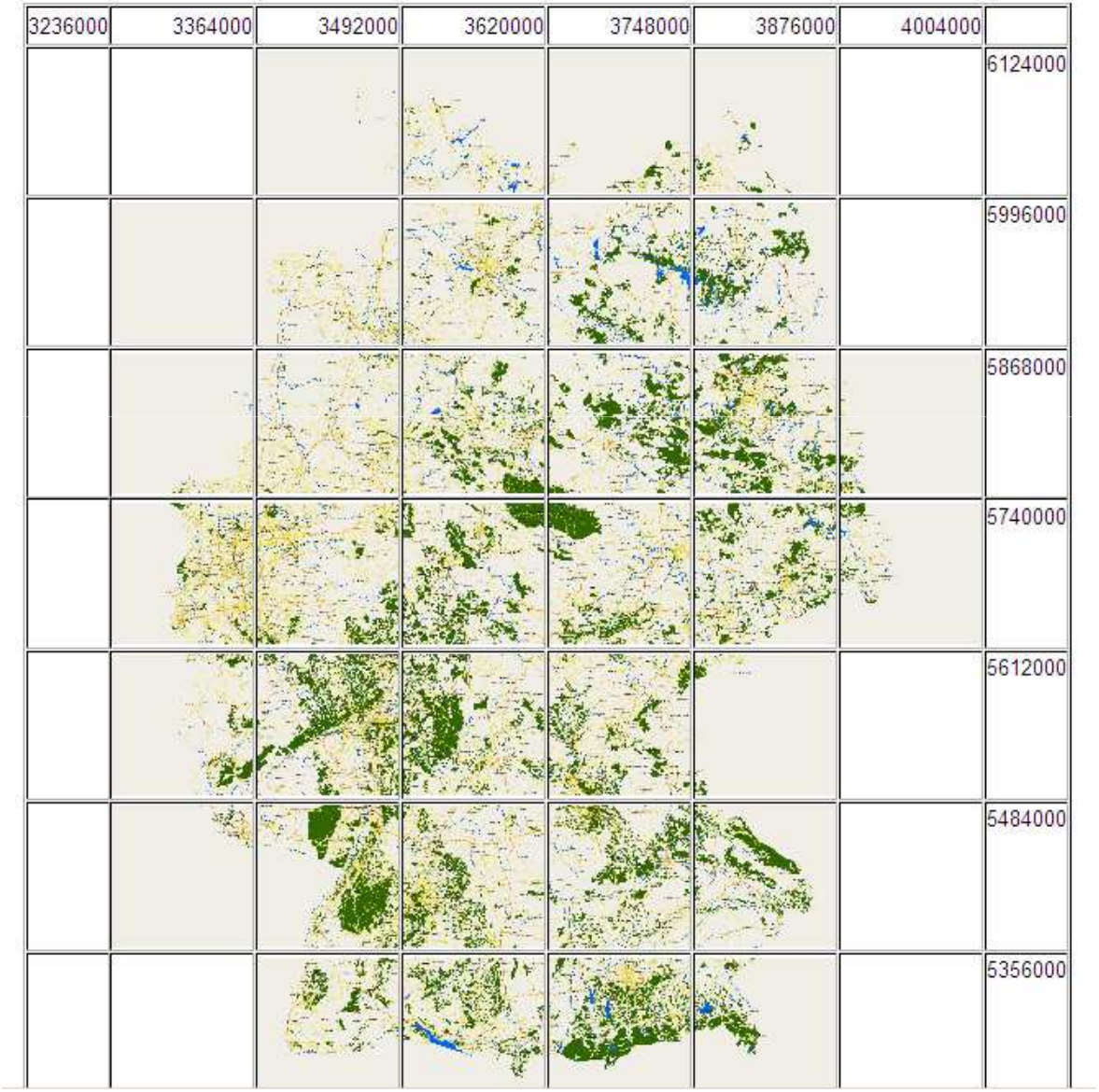
35 tiles a 128km; 9Mio tiles a 500 meter

GDI3D

- Quadtree
- LOD level
  - 128000
  - 64000
  - 32000
  - 16000
  - 8000
  - 4000
  - 2000
  - 1000
  - 500

  length in meter

  35* 4^9 tiles



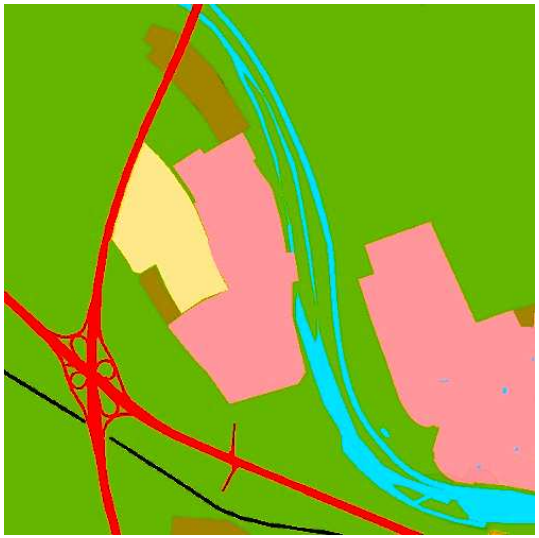
Generalisation results of integrated DEM

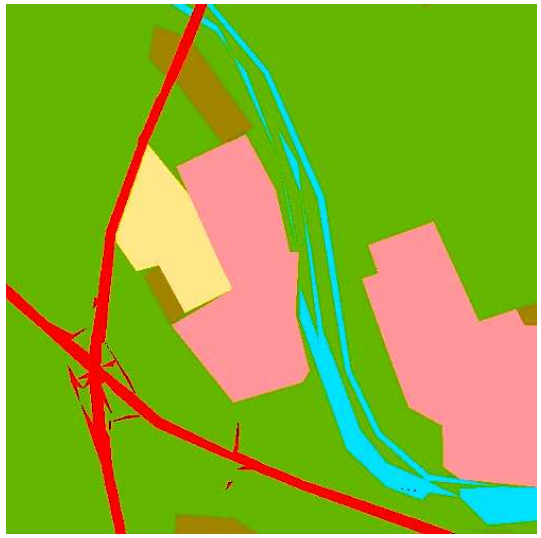
GDI3D

LOD 500
1699 KB

LOD 1000
552 KB

LOD 8000
102 KB





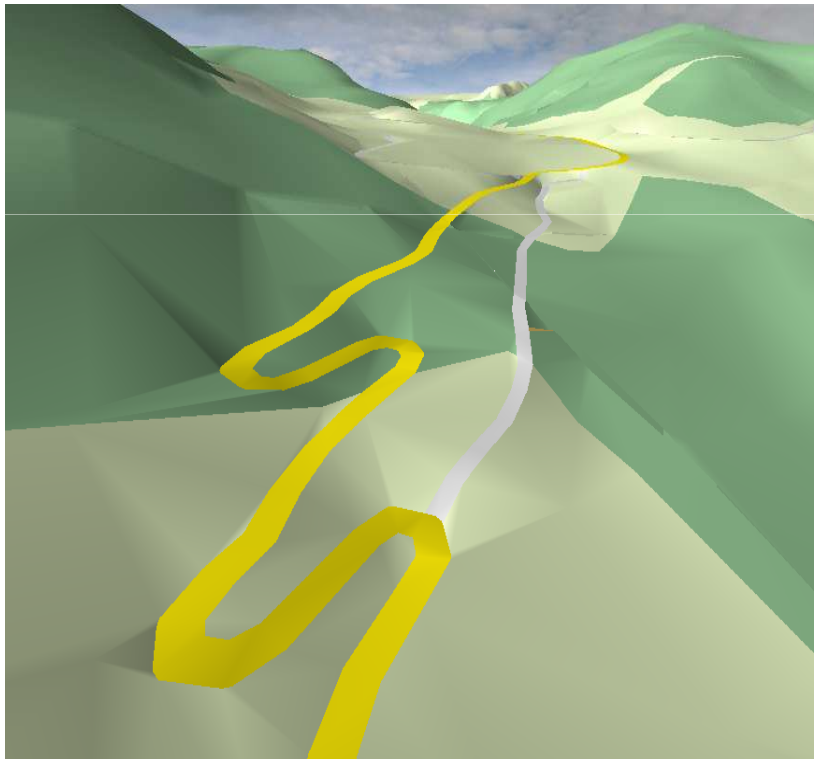
LOD 16000
43 KB

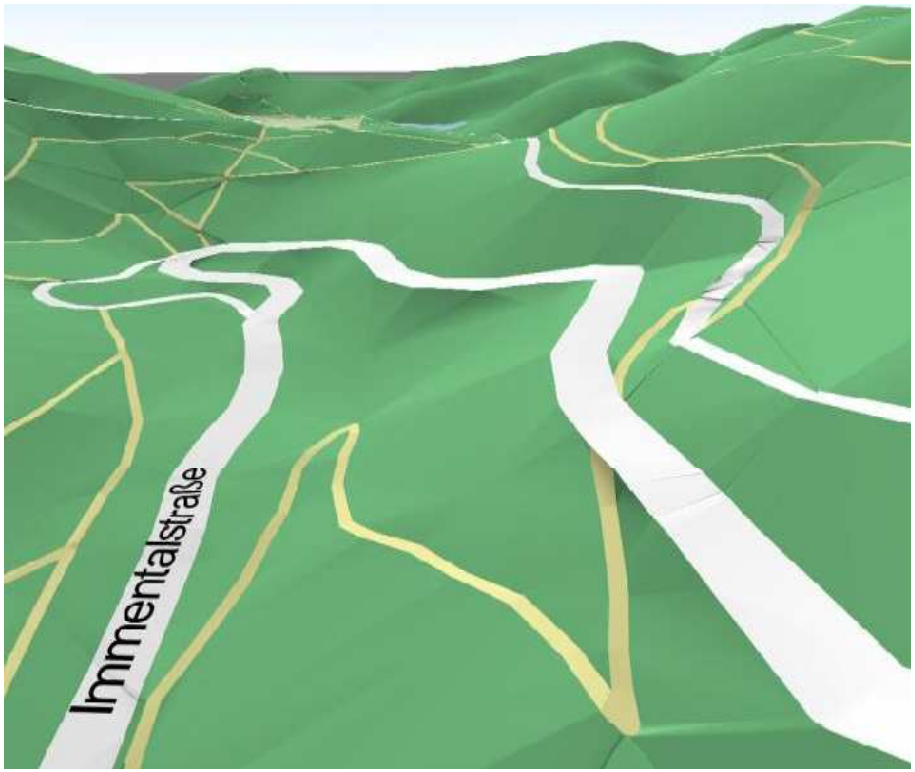
Example: area of 3600 * 3600 meter (Heidelberg); file size in kilobyte

Smoothed streets in 90meter DEM

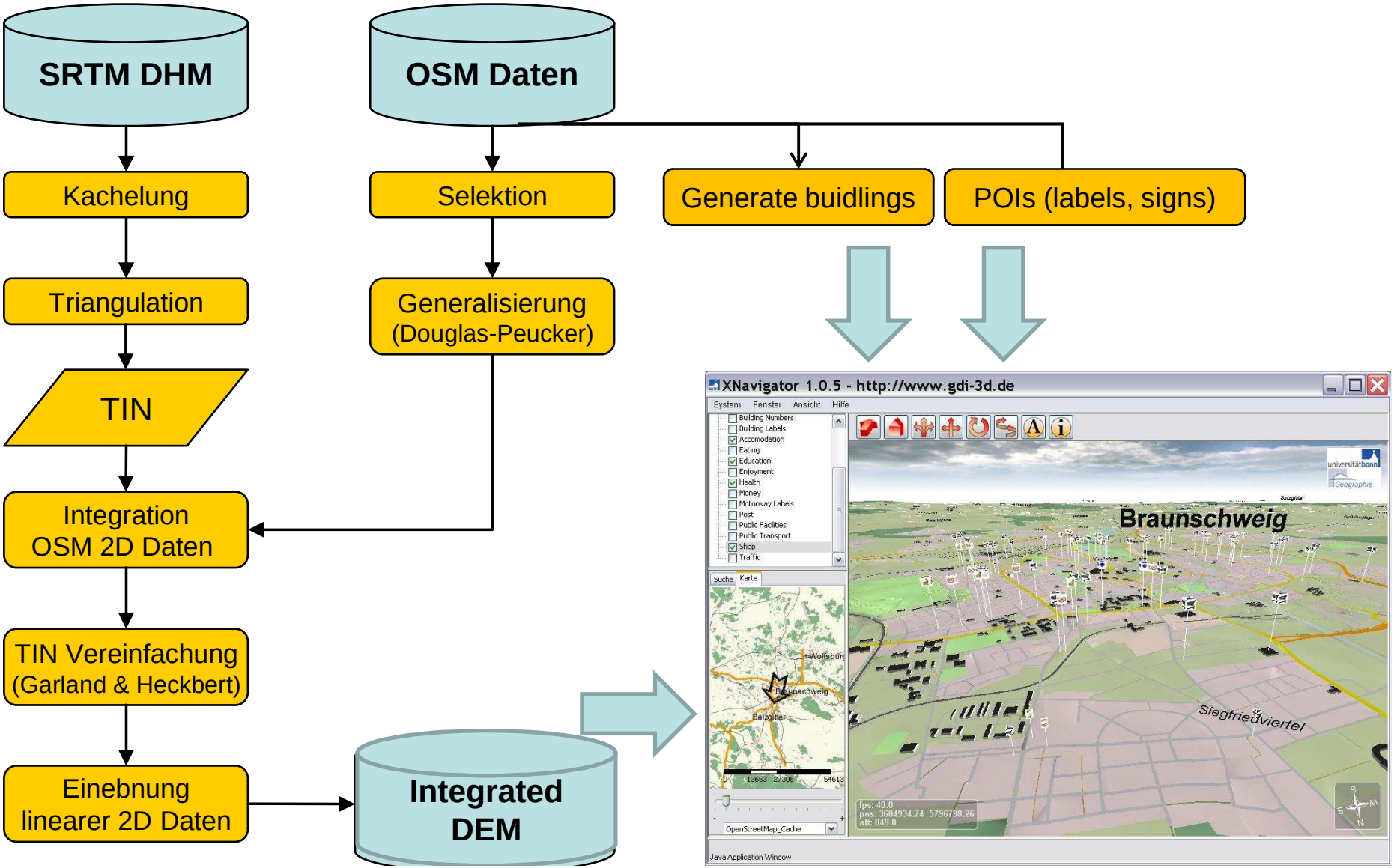
GDI3D

- Improved visualization despite coarse DEM



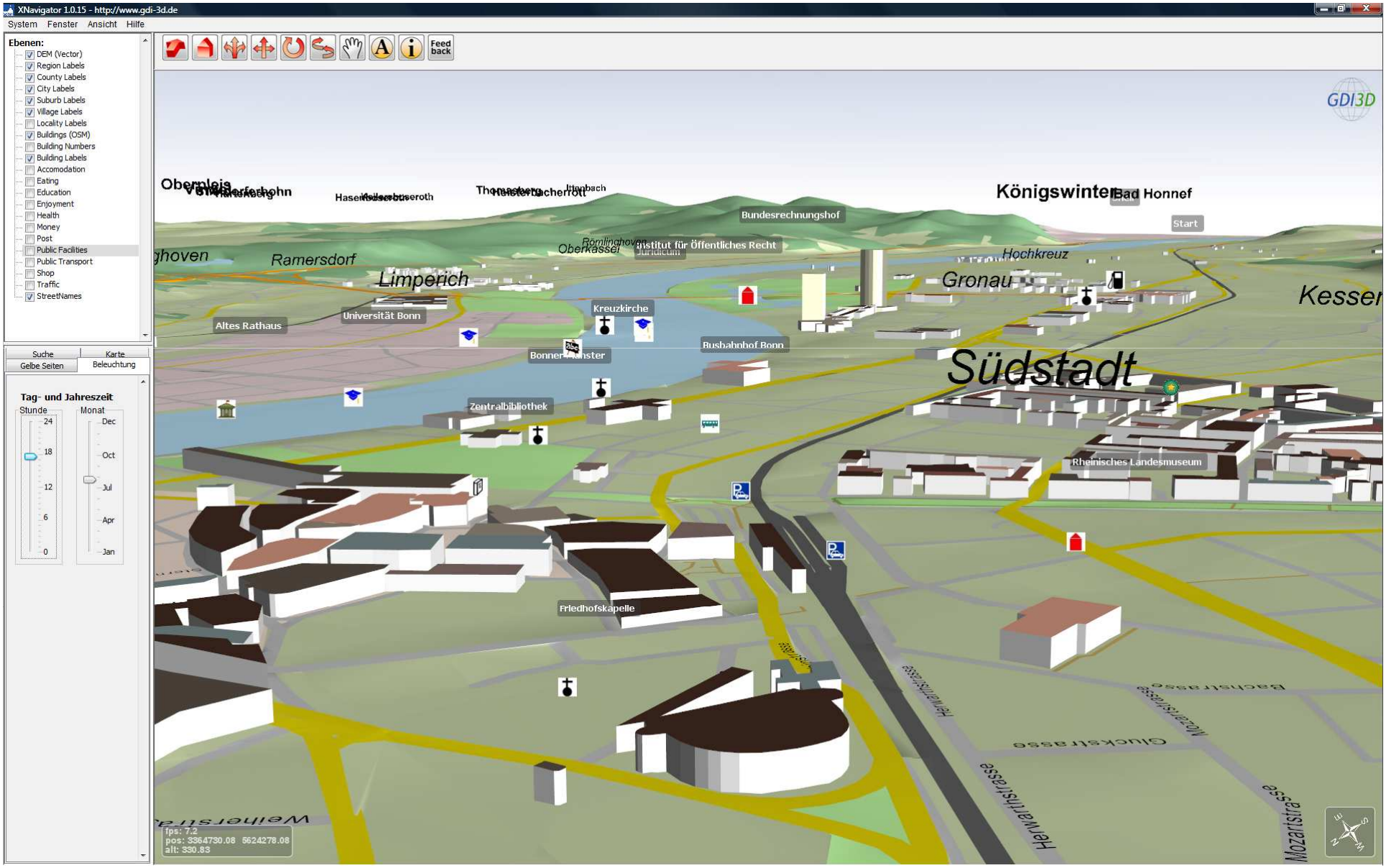


Integrating OSM 2D landuse & SRTM DEM



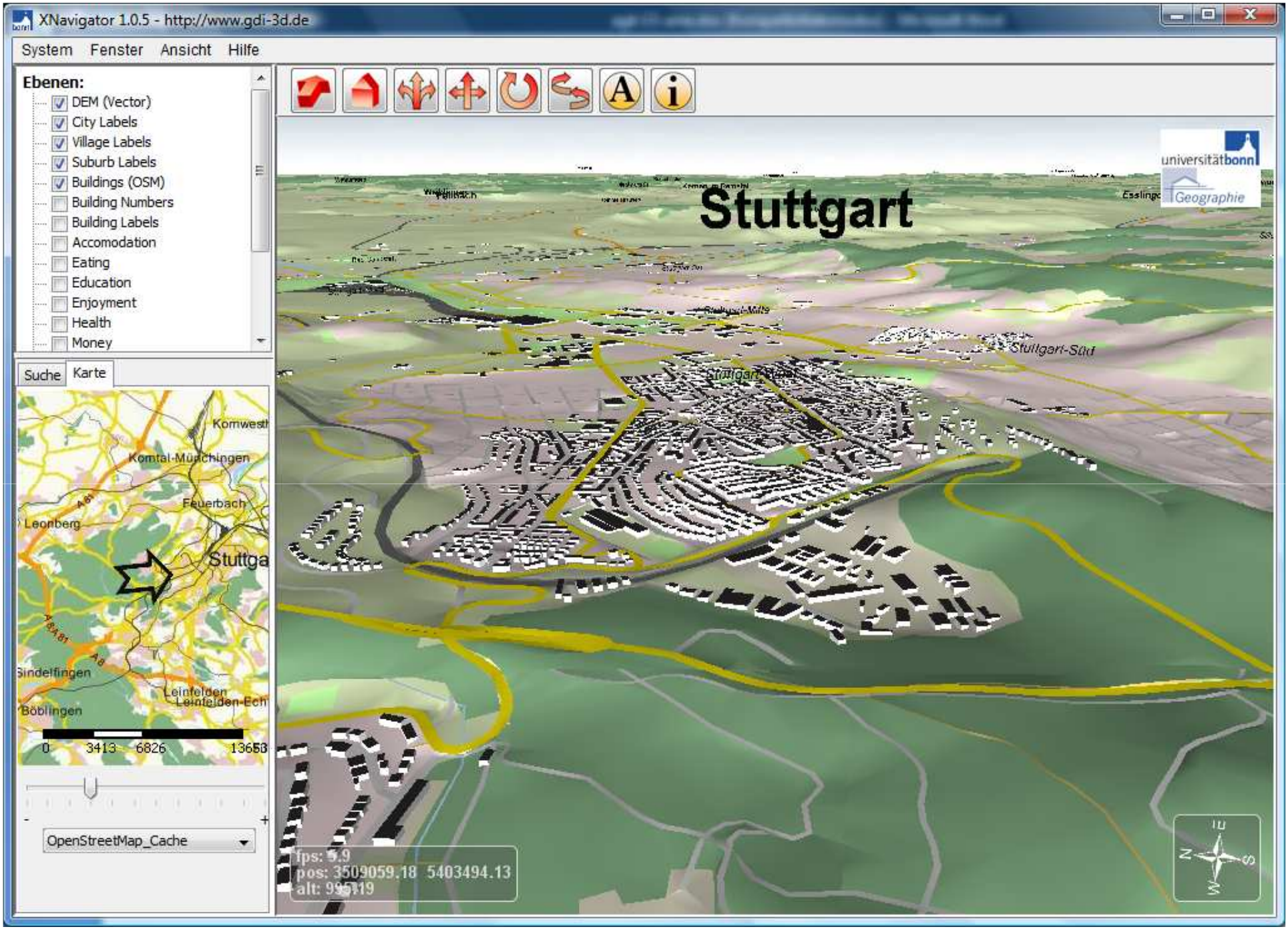
www.OSM-3D.org Germany

GDI3D



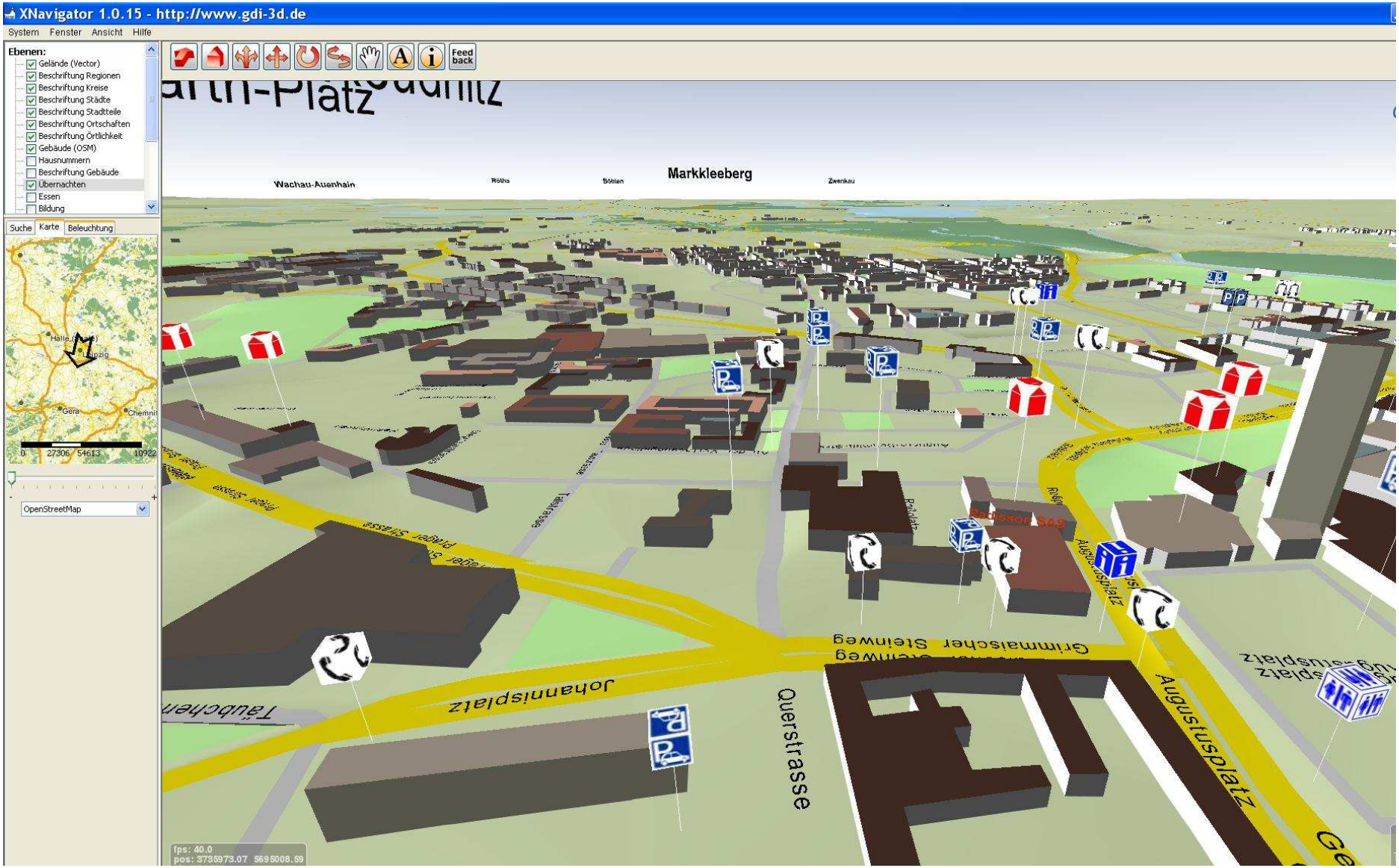
www.OSM-3D.org Germany

GDI3D


XNavigator 1.0.5 - http://www.gdi-3d.de
System
Fenster
Ansicht
Hilfe
Ebenen:
DEM (Vector)
City Labels
Village Labels
Suburb Labels
Buildings (OSM)
Building Numbers
Building Labels
Accomodation
Eating
Education
Enjoyment
Health
Money
Suche
Karte
Komwestl
Korntal-Münchingen
Feuerbach
Leonberg
Stuttga
Sindelfingen
Leinfelden
Leinfelden-Ech
Böblingen
0
3413
6826
13653
OpenStreetMap_Cache
Stuttgart
Stuttgart-Süd
universitätbonn
Geographie
fps: 5.9
pos: 3509059.18 5403494.13
alt: 995.19
N
E
S
W

www.OSM-3D.org Germany

GDI3D



The big picture: 3D cities on the Web

GDI3D

Today: proprietary virtual globes

- Google Earth / Microsoft Virtual Earth
- Nasa Worldwind… …

Only Visualisation !

OGC working group: 3D Portrayal Services

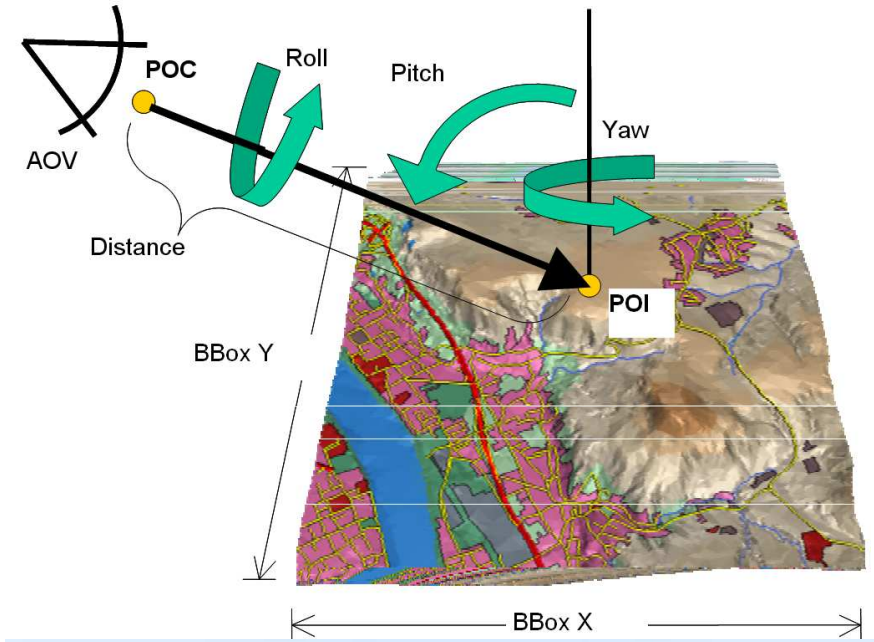
- Web 3D Service (W3DS)
- Web Perspective View Service (WPVS)
- 3D Symbology Encoding

Integrated in SDI Framework !

OGC Web 3D Service (W3DS) draft

GDI3D

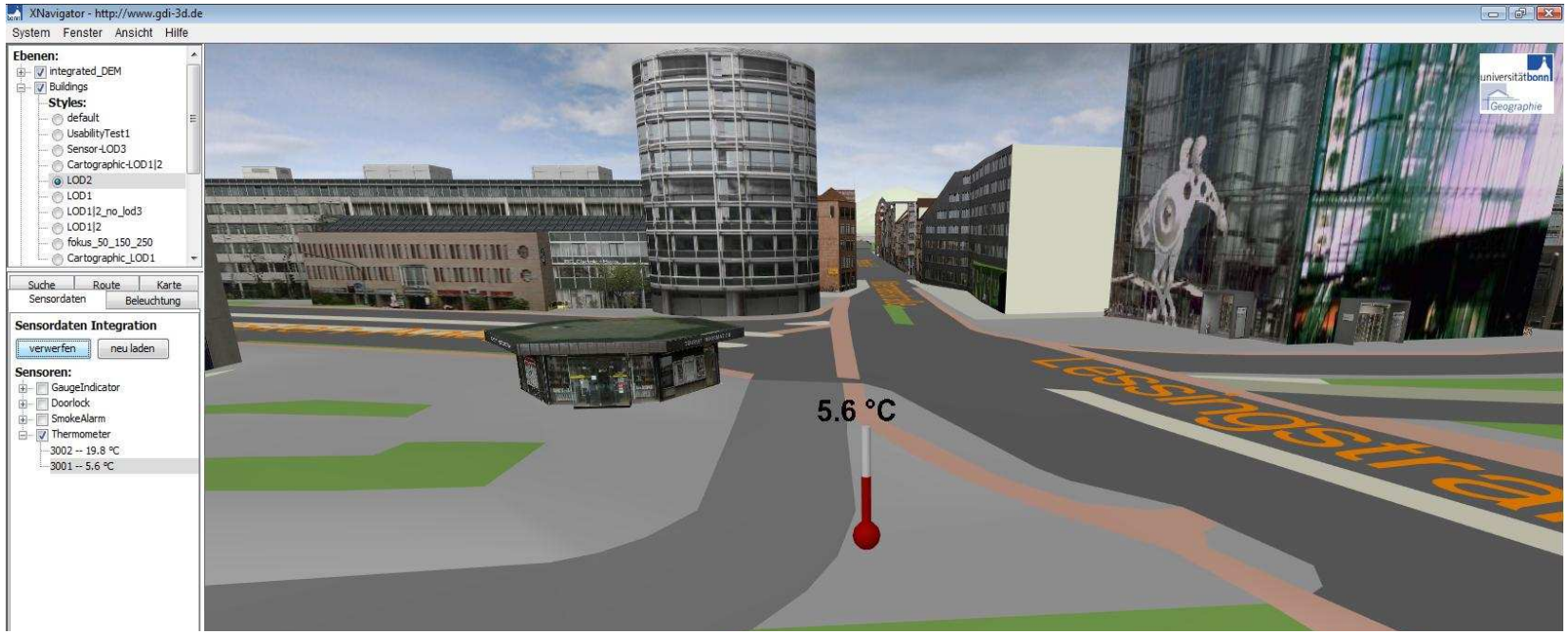
- delivers 3D scenes
  - display elements
  - VRML, KML, X3D
- imports 3D city models
  - OGC CityGML format
- interface similar to WMS
  - ~15 parameter..
  - 3D Symbology Encoding Draft
  - Including OGC Filter Encoding



From static to dynamic data in 3D SDI

GDI3D

- provide real-time sensor data in SDIs
- based on OGC Sensor Web Enablement (SWE)
- Web-based access and control of sensor networks
  - Example: integration of different sensors in 3D-SDI
  - Visualization in XNavigator



Sensors in GDI-3D building monitoring: smoke, locks

Sensors in GDI-3D

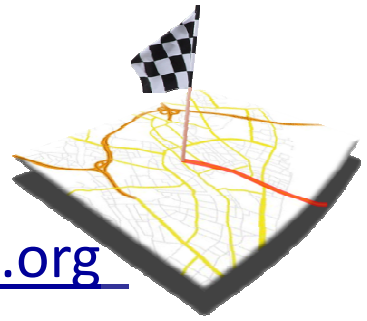
gauge, water height GDI3D

Integration of Location Based Services LBS GDI3D

OpenGIS Location Services (OpenLS)

- Part 1 Directory Service — spatial yellow pages
- Part 2 Gateway Service — position from wireless network
- Part 3 Location Utility Service — (reverse) geocoder
- Part 4 Presentation Service — route maps with POIs
- Part 5 Route Service — several options
- New Tracking Service — track people & goods

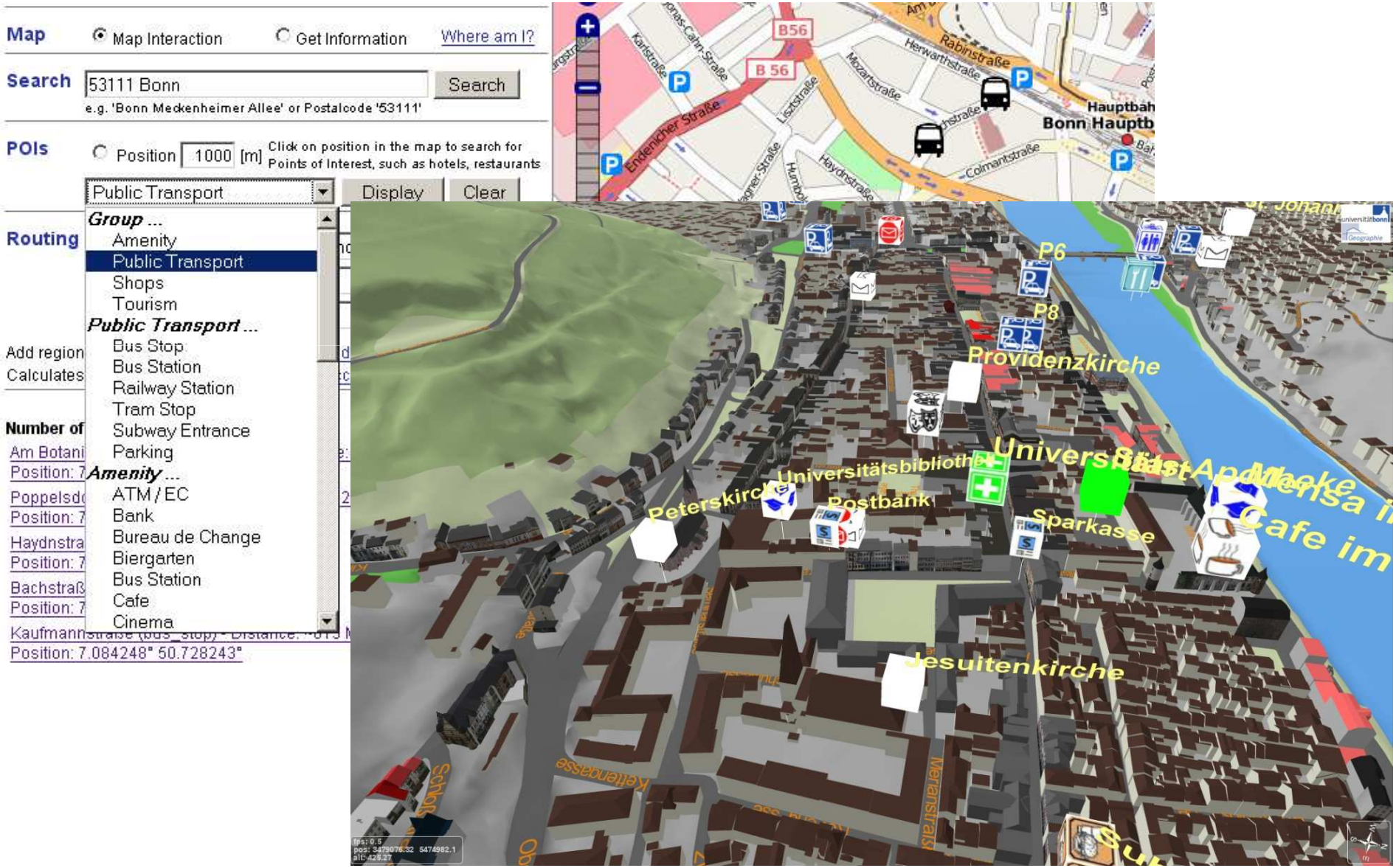
GDI3D



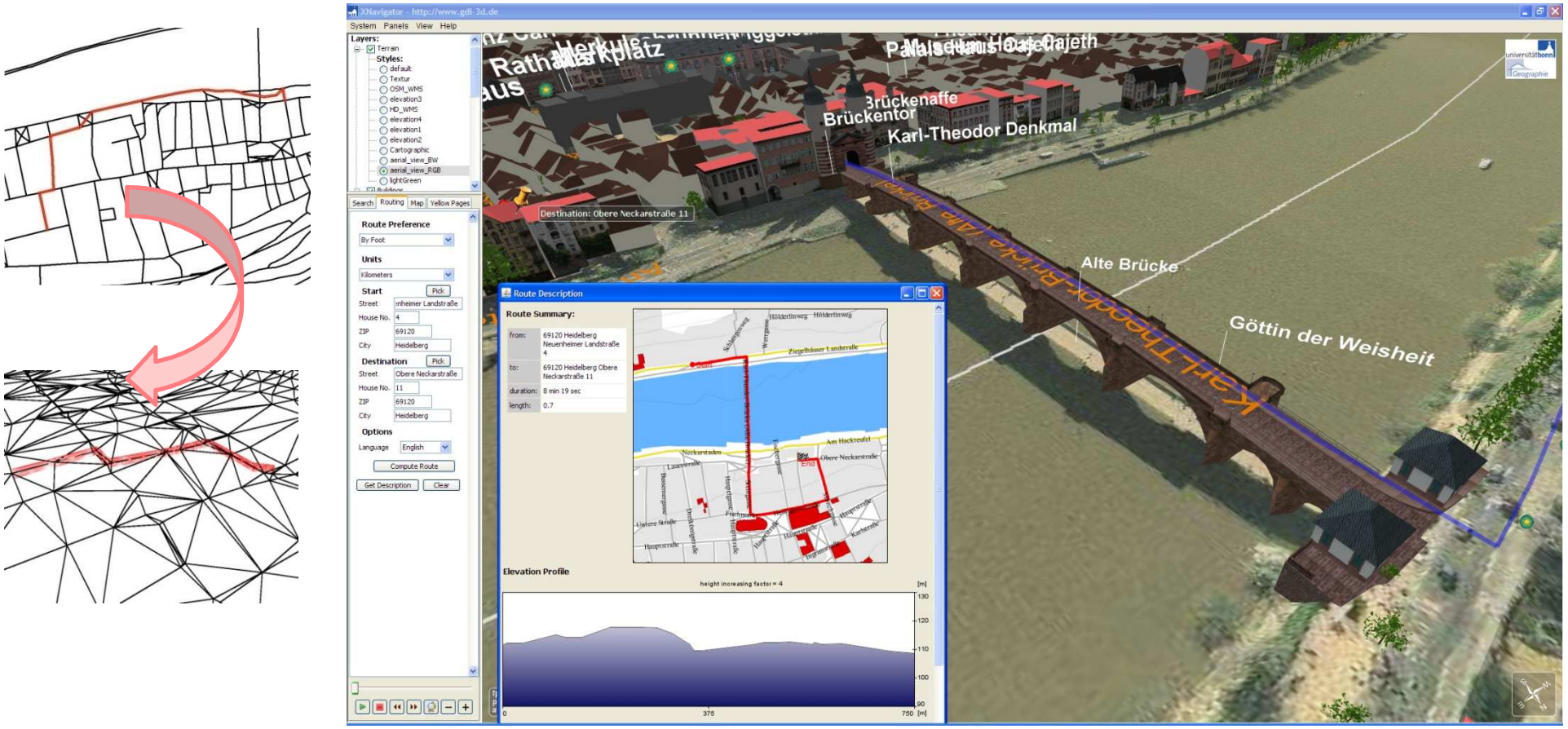
www.OpenRouteService.org

Directory Service: OSM Points of Interest

GDI3D

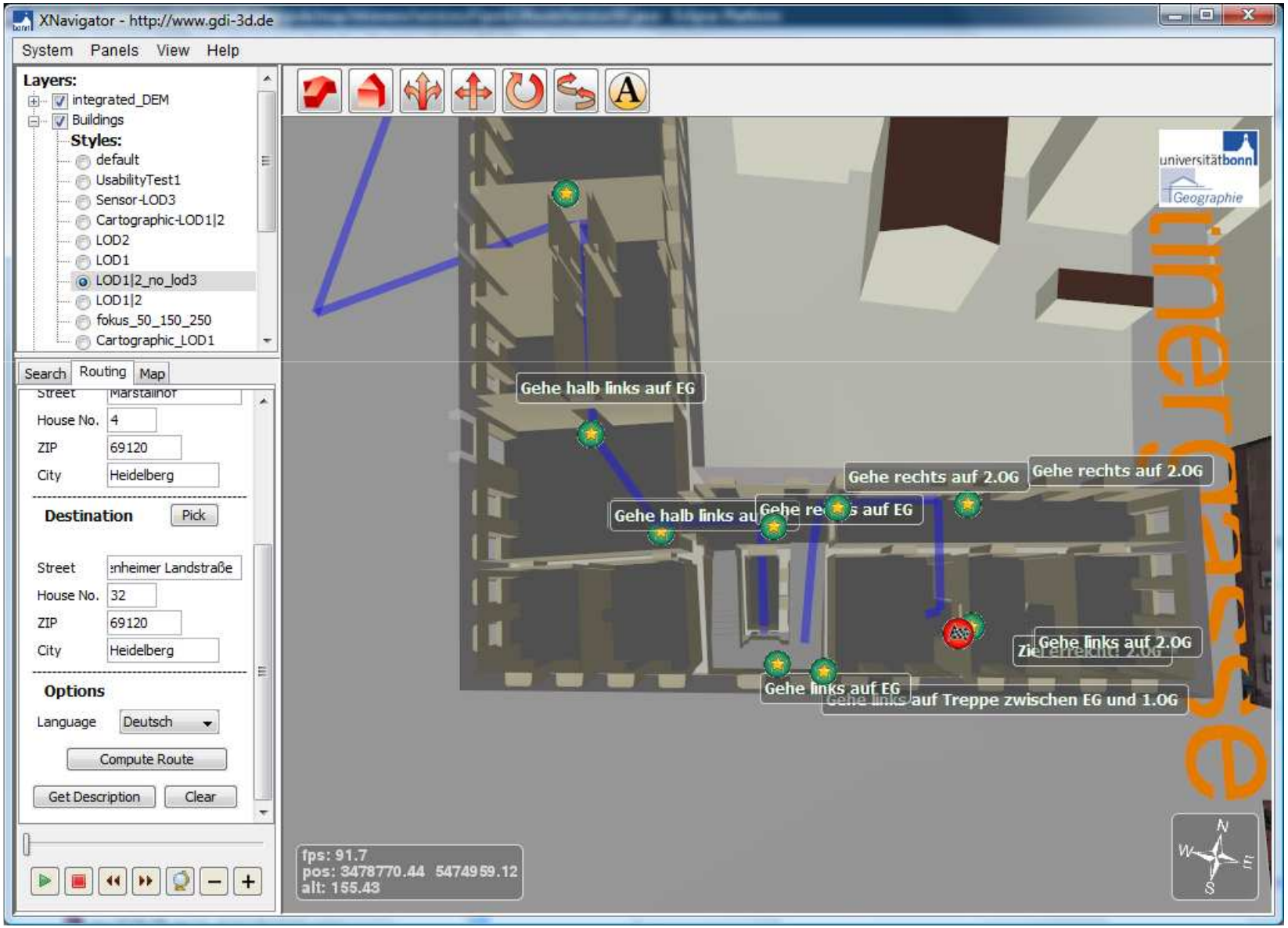


OpenLS Route Service 3D



Automatic generation of 3D graph,; Usage of 3D route service through XNavigator

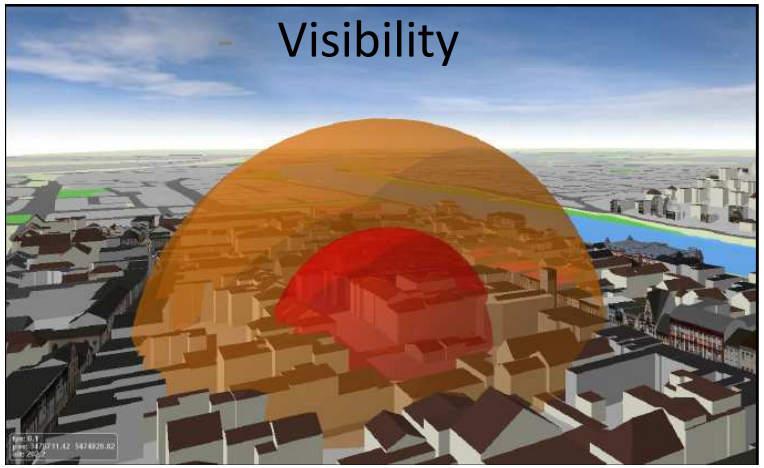
n e x t : 3D Indoor Routing (airport disaster scenario)

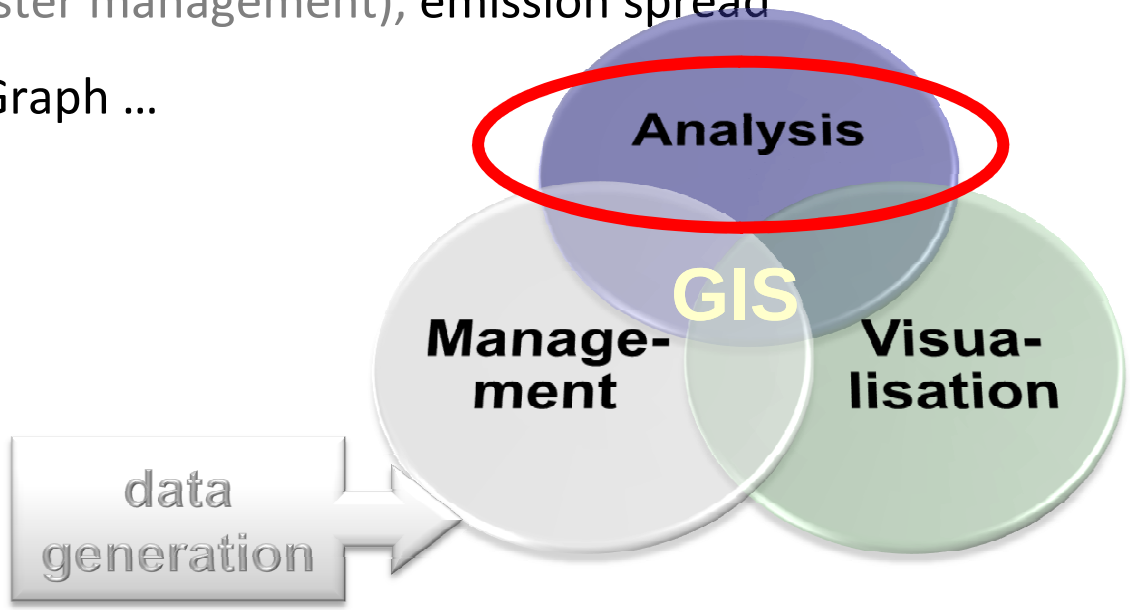


Analysis in 3D-SDI?

GDI3D

- OGC Web Processing Service (WPS)
- Processing & analysis of DEM & 3D geodata
  - DEM (pre)processing: **tiling, triangulation, generalisation …**
  - Domain specific scenarios:
    - bomb finding (disaster management), emission spread
  - Slope, Aspect, Profile Graph …
  - Visibility

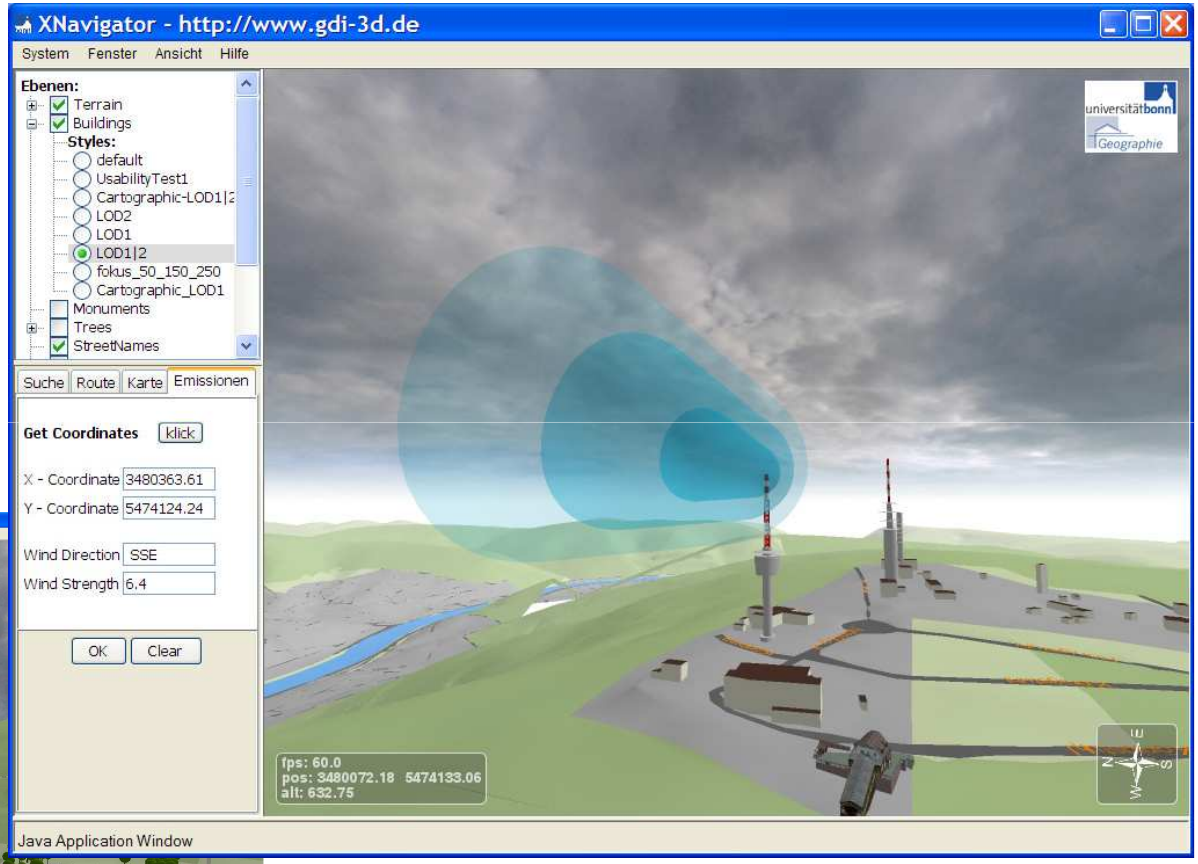


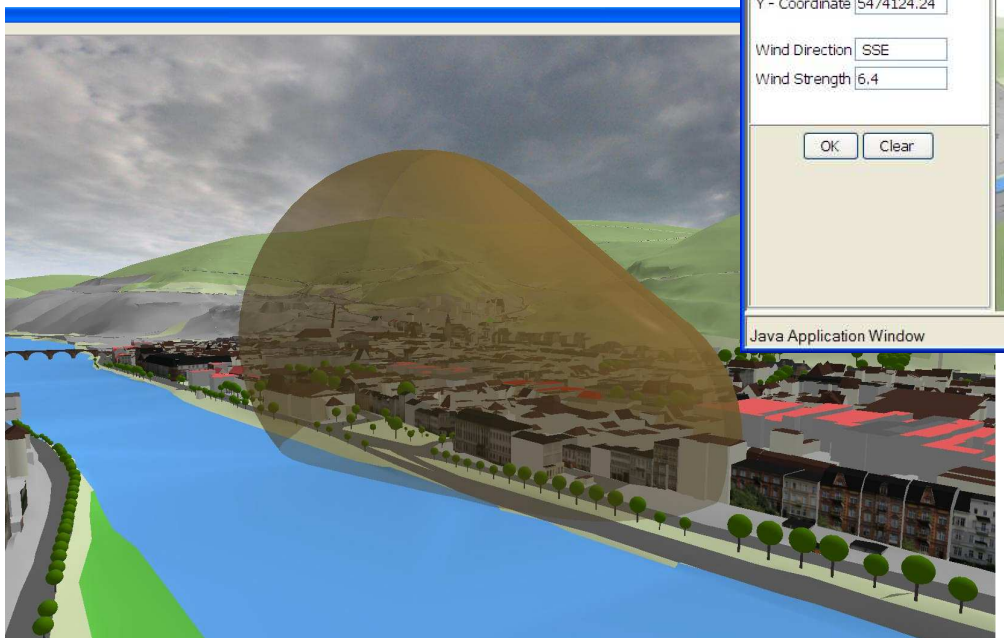


Visualisation of emission simulations

GDI3D

dynamically calculated by WPS
with actual wind informaton
through OGC SOS
(Sensor Observation Service)

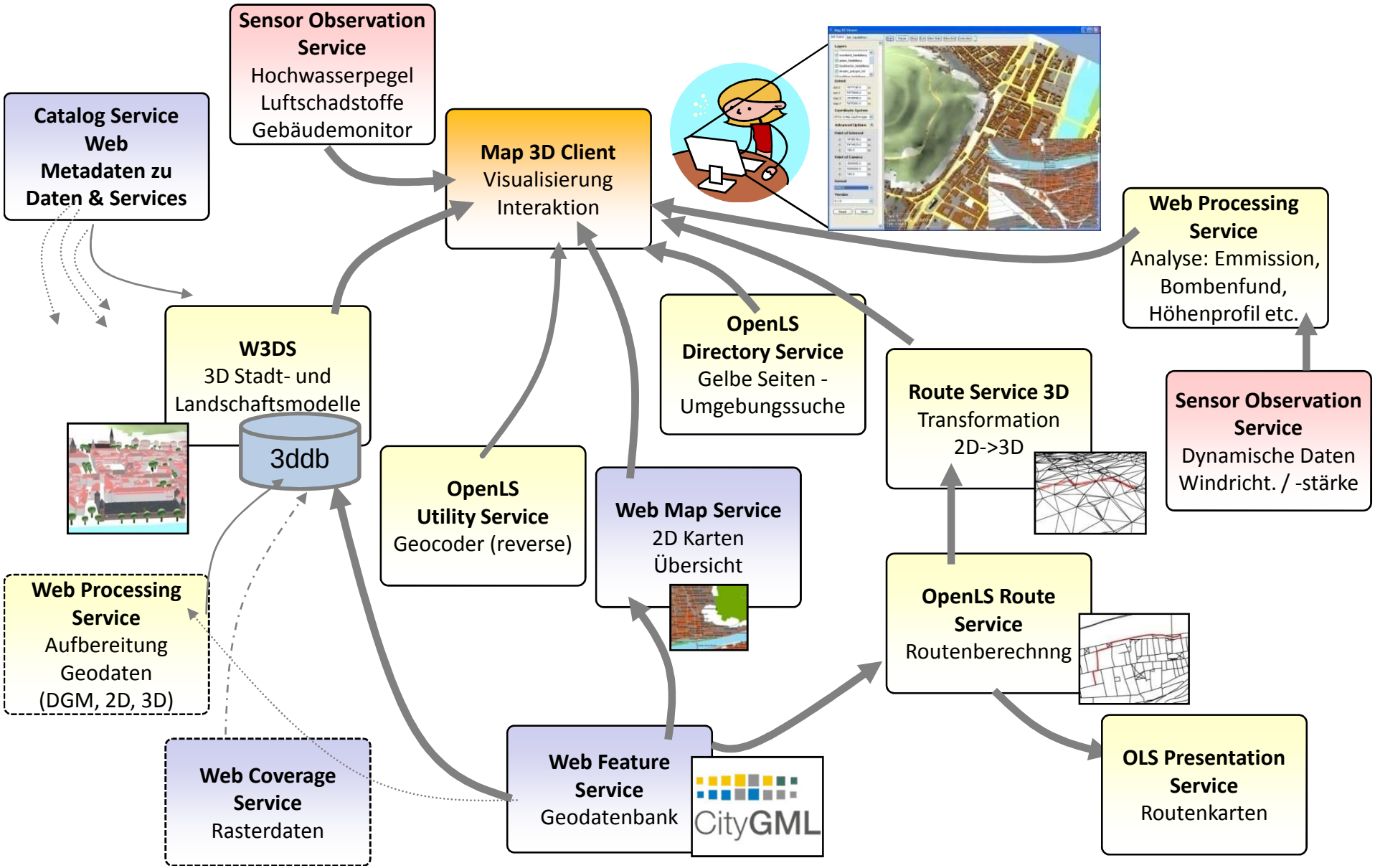




only proof of concept

OGC Services Architecture of GDI-3D.de

GDI3D



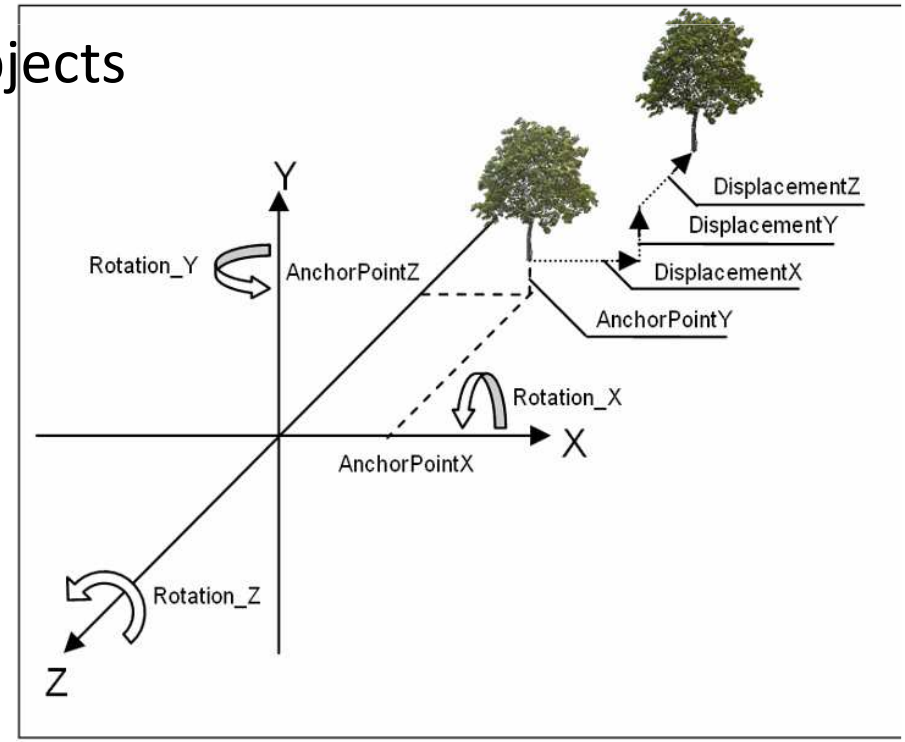
3D Symbology Editor (Client)

GDI3D

3D SLD (Styled Layer Descriptor)

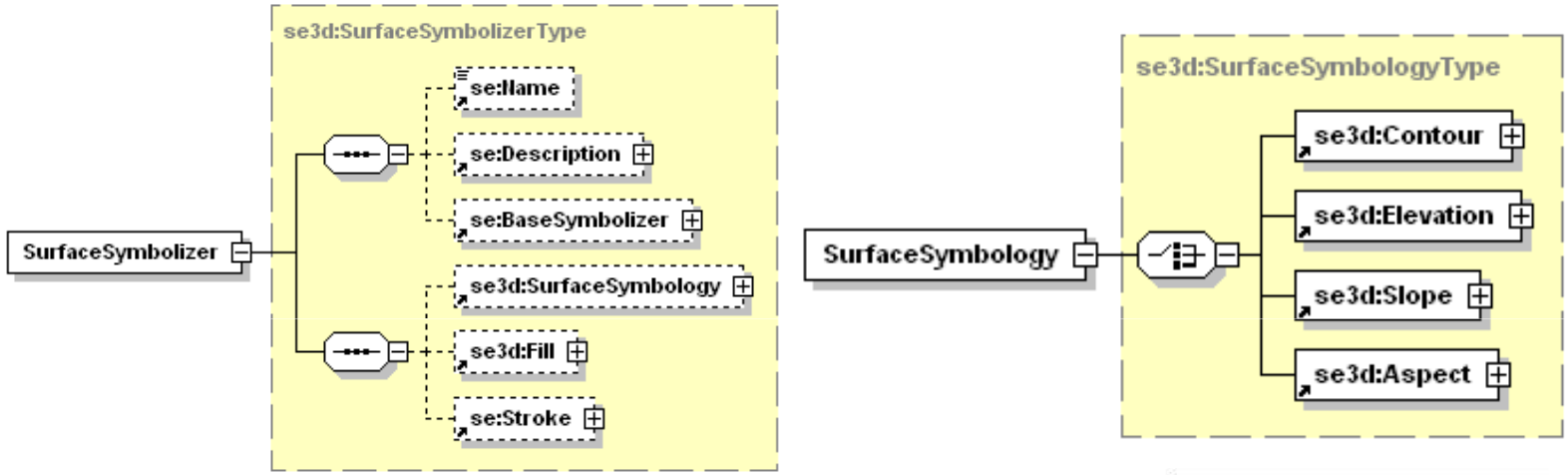
GDI3D

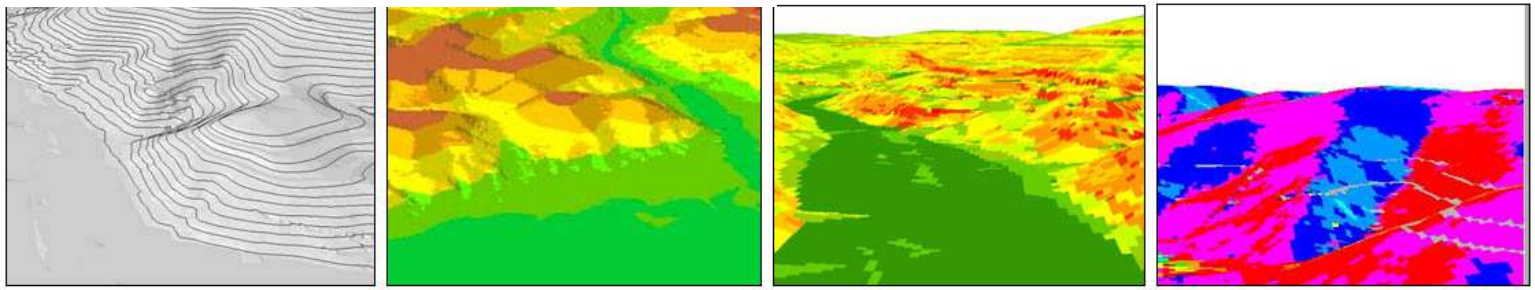
- Extension of SLD for 3D
  - Rotation of elements for all three axes
  - Displacements and positions are extended by Z
  - SurfaceSymbolizer
  - Integration of external 3D objects
  - 3D Material Properties
  - Billboards
  - 3D legends
  - Lines displayed cylindrical (e.g. for routing, etc)



3D Symbology Encoding

SurfaceSymbolizer for analytical DEM-Visualisation

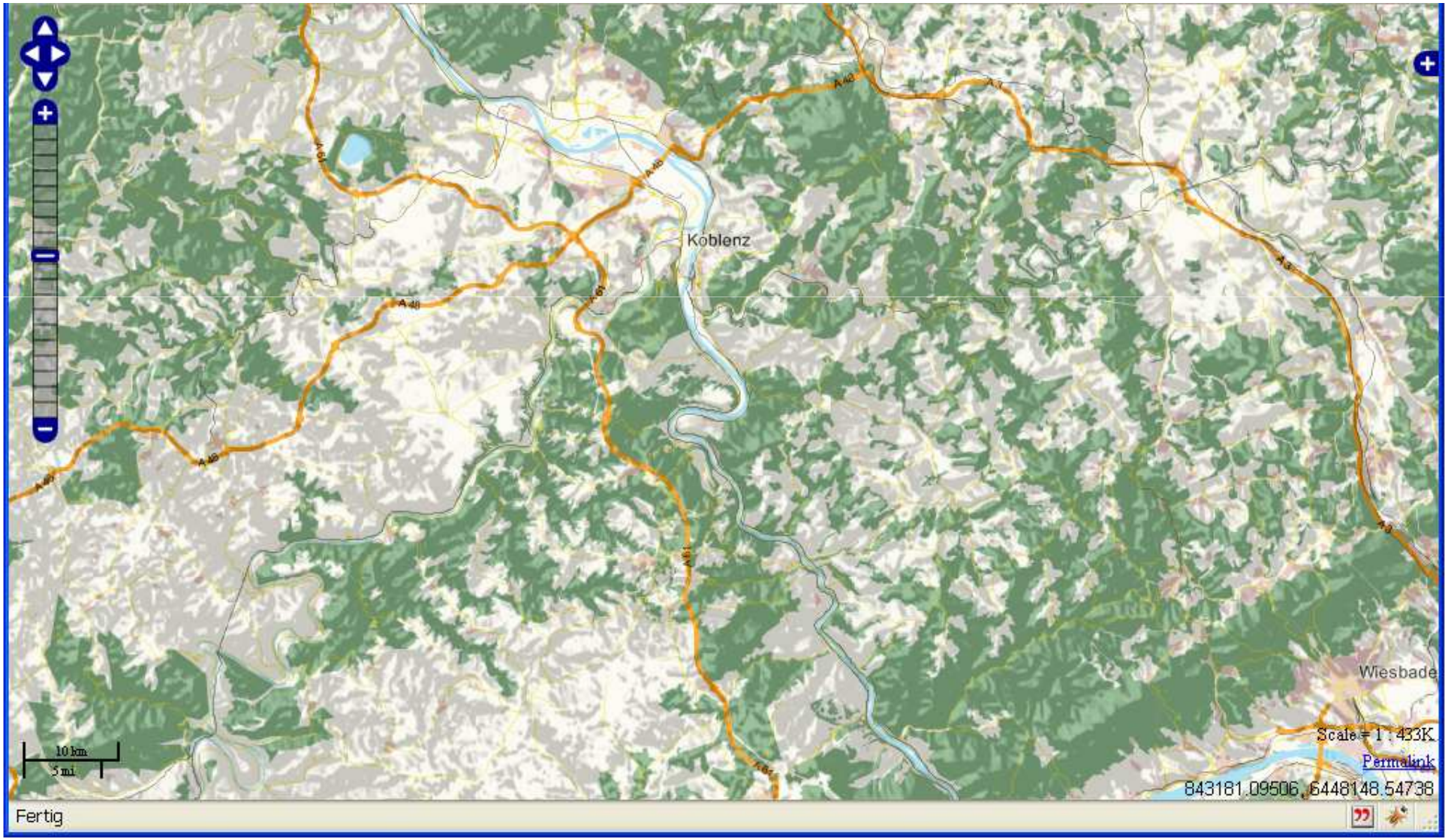




Höhenlinien | Höhenschichten | Steigung | Ausrichtung

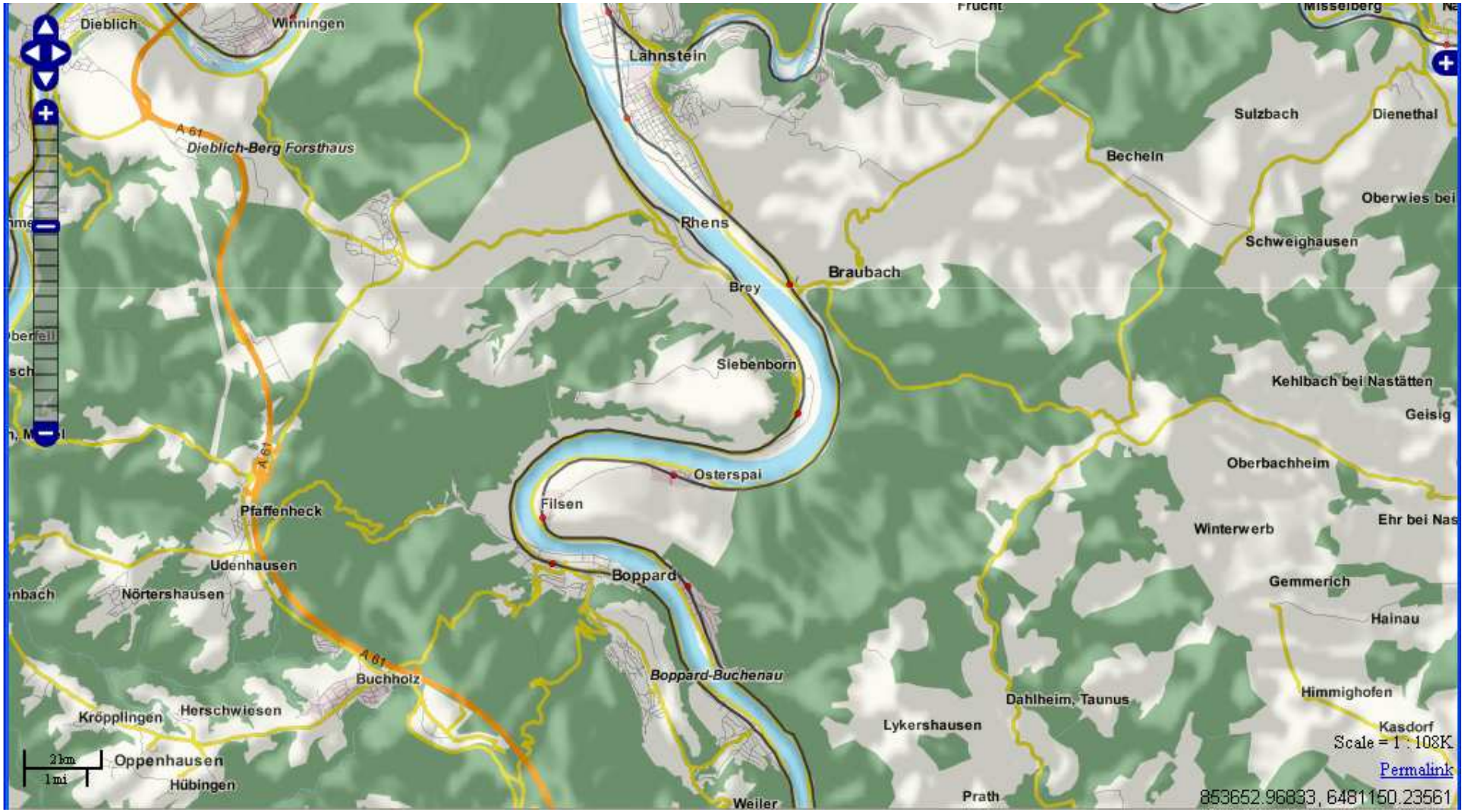
SRTM für Hillshade in OSM-WMS.de

GDI3D

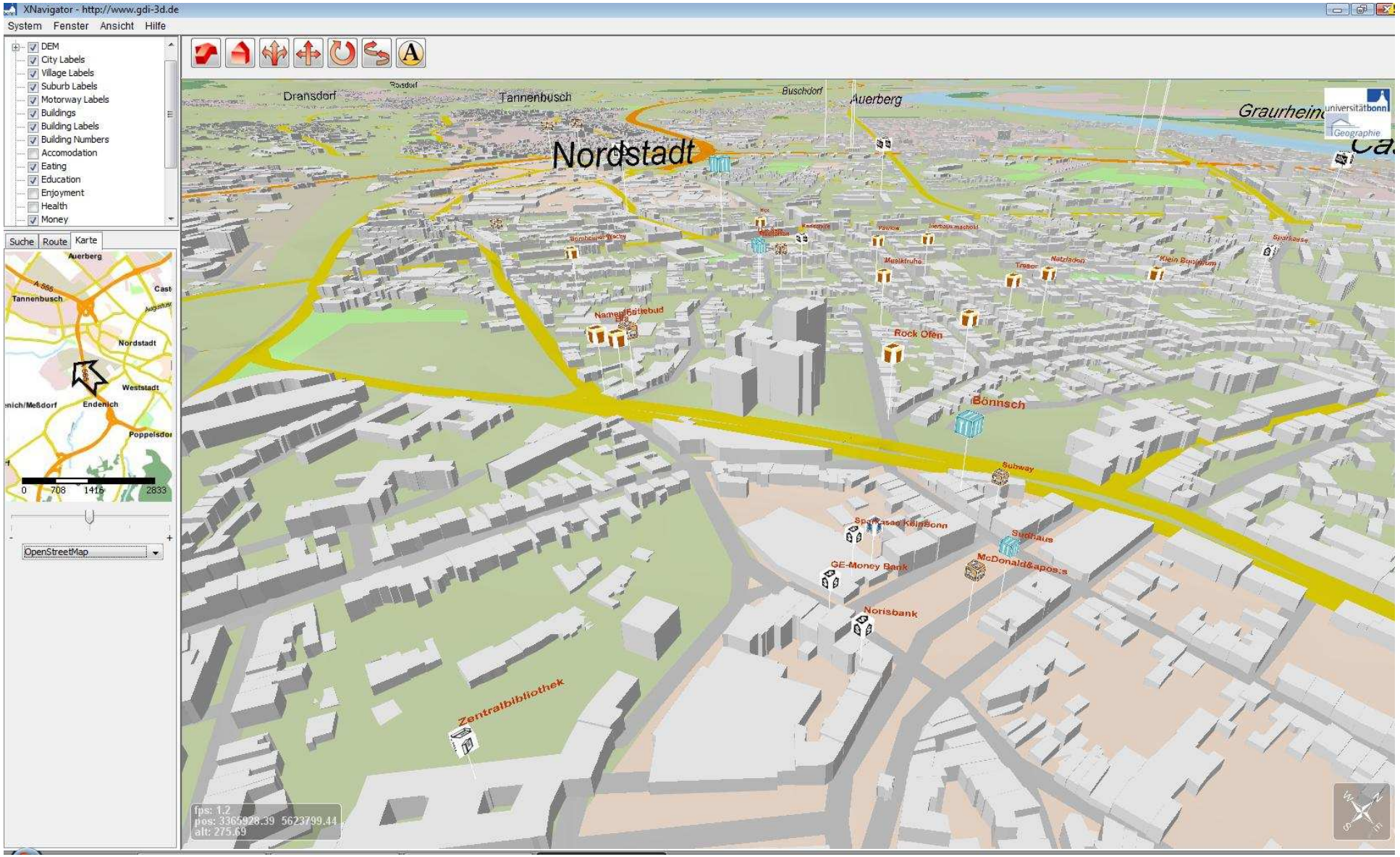


SRTM für Hillshade in OSM-WMS.de

GDI3D



www.NRW-3D.de (Bonn) 6 Mio Buildings



1st lessons learned

GDI3D

- Both 3D & Location Services scale to large regions
  - Europe — Map Service, (Reverse) Geocoder, Directory Service, Route Service, WFS
  - Germany — W3DS, (3D Route Service), SOS, WPS
  - NRW — W3DS with >6 Mio LOD 1 buildings
- Preprocessing on computer cluster required
  - ~1300 CPU hours DEM processing OSM3D Germany
  - ~ 100 Mio files generated OSM3D Germany DEM (28 GB in DB)
  - ~300 CPU hours processing buildings NRW3D
  - > 1000 CPU hours DEM for 3D route graph Germany
- Frequent updates remain a challenge
  - GRID-Computing
  - need for high automation, fault tolerance and improved algorithms

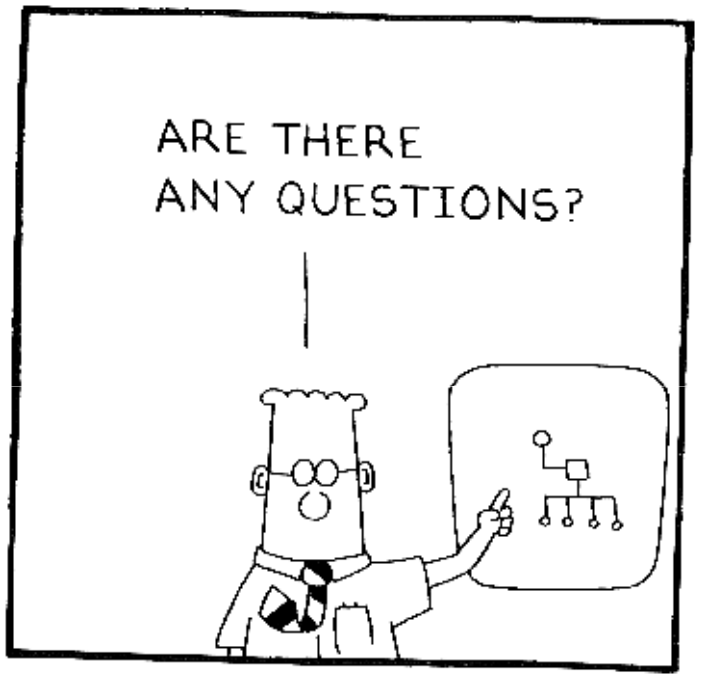
Summary & Outlook

GDI3D

- Search for best compromize between generalization (low data volume) & visual appearance
  - Improve visualization, usability, empirical user tests
- Potential of user generated geo-content (mass market)
  - Not all maps will be Google Maps in the future ;-)
- OGC services allow for non-trivial applications
  - need for control over the DEM for high quality data integration
  - one step towards Web-based 3D GIS

Thank you very much!

GDI3D



http://www.gdi-3d.de
http://www.osm-3d.de
http://www.nrw-3d.de
http://www.openRouteService.org
http://www.mona3d.de
http://www.gdi-grid.de
http://www.ok-gis.de
http://www.hgis-germany.de
http://www.sutren-3d.de
http://www.3dgismarkt.de

Prof. Dr. Alexander Zipf
Department of Geography
University of Bonn
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GDI3D