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GWF 2016

CityGML-based SDIs
Implementation requirements and examples

Geospatial World Forum, May 23-26, 2016, Rotterdam

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CityGML-based SDIs

Implementation requirements and examples

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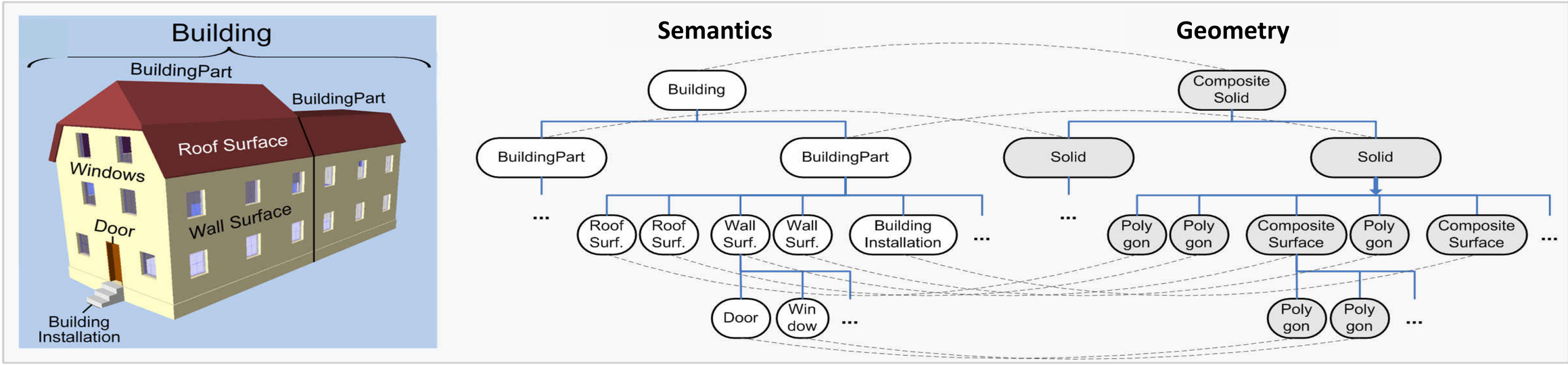
What is CityGML?

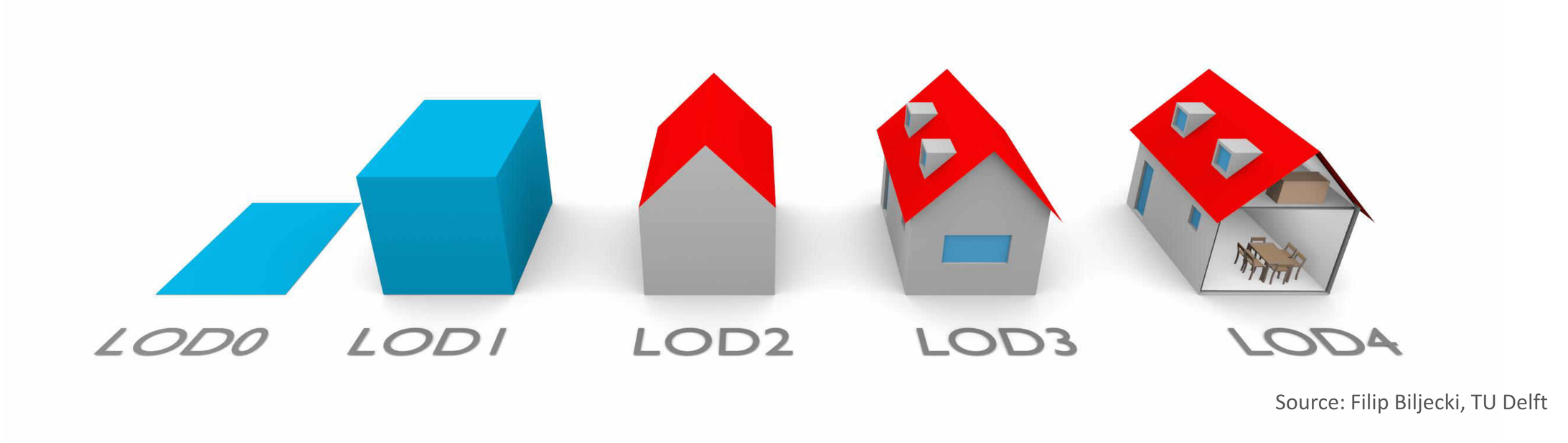
- **International OGC standard** for **semantic** 3D city models
- Represents **all relevant topographic object types** of a city (buildings, vegetation, water, terrain, traffic, etc.)
- ISO 19100 compliant, extensible **information model** and GML-based **exchange format**
- CityGML represents the city objects with **3D geometry**, **3D topology**, **semantics** and **appearance**

Why CityGML?



- Rich in semantics compared to pure 3D graphics and 3D map formats
- Objects know **WHAT** they are and **WHERE** they are
- Hierarchical structure of features and their components
- **Required** for sophisticated **queries, simulations** and **analyses**

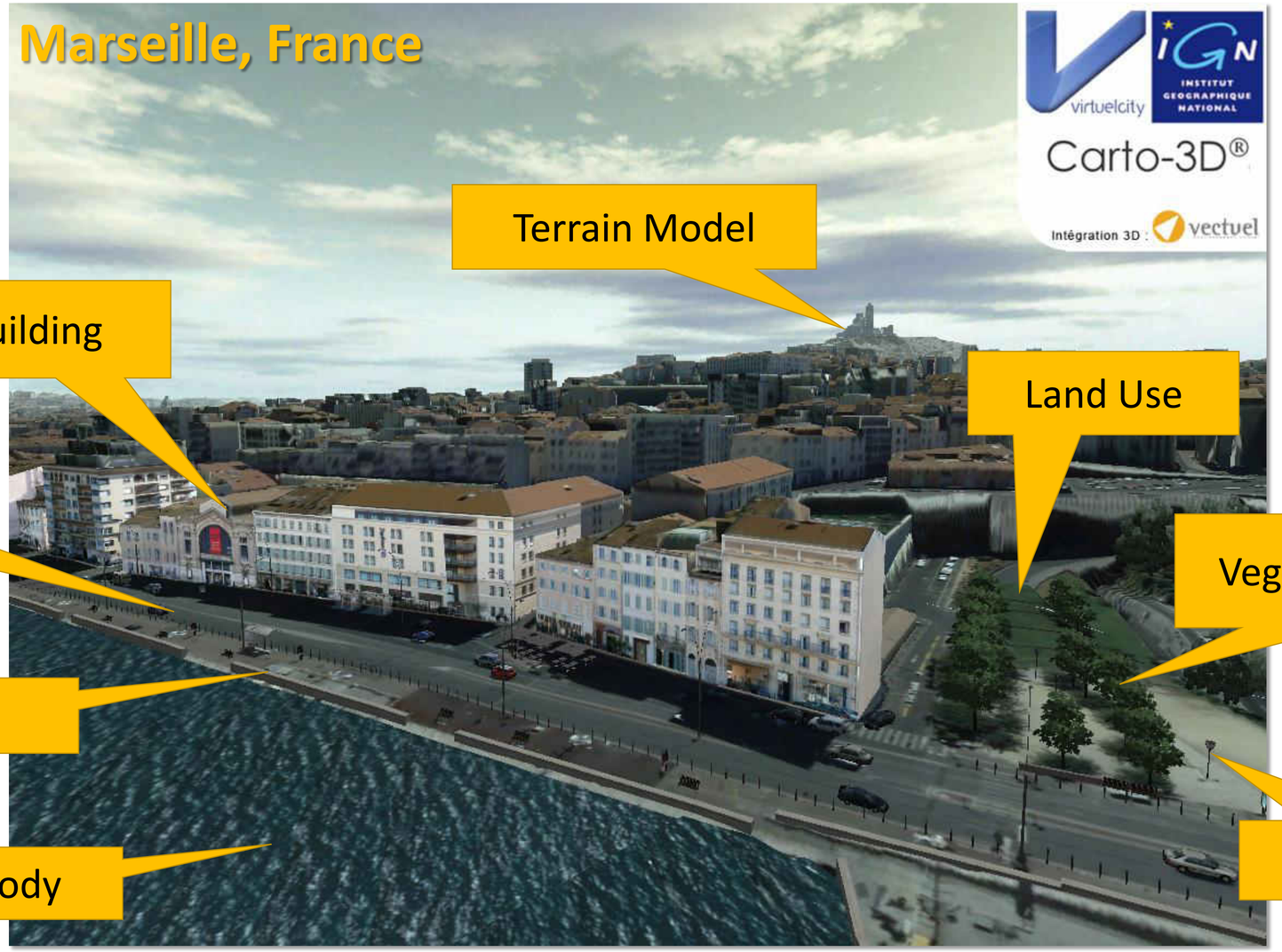
Why CityGML?



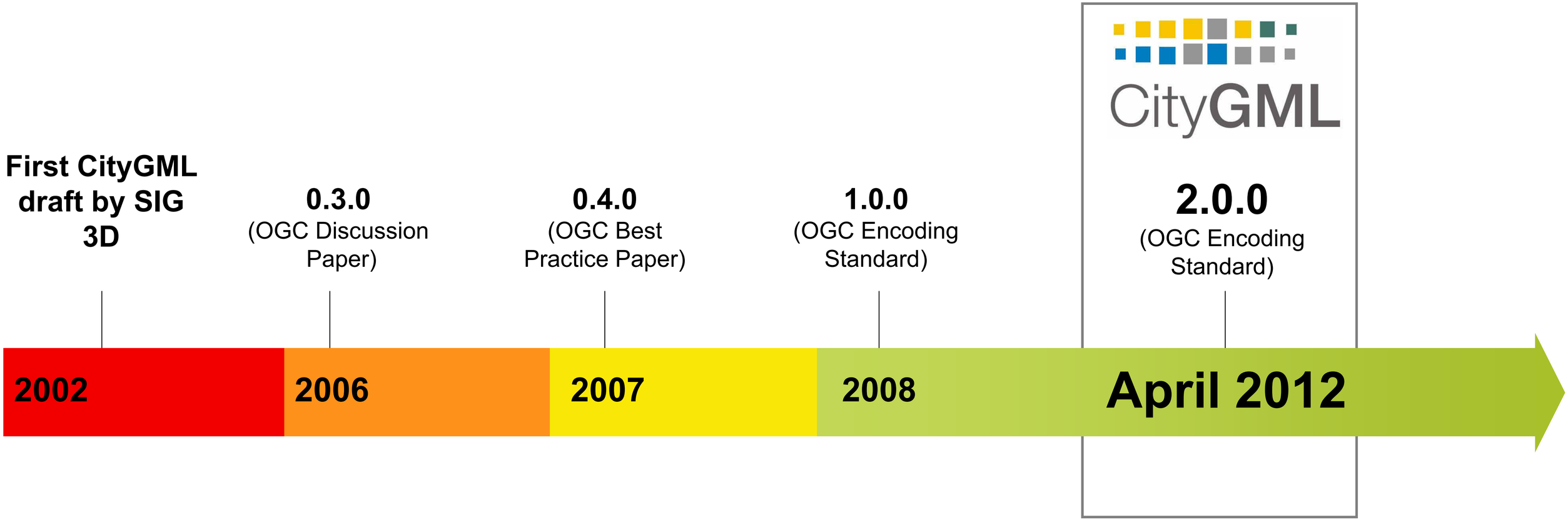
Source: Filip Biljecki, TU Delft

- Five Levels-of-Detail suitable to many different applications fields
- **Every city object** can be represented in each LOD **simultaneously**

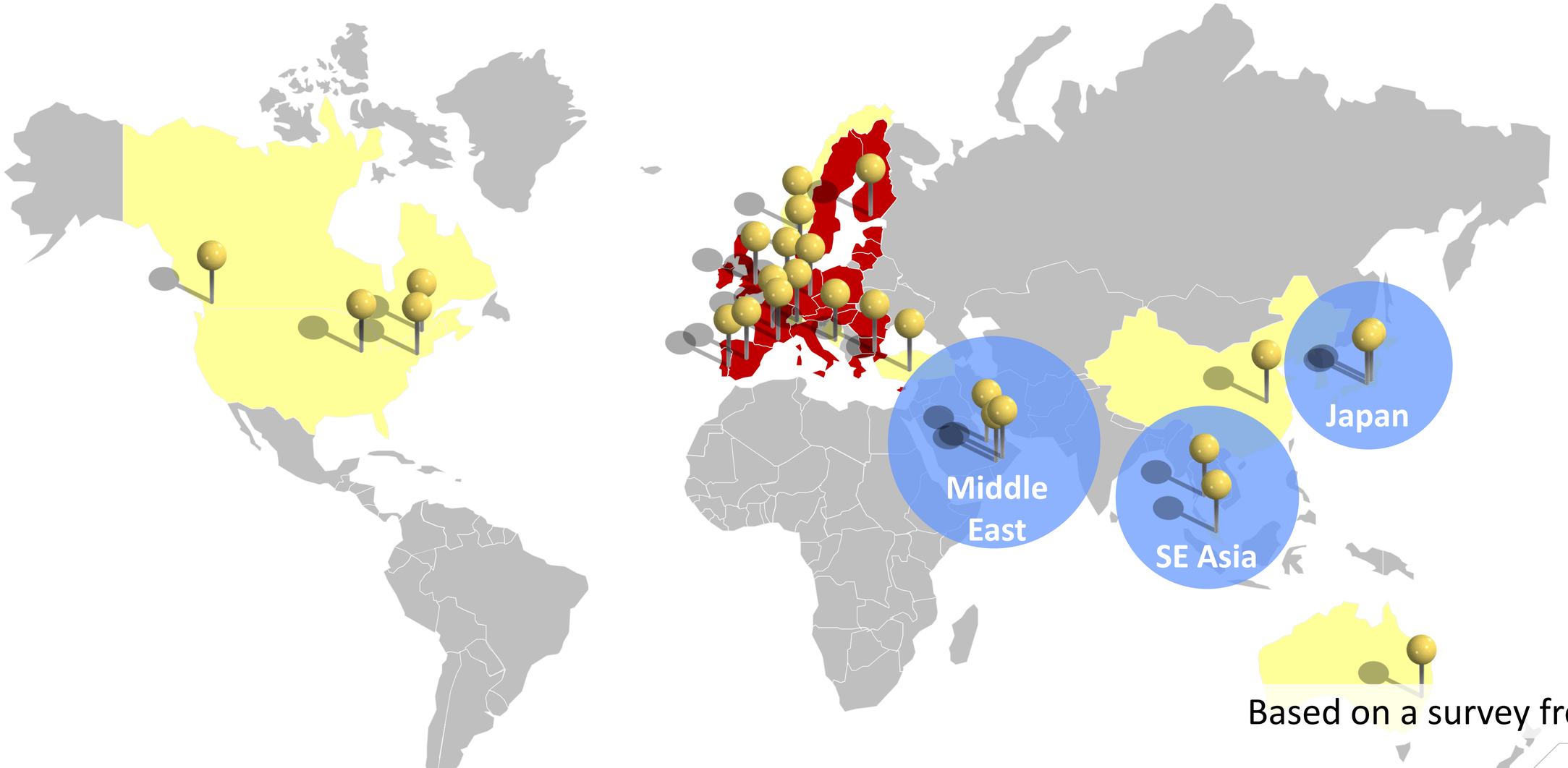
Why CityGML?


Marseille, France
virtuelcity
IGN
INSTITUT GEOGRAPHIQUE NATIONAL
Carto-3D®
Intégration 3D : vectuel
Terrain Model
Building
Land Use
Road
Vegetation Object
Traffic Area
City Furniture
Water Body

CityGML timeline



CityGML world map



Based on a survey from 2010

CityGML-based SDIs

Implementation requirements and examples

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Implementation requirements

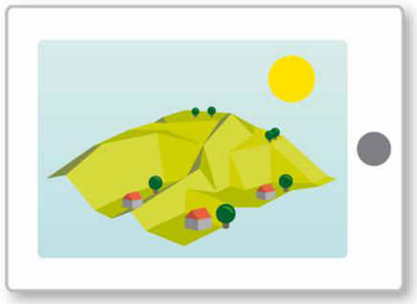
- **Robust** and **scalable** data storage
- **Update** and **maintenance** workflows
- Easy-to-use **publishing/visualization** of data
- Integration with **OGC web services** and existing infrastructure

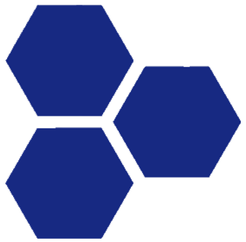
Implementation requirements

Update/maintain

Store

Distribute





OGC Service

Storing CityGML data – The 3D City Database

"The award winning 3D City Database is a free 3D geo database to **store and manage virtual 3D city models** on top of a **standard spatial relational database**. The database model contains semantically rich, hierarchically structured, multi-scale urban objects facilitating complex GIS modeling and analysis tasks, far beyond visualization."

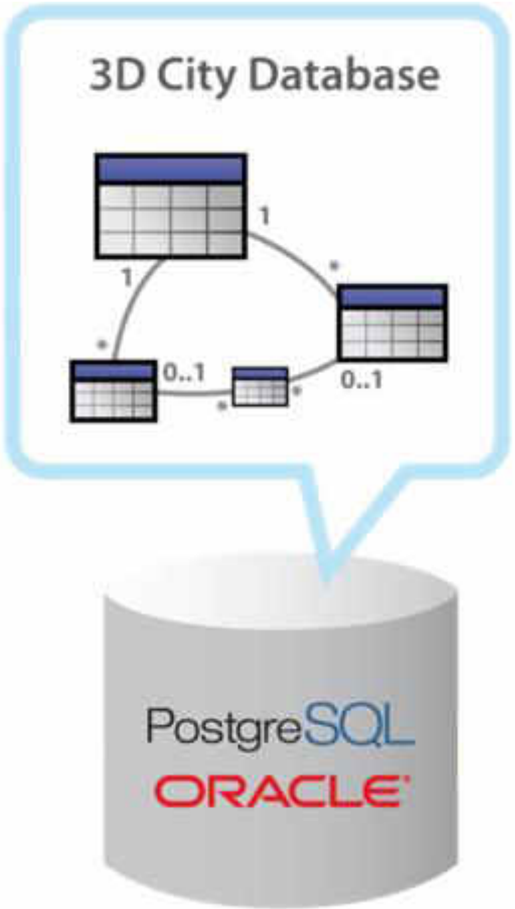
http://www.3dcitydb.org

What is the 3D City Database?

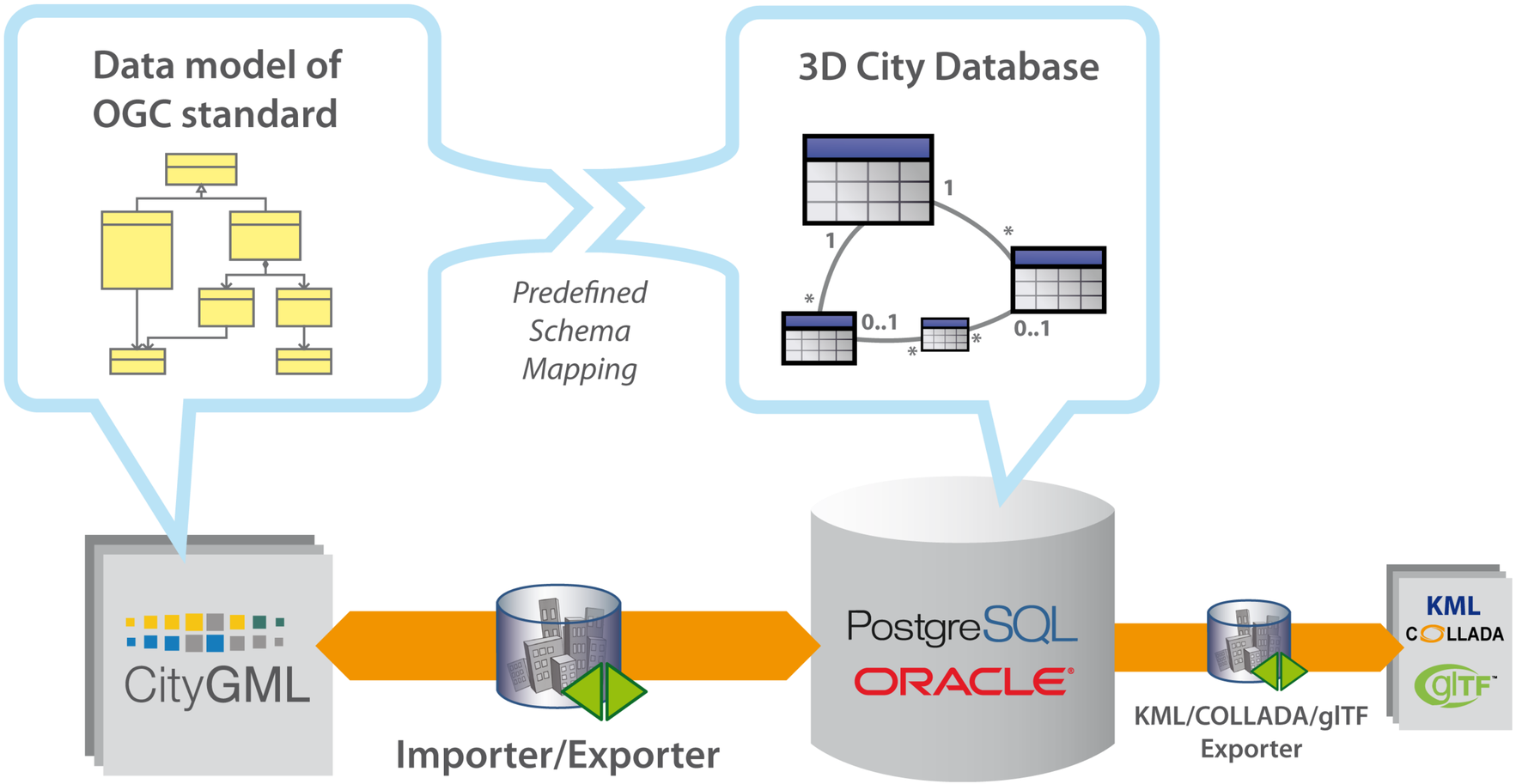
- CityGML data management solution
  - CityGML 2.0 compliant **relational schema** for 3D city models
  - Realized on top of **established spatial database systems** (PostgreSQL/PostGIS, Oracle)
  - Oracle Spatial Excellence Award 2012

- Efficient database tools
  - Loading/extracting massive CityGML-based 3D city models
  - Export of KML/COLLADA/glTF visualization models

- **Open Source** project under **LGPL 3.0**



CityGML, 3D City Database and tools



OGC Web Feature Service (WFS) interface

- **OGC WFS 2.0** service interface for the 3DCityDB
  - Live queries to the city model using spatial and thematic filters
  - Transactions (insert, update, delete) on the data
  - Open Source (WFS Simple conformance class)
- **Open and standardized**
  - CityGML used as data exchange format
  - Vendor-neutral data workflows and processes
  - WFS abstracts from the data backend
- **Web-based data management** of the 3D city model data

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Query your City Model

Legend | Measure | Query | Export | Shadow
OGC-Services | Explorer | Routing | Info

Query Free Query

- Object filter

Feature Building

- Geometry filter

DWITHIN | XYZ | BOX

500

- Attribute filter

Start query

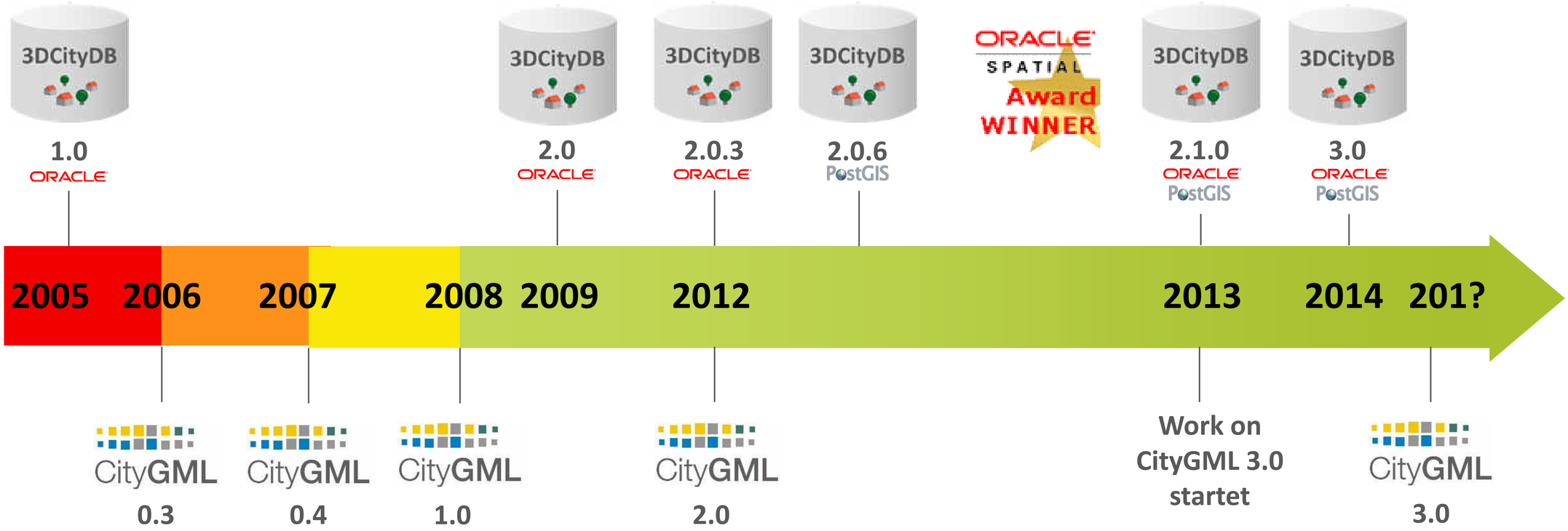
Result: 259 Features

#FF7F00FF

add | set | zoom | clear

X:392239.98, Y:5819872.42, Z:35.55

3D City Database timeline



CityGML-based SDIs
Implementation requirements and **examples**

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Senate of Berlin / Berlin Partner

Main use is for City marketing

Berlin

- Update and maintenance
  - on a project base
  - Change detection and update every 3-5 years
- Storage
  - Since 2009 in 3DCityDB
- Visualization
  - 2009: Autodesk LandXplorer (Desktop) and Google Earth (Web)
  - 2011: virtualcityMAP / 3DMaps from Agency9 (Web)
  - 2016: virtualcityMAP / CesiumJS

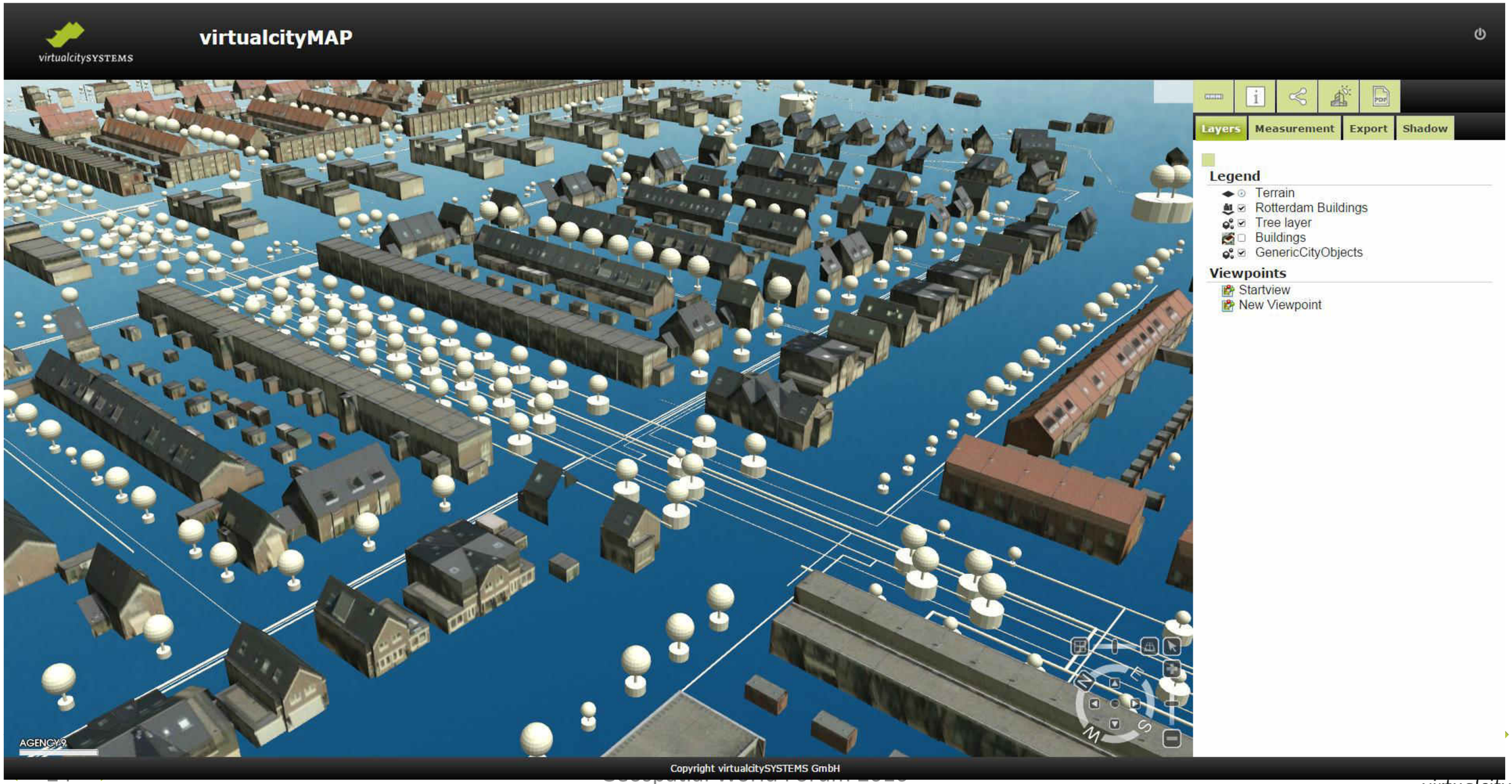
URL: http://www.businesslocationcenter.de/wab/maps/main/

Rotterdam

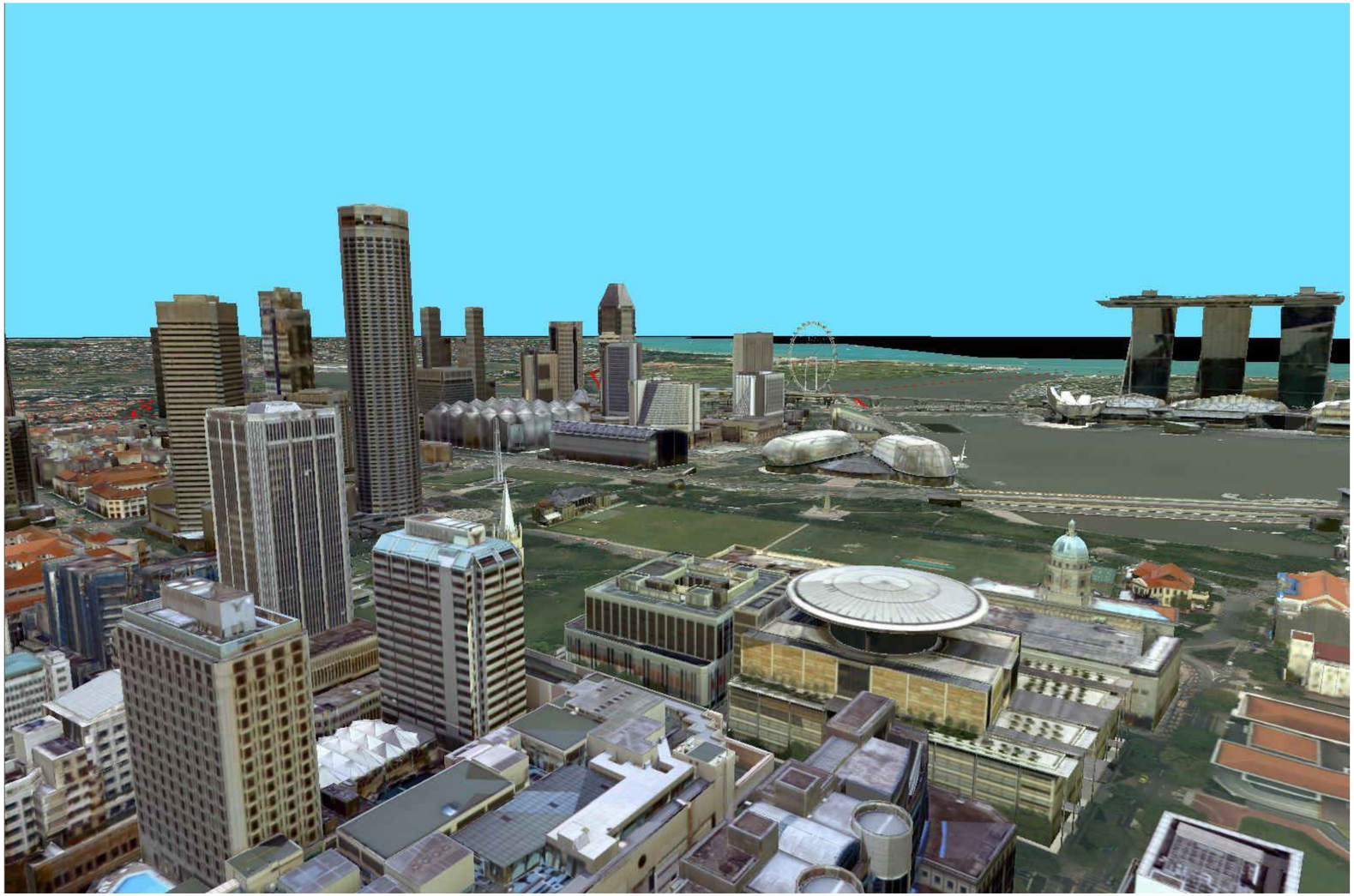
Rotterdam challenges

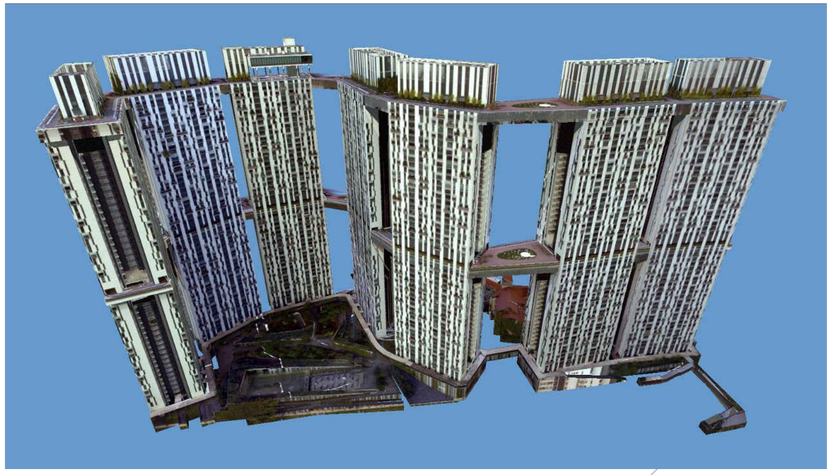
- 3D City Model shall become an integrated and reliable base dataset for many different applications
  - Urban planning
  - Collision detection
  - Solar potential
  - Energy planning
  - …
- Approach: Rotterdam 3D working group
  - Ask the users from different departments
  - Create proof-of-concepts
  - Define workflows
  - Integrate with exisiting systems and workflows

Rotterdam – Underground infrastructure



Singapore





Singapore

- Data creation: Bentley Map
- Data storage: 3DCityDB
- Core requirement: Data update and maintenance is still unsolved
  - Direct connection between Bentley Map and 3DCityDB
  - Check out and feature look mechanism
  - Support of the complete CityGML information model

➔ **In 2D solved but in 3D still a challenge**

Further users of the 3D City Database

- In production use in many cities and organizations worldwide
  - Berlin, Hamburg, Munich, Frankfurt, Dresden, Potsdam, Kempten, …
  - Federal Surveying departments in Germany
  - London, Rotterdam, Den Haag, Helsinki, Finish Land Survey, Vienna, Salzburg, Zurich, Singapore
  - ZSHH in Germany: Nation-wide CityGML model containing buildings in LOD1 and LOD2 (ongoing); Currently more than 50 Mio. buildings in one 3DCityDB instance

- Research & Development
  - TU Delft, TU Munich, TU Berlin, Karlsruhe Institute of Technology, Eifer, EDF, …

- Companies
  - virtualcitySYSTEMS, MOSS, Luciad, …

Interested in 3D SDIs?
Open Source tools to get you started

3dcitydb-web-map

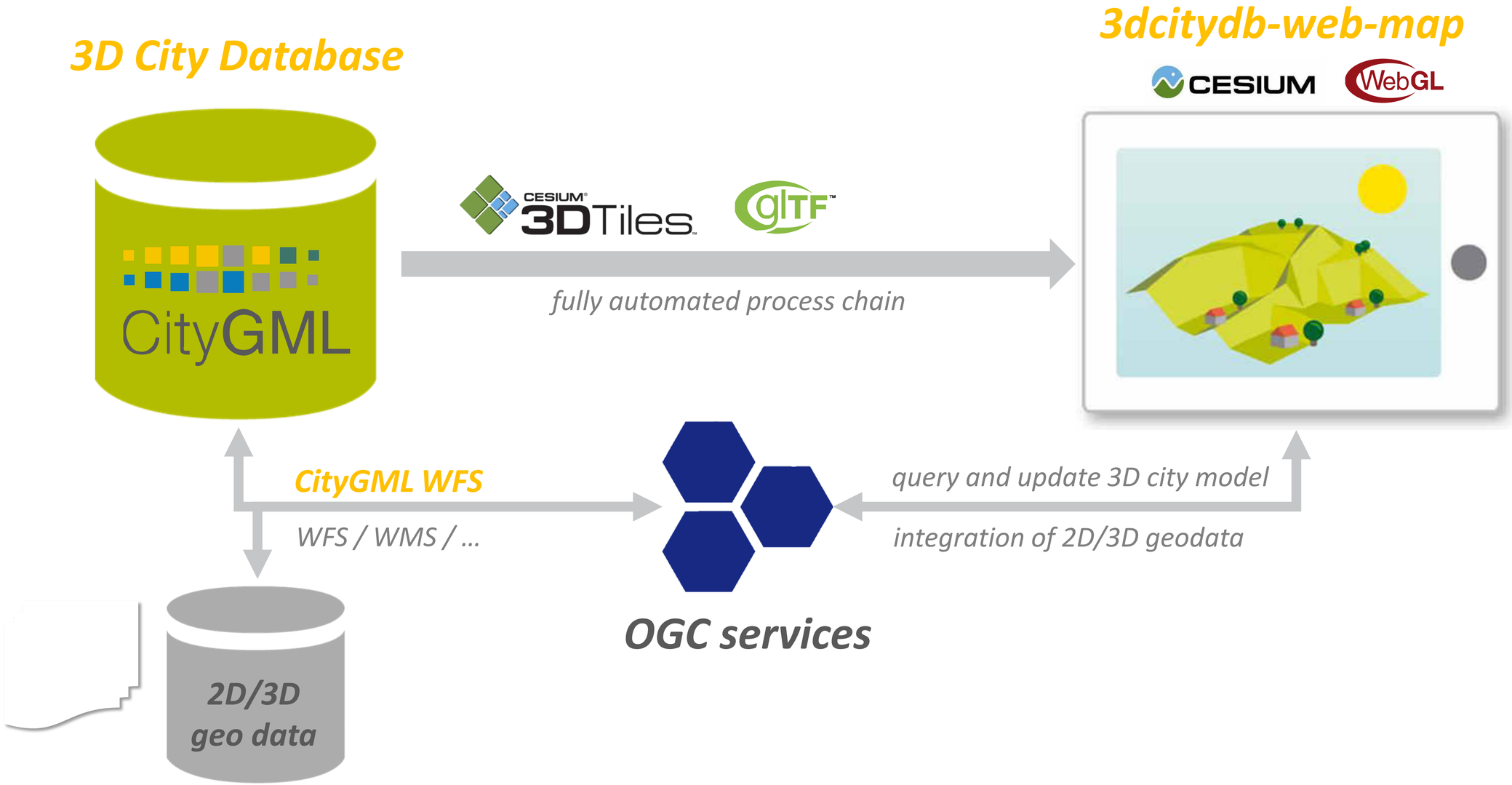
- **Streaming** of arbitrarily large **CityGML-based** 3D city models on the web

- **Open Source** JavaScript API on top of **Cesium**

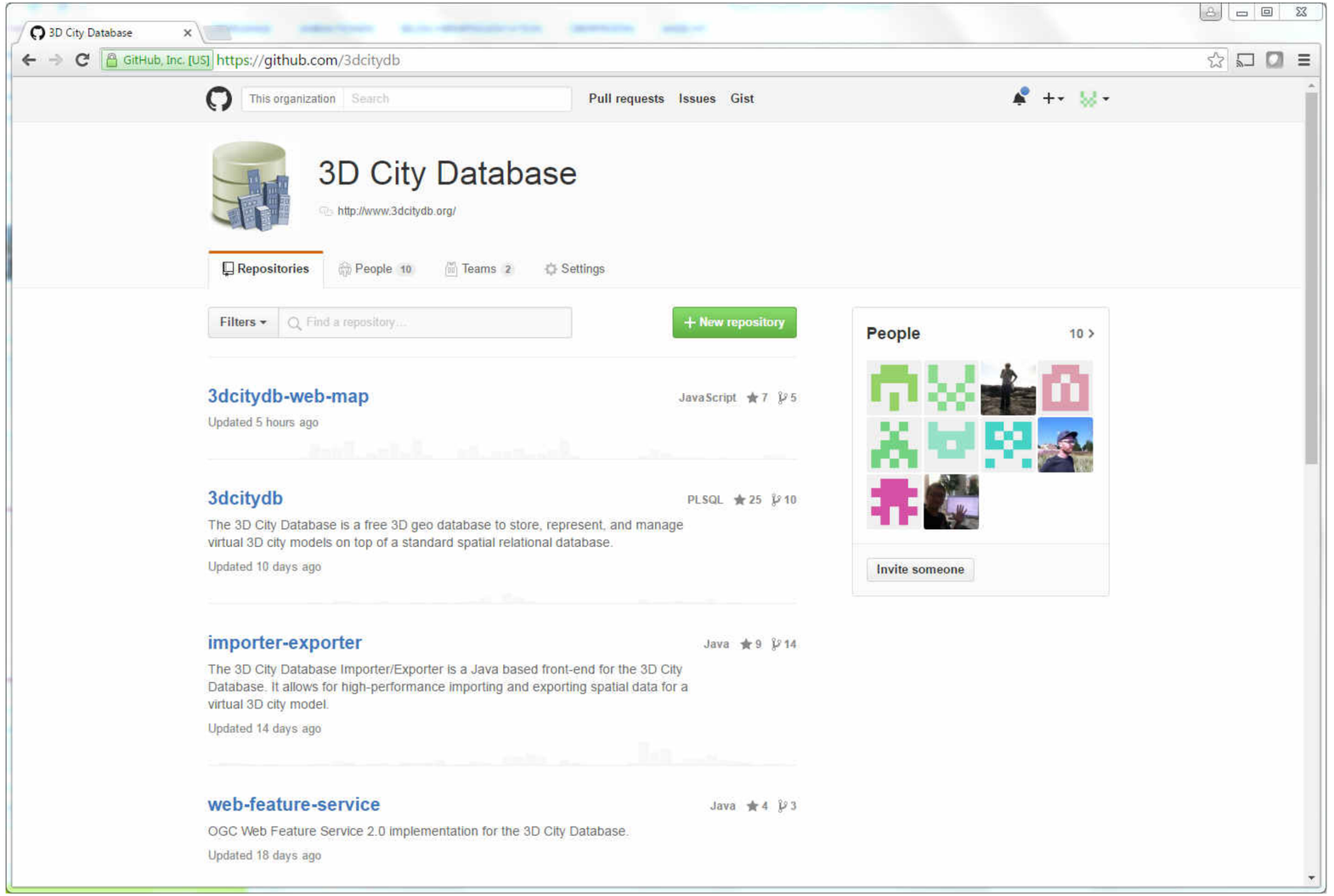
- Allows for **adding 3D object layers** and for **interacting** with the content
  - Tile-based loading and unloading
  - Selection and highlighting of objects
  - Hide/show 3D objects
  - Cloud-based access to object attributes

- **SIMPLE:** glTF exports from the 3DCityDB can be directly loaded into Cesium

Connecting 3DCityDB ecosystem to



Find the 3DCityDB and tools on GitHub



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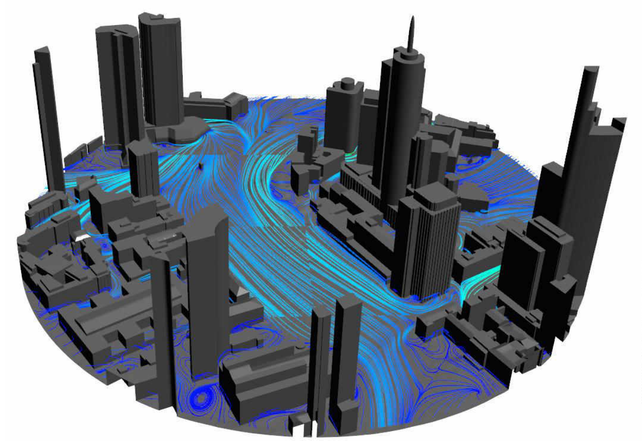
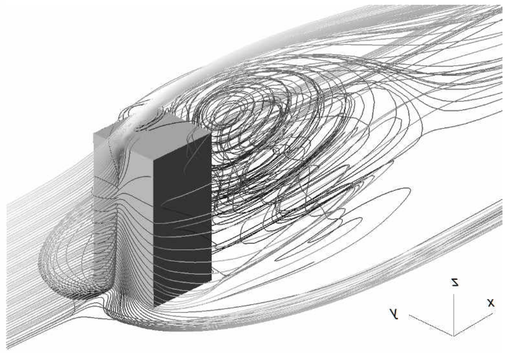
Conclusions

- Reliable solutions for data storage and data distribution are available
  - 3DCityDB
  - 3DCityDB Web Feature Service
  - virtualcityMAP / virtualcityPUBLISHER

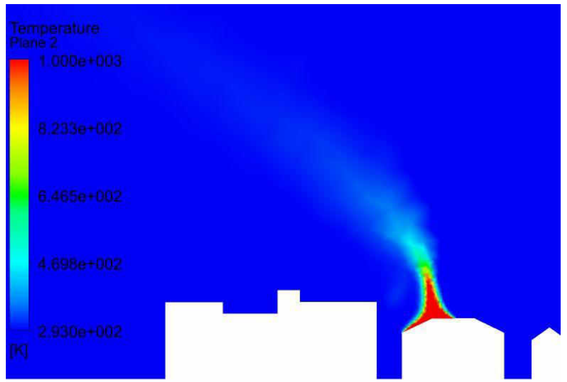
- Data creation, maintenance and update is still not fully solved
  - Deleting and replacing features – ok
  - Replacing the complete model – ok
  - Continuous updates through import and export workflows – ok
  - Direct database connection using an editor – not yet implemented

3D SDI as basis for complex Urban Simulation

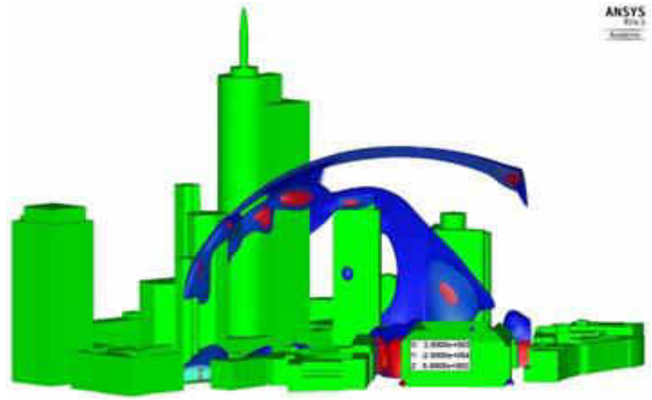


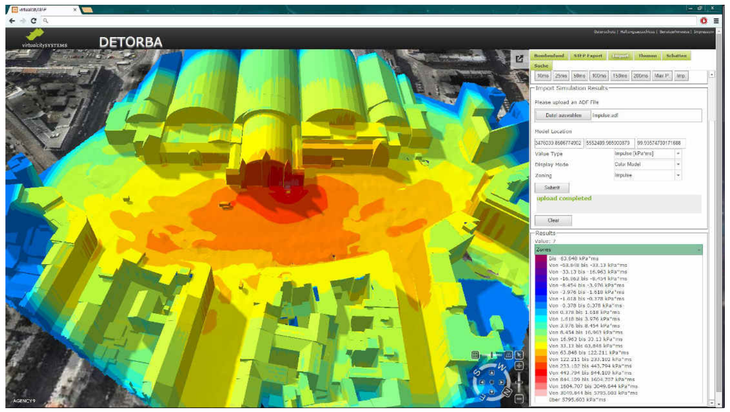


Wind field and turbulence simulation

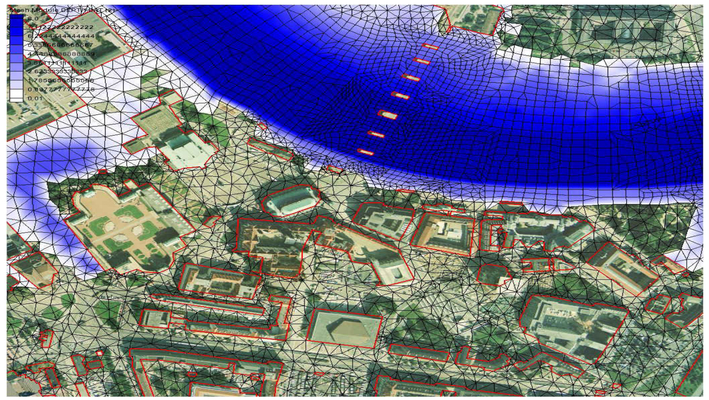


Smoke dispersion simulation





Blast simulation



Flooding

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The next generation of 3D city models

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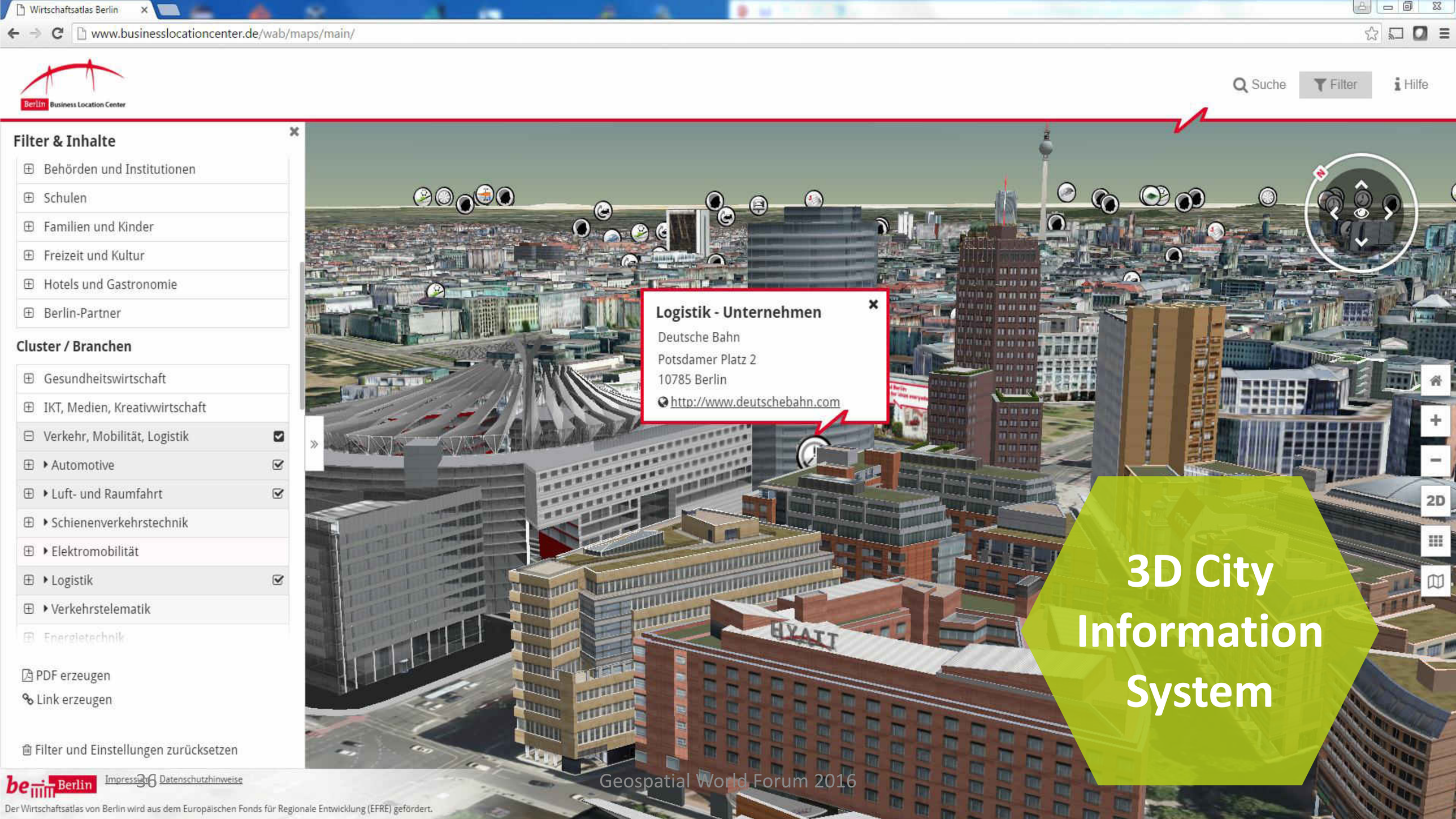
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Potsdamer Platz 2
10785 Berlin
http://www.deutschebahn.com
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3D City Information System
be Berlin
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Der Wirtschaftsatlas von Berlin wird aus dem Europäischen Fonds für Regionale Entwicklung (EFRE) gefördert.

ROTTERDAM

Apps VCS Maven SIG3D tmp virtualcityMAPs WebGL Weitere Lesezeichen

ROTTERDAM

Legende | Messen | Schatten | Query

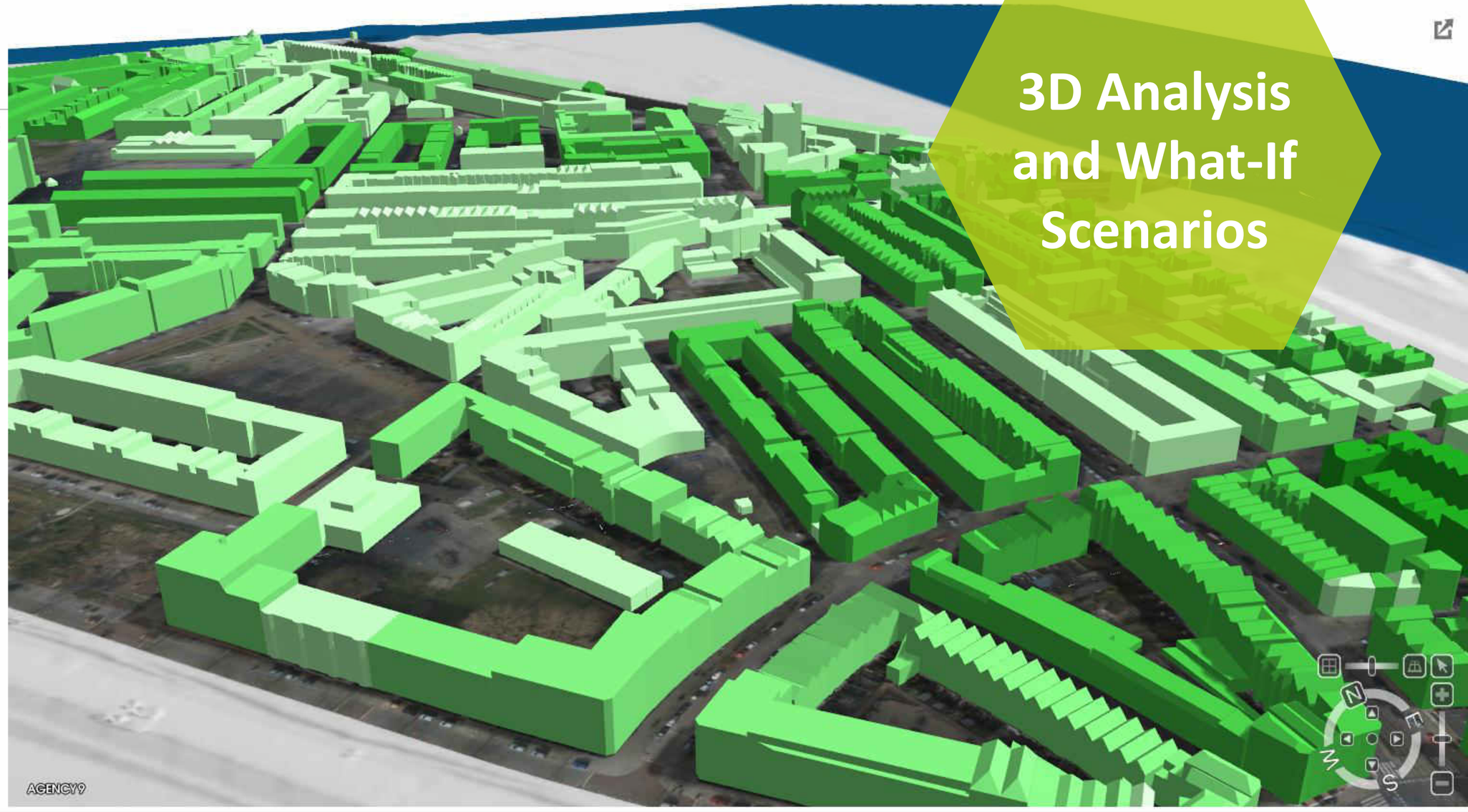
Feature Explorer

Legende

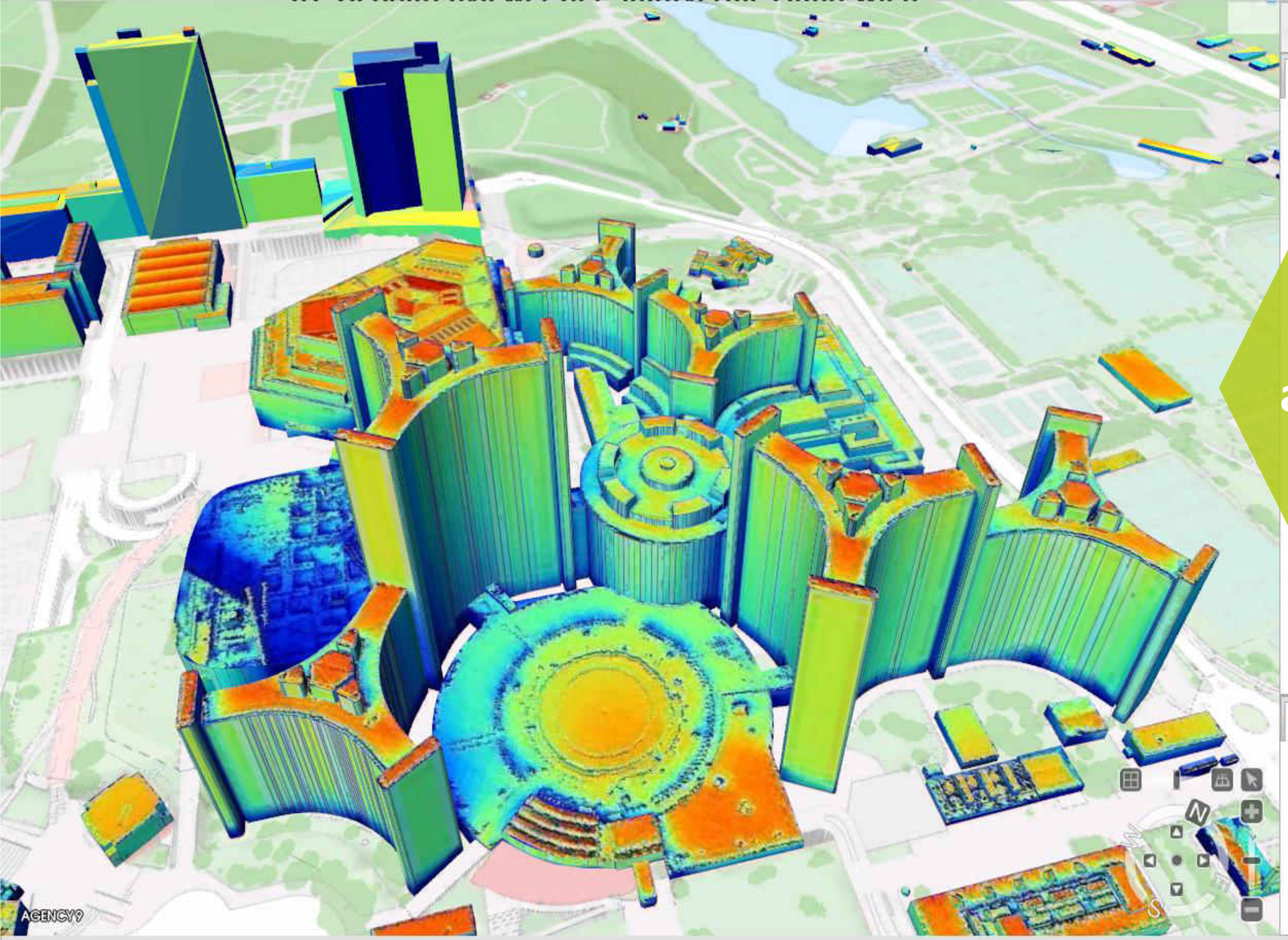
- LoD1
- LoD2
- Fazit pro Wohnblock
- Baselayer
- Themen
  - Solar Potenzial
  - Energieeinsparung
    - 0 - 50 (kWh/m2/jr)
    - 51 - 80 (kWh/m2/jr)
    - 81 - 110 (kWh/m2/jr)
    - 111 - 140 (kWh/m2/jr)
    - > 140 (kWh/m2/jr)
  - Energieverbrauch
  - Wärme-Netz Potenzial
  - Eigentum
  - Geothermie Potenzial
- Geothermal potential

Ansichten

- Anfangsansicht



3D Analysis and What-If Scenarios



3D Analysis and Thematic Mapping

Themen | Messungen | Shadow

activate FastGraphs | deactivate FastGraphs

Ebenen

- Situationsdarstellung
  - Detailmodell (LOD 3)
  - Gebäudemodell
  - Blockmodell (LOD 1)
  - Karte
- Brücken
  - Karte
- Thematische Darstellung
  - [kWh/Jahr]
- Gelände
  - Karte
  - Fototextur

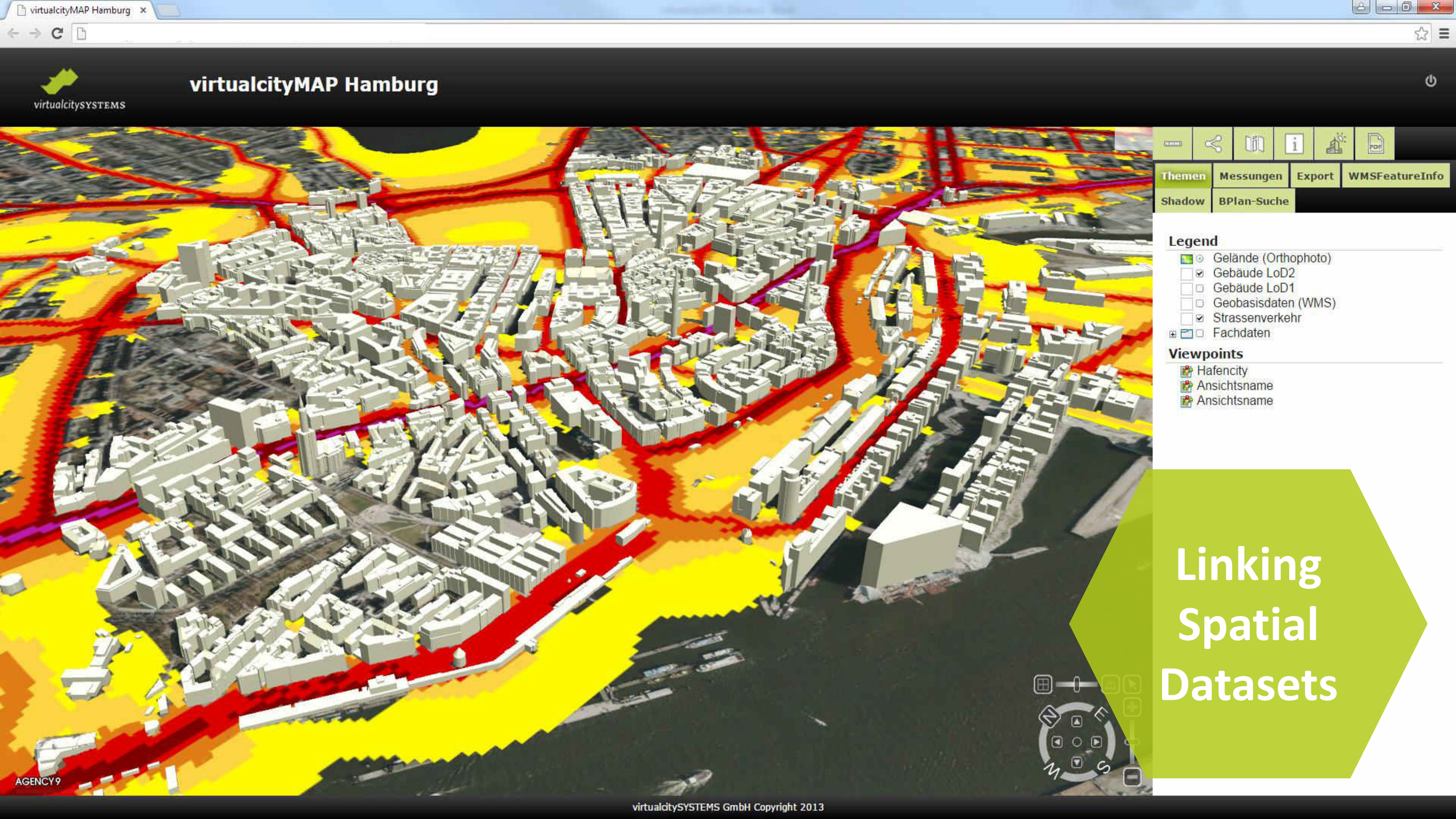
Viewpoints

- Donau City
- AKH Wien
- Vienna Twin Towers
- Rathaus

Impressum

Information Geodaten | Bedienung | Kontakt

AGENCY9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Themen
Messungen
Export
WMSFeatureInfo
Shadow
BPlan-Suche
Legend
Gelände (Orthophoto)
Gebäude LoD2
Gebäude LoD1
Geobasisdaten (WMS)
Strassenverkehr
Fachdaten
Viewpoints
Hafencity
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