CityGML –
OGC Standard for Photogrammetry?

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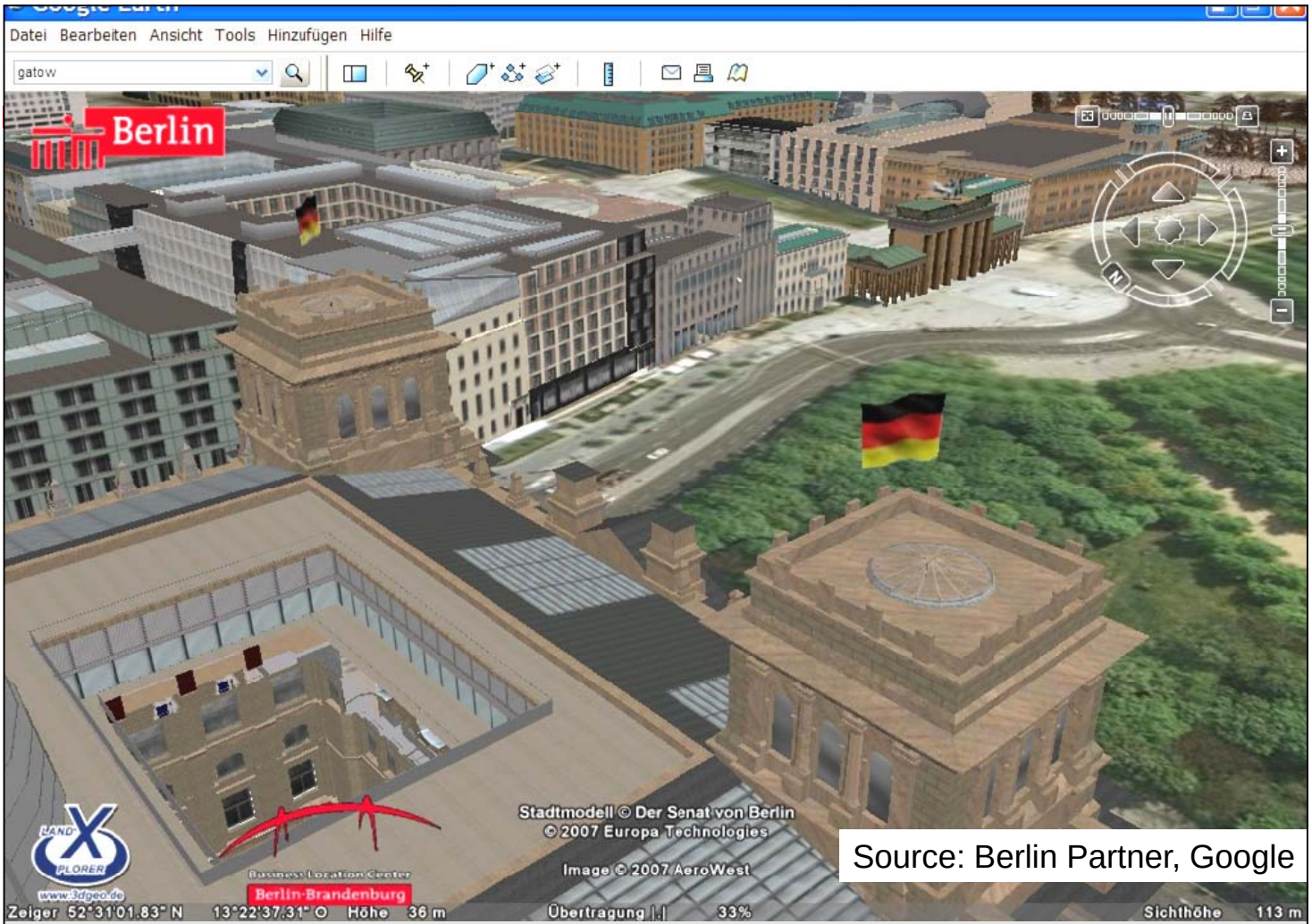
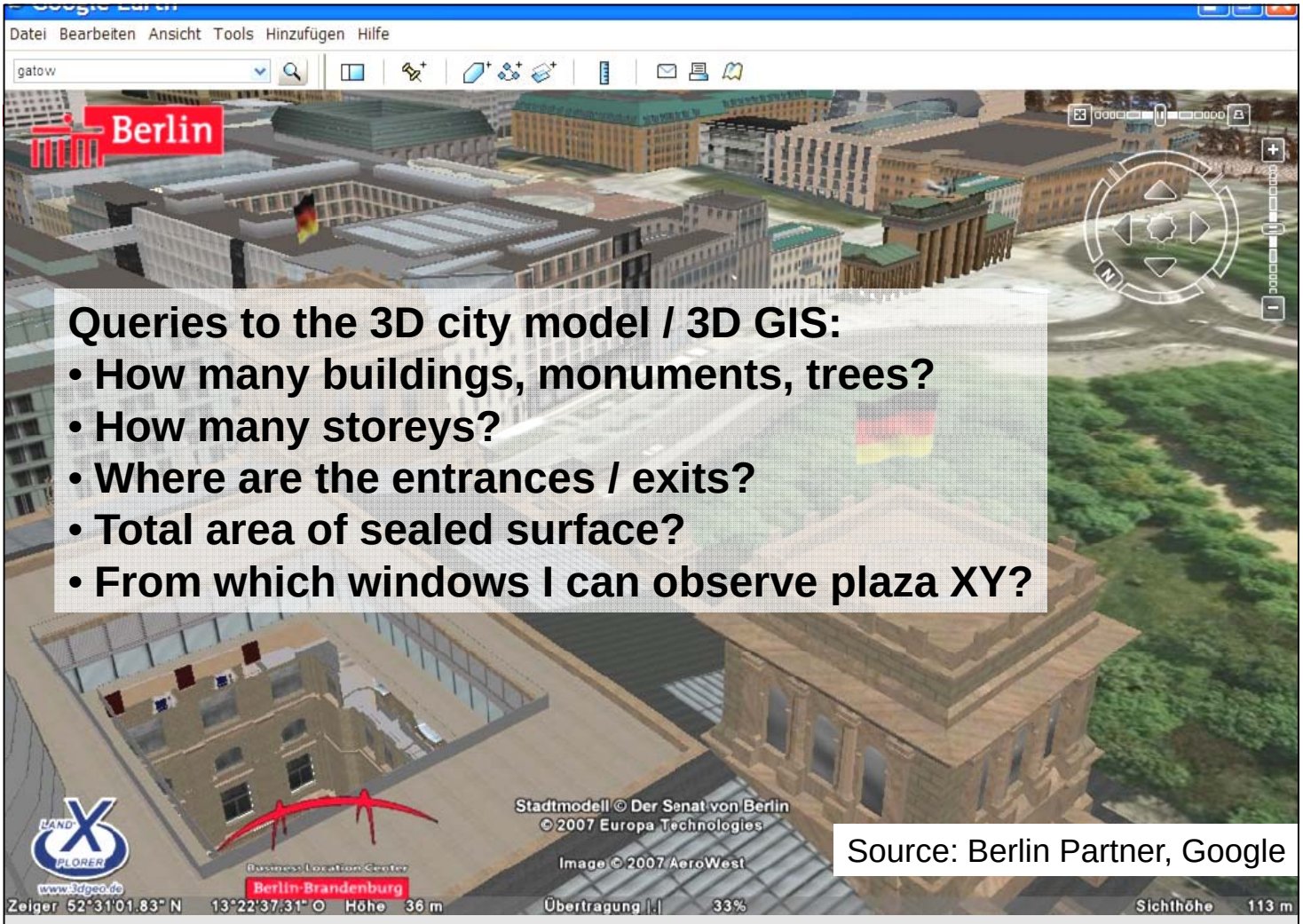


Source: Berlin Partner, Google



3D City Modelling

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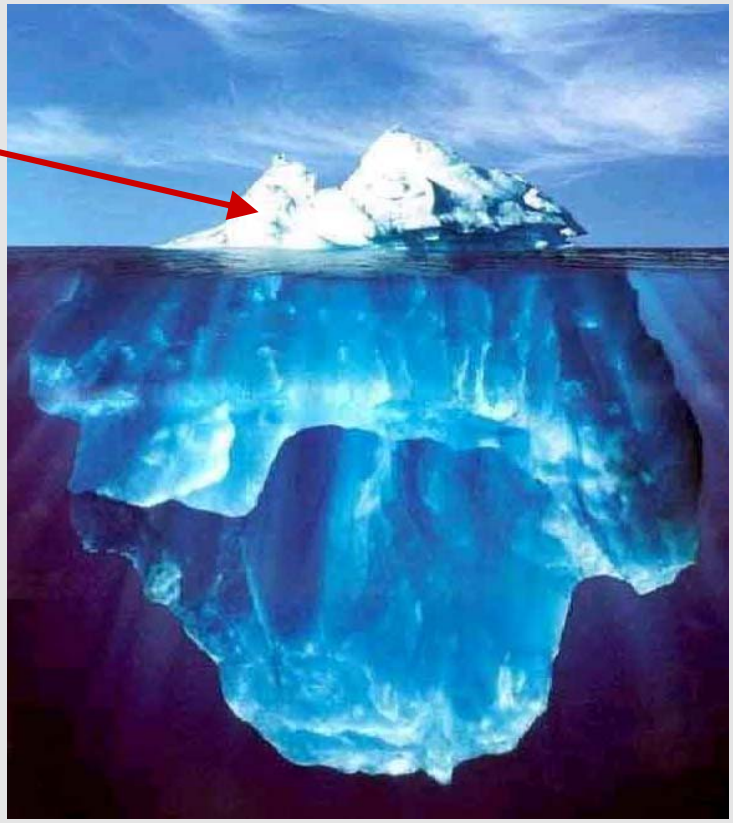
… is far more than the 3D visualization of reality

In fact, the **geometry** and its **appearance** are **only one aspect** of an entity!

Key issue:
Semantic Modelling



Semantic 3D City Models
Application #1: Energy Assessment

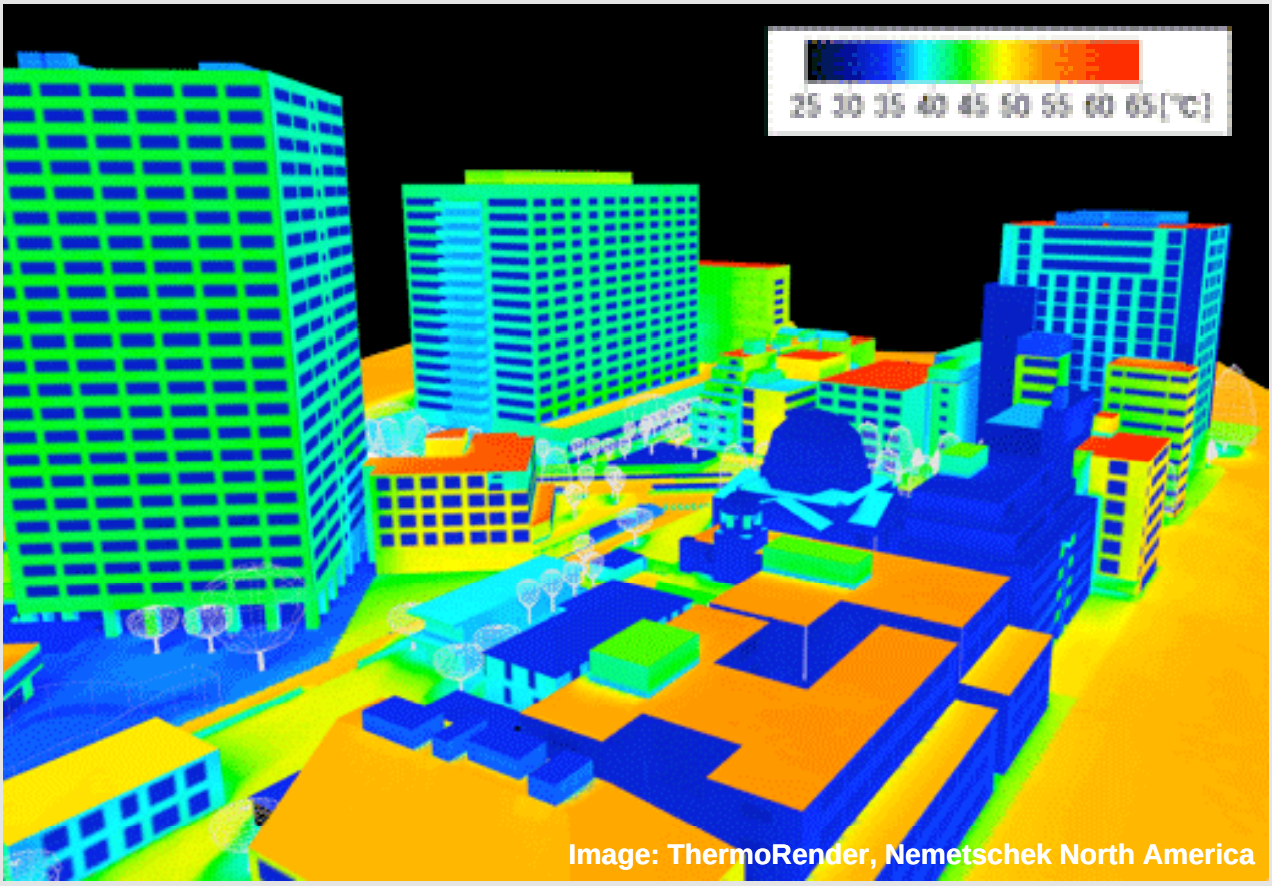


Image: ThermoRender, Nemetschek North America

Semantic 3D City Models / Building Information Models
Application #2: Space Management

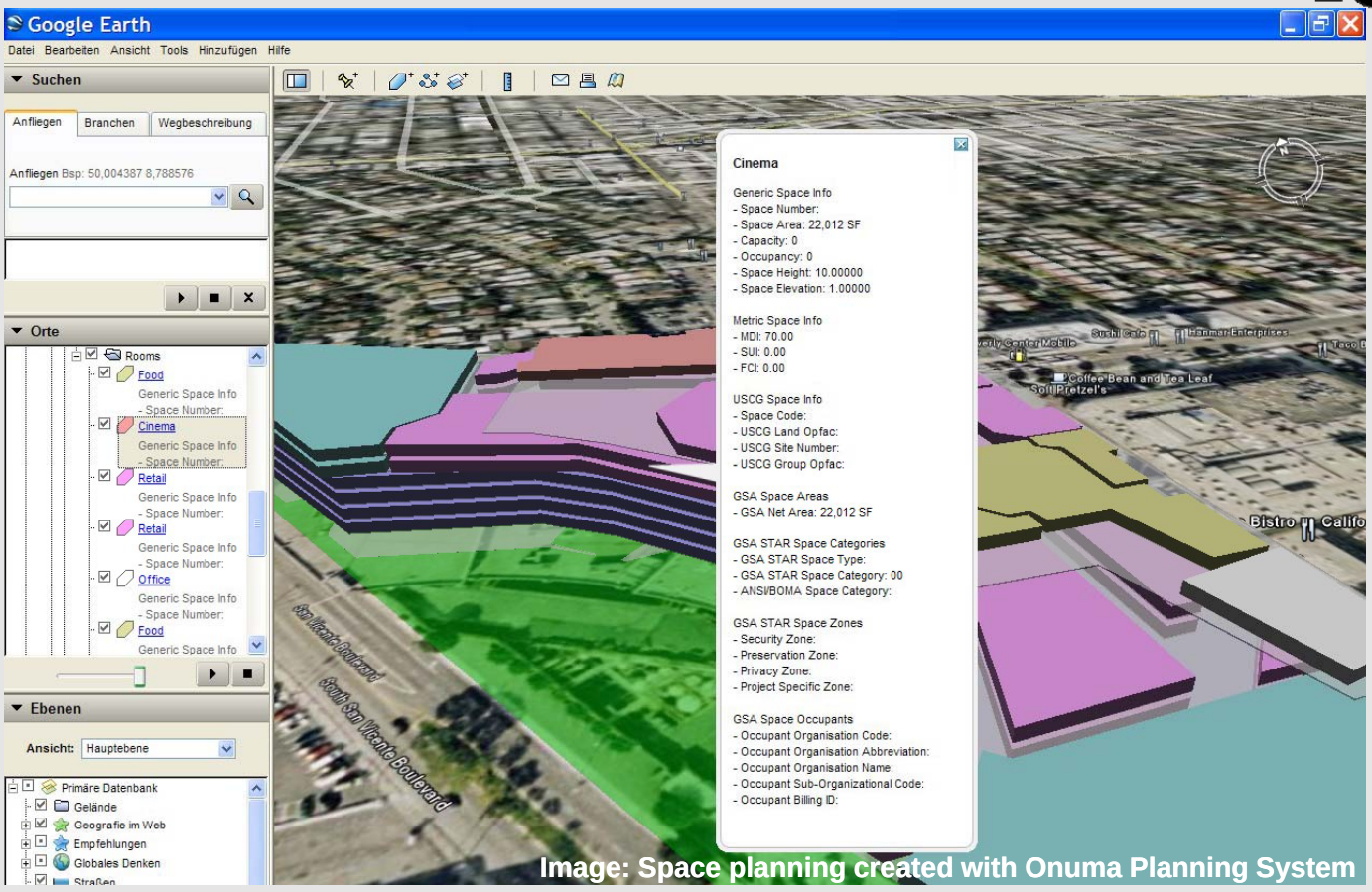


Image: Space planning created with Onuma Planning System

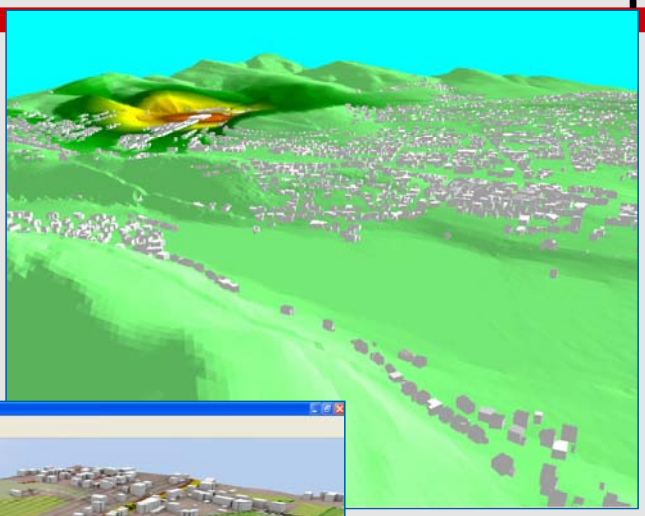
Semantic 3D City Models / Building Information Models
Application #3: 3D Cartography

Non-photo realistic rendering. © J. Döllner & M. Walter, 2003

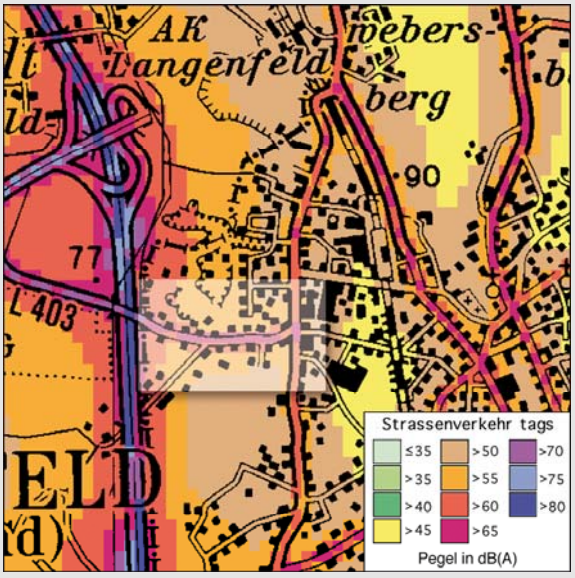
Semantic 3D City Models
Application #4: Noise Pollution Mapping [Simulation]

3D block model in CityGML from WFS-T

DTM 10m grid in GeoTiff from WCS



noise immission simulation



noise pollution maps for European Union reporting (using WMS)

Requirements for 3D City Modeling

- **Geometric** and **radiometric** modeling
- 3D Coord. Reference Systems (3D or 2D+1D / geo. or proj.)
- **Topology**
- **Semantic modeling / Object classification**
  - Distinct thematic models / **feature types with thematic attributes** (DTM, Buildings, Transportation, Water bodies, Vegetation, etc.)
  - Common information model / standardized data model
- **Different but well-defined granularities** / abstraction levels
  - Multi-scale modeling; support for generalisation
- Support for the **integration** of different datasets

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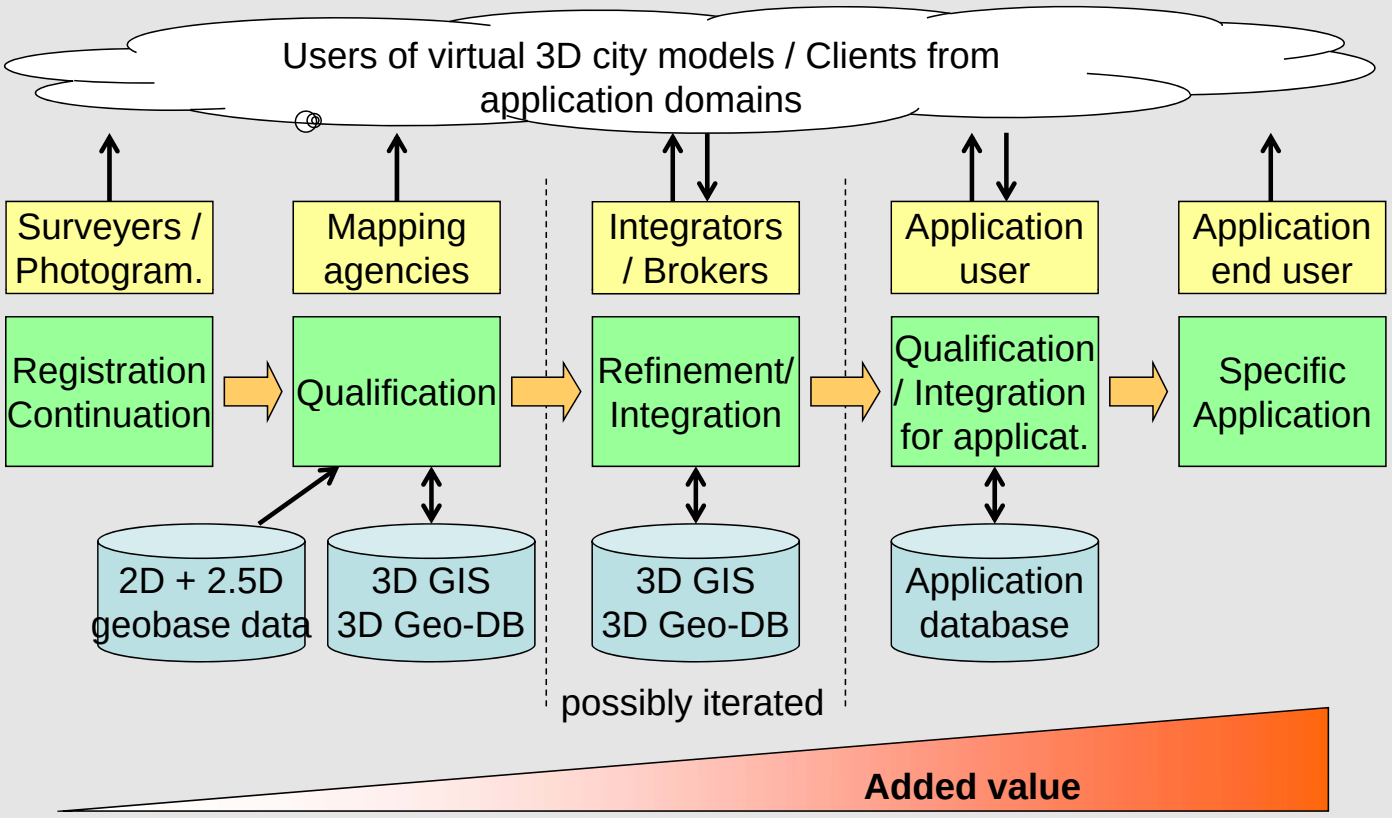
City Model Processing Chain



Difficulties along the Processing Chain

- **Diverse qualities** of **3D models** in the different steps
  - different degree of fidelity of geometry, topology, appearance
  - from simple structured objects to complex application models
- Until now: often **change of data models** and **exchange formats** inbetween the processing steps
  - loss of data because of limited modeling powers / expressivity of models and formats
  - difficult preservation of object identities
- **Missing back links / references** to original data of preceding processes
  - causes problems with updates / continuations
- **CityGML can be used along the full processing chain**

CityGML – Modelling Urban Spaces

Application independent Geospatial Information Model (semantic model) for virtual 3D city and landscape models

- comprises **different thematic areas** (buildings, vegetation, water, terrain, traffic etc.)
- data model (UML) **based on ISO 191xx** standard family
- **exchange format** results from rule-based mapping of the UML diagrams to a **GML3 application schema**

CityGML represents

- 3D geometry, 3D topology, semantics and appearance
- in 5 discrete scales (Levels of Detail, LOD)

Goals of CityGML

Establish **high degree of semantic** (and syntactic) **interoperability**

- enabling multifunctional usage of 3D city models
- definition of a **common information model (ontology)**
- „3D geo base data“ (in the tradition of most European 2D digital landscape models, cadastre models)
- like *Building Information Models*, but on a smaller scale

Representation of **3D topography** as observable

- explicit 3D shapes; mainly surfaces & volumes
- identification of **most relevant feature types** usable in a **wide variety of applications**

CityGML Development

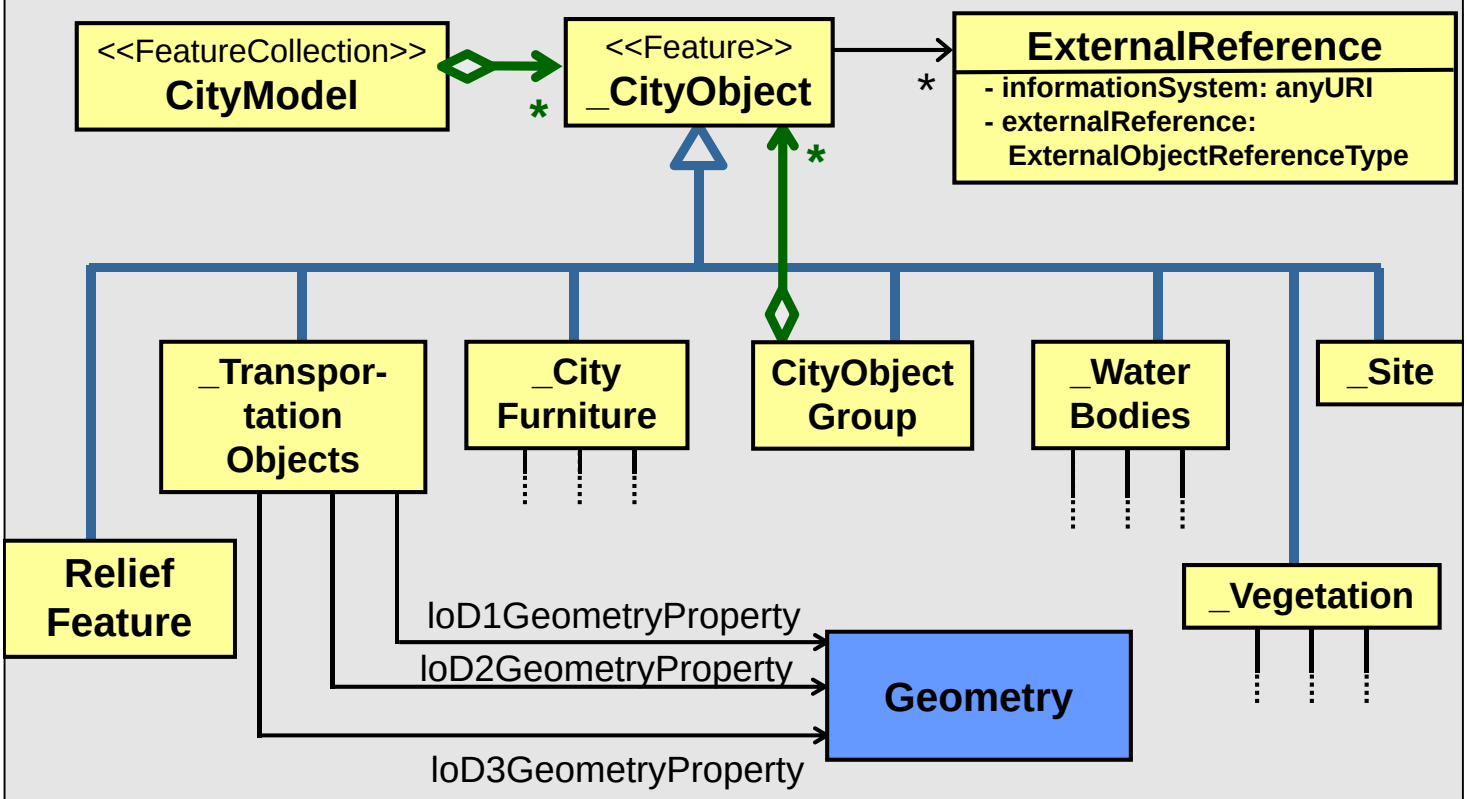
Originator: **SIG 3D** of the Initiative Geodata Infrastructure North-Rhine Westphalia in Germany (**GDI NRW**) in 2002

- **Open group** of more than 70 parties / institutions working on technical and organizational issues about virtual 3D city models
- e.g. T-Mobile, Autodesk, Bayer AG, Rheinmetall Defence, Environmental Agencies, Municipalities, State Mapping Agencies, UK Ordnance Survey, 11 Univ.

CityGML was brought into **Open Geospatial Consortium** for international standardisation by the end of 2004

- Handled by the **3D Information Modelling Working Group (3DIM WG)** and the **CityGML Standards Working Group (CityGML SWG)**
- **Adopted OGC standard since 08/2008**

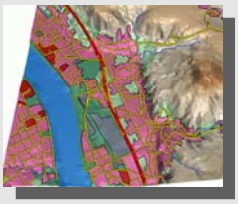
Thematic Modelling in CityGML



Multi-scale modelling: 5 levels of details

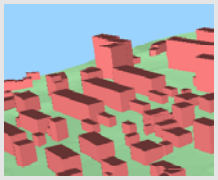
LOD 0 – Regional model

- 2.5D Digital Terrain Model



LOD 1 – City / Site model

- "block model" w/o roof structures



LOD 2 – City / Site model

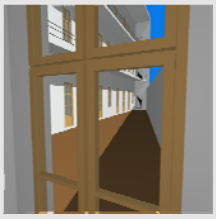
- textured, differenciated roof structures

LOD 3 – City / Site model

- detailed architecture model

LOD 4 – Interior model

- "walkable" architecture models

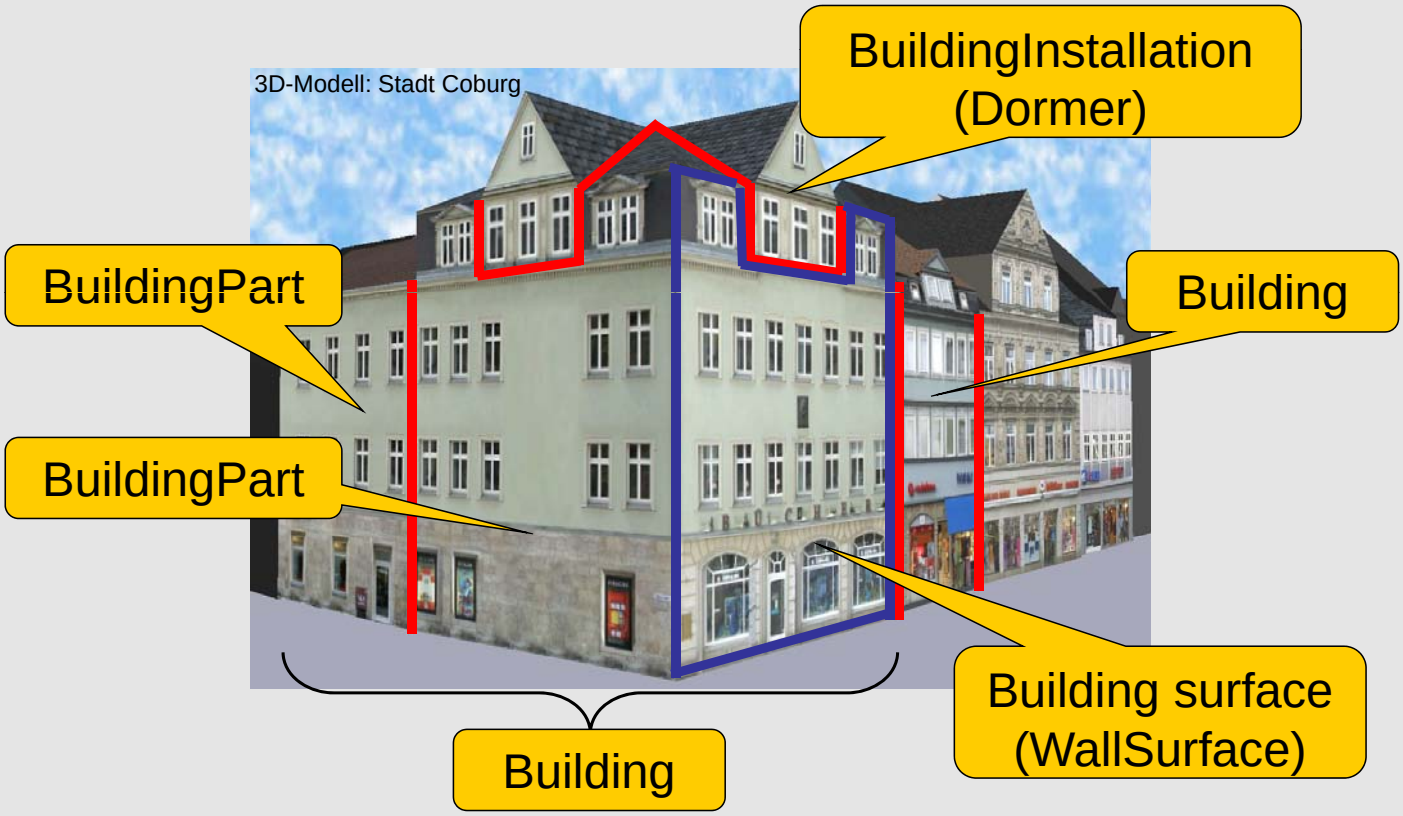


Building Model

- Coherent aggregation of spatial and semantical components
  - (recursive) composition of **building parts**
  - **thematic surfaces** (roof surface, wall surface, etc.) [from LOD2]
  - **building installations** like dormers, stairs, balconies [from LOD2]
  - **openings** like doors and windows [from LOD3]
  - **rooms** and **furniture** [in LOD4]

- Components contain relevant **thematic attributes**
  - name, class, function, usage, construction and demolition date, roof type, address
  - no. of storeys above / below ground, storey heights

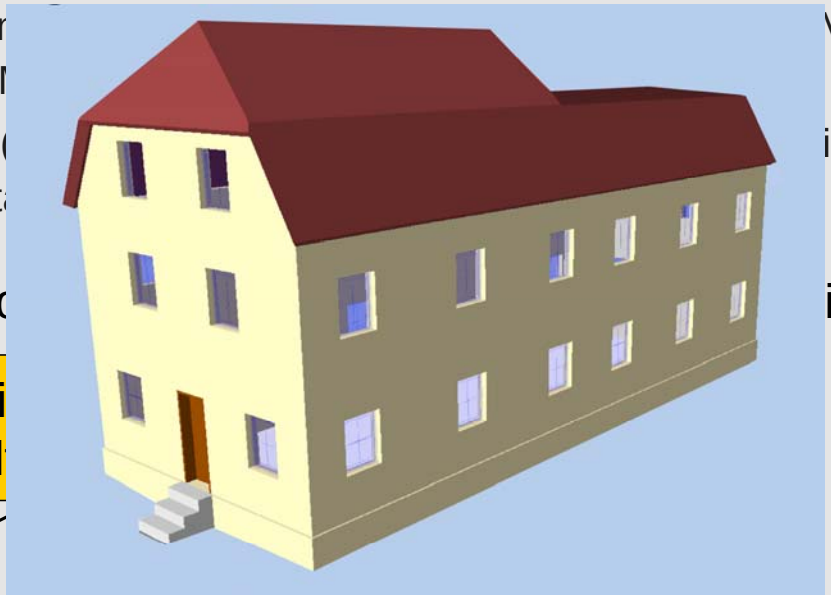
Spatio-semantical Composition



Spatio-semantical Coherence (I)

- **1st case:** structured / unstructured geometry only, possibly along with appearance properties
  - typical r ML, X3D, KM
  - usable (ility comput

Geo ics



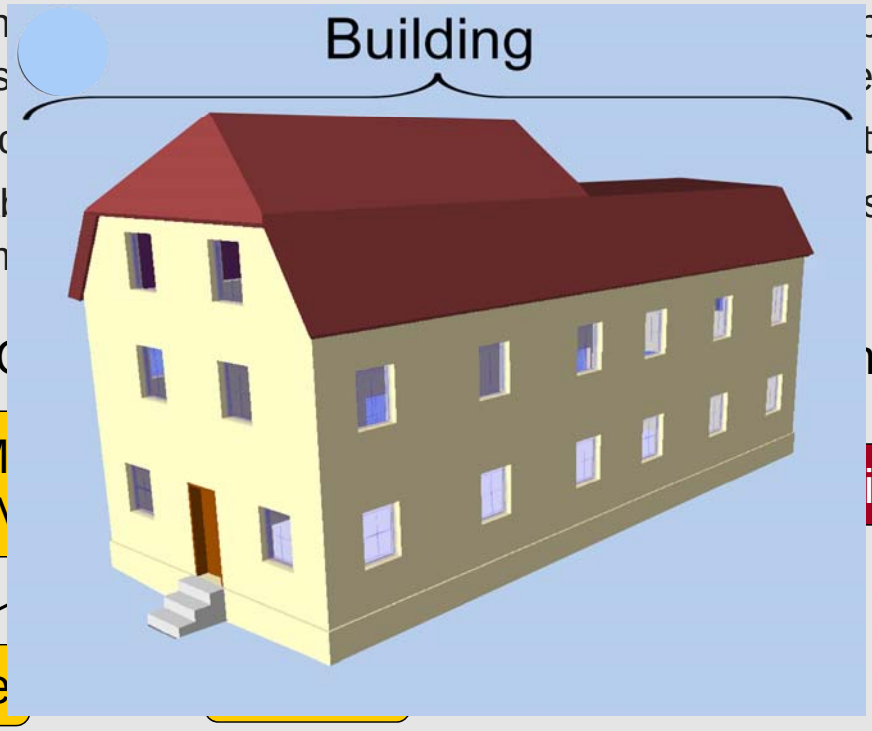
Multi („Mul

Surface

Surface

Spatio-semantical Coherence (II)

- **2nd case:** simple object with unstructured geometry
  - iden… …perties (this… …es)
  - typic… …tion systems
  - usab… …simple visibility com…



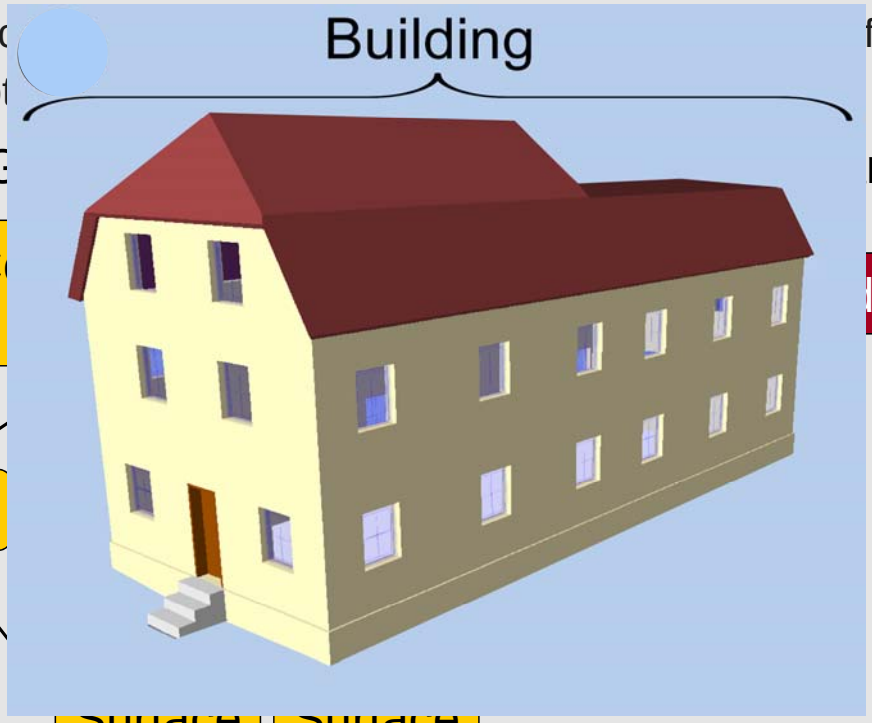
…ntics

M… („M… …ing

Surface…

Spatio-semantical Coherence (III)

- **3rd case:** simple object with structured geometry
  - typic… …few) phot…



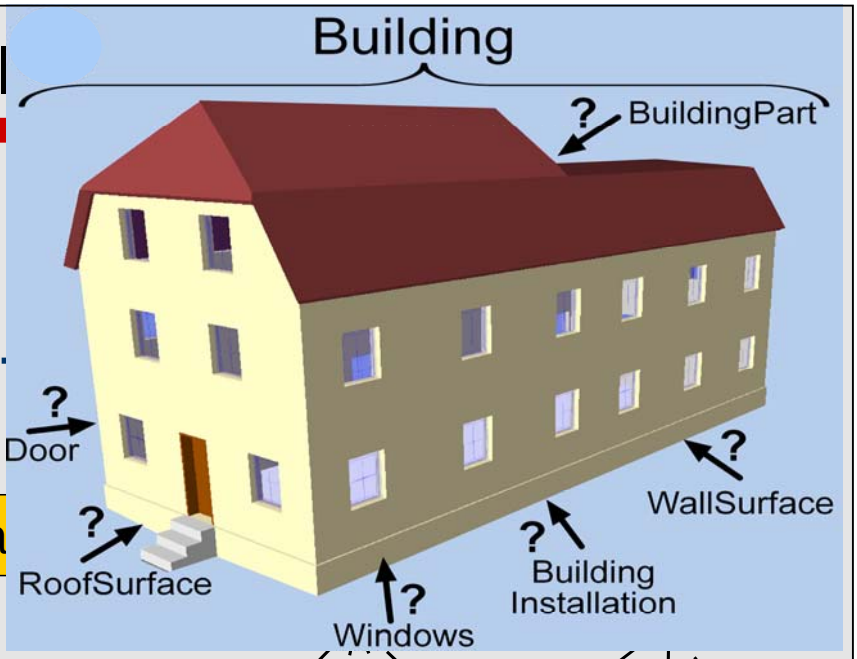
G… …ntics

C… …ling

Solid

Surface Surface

Spatio-semantical



Geometry

MultiSurface („MultiPatch“)

Surface

Surfa

- **4th case:** complex object with unstructured geometry
  - Data is typically derived from Building Information Models like IFC or retrieved from Facility Management

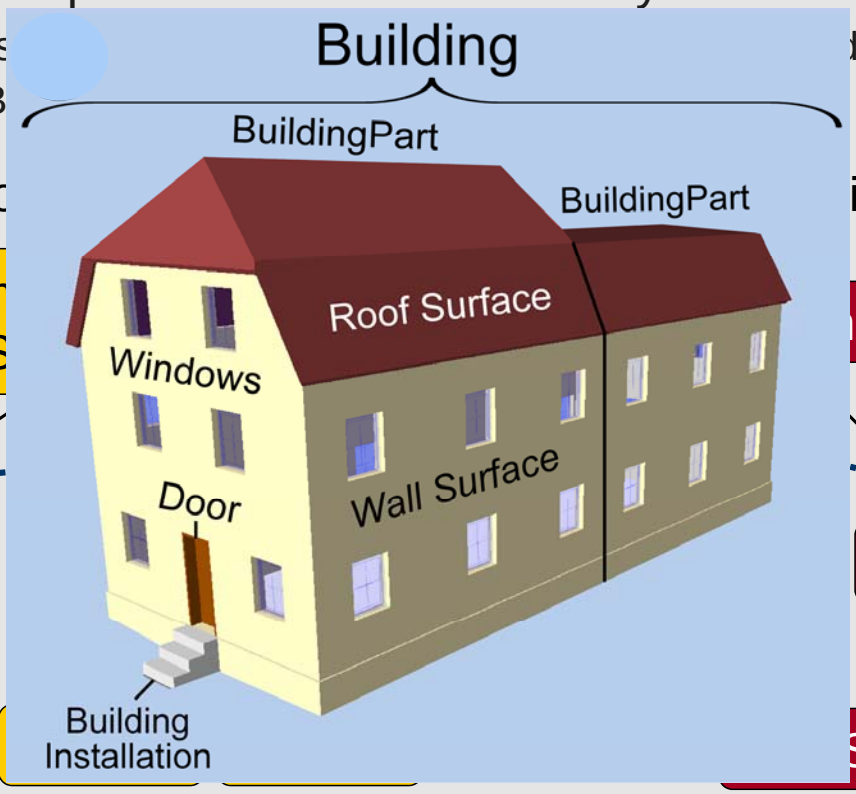
Stairs

RoofSurface

WallSurface

Spatio-semantical Coherence (V)

- **5th case:** spatio-semantical coherently structured object
  - Highes derivation from B



Geo ics

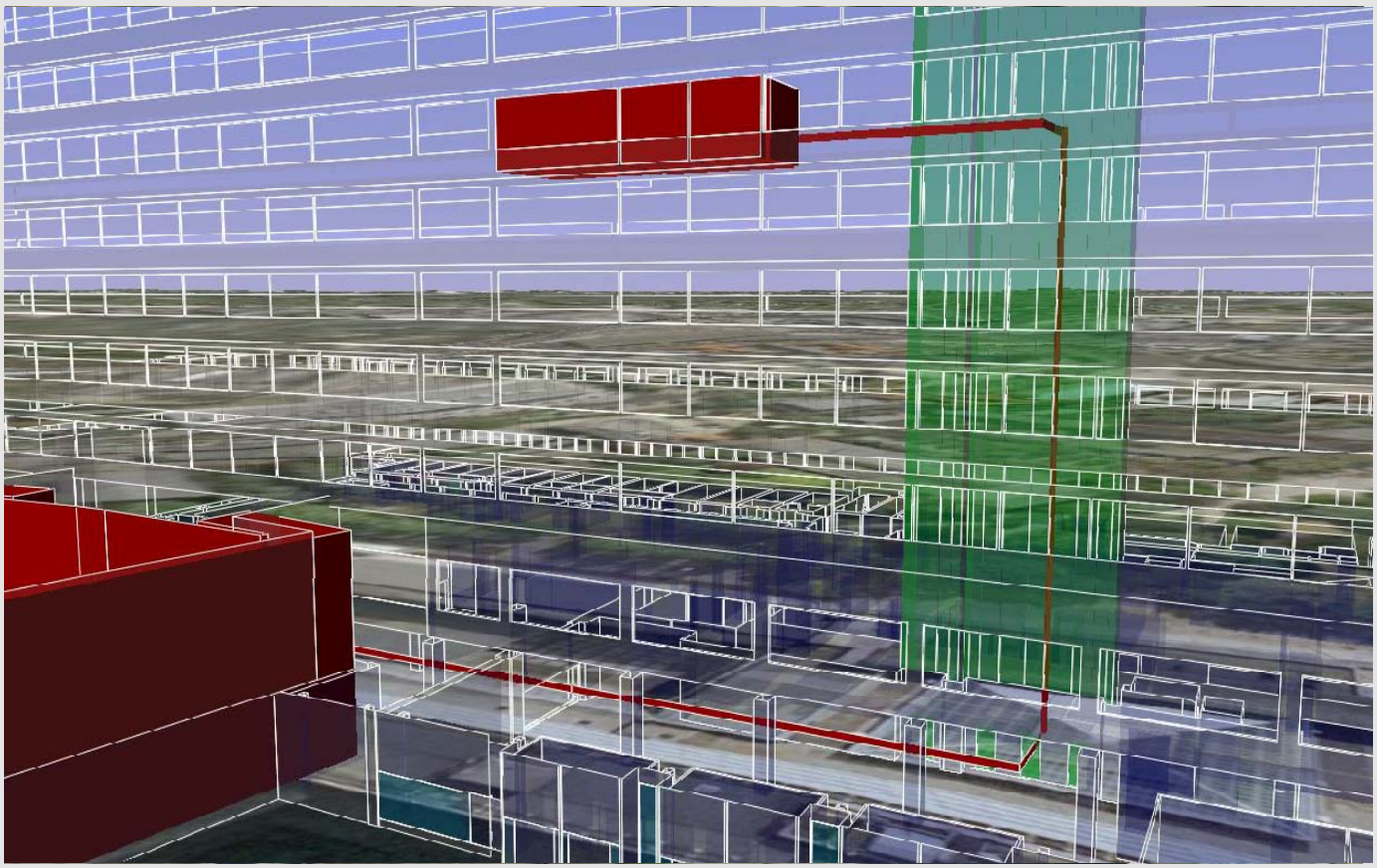
Com S g

Solid

Garage

Surface

Coherent Building Model in Level of Detail 4



Summary

www.citygml.org

CityGML is a

- **Geospatial Information Model** (based on ISO 191xx)
- and **Exchange Format** for virtual 3D city and regional models (implemented as GML3 Application Schema)

CityGML represents
Geometry, Topology, Semantics, and Appearance

- esp. semantic / structural information is needed for a range of applications
- gives city model data enough space to „grow“ with respect
  - to geometric, radiometric, and semantic contents & complexity
  - to semantic qualification / interpretation
  - to geometric / topological correctness

CityGML – OGC Standard for Photogrammetry?

- **YES** – if you are producing / working with city models (which includes digital terrain models)
- **NO** – if you don't …but
  - modern geospatial information products will require handling of complex object structures (including geometric and thematic structuring) anyway
  - CityGML can be seen as an example for these new generation of data models
  - other application domains also require support of 3D CRS
  - generally topology is important for 3D volumetric shapes

- What is missing?
  - Structure (both with respect to geometry & semantics)
  - Thematic information (classifications, attributes + aggregations)
- Structure:
  - Hierarchical decompositions
- Structure and semantics are key to more advanced applications and analyses of 3D city models
- Folie, die den Raum darstellt, den CityGML 3D-Stadtmodellen zur Entwicklung bereitstellt

- Situation in the past: structure of acquired data – and delivered product – is mostly influenced/determined by the sensing technology
- Important for applications: specific structures due to logical/semantic considerations – and not to sensor specific
- How to do this transition (which spans several stages)
- To which extent are people and software from photogrammetry responsible/interested