CityGML and 3D modelling

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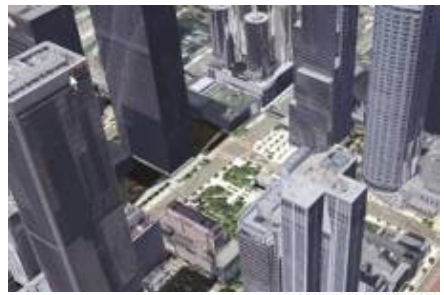
Research Department

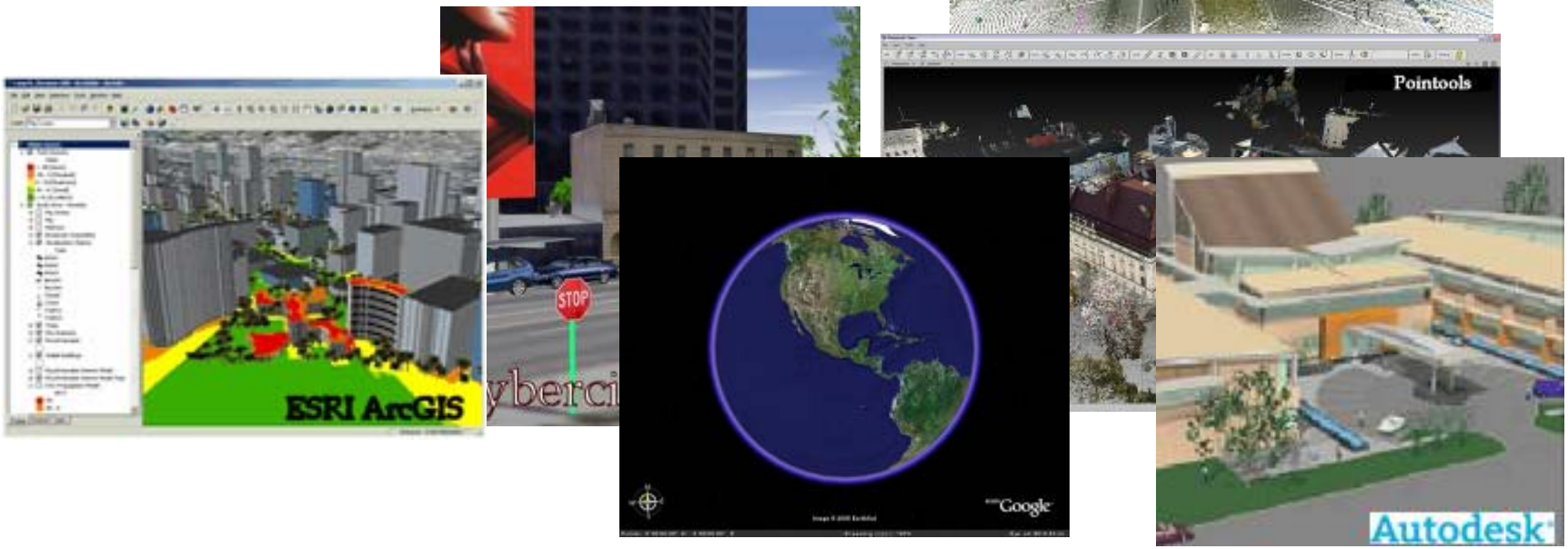
Introduction

- Why is cityGML necessary
- CityGML development – who is responsible?
- Ordnance Surveys interest
- 3D modelling – basic concepts
- CityGML – the basics
- CityGML in detail
  - Individual themes – buildings, DTMs
  - Other modelling concepts – TICs, Closure surfaces, topology etc
- OGC Standards & Web Services
- Extending cityGML – ADEs and Generic Objects/Attributes
- Software
- Example datasets
- Conclusions

Why is CityGML necessary?

- Increasing interest in 3D
- Research shown a definite need for 3D
- Standards led approach





Responsibility for CityGML

- Origins are with the Geodata Infrastructure North Rhine-Westphalia – 6 SIG WG
- Special Interest Group 3D (SIG3D)
  - Open group >70 members
  - Members range from industry, government, municipalities and academia
  - Participants from Germany, Austria, Switzerland and UK
  - Technical leads are Thomas Kolbe and Gerhard Gröger

SIG3D Members

Municipalities

- Berlin
- Hamburg
- Köln
- Dusseldorf
- Bremen
- Essen
- Wuppertal
- Bochum
- Stuttgart

Administration

- State mapping agencies (Germany)
- Ordnance Survey (GB)

Companies

- T-Mobile
- Bayer Industry Services
- Rheinmetall Defence
- 3D Geo
- CPA Geoinformation
- Con Terra
- GIStec
- Citygrid
- Cybercity
- Snowflake Software

Science/Academia

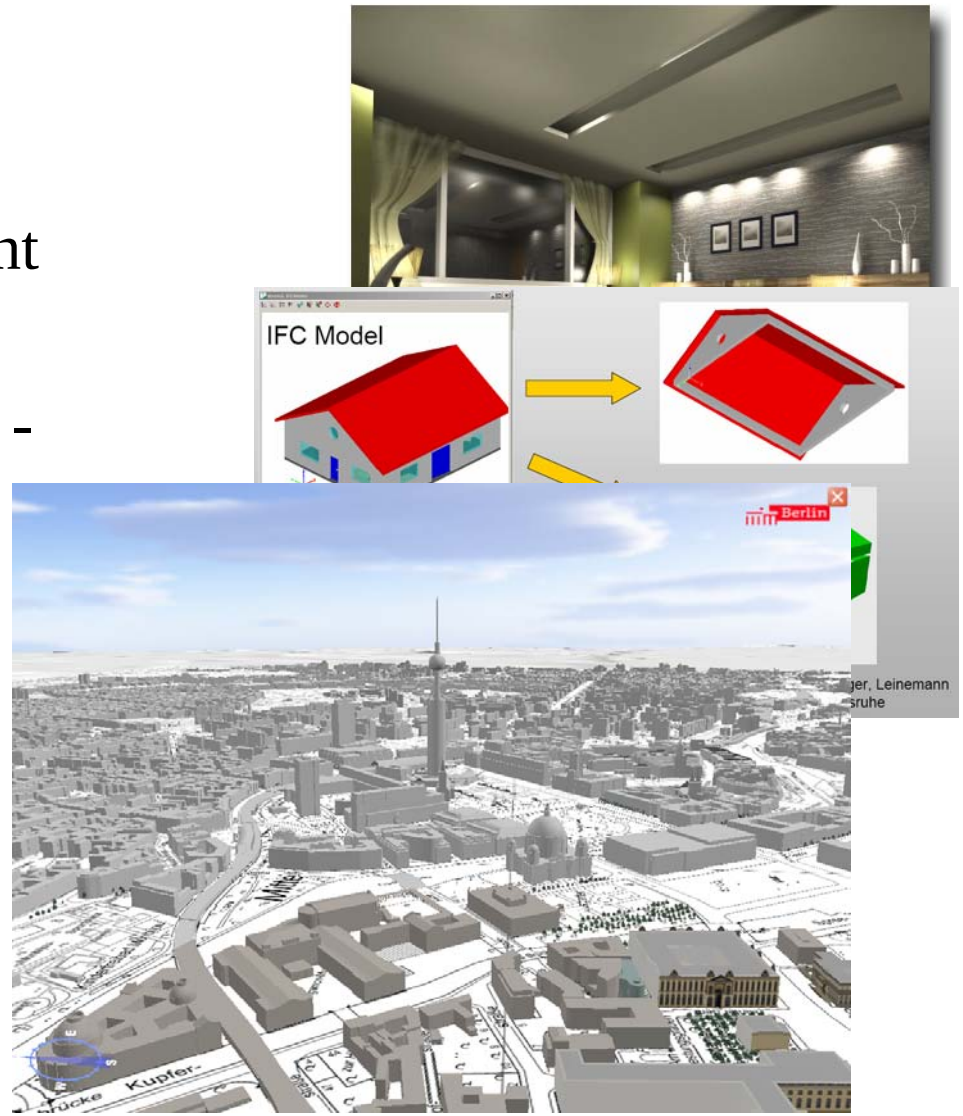
- Univ of Bonn
- Univ of Berlin
- Univ of Potsdam
- Univ of Hannover
- Univ of Dortmund
- Univ of Munster
- Fraunhofer Inst. for computer graphics, Darmstadt
- Helmholtz Research Centre, Karlsruhe
- Univ of Applied Sciences, Stuttgart

Why is Ordnance Survey interested in cityGML?

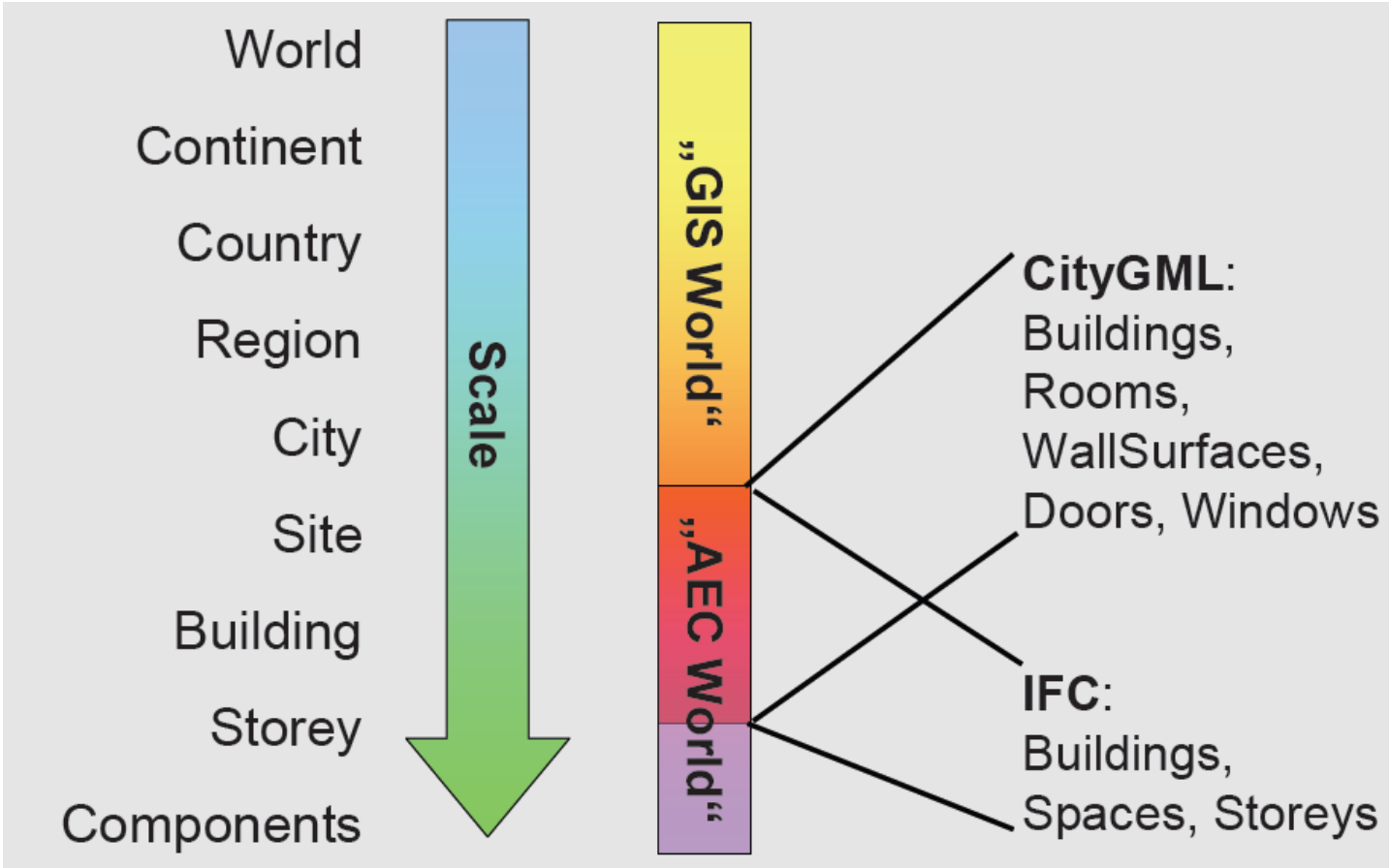
- OS have had an interest in 3D for a number of years
- Customer research – high level of interest
- OS competes with commercial organisations
- Thought leader
- Extensive research at OS
  - Requirements from customers
  - Requirement for a 3D standard

3D modelling – an introduction

- 3D Modelling can be applied to several different domains/industries
  - Computer graphics - visualisation
  - CAD/BIM (IFC)
  - GIS



CityGML and BIM / IFC



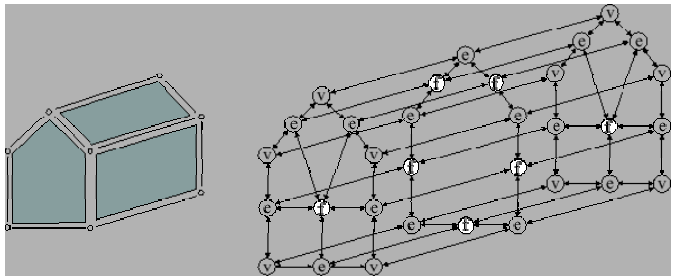
CityGML – the basics

- Application independent topographic information model for virtual 3D city models
  - Basic set of features defined
  - Standardised meaning/interpretation of feature types (UML/GML)
- Comprises different themes – buildings, relief, water body, vegetation, landuse, appearance, city furniture, generic objects etc
- Data model (UML) ISO 191xx standard family
- Exchange format
- Realised as a GML3 application schema
- Applications – city planning, architectural design, environmental, telecoms, disaster management, estate management, etc
- August 2008 – cityGML version 1.0.0 accepted as an official OGC standard

Most important aspects for 3D models

Geometry

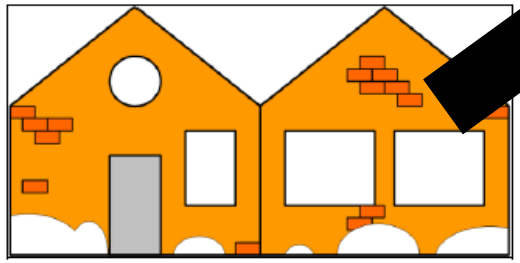
Semantics



3D City Model

Appearance

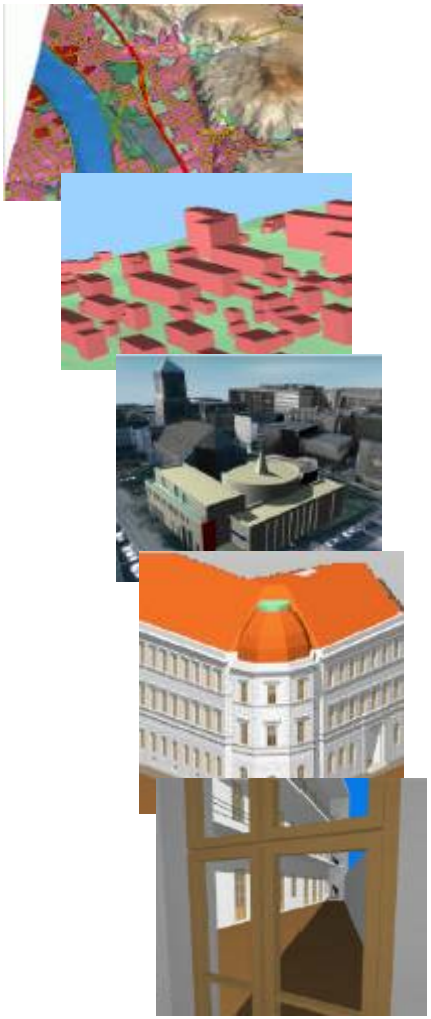
Topology



CityGML – goals

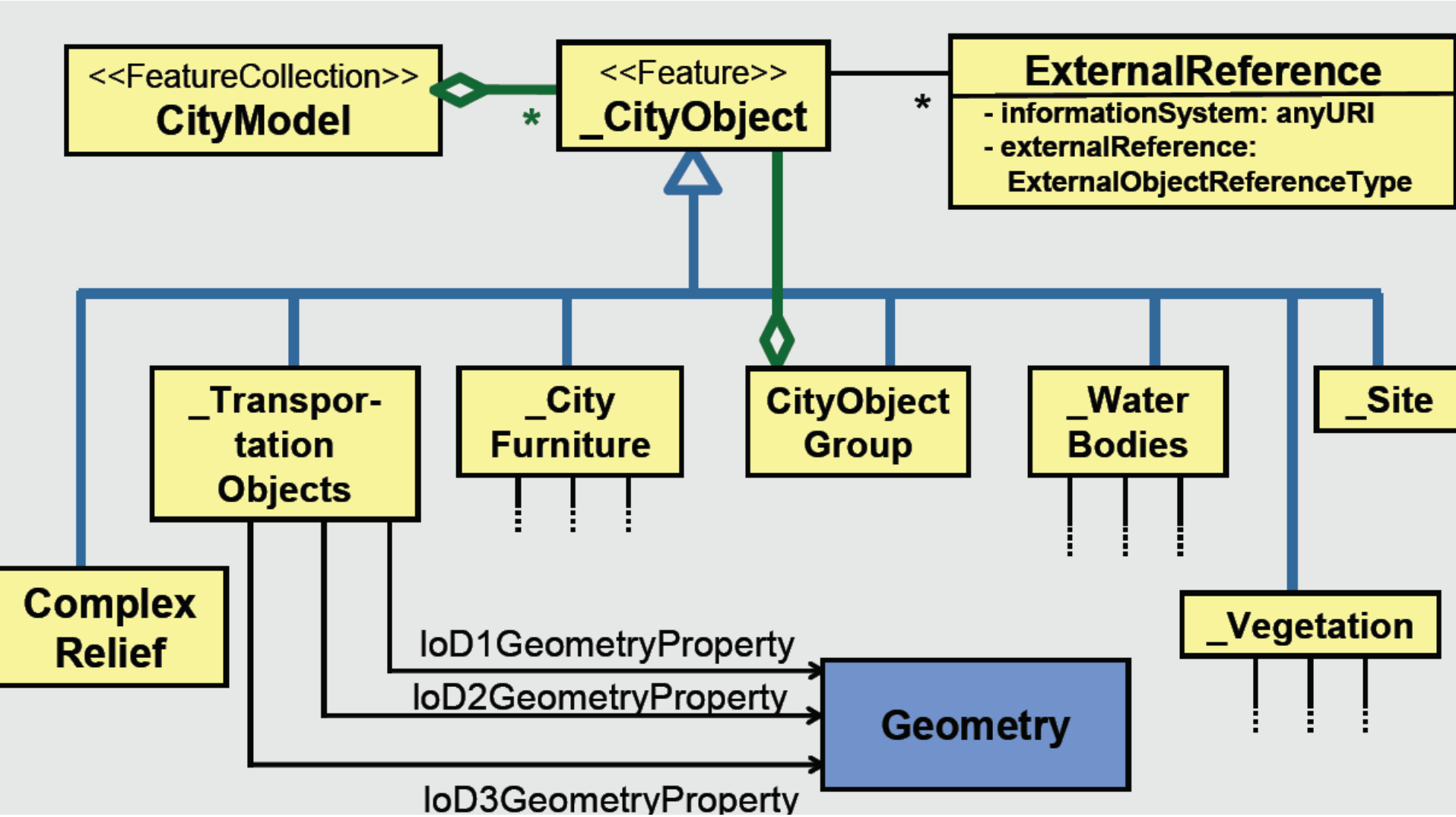
- Establish a high degree of semantic interoperability
  - Enable multifunctional usage of 3D models
  - Definition of a common information model
  - Potential for 3D geo database (similar to more traditional 2D)
- Representation of observed 3D topography
  - Explicit 3D shapes – surfaces and volumes
  - Identification of most relevant feature types – useful for variety of applications
- Suitable for use in SDI
- Simple to use

Multi-scale modelling - Level of Detail



- **LOD 0 — Regional Model**
  2.5D Digital Terrain Model
- **LOD 1 — City model**
  block model, no roof structures
- **LOD 2 — City model**
  roof structures, optional textures
- **LOD 3 — Site model**
  detailed architectural model
- **LOD 4 — Interior model**
  Walkable interior spaces

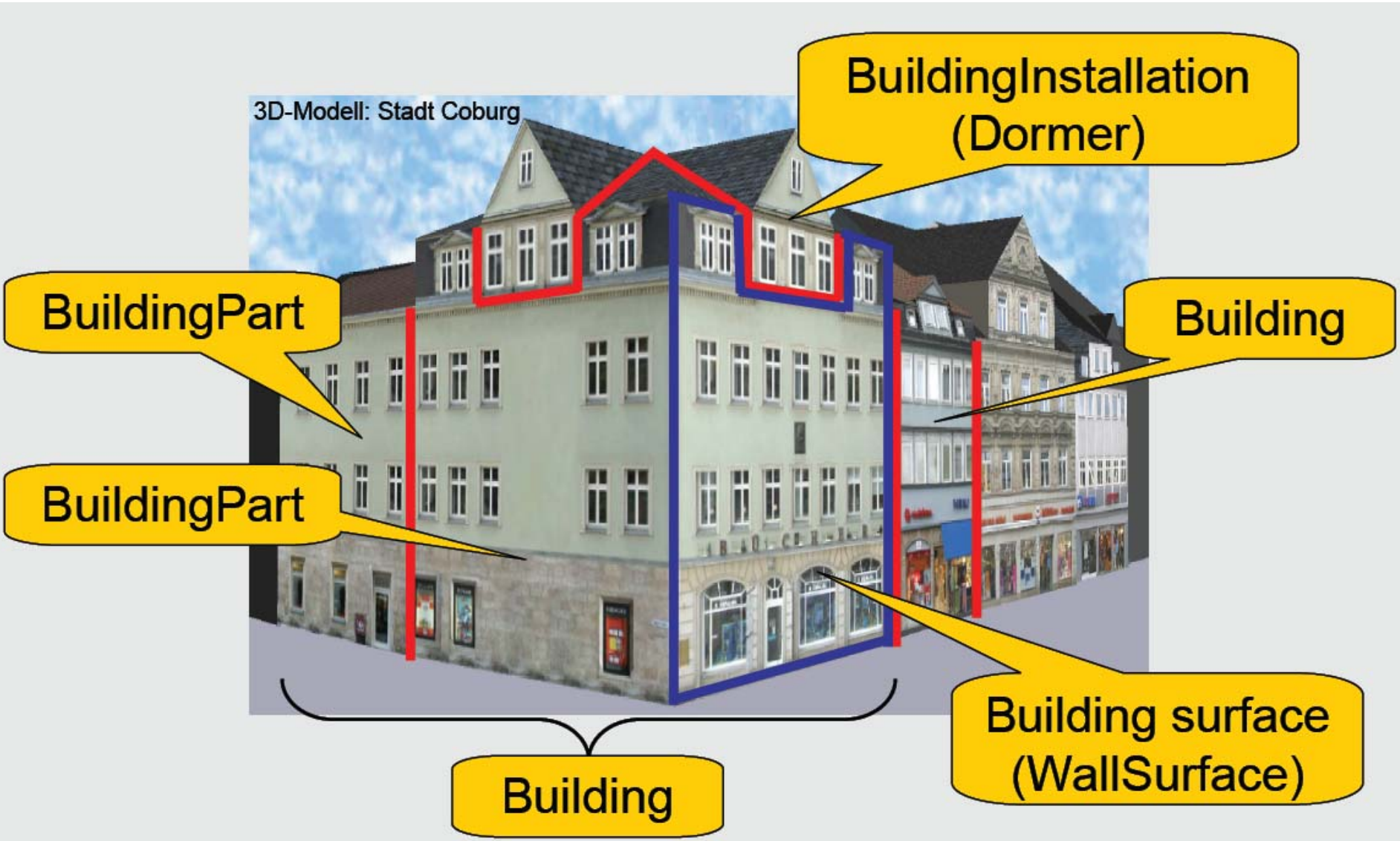
More detail – Thematic modelling



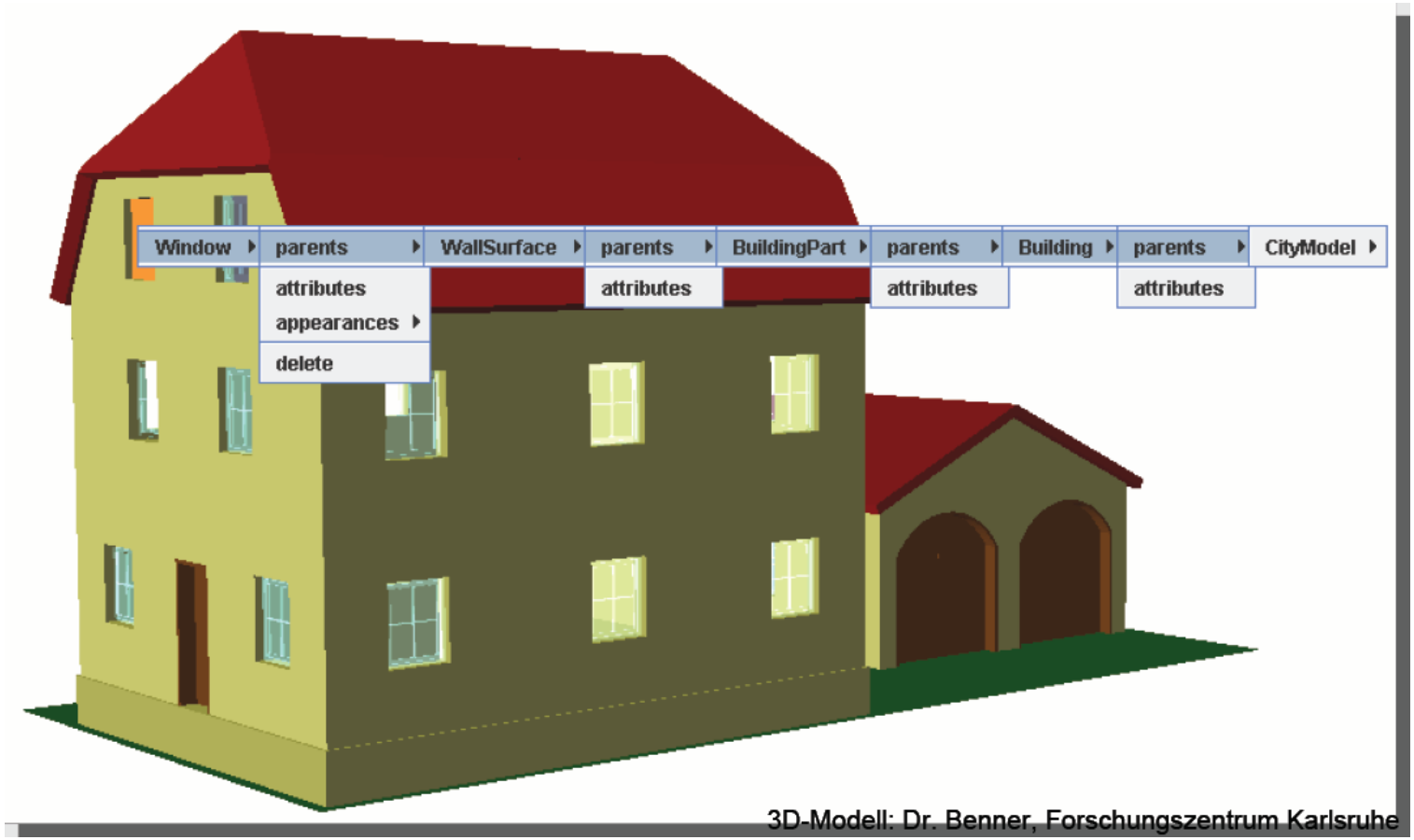
The building model

- Coherent aggregation of spatial and semantical components
  - (recursive) composition of building parts
  - Thematic surfaces – roofs, wall etc
  - Building installations – dormers, stairs, balconies (from LOD2)
  - Openings – doors, windows (from LOD3)
  - Rooms and furniture (only LOD4)
- Components contain relevant thematic attributes
  - Name, class, function, usage (dates, roof type, address)
  - Number of storeys above/below ground
- Surface appearance – textures and colours

The building model



Example – Building model at LOD3



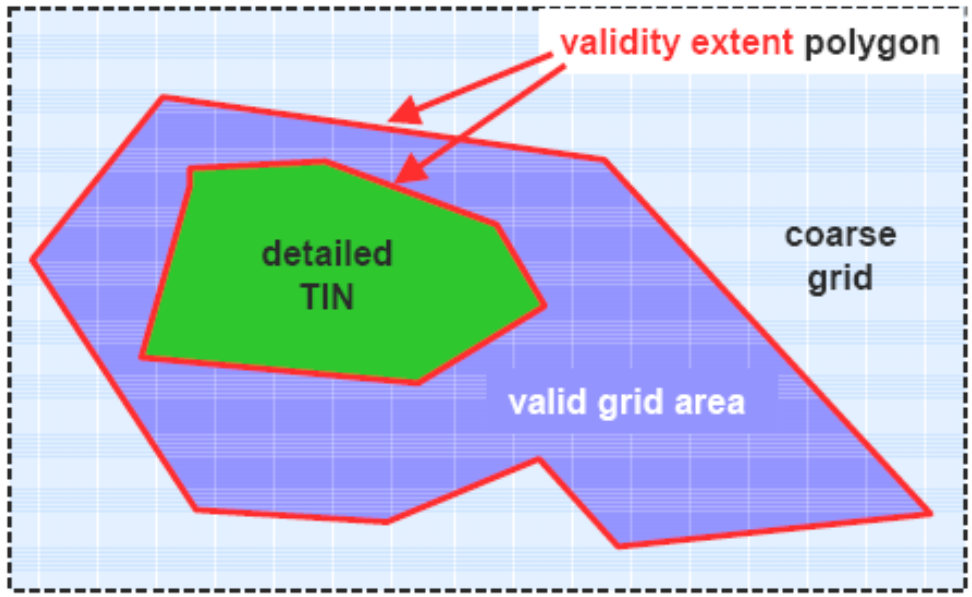
Digital terrain models

DTM at each LOD can be composed of –

• Triangulated Irregular Network (TIN), grids, 3D breaklines and 3D Mass points

• Each DTM component can be restricted to be valid in a specific region – validity extent polygon

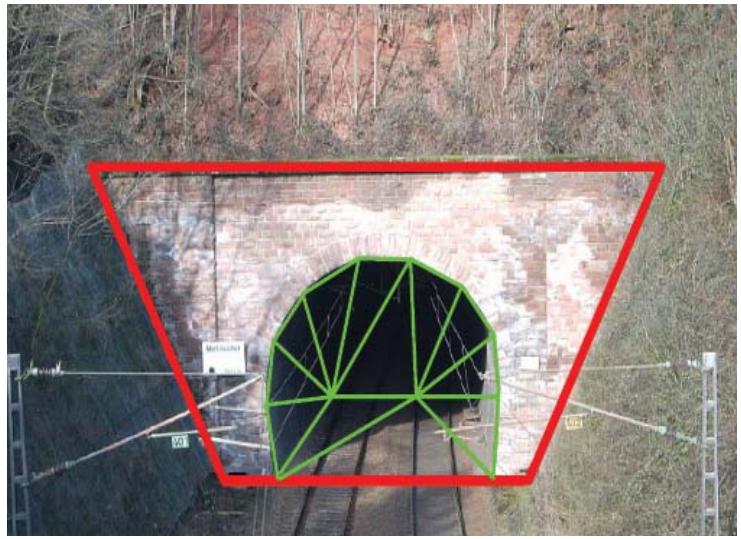
- Nested DTMs



Other concepts - Support for spatial homogenisation - Terrain Intersection Curve

Often a poor correspondence between terrain and features on the terrain

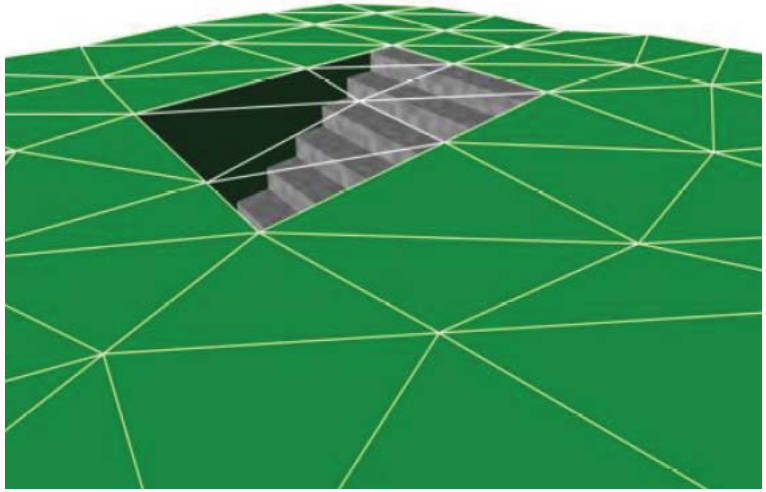
- Leads to features floating/sinking below terrain surface
- Terrain Intersection Curve, TIC, ensures matching
- DTM may be locally warped to fit the TIC



Other concepts - Closure surfaces

Open ended objects may exist – buildings, terrain

- Closure surface concept – seals 3D objects
- Allows computation of volumes

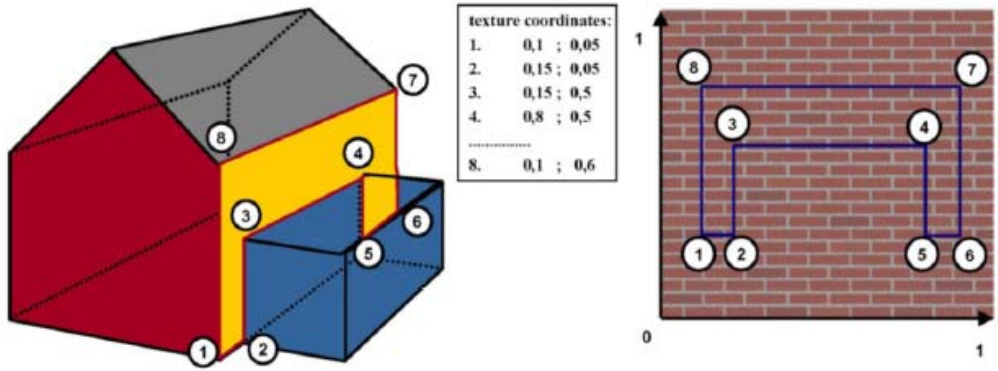


Other concepts

•Explicit linking – every citygml object can have an arbitrary number of links to external resources

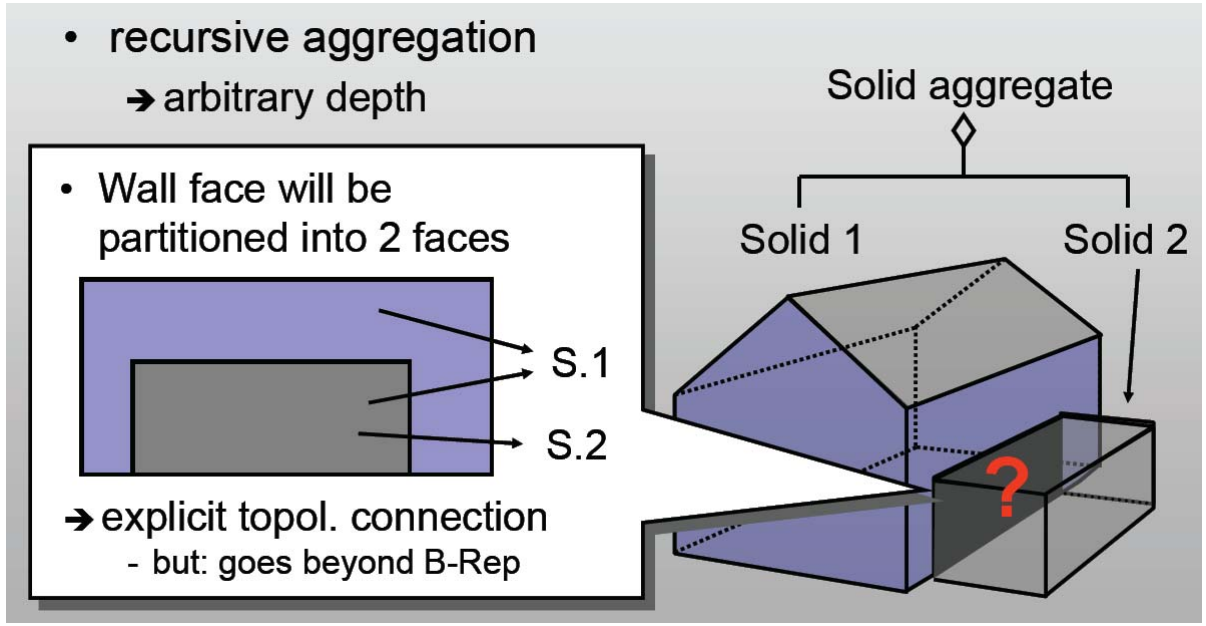
•Appearance model – based on X3D, Collada

- Models textures and colours
- Not restricted to visual data – can also represent IR radiation, noise pollution etc
- Data for each surface geometry (can have multiple representations)



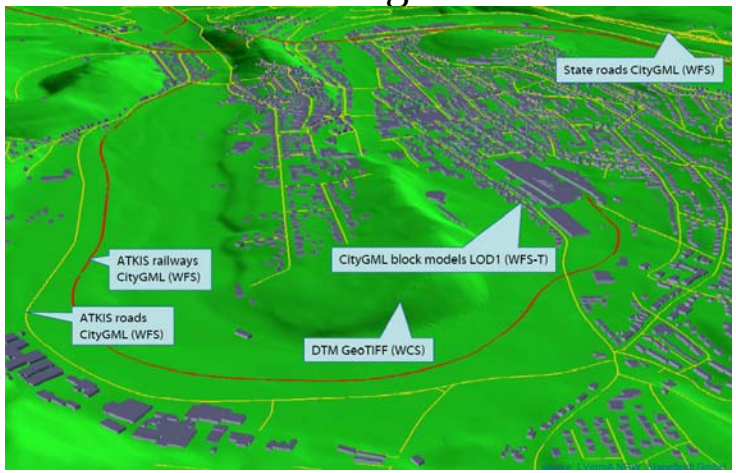
Other Concepts - Topology

- Does not use complex topology that exists in GML3
- Explicit modelling – sharing of geometry between features
- Xlinks - geometries have Ids – referenced using href attribute



Web Services

- CityGML based on GML3 – combines with other OGC standards
  - WFS, CS-W, WCTS and WPS especially
- Examples
  - OGC Web Services – 4 (OWS-4) Testbed – showed how cityGML/IFC 3D data can be used in disaster management
  - Statewide 3D SDI with cityGML – NRW. Noise modelling
  - SDI Berlin – city urban planning, civic participation etc
  - Heidelberg



Software supporting cityGML

- 3D Geo **LandXplorer** CityGML Viewer (free)
- University of Bonn: **Aristoteles** Viewer (free)
- Snowflake Software: **Go Loader & Publisher** WFS
- Interactive Instruments: WFS
- **Oracle** 11g: 3D data types and CityGML loader
- Tech. University of Berlin: **Oracle schema/loader/updater**
- Safe Software **FME** reader (writer in development)
- ESRI – ArcGIS 9.3 – **Interoperability Extension**
- **Bentley**: Work in progress
- **Autodesk**: Work in progress

Extending CityGML

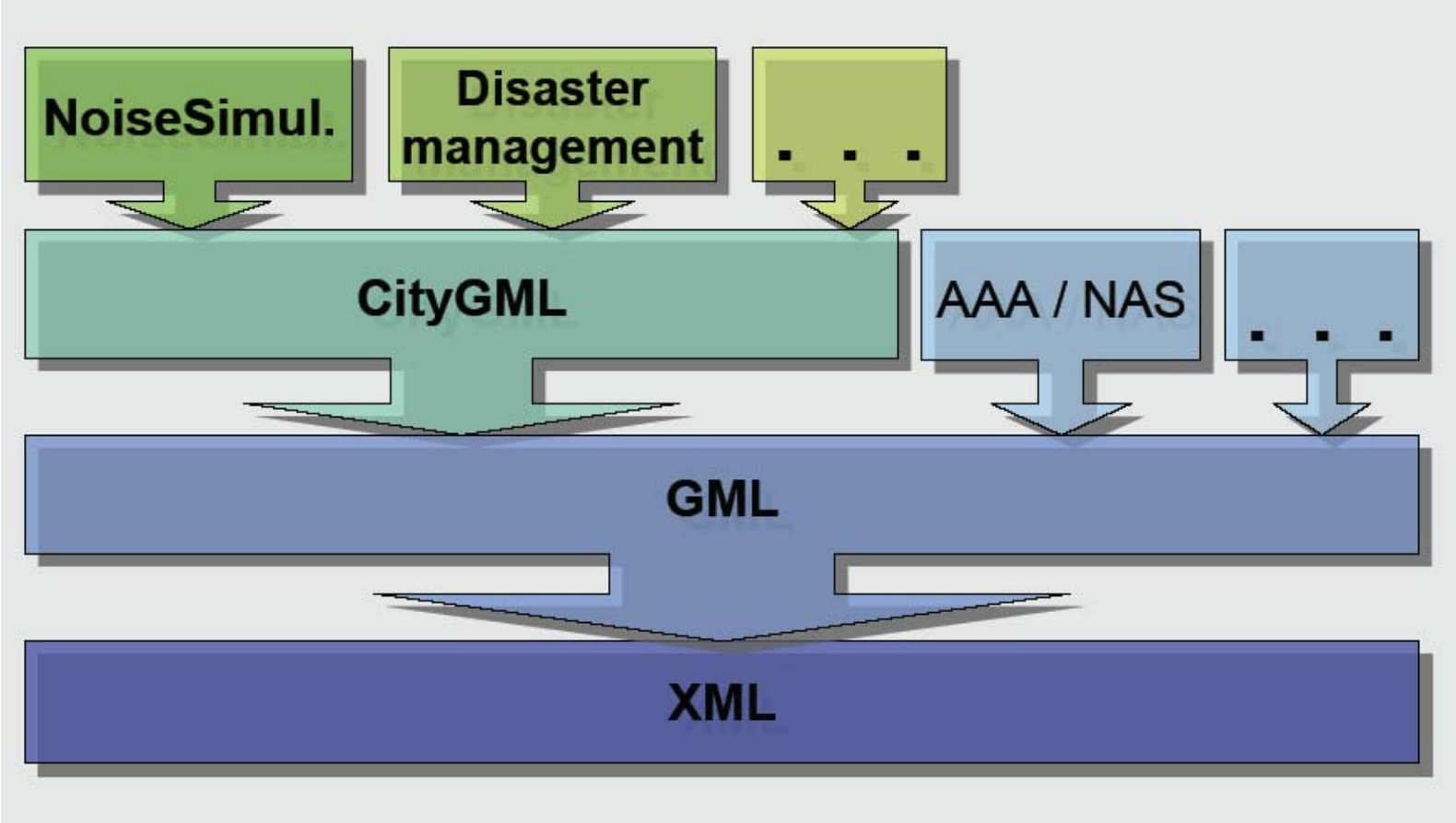
- 2 methods for extending basic functionality of cityGML
  - Generic Objects/Attributes
  - Application Domain Extensions

- Generics – allow extensions during runtime i.e. no additions to XML schema
  - Classes GenericCityObject & GenericAttribute
  - Only used for features not in cityGML model
  - Issues
    - May occur arbitrarily – no formal specification, reduces semantic interoperability
    - Naming conflicts may occur

Application Domain Extensions

- CityGML – Base information model. Specific applications need extra information. E.g. Environmental simulations, Utility networks, etc
- Types of domain extension
  - Extend existing cityGML feature types
    - Extra spatial/non spatial attributes
    - Extra relations/associations
  - Definition of new feature types
    - Preferably based on cityGML base class CityObject
  - Each ADE requires its own XML schema definition

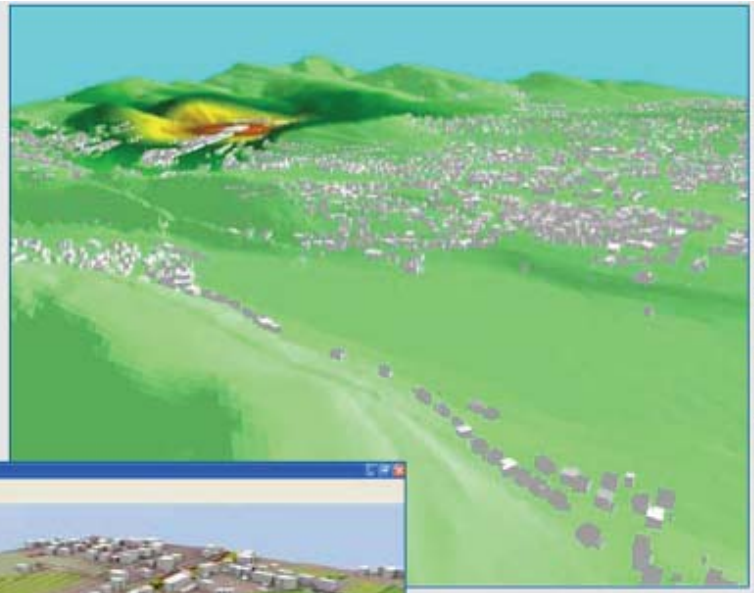
Application Domain Extensions



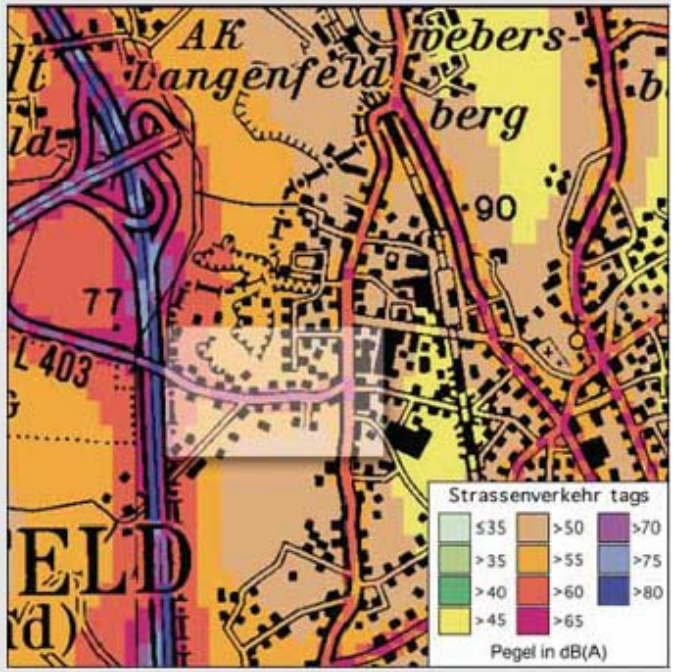
Examples - Noise simulation using Noise ADE

3D block model in CityGML from WFS-T

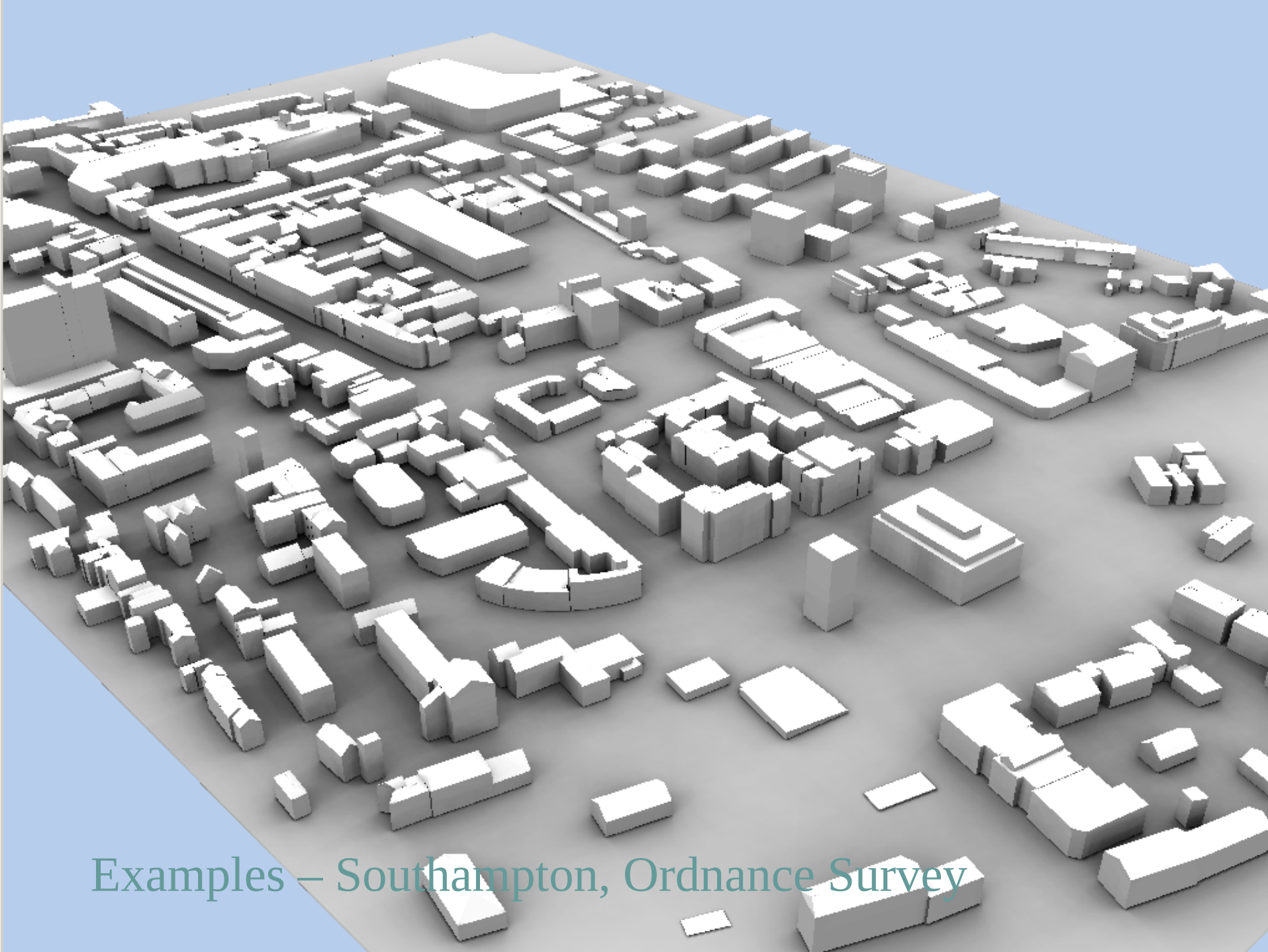
DTM 10m grid in GeoTiff from WCS



noise immission simulation



noise pollution maps for European Union reporting (using WMS)



Examples – Southampton, Ordnance Survey

Large models: 55 000 detailed buildings

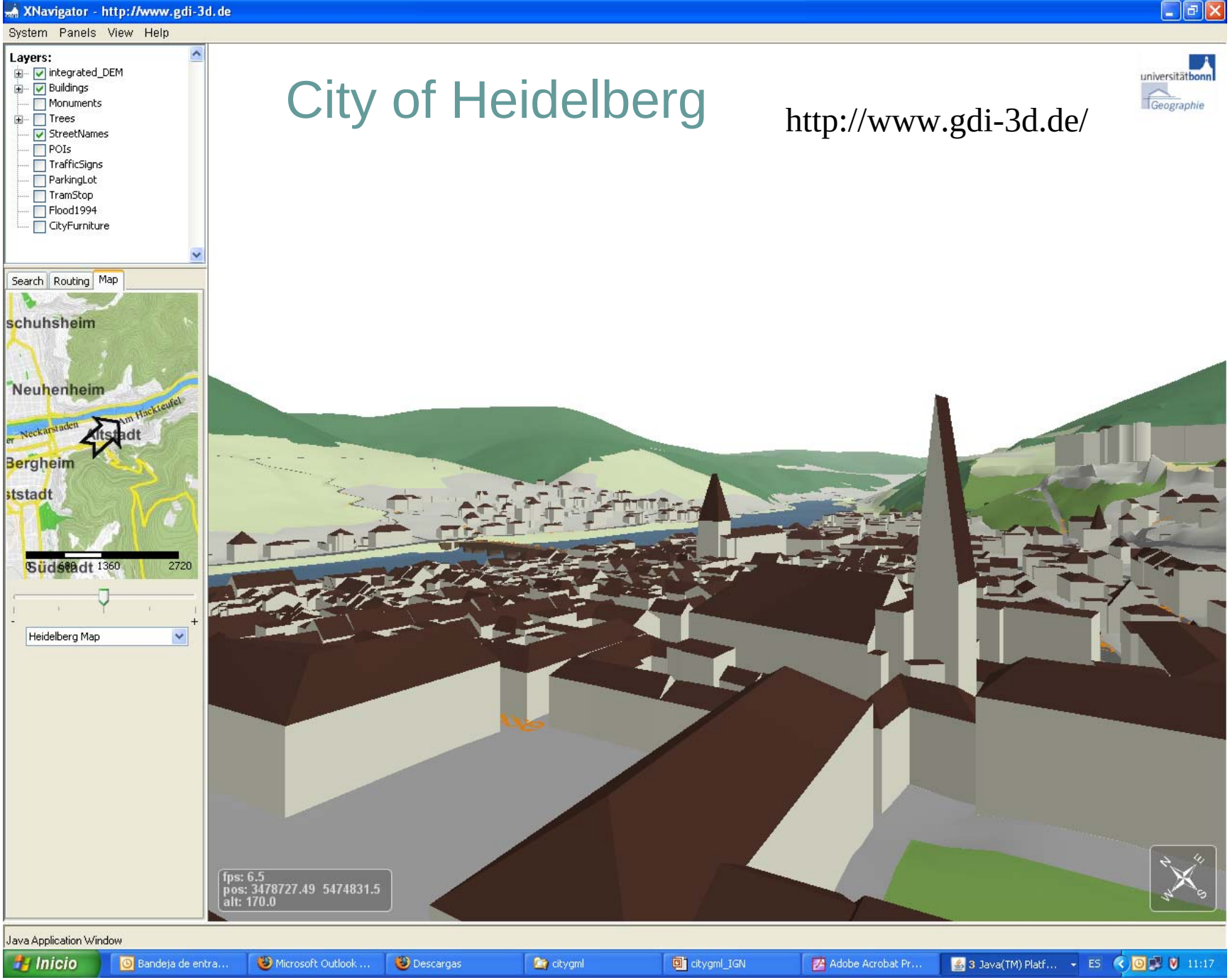
(>50km2)

Image: Reality maps, Berlin 3D


Berlin
Kupfer-

City of Heidelberg

http://www.gdi-3d.de/



Conclusions

- CityGML is a Geospatial Information model (based on ISO191xx), which can be mapped to a database environment
- Exchange format for virtual 3D city and regional models (realised as a GML3 Application schema)
- CityGML represents geometry, topology, **semantics** (esp. important) and appearance
- Can be considered as a rich 3D information source for generation of 3D visualisations
- Not just a tool for visualisations – semantics
- Model contains most important core concepts – these can be extended for particular applications
- Recently accepted as OGC standard and is creating high level of interest – software being developed, applications etc

Any questions?

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