Technische Universität Berlin
Institut für Geodäsie und Geoinformationstechnik

Section VI
Relations to other Standards

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EduServ6 Course on CityGML

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Overview

- Section I
  - Introduction: Urban Information Modelling
  - CityGML Overview and Status
  - OGC Geography Markup Language (GML)
- Section II
  - Further GML Concepts and Application Modelling
- Section III – CityGML Details, Part 1
- Section IV – CityGML Details, Part 2
- Section V
  - Extending CityGML
  - Application Examples
- Section VI
  - Relations to Other Standards

Relations to other Standards

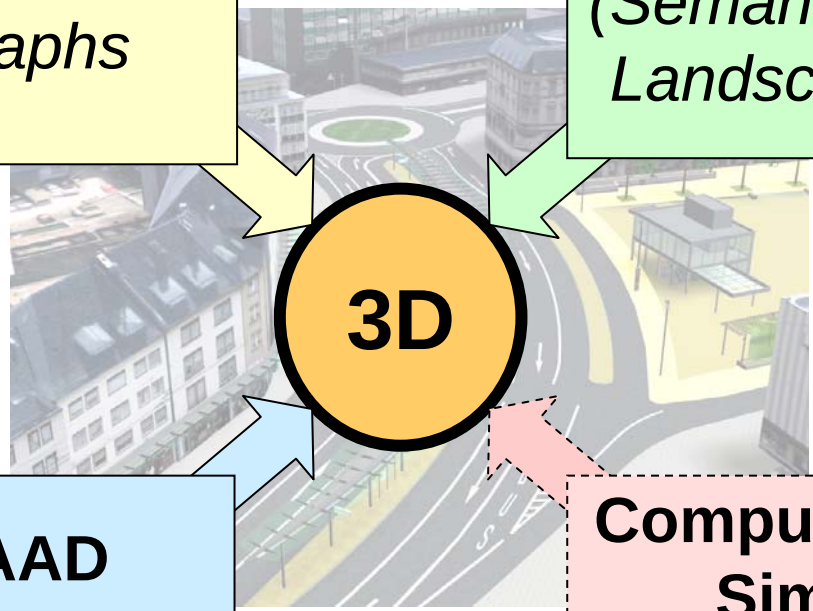
Approaches to Virtual 3D City Modelling

Computer Graphics

Scene Graphs

Geospatial / GIS

(Semantic) City and Landscape Models



AEC / CAAD

Building Information Models

Computer Games / Simulation

Simulation and Interaction Models

Computer Graphics Approach

- **What is modelled?**
  - geometry (parametric primitives; boundary representation)
  - material / appearance
  - limited topology
  - typically no semantic information
  - interaction methods and object behaviour
- all elements are structured within **scene graphs**
  - aggregation using group nodes; transformation nodes
  - allows to define prototypes / reuse object definitions
- some exchange formats support georeferencing
  - GeoVRML, X3D, KML
  - but: models are restricted to cartesian coordinate system

AEC / CAAD Approach

- **What is modelled?**
  - geometry (parametric primitives; boundary representation; constructive solid geometry; sweep volumes)
  - topology
  - limited material / appearance
  - explicit semantics within building information models (BIM) (but not with legacy CAD formats)
- Most important BIM exchange format is IFC (**Industry Foundation Classes**)
  - IFC defines a **product data model for buildings / sites**
- elements of a BIM dataset are aggregated within a **project**
- only the format IFG (IFC for GIS) supports georeferencing
  - but: models are restricted to cartesian coordinate system

Geospatial / GIS Approach

- **What is modelled?**
  - geometry (3D in ISO 19107: only boundary representation)
  - topology
  - semantic information
  - limited appearance / material properties
- Models are based on the notion of **geographic features** (according to ISO 19109); exchange format is **GML**
- **Application schemas** define ontologies, i.e. taxonomies and partonomies of feature types (using OO concepts)
  - Ontology for 3D city models: **CityGML**
- always georeferenced; any 3D coordinate reference system (CRS) can be used (and mixed within the same dataset)
  - all geometries must belong to a CRS; up to now no nesting

Who standardizes (geo)virtual 3D worlds?

Open Geospatial Consortium (OGC)

- Exchange format GML; CityGML; KML; Web Services: WFS, WTS, W3DS

International Alliance for Interoperability (IAI)

- Product model for AEC/FM: Industry Foundation Classes (IFC)

Web 3D Consortium (W3D)

- Originator of VRML, GeoVRML, X3D

3D Industry Forum (3DIF)

- Graphics format “Universal 3D“ (U3D) -> direct embedding in PDF

Khronos Group

- Exchange format COLLADA (used within Playstation, Google Earth)

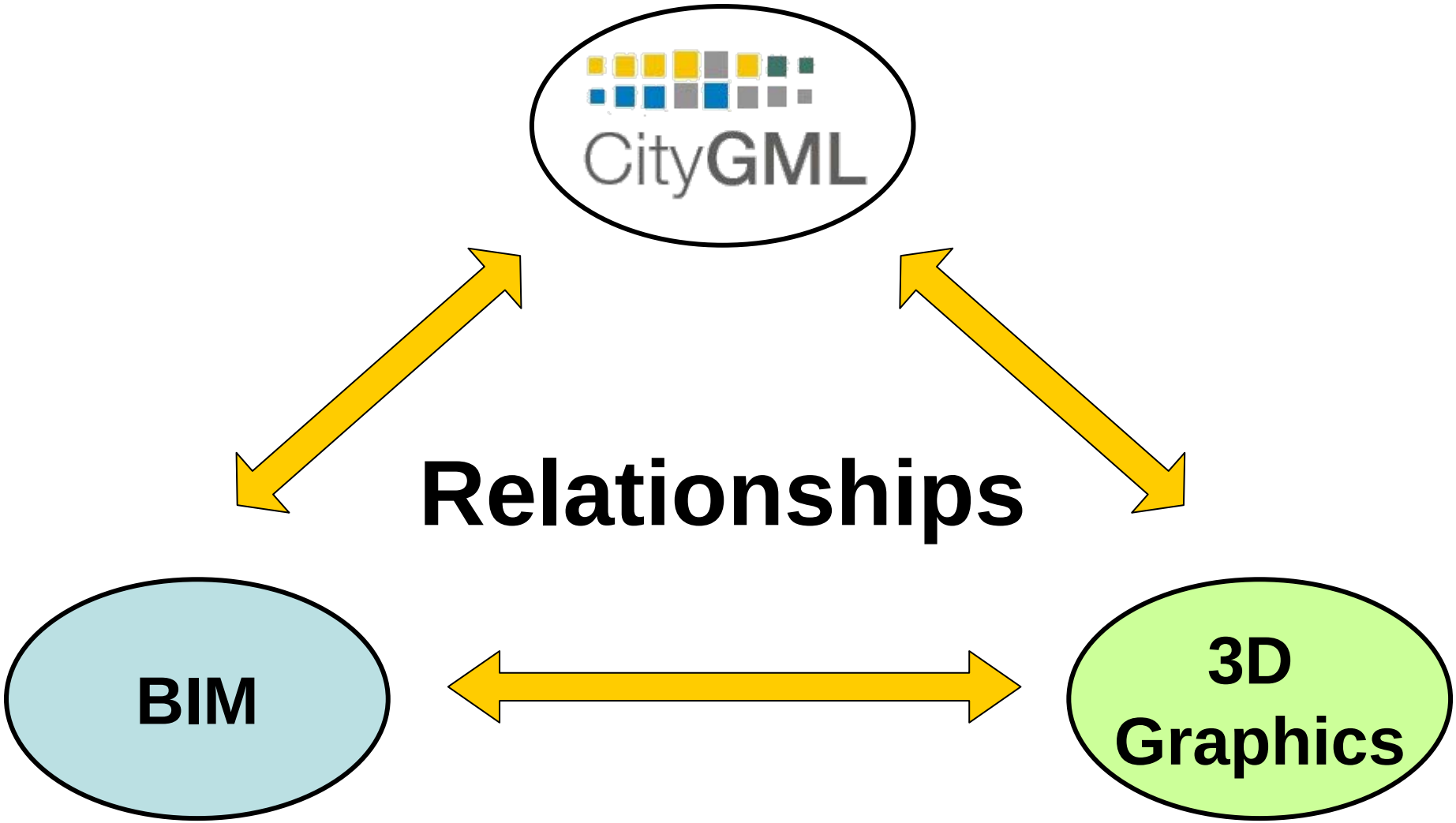
International “De Jure“ Standardisation: ISO

- ISO standards of the 191xx family (≈ OGC Standards), X3D, IFC

Virtual Reality Exchange Formats

	X3D	U3D	KML	COLLADA	IFC	CityGML
geometry	+	+	0	+	++	+
georeferencing	+		+		(IFG +)	++
appearance	+	+	0	++	0	+
topology	0	0		0	+	+
semantics	0			0/+	++	++
linking / embedding	+		++	++		++

Legend: 0 = basic, + = sophisticated, ++ = comprehensive; empty = not supported


CityGML
Relationships
BIM
3D
Graphics

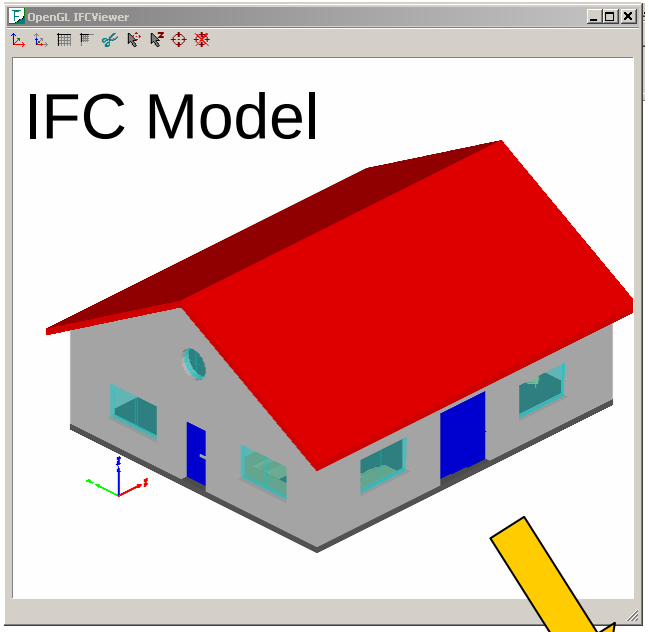
CityGML from the BIM perspective

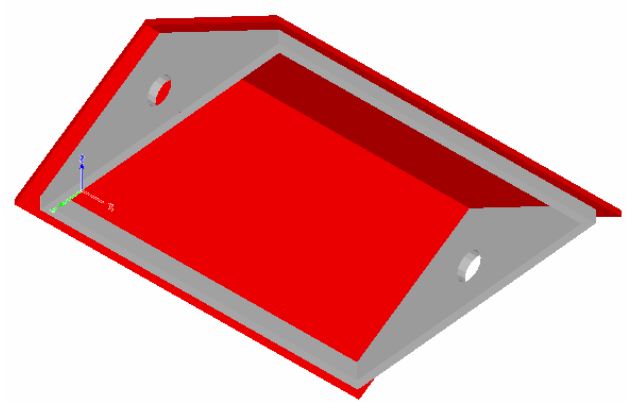
- Provision of **information about the surroundings** / environment of buildings and sites
  - **Embedding of 3D models** into the real world‘s coordinate frame
  - Analysis and **identification of suitable locations** for construction
  - Querying 3D urban objects with **geospatial selection criteria**
  - Useful for planners, architects, and engineers
- Can be a source format for the creation of Building Information Models from observed data
  - for example CityGML -> IFC
  - CityGML objects already carry semantic information which are helpful in interpretation processes
  - CityGML especially suited for the stepwise reconstruction and refinement of urban objects (coping with different model qualities)

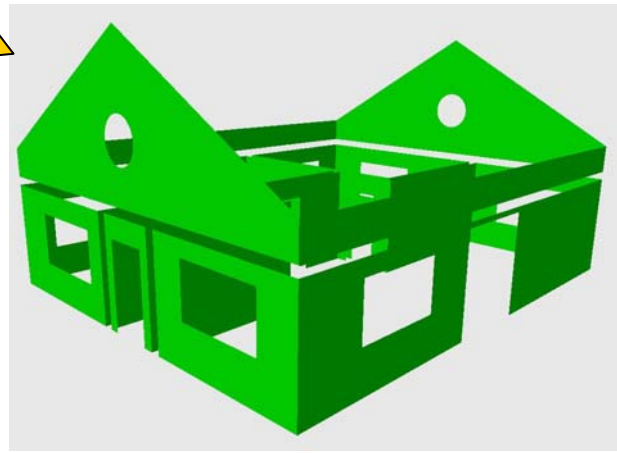
BIM from the CityGML perspective

- Behind **IFC** there is also a **semantically rich information model**
  - In fact, it is more detailed than CityGML
  - However, **lack of other city features**; **limited georeferencing**
- **Source for highly detailed building model data**
  - with respect to geometry and semantics
  - can be used to provide LOD3 and LOD4 models
- CityGML building model adopted some of the conceptual modelings of IFC
  - IFC spaces -> CityGML rooms
  - IFC Property Sets -> CityGML generic attributes, now also ADEs

Deriving LOD4 models from IFC







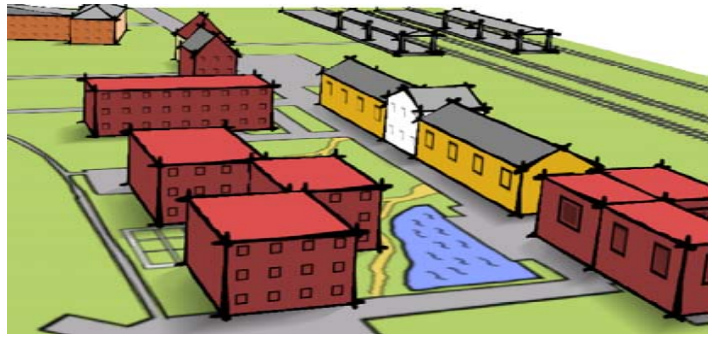
Current research of Benner, Geiger, Leinemann
Helmholtz Research Center Karlsruhe

CityGML from the 3D visualization perspective

- **Provision of large amounts of 3D geospatial data**
  - rich attributes and geometric and semantic decompositions
- Not optimized wrt. transfer size and efficient visualization
  - absolute world coordinates (need for projection or transformation)
  - no grouping according to scene graph concepts
  - however: easy to map to 3D graphics as only the Boundary Representation is being used
- No support of more sophisticated appearance properties, shaders, graphical materials, and light sources
  - but: can be derived in many cases from the semantic information of the CityGML features
  - option: definition of a CityGML „High Definition Graphics“ ADE

3D visualization from the CityGML perspective

- **3D visualization** is the **result of a portraying process** applied to a CityGML model
  - **CityGML** is a source structure for visualization processes; **not intended to be used as a 3D graphics format**
- Portraying
  - **simplest form: 1:1 conversion** of geometry and appearance data to a 3D graphics format (incl. coordinate transformations)
  - **more sophisticated: 3D cartographic design**, for example:
  - Text and label placement
  - Symbolization and non-photo realistic rendering
  - Generalization



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