Section III
CityGML in Detail – Part 1

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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
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
Thematic Modelling in CityGML

- **CityModel**
- **CityObject**
- **ExternalReference**
  - informationSystem: anyURI
  - externalReference: ExternalObjectReferenceType

<<FeatureCollection>>

- _Transportation Objects
- _City Furniture
- CityObject Group
- _Water Bodies
- _Site

- _Vegetation

<<Feature>>

- Relief Feature
  - loD1GeometryProperty
  - loD2GeometryProperty
  - loD3GeometryProperty

Geometry
DTM for each Level of Detail can be composed of

- **TINs** (Triangulated Irregular Network), **Grids**, **3D Breaklines**, and **3D Mass Points**

- Each DTM component may be restricted to be valid in a specific region by providing a **validity extent polygon**

Validity extent polygon can have holes which allow nested DTMs!
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Site Model

_CityObject

_Site

- Excavation
  - Wall
  - Bridge

- Tunnel

_Abstract Building
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
Building Model in LoD1: UML Diagram

AbstractBuilding

+ function: BuildingFunction[0..*]
+ yearOfConstruction: integer[0..1]
+ roofType: RoofType[0..1]
+ measuredHeigth: LengthType[0..1]
+ ...

BuildinPart

0..1

Building

0..*

Address

+ zipCode: int
+ city: String
+ street: String
+ houseNumber: String

implemented in CityGML using the xNAL standard from OASIS
Building Model in LoD2

_AbstractBuilding

+ function: BuildingFunction[0..*]
+ yearOfConstruction: integer[0..1]
+ roofType: RoofType[0..1]
+ measuredHeigth: LengthType[0..1]

_CityObject

_BoundarySurface

Solid Geometry
- IoD1SolidProperty
- IoD2SolidProperty

Surface Geometry
- IoD2SurfaceProperty
- IoD2LineProperty
- IoD2TerrainIntersectionCurve

Line Geometry
- IoD2SurfaceProperty

Roof  Wall  Ground  ClosureSurface
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Building Features in LoD4

- Exterior Shell
- Roof
- Wall
- Ceiling
- Interior wall
- Interior wall
- Opening (Door)
- Opening (Window)
- Room
- Floor
- Ground
Can be used e.g. for escape route planning in disaster management or for mobile robotics.

Topology implies Accessibility Graph!

- Entrance door
- Passage (w/o door)
- Doorway (with door)
- "Back room"
- "Living room"
- "Hallway"
- Rooms

Example labels:
- "Hallway"
- "Back room"
- "Living room"
Example for CityGML file structure

```xml
<?xml version="1.0" encoding="UTF-8"?>
<CityModel xmlns="http://www.citygml.org/citygml/1/0/0" ...further namespaces omitted>
  <gml:name>Cologne</gml:name>
  <gml:boundedBy>
    <gml:Envelope
      <gml:pos> 5659800.0 2561800.0 15.9 </gml:pos>
      <gml:pos> 5662200.0 2564200.0 95.7 </gml:pos>
    </gml:Envelope>
  </gml:boundedBy>
</CityModel>
```

Combined horizontal and vertical CRS

Bounding volume of the whole city model

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```

Combined horizontal and vertical CRS

Bounding volume of the whole city model
...<Building gml:id="Building0815">
    <gml:name>My nice building</gml:name>
    <externalReference>
        <informationSystem>http://www.adv-online.de</informationSystem>
        <externalObject>
            <uri>urn:adv:oid:DEHE123400007001</uri>
        </externalObject>
    </externalReference>
    <function>1012</function>
    <yearOfConstruction>1985</yearOfConstruction>
    <roofType>3100</roofType>
    <measuredHeight uom="m">8.0</measuredHeight>
    <lod2Solid>
        <!-- geometry (for Level of Detail 2) see next slide -->
    </lod2Solid>
</Building>
...

Please note that geometries are objects that can have IDs.
<Building gml:id="Building0815">  
  <lod2Solid>  
    <gml:Solid>  
      <gml:exterior>  
        <gml:CompositeSurface>  
          <gml:surfaceMember>  
            <!-- front surface as in previous slide -->  
          </gml:surfaceMember>  
          <gml:surfaceMember>  
            <!-- side surface -->  
          </gml:surfaceMember>  
          <gml:surfaceMember>  
            <!-- here come side, back, roof, and ground surfaces -->  
          </gml:surfaceMember>  
        </gml:CompositeSurface>  
      </gml:exterior>  
    </gml:Solid>  
  </lod2Solid>  
</Building>
3D-Modell: Stadt Coburg

Building

BuildingPart

BuildingInstallation (Dormer)

BuildingPart

Building surface (WallSurface)
Coherent Building Model in Level of Detail 3

3D-Modell: Dr. Benner, Forschungszentrum Karlsruhe
Coherent Building Model in Level of Detail 4
Transportation Objects

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Transportation Objects

CityModel

CityObject

ExternalReference

LoD1
LoD2..4

gml: AbstractFeature
+ name[0..*]: String

_TransportationObject

TransportationComplex
+ function[0..*]

AuxillaryTrafficArea
+ function[0..*]
+ surfaceMaterial[0..1]

TrafficArea
+ function[0..*]
+ usage[0..*]
+ surfaceMaterial[0..1]

Track
Road
Railway
Square

gml:_Surface
LoDXGeometry, x in {1..4}
Example: Transportation Model in LoD2

- Road
- Traffic Area
- Auxiliary Traffic Areas

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