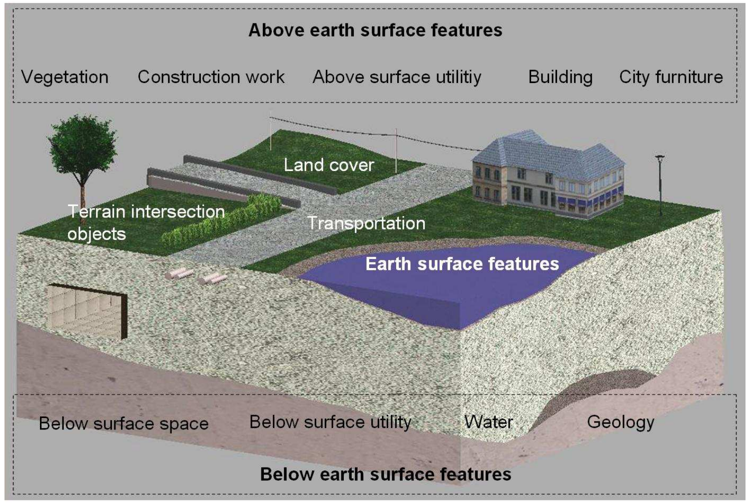
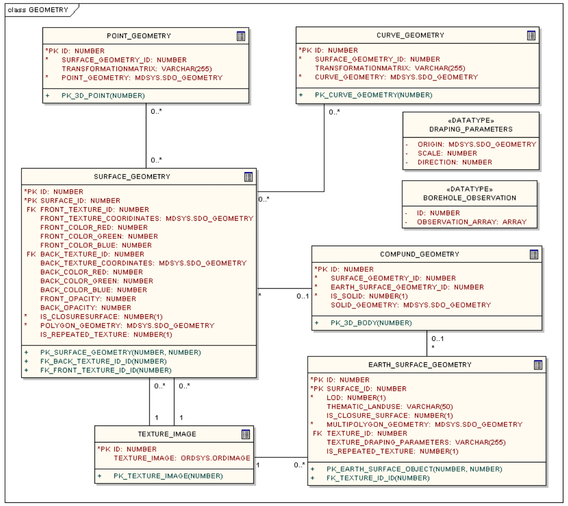
Implementation alternatives for an integrated 3D Information Model





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2007-12-11

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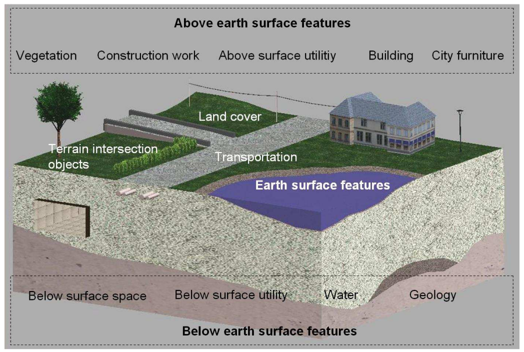
Research question

Can we define a formal methodology that allows integration of geographic 3D features into an application independent reference information model?

(including both natural and man-made features above and below the earth surface)

concept: 3DIM



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3DIM development - initial iteration 2007

1. Studies of existing models CityGML + subsurface information models
2. Conceptual modelling (UML) top-level objects of 3DIM
3. Database implementation (UML)
4. Collection and preparation of test data (TU Delft Campus)
5. FME Data processing to reach 3DIM structure on test data
6. Database import of test data (to Oracle Spatial)
7. Verification and retrieval in CityGML (without subsurface features)

Two implementation alternatives compared

Research problem

- The existing formats and data models are often domain specific.
- The geometry representation is mostly two-dimensional
- Many models miss semantics

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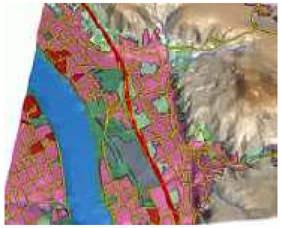
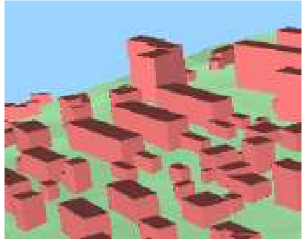
CityGML

- Application independent information model
- Well-described thematic semantic approach for 3D city modelling

Problems

- Misses subsurface features
- Sparse relations between geometries

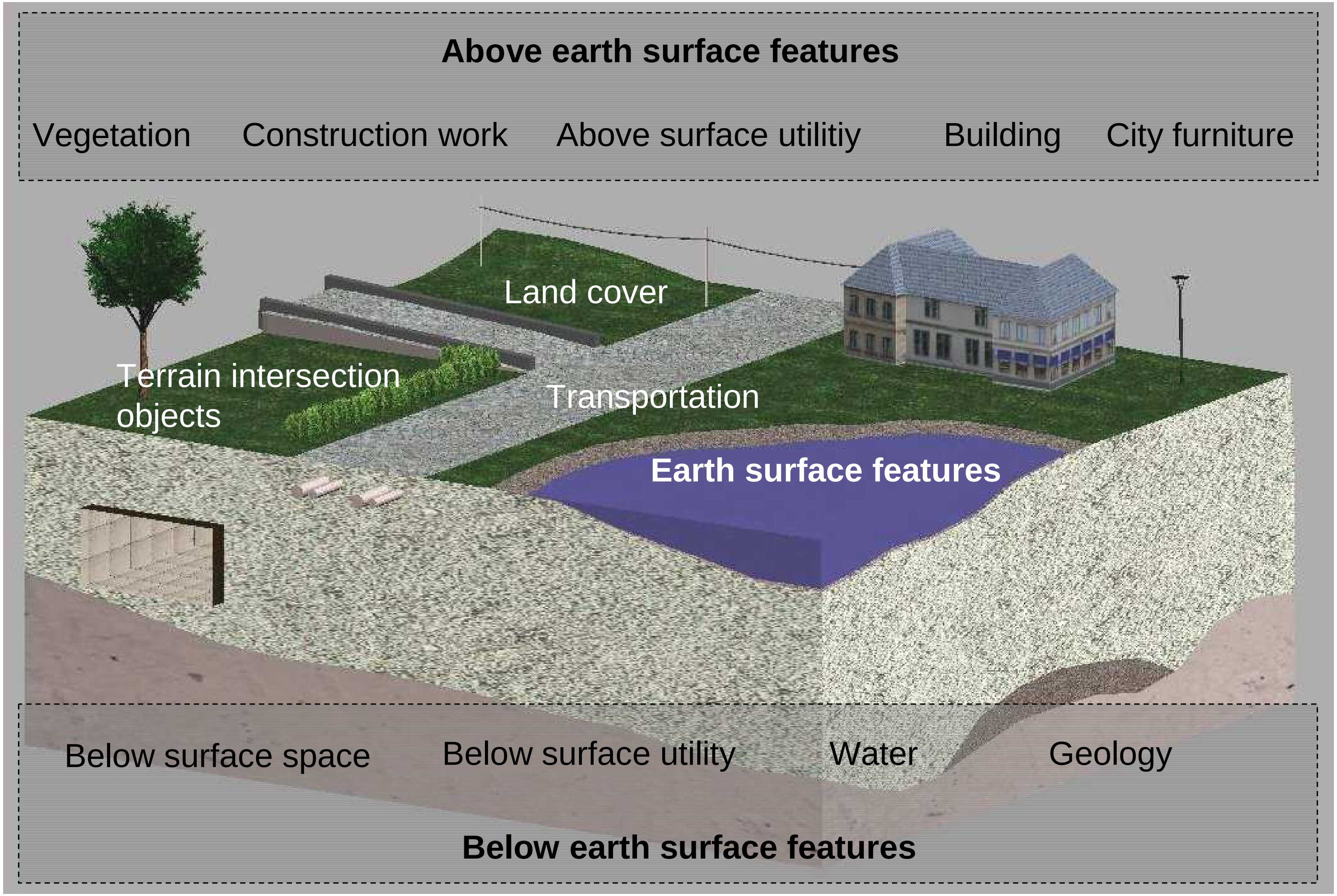




3DIM summary

Generic reference model (only semantics and attribures of interest in many applications)

- Divison of feature classes into above, below and on the surface
- Definition of general classes for the subsurface
- Full partition of the earth surface model
- Extended integrity/relation between earth surface model and objects above and below: terrain intersection objects


Above earth surface features
Vegetation
Construction work
Above surface utilitiy
Building
City furniture
Land cover
Terrain intersection objects
Transportation
Earth surface features
Below surface space
Below surface utility
Water
Geology
Below earth surface features

Rules

1. A semantic feature must have a geometric representation.
2. Only one geometry representation with respect to a LOD.
3. Texture images, color coding and symbols created before referenced
4. The earth surface - fully partitioned surface.
5. Terrain intersection object must have referenced geometry
6. A surface geometry must exist for solids
7. Surfaces and earth surface defined in same LOD
8. TerrainIntersectionSurface for geology: mountain or beach

Implementation approach

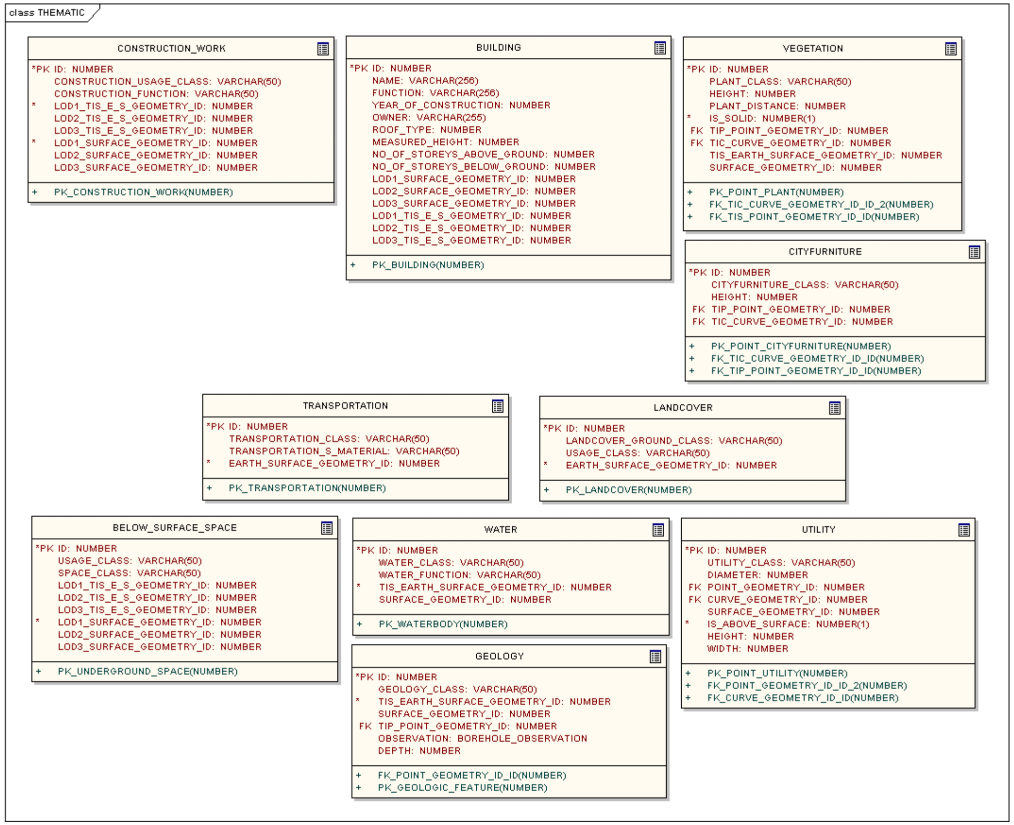
- Geometries: point, curves, polygons and solids from polygons
- Textures: on each polygon or draped

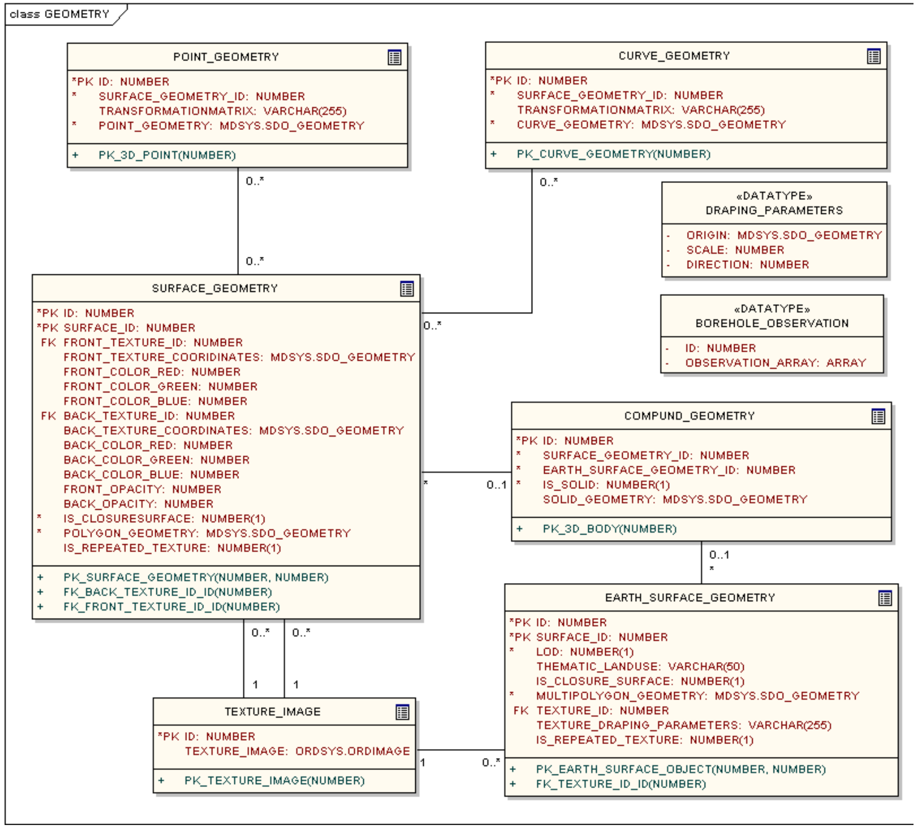
Approach: Top-level classes represented by semantic tables (compare with other approach Plümer et al. 2007).

Two alternatives: 1. Divided semantic and geometry and 2. not divided

Oracle Spatial: object-relational using SDO_GEOMETRY and ORDSYS.IMAGE

Database structure alt I





Semantics tables

Geometry tables

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Imlementation of rules - alt I

1. A semantic feature must have a geometric representation.
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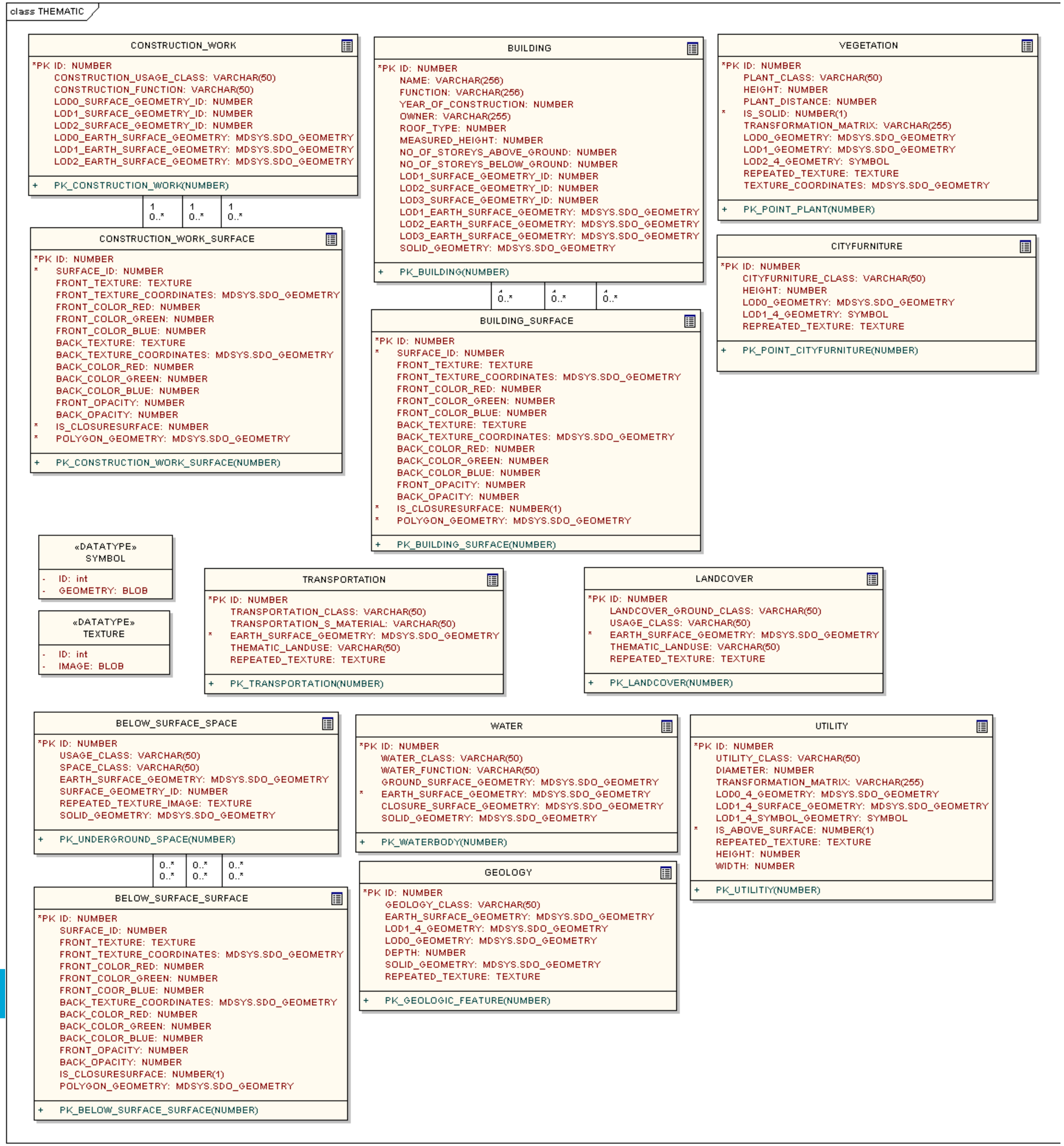
Foreign keys

Usage rules

Database structure alt II

Geometry column integrated in semantic tables



Imlementation of rules - alt II

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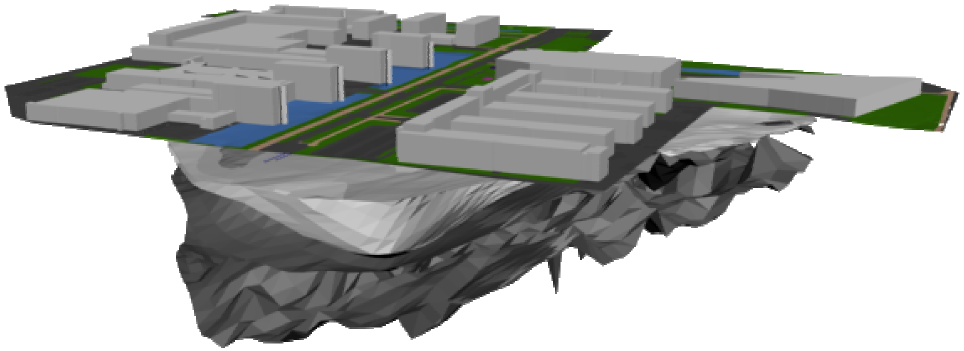
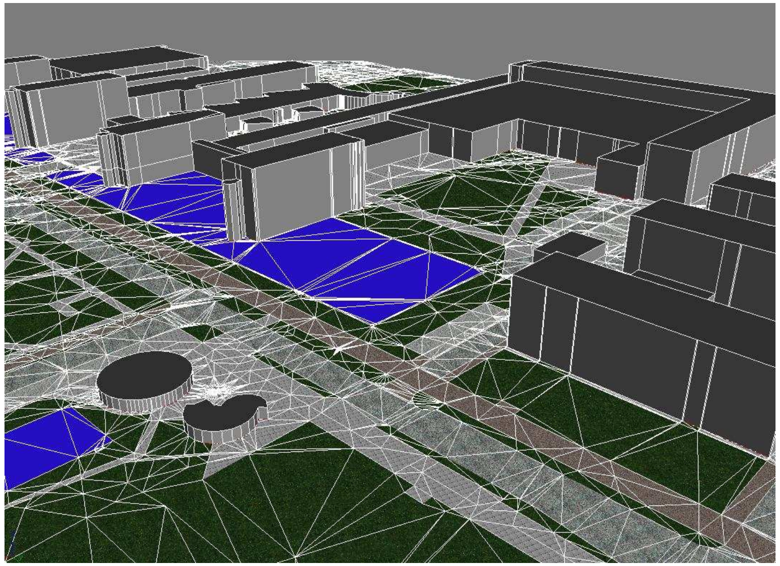
Can be triggers

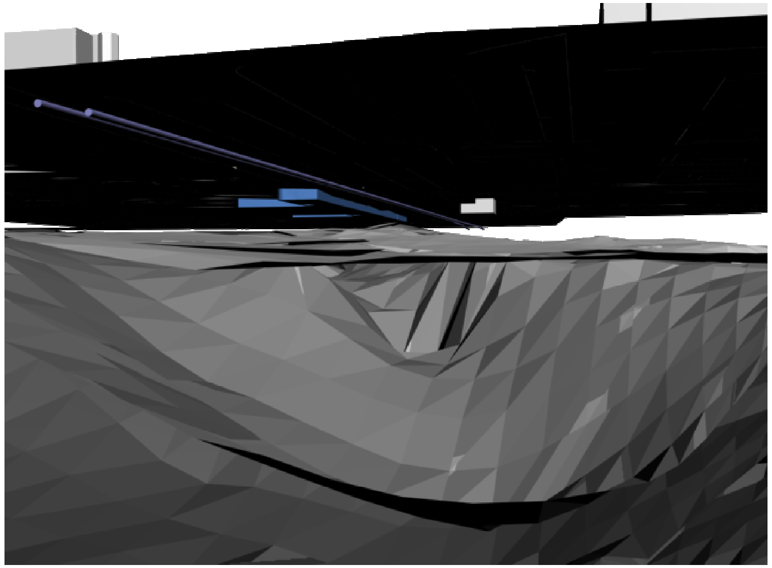
Usage rules

Expected comparision results

- Alt II – simpler, Alt I – more robust (consistency)
- Loading more straight forward in alt I (performance)
- More redundancy in alt II
- Query performance depends on geometry based query (alt I) or semantic based query (alt II)







- Testing on Campus
- All semantic features tested
- Processing in FME
- Load and retrieval in Oracle
- Test mapping to CityGML

Conclusion

Comparision results

- More complex to load data into Alt I – constraints > geometry first. Also more destination datasets
- More complex to retreive data into CityGML using views in Alt I

Conclusion

- None of the alternatives have a strong advantage
- All geometry in the same table not an advantage for e.g. buildings but for earth surface
- A combination of Alt I and Alt II could be the solution

Future Work