



L1.3 BIM-GIS Data Conversion

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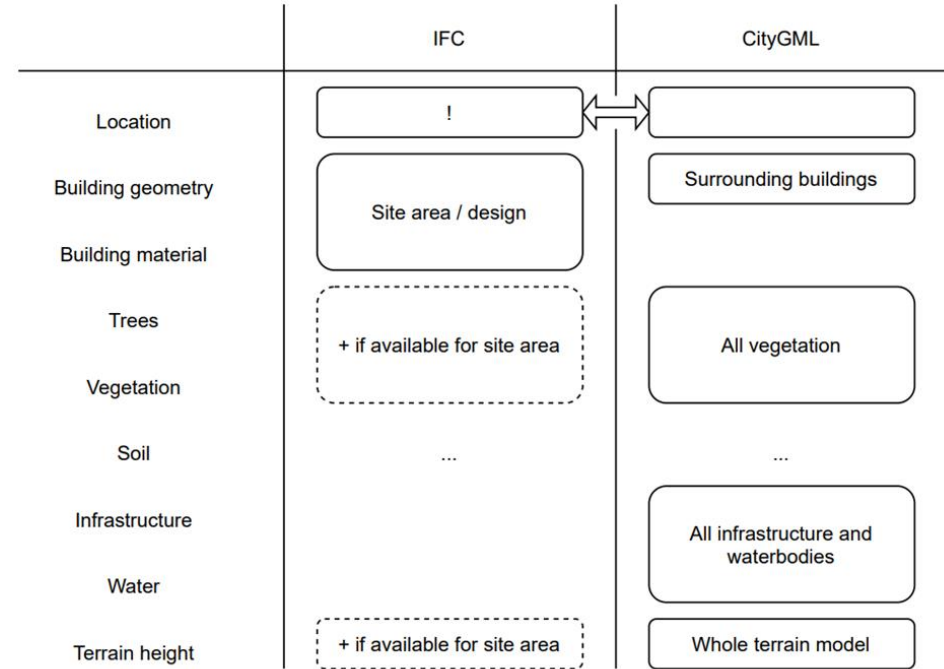
Learning outcomes

At the end of this lecture, the learner is expected to be able to:

- Summarize what information can be provided from BIM and GIS model
- Describe the main steps and challenges of conversion BIM-to-GIS
- Describe the main steps and challenges of conversion GIS-to-BIM

What information from which model?

- Conversion direction depends on application
- GIS provide spatial context, surroundings, environment
- BIM usually design of new facilities, restricted to project site
- Well defined integration goals needed



Information provided by different models I

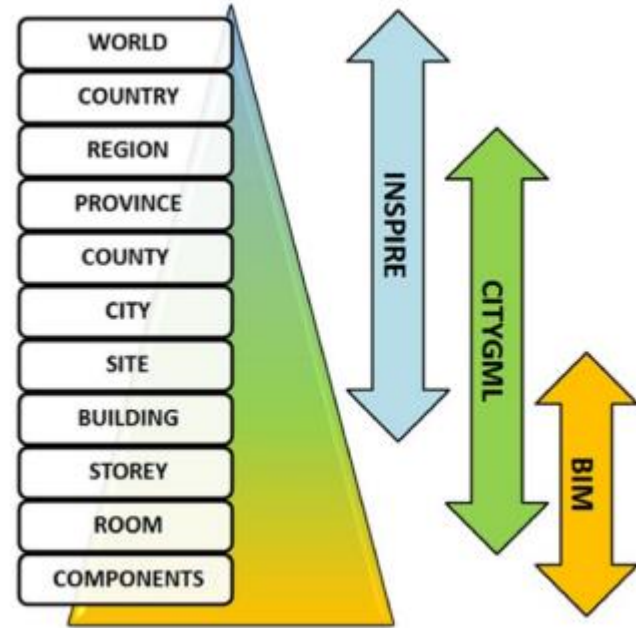
The newest versions of standards

CityGML 3.0 version

- better integration with BIM
- indoor spaces in different Levels of Detail support for dynamic sensor data
- time modelling
- Application Domain Extensions (ADEs)

IFC 4.3 version

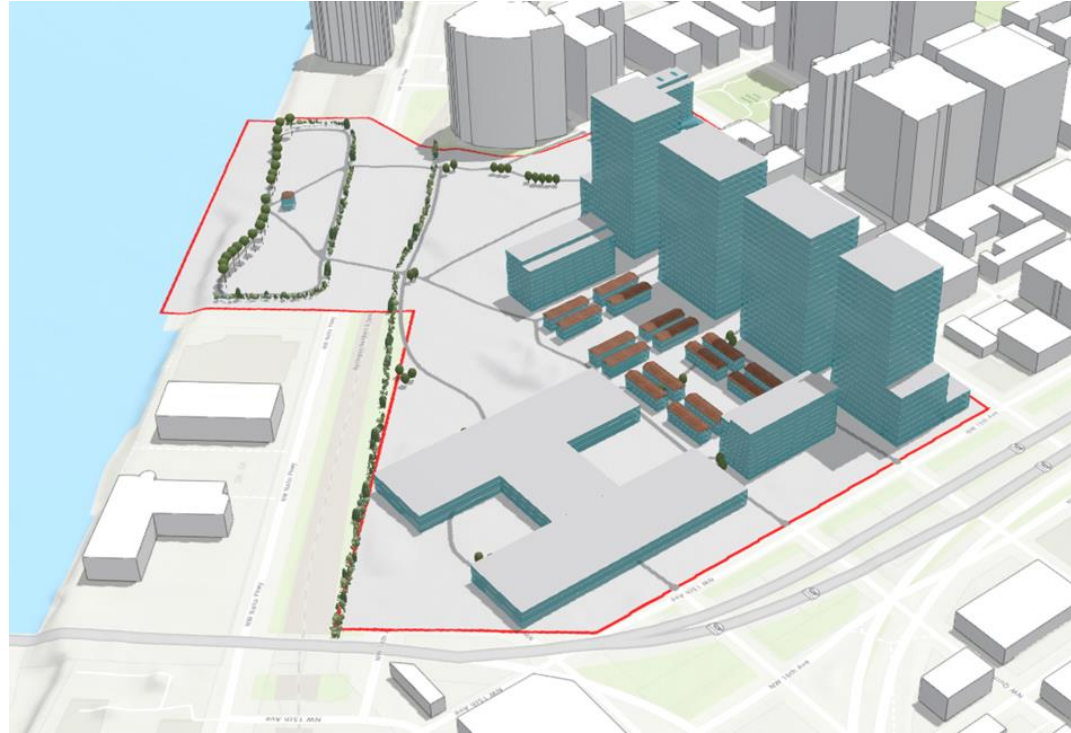
- improved interoperability with CityGML
- 4D and 5D modelling
- energy and environmental entities
- Infrastructure BIM



Information provided by different models II From Bachert
(2023) Mapping the Energy ADE to CityGML 3.0

Conversion BIM to GIS I

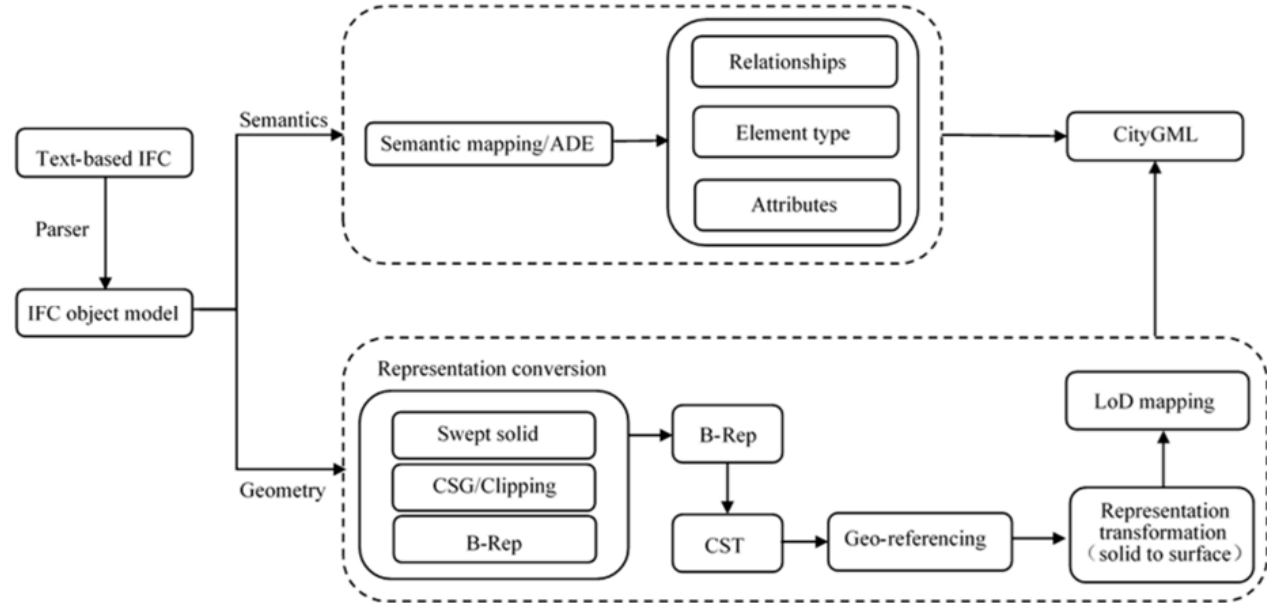
- Visualizing and analyzing newly planned development together with existing objects
- CityGML model consists of a geometric and a semantic layer
- Geometric– semantic consistency needed for object existing in both layers
- Semantic and geometric conversion



New development visualised in existing city environment.
Screenshot of Esri's training data.

Conversion BIM to GIS II

- 1) Parsing objects from IFC text-file
- 2) Conversion itself, semantic and geometry separately
- 3) Visualisation and validation



Any conversion from IFC to CityGML entails loss of information.

The IFC to CityGML Conversion. From: Tan, Liang, Zhu (2023) CityGML in the Integration of BIM and the GIS: Challenges and Opportunities. Buildings 13, <https://doi.org/10.3390/buildings13071758>

Semantic mapping

Mapping of element types, relationships and attributes from IFC to CityGML

Several situations:

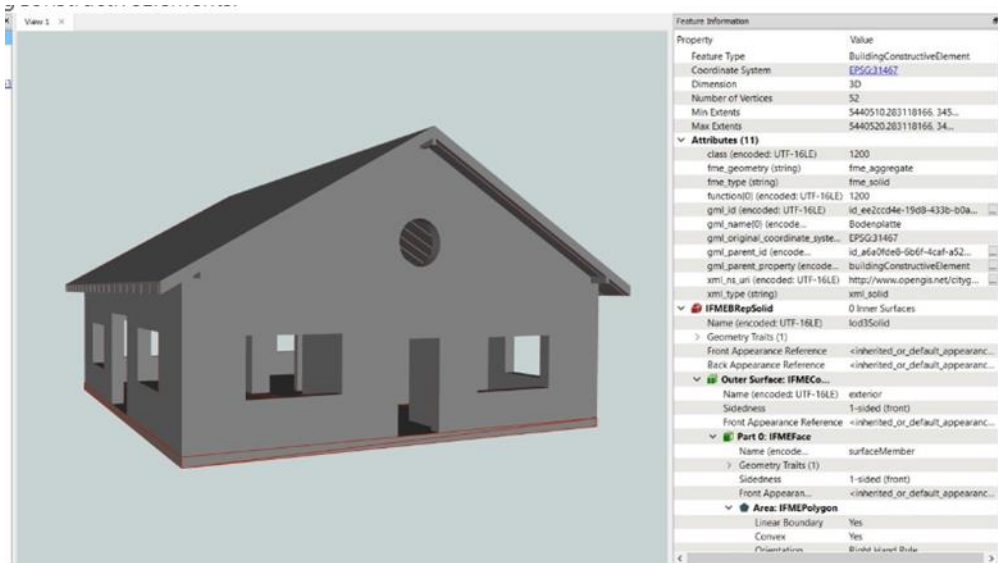
- Some objects map directly one-to-one
- Other map into several CityGML classes
- Many IFC objects map into one CityGML class
- Indirect mapping

Semantics is usually the main limitation of the conversion

IFC-CityGLM mapping. From: Sahleb et al (2020) Automatic conversion from CityGLM to IFC, <https://doi.org/10.5194/isprs-archives-XLIV-4-W1-2020-127-2020>

| CityGML | IFC |
|--|---|
| AbstractBuilding | IfcBuilding |
| -GroundSurface -FloorSurface -CeilingSurface | IfcSlab -GroundSlab -FloorSlab -CeilingSlab |
| RoofSurface | IfcRoof |
| -WallSurface -InteriorWallSurface | IFCWall -Interior Wall -Exterior Wall |
| WallSurface | IfcCurtainWall |
| GenericCityObject | IfcBuildingElementProxy |
| SolitaryVegetationObject | IfcBuildingElementProxy |
| Opening Door Window | IfcOpeningElement IfcDoor IfcWindow |
| BuildingInstallation | IfcBeam, IfcColumn, IfcCovering, IfcStair, IfcRailing, IfcRamp |

Geometry transformation



FZK Haus (known from IFC lecture) converted into CityGML by FME; building elements are visualised. Source: [GitHub - tum-gis/ifc-to-citygml3](https://github.com/tum-gis/ifc-to-citygml3): An FME workspace for converting IFC data sets to CityGML 3.0 data sets

Each IfcObject in IFC file is checked if:

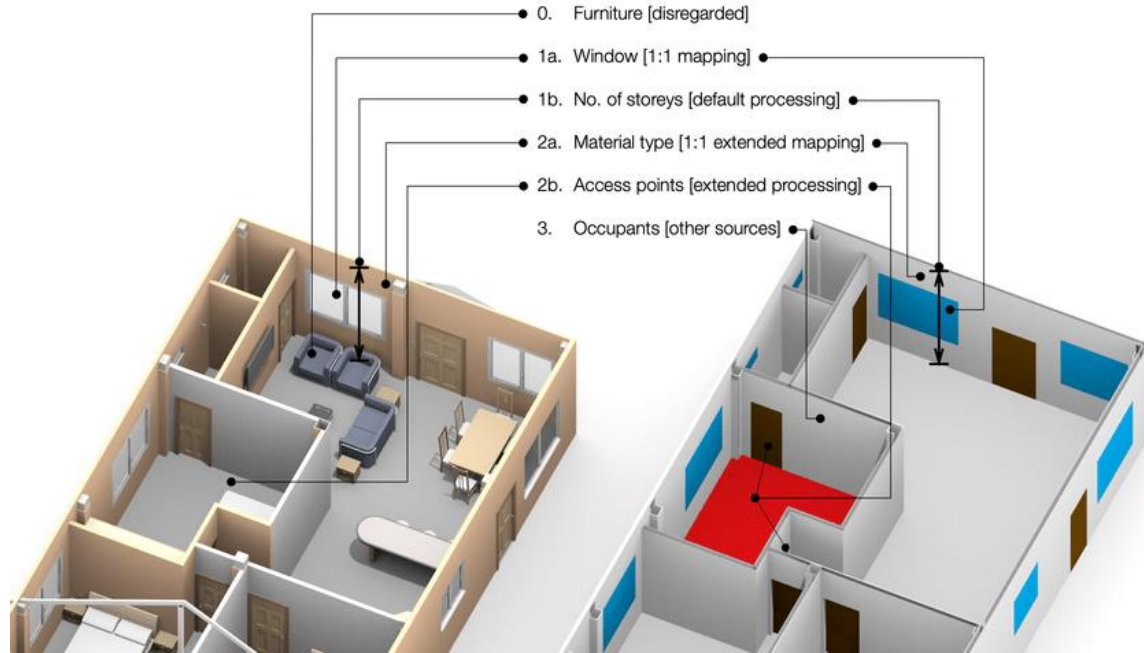
- it has a geometry
 - it is outside or inside a building
- It is then stored as a gml:Solid or a gml:MultiSurface.

Challenges arise from different geometric representation and different level of detail

Georeferencing and coordinate system transformation can be performed in this step

Simplification

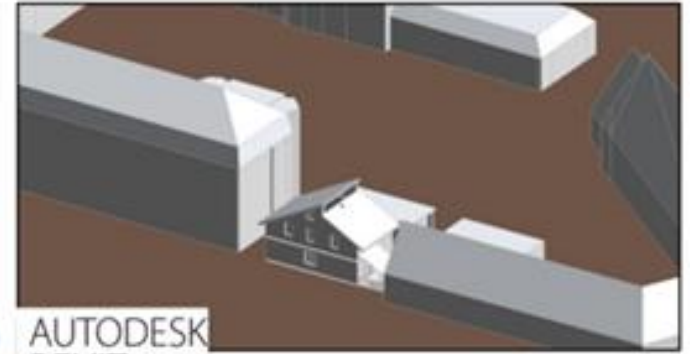
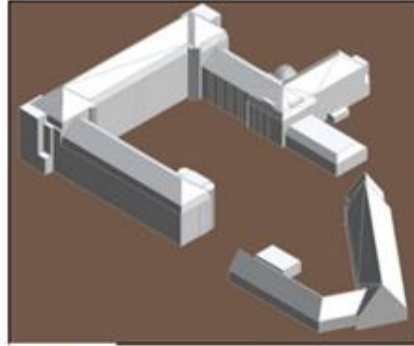
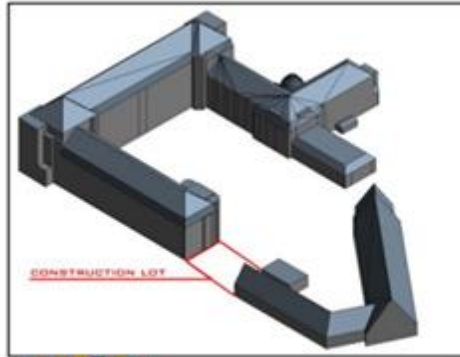
- Conversion BIM-to-GIS leads to simplification and removing details
- Choosing optimal level is crucial
- Best to customize IFC model already on BIM-level, not in the conversion
- Use of Model View Definitions (MVD) recommended



[Illustration-of-the-relation-between-IFC-and-CityGML-showing-examples-of-categories-in.ppm \(850x478\) \(researchgate.net\)](#)

Conversion GIS to BIM I

- GIS data used in BIM – usually conversion CityGML to IFC
- Improves information about surroundings



- 1) Defining surroundings in city model /CityGLM datafile
- 2) Export from CityGLM to IFC
- 3) Import to BIM software to join with a planned building

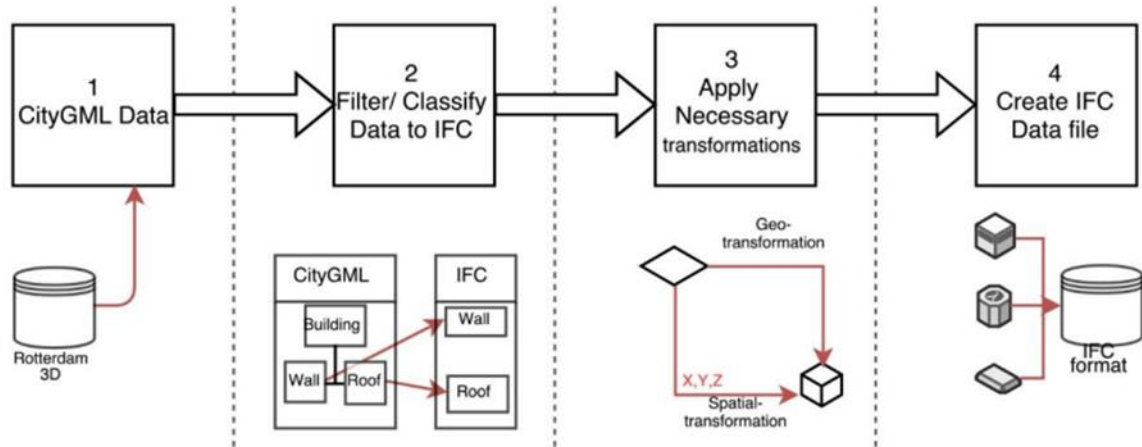
Visualisation of CityGLM to IFC conversion steps. From: Salheb (2019) Automatic Conversion of CityGML to IFC, MSc thesis, TU Delft

Conversion GIS to BIM II

Usage:

- Analyses for design and construction
- Digital twin, facility management
- Both IFC and CityGML are semantic models with strict separation between geometry and semantics

- Simpler model is converted to the more detailed one

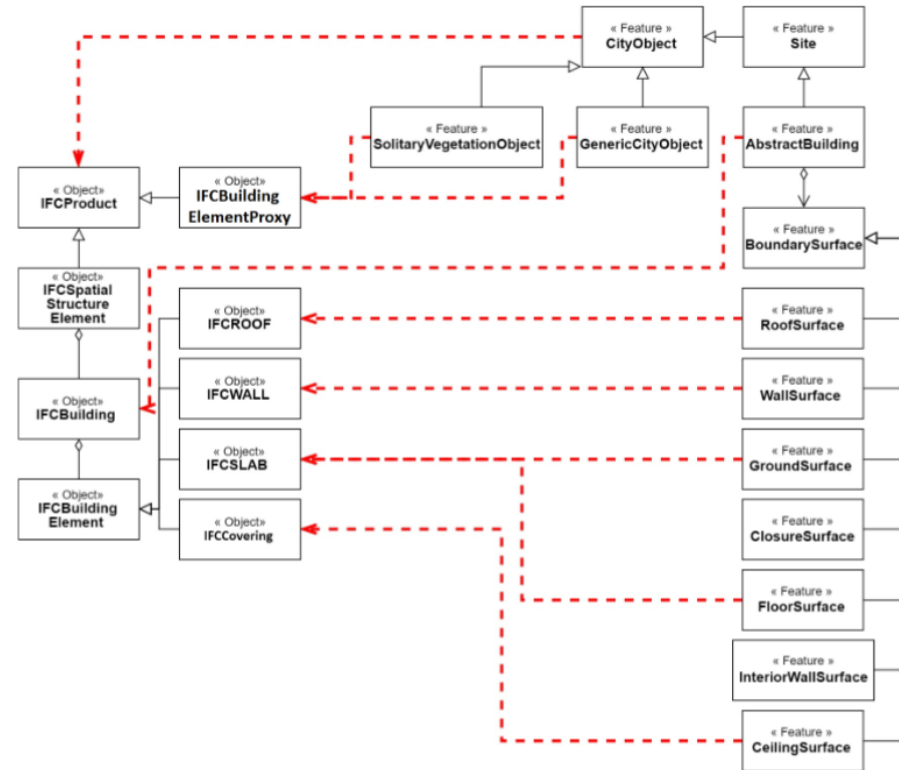


Schema of conversion workflow from CityGML to IFC. From: Salheb (2019) Automatic Conversion of CityGML to IFC, MSc thesis, TU Delft

Semantic mapping I

- IFC has more classes than CityGML
- Only minority of classes relevant for conversion
- Common with different semantic meaning of objects

Challenge - how to best map semantics from CityGML to their equivalents in IFC?



Semantic mapping from CityGML to IFC. From Sahleb et al (2020) Automatic conversion from CityGLM to IFC, <https://doi.org/10.5194/isprs-archives-XLIV-4-W1-2020-127-2020>

Semantic mapping II

Steps:

- Matching IFC and CityGML schemas
- Investigation which objects and attributes correspond to each other
- Relevant data filtered and classified into IFC

Certain loss of semantic information is inevitable because many parts are not applicable for the conversion

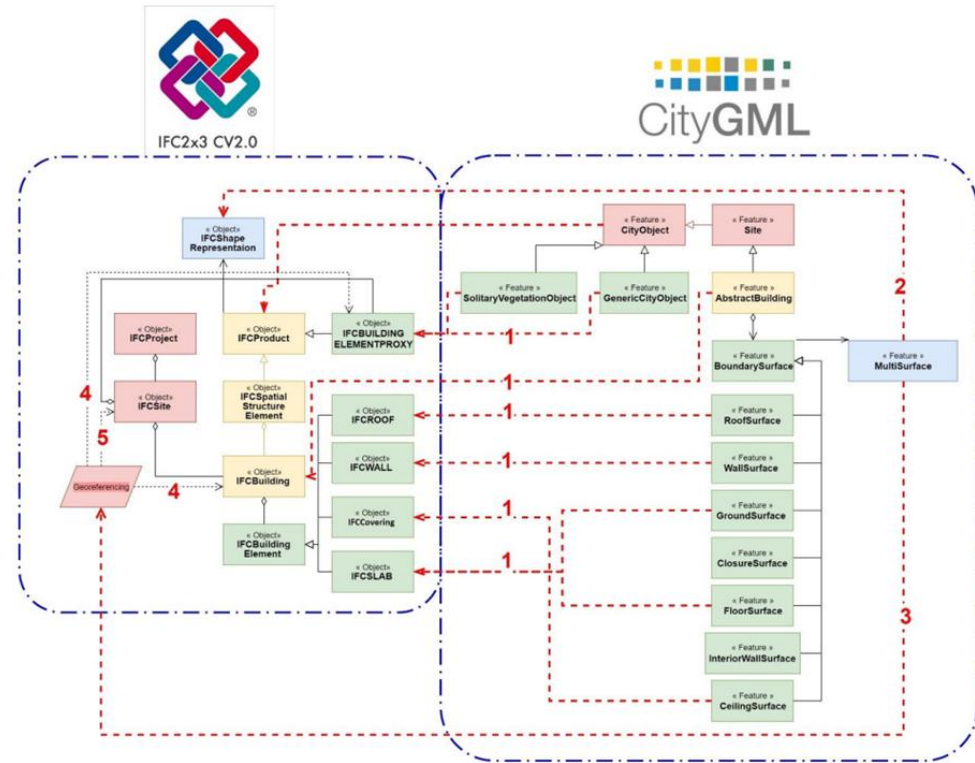
| IFC objects | CityGML 3.0 objects |
|---------------------|-----------------------------|
| IfcProject | CityModel |
| IfcSite | LandUse |
| IfcBuilding | Building |
| IfcBuildingStorey | Storey |
| IfcSpace | BuildingRoom |
| IfcWallStandardCase | BuildingConstructiveElement |
| IfcBeam | BuildingConstructiveElement |
| IfcSlab | BuildingConstructiveElement |
| IfcMember | BuildingConstructiveElement |
| IfcDoor | Door |
| IfcWindow | Window |
| IfcRailing | BuildingInstallation |
| IfcStair | BuildingInstallation |

Mapping between IFC and CityGLM objects.

Geometry transformation

Steps:

- Creating Geometry resources for IFC objects based on source CityGML geometry (red line 2 in the figure)
- Creating georeferencing point from CityGML (line 3)
- Georeferencing IFC objects (4)
- Storing georeferencing information in the IFCSite (5)



Complete methodology of GIS-to-BIM conversion. Red lines marked 1 stay for the semantic mapping. From Salheb et al (2020) AUTOMATIC CONVERSION OF CITYGML TO IFC. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLIV-4/W1-2020

Integration software

- Free software
KIT Model Viewer
- Commercial software
FME
Esri-Autodesk apps
- Own algorithms

All convert in different ways,
which results in varied outputs



Esri-Autodesk cooperation apps: Adding City Furniture from ArcGIS to Infraworks (up), BIM model added to a city model in ArcGIS GeoBIM (screenshots)

Thank you for your attention



<https://birgitproject.eu/>

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