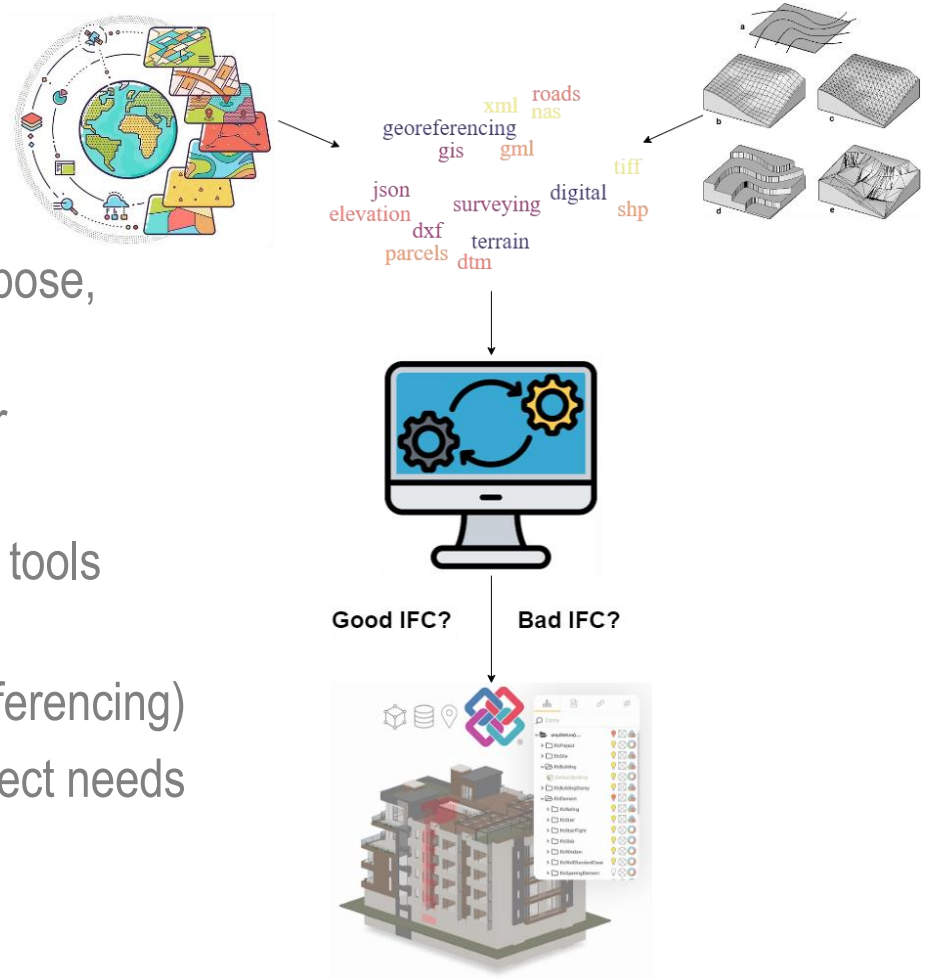
Conception, Validation and Publication of ETL Processes for the Conversion of Geospatial Data for openBIM Projects with FME

Authors:
M. Eng. **Christoph Frey** – HTW Dresden - Faculty of Spatial Information
Dipl. Geoinf. **Christian Dahmen** – con terra GmbH
Prof. Dr. Ing. **Christian Clemen** – HTW Dresden - Faculty of Spatial Information

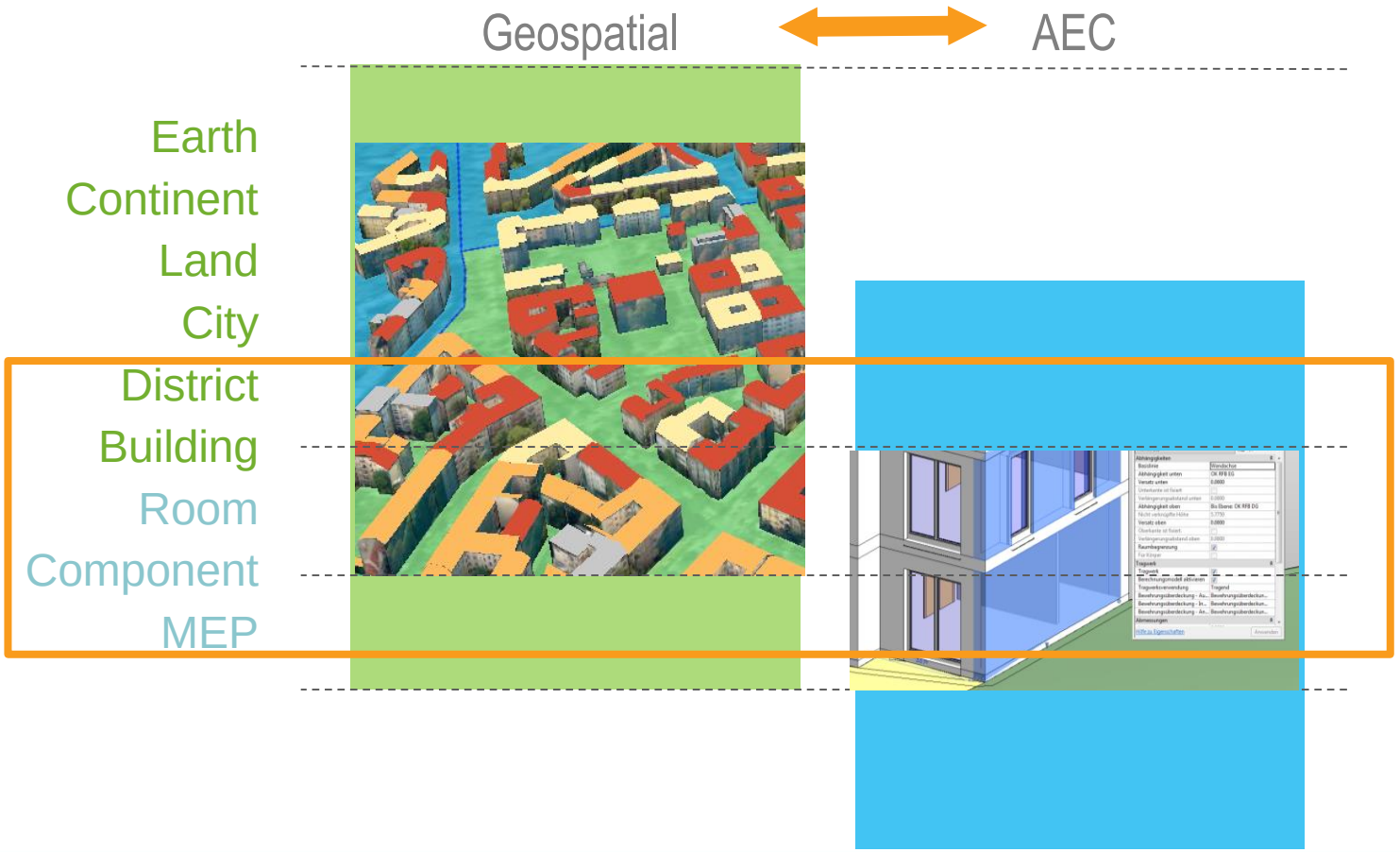
Acknowledgements:
Project partner: con terra GmbH

Problem Definition



- transforming **geodata** to **IFC** is challenging due to **differences** in purpose, semantics, geometry representation, or georeferencing
- info: the Industry Foundation Classes (IFC) provide a software vendor independent geometric-semantic data schema for openBIM projects
- current state: Transforming geodata to IFC is possible, however most tools export **invalid or poor** IFC models.
  - not using the richness of IFC (semantics, spatial structure, georeferencing)
  - the “IFC export” can not be customized according to the BIM project needs

Motivation: Bi-directional Information Needs



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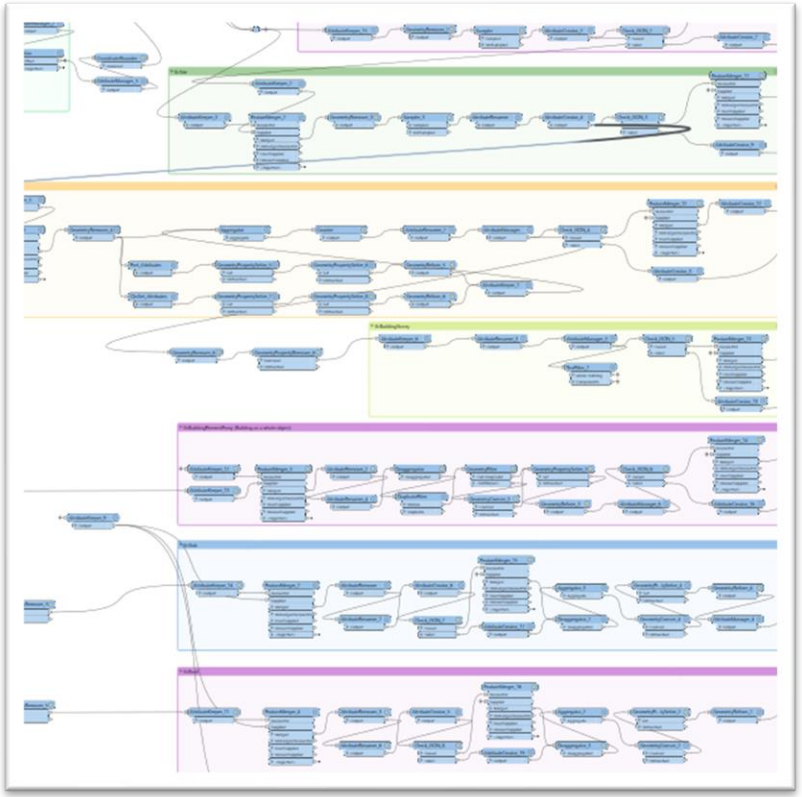
Info: FME is an Extract-Transform-Load (ETL) software for geospatial data



FME

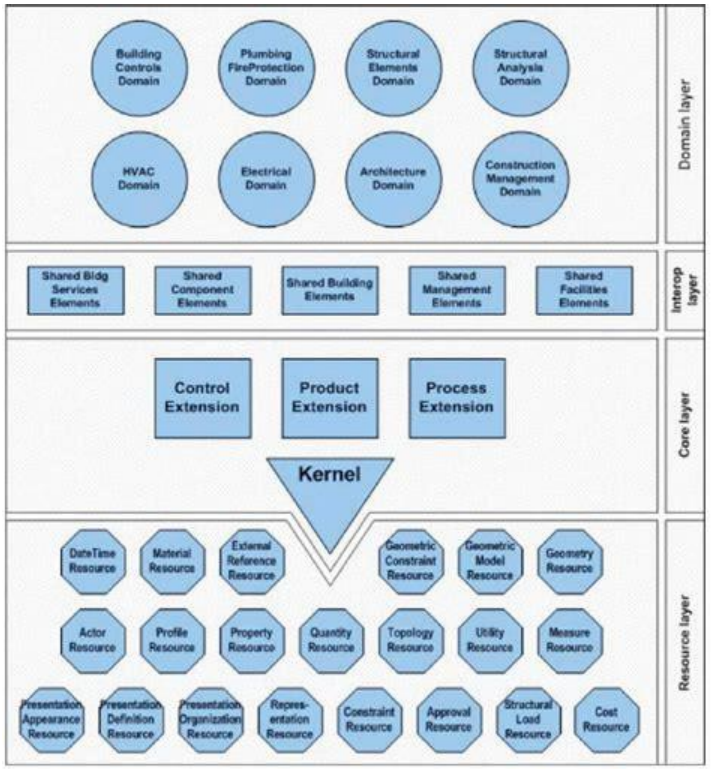
- is suitable for **automatic data conversions**, running in the backend (server), e.g. as cronjob
- can be programmed with (easy) **visual programming** and additional python plug-ins
- provides „Reader“ and „Writer“ for many, many, many **geospatial data formats**
- provides many **functional blocks**, called „Transformer“. E.g. buffer, coordinate-transformer, topology builder, terrain draping and many, many more
- has its main focus on **geospatial data**, however it supports IFC for openBIM projects

Background – IFC

buildingSMART International home of openBIM

Essential features of the IFC:

- **open** and **text-based** (ifc, ifcxml, ifcOwl/RDF)
- semantically structured, **component-oriented**
- object-oriented **inheritance** hierarchy
- **spatial aggregation** concepts
- **separation of semantics and geometry**
- objectified model **relationships**
- many **different geometry model** types
- semantically extensible (domain) and generically extensible (**IfcPropertySets**)



Aim of the Research

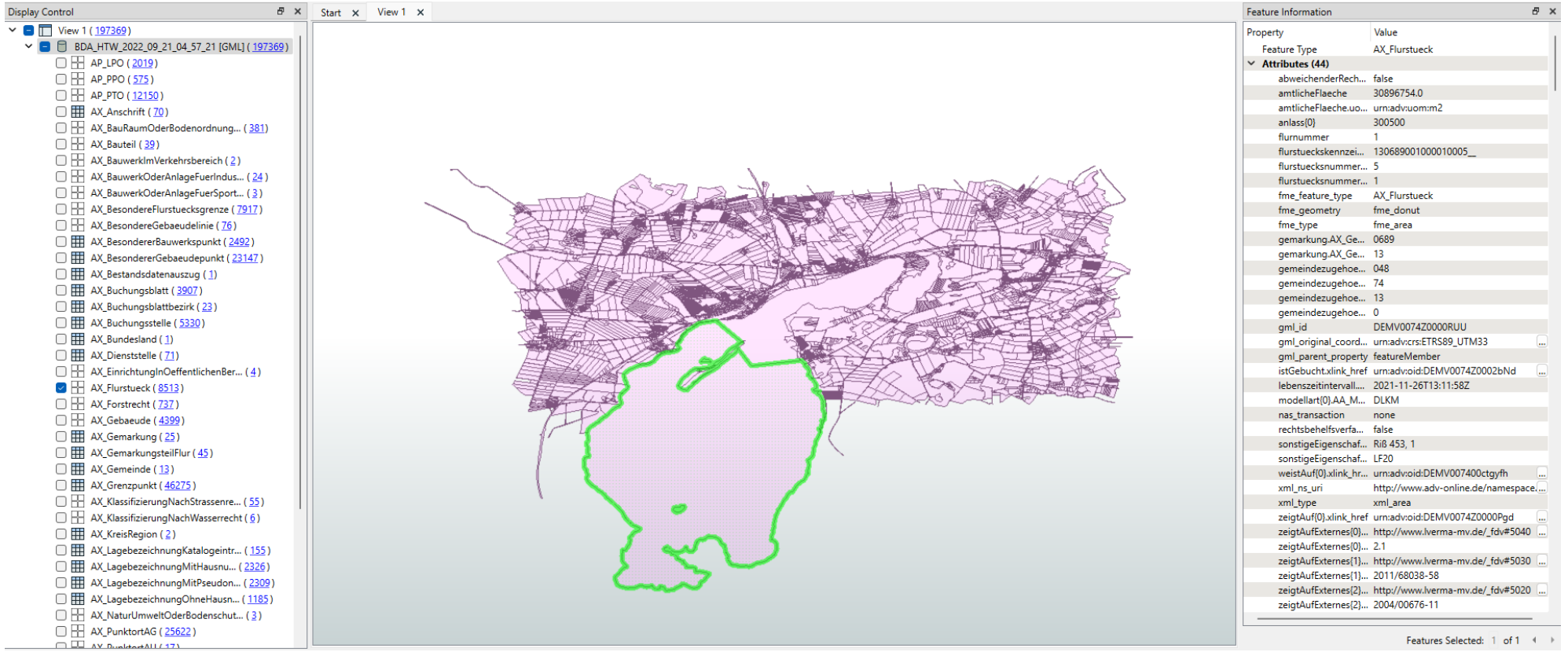
- development of **automated FME** workflows (geospatial data to IFC4)
- using FME Form as a **customizable** framework

- creation of **high-quality** IFC4 data
  - **lossless** transformation of geometry, topology, semantics and georeferencing in IFC
  - **preservation** of input attributes
  - creation of **Property-** and **QuantitySets**
- evaluate the **success** of the conversion

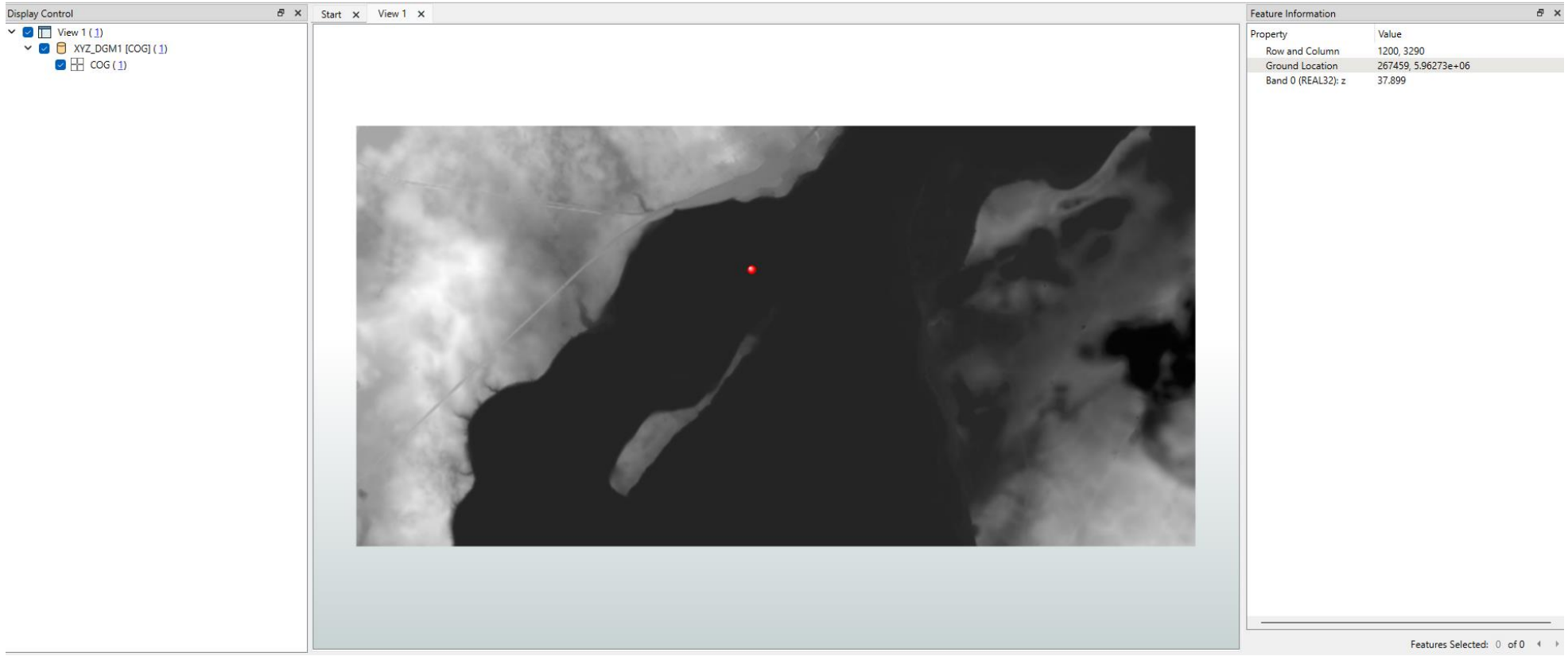
IFC

FME by Safe Software

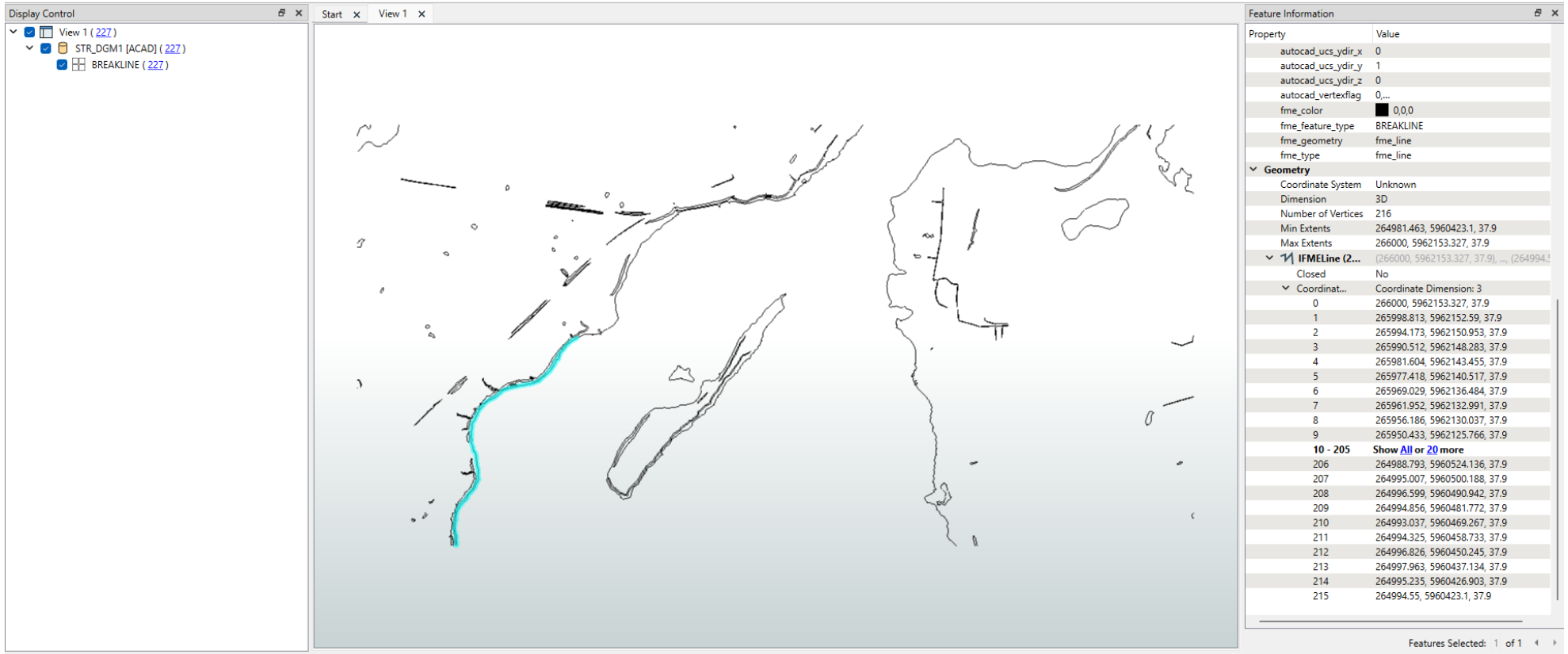
Data: 2D geospatial data (ALKIS: Cadastral parcels = GML with German semantics)



Data: Digital Terrain Model (GeoTIFF, ca. 7 x 3.5 km)

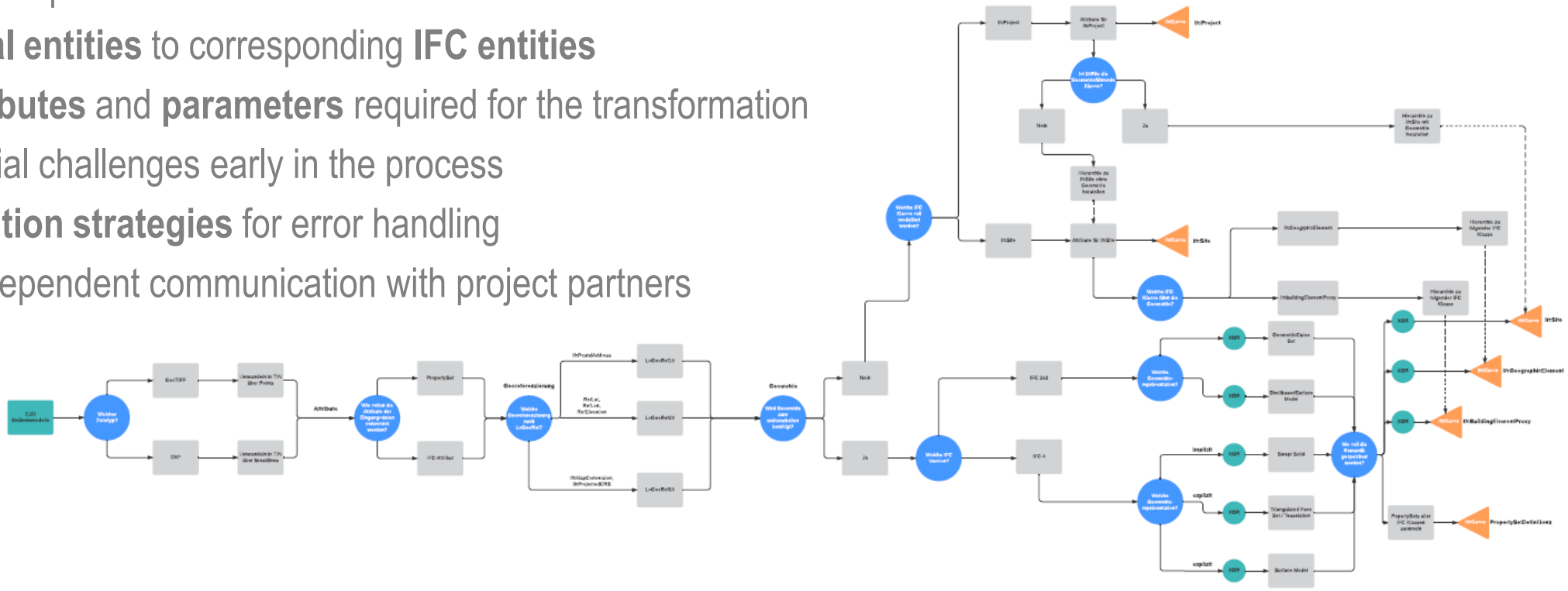


Data: Digital Terrain Model (DTM Breaklines, DXF)

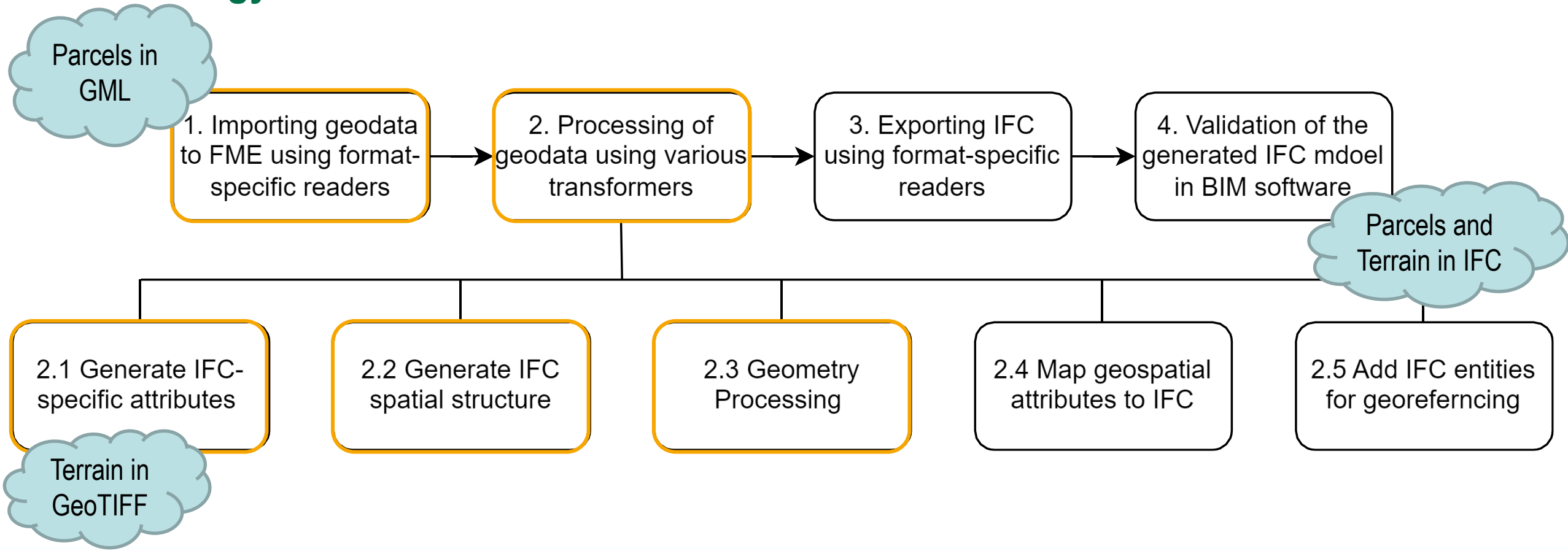


Methodology: Decision Tree

- Decision tree as concept to…
  - map **geospatial entities** to corresponding **IFC entities**
  - determine **attributes** and **parameters** required for the transformation
  - **identify** potential challenges early in the process
  - develop **resolution strategies** for error handling
- Serves for FME-independent communication with project partners

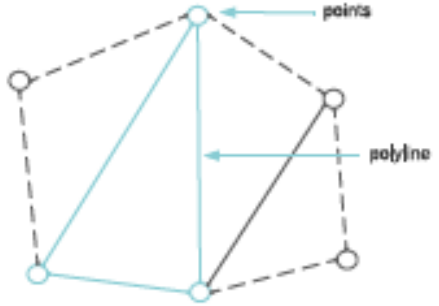


Methodology and Realization

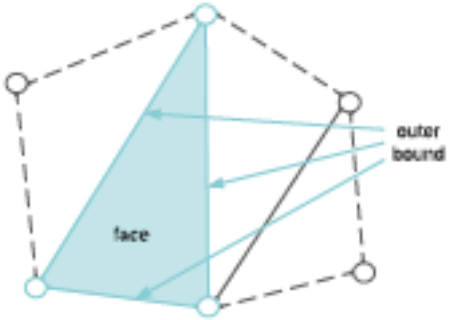


Excursus: geometry representation for terrain in IFC

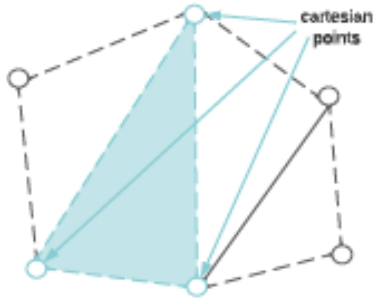
- **GeometricCurveSet**
  - describes a 3D object through a collection of curves
  - curves can be lines, arcs or complex shapes
- **ShellBasedSurfaceModel**
  - uses a shell to represent the outer surface of a 3D object
  - shell consist of a collection of closed surfaces (faces)
- **IfcTriangulatedFaceSet** (IFC4 only)
  - represents the surface of a 3D object by triangulation
- **ExtrudedAreaSolid**
  - surfaces extruded along a path



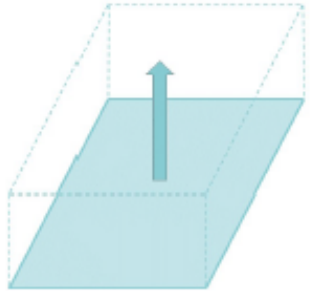
GeometricCurveSet



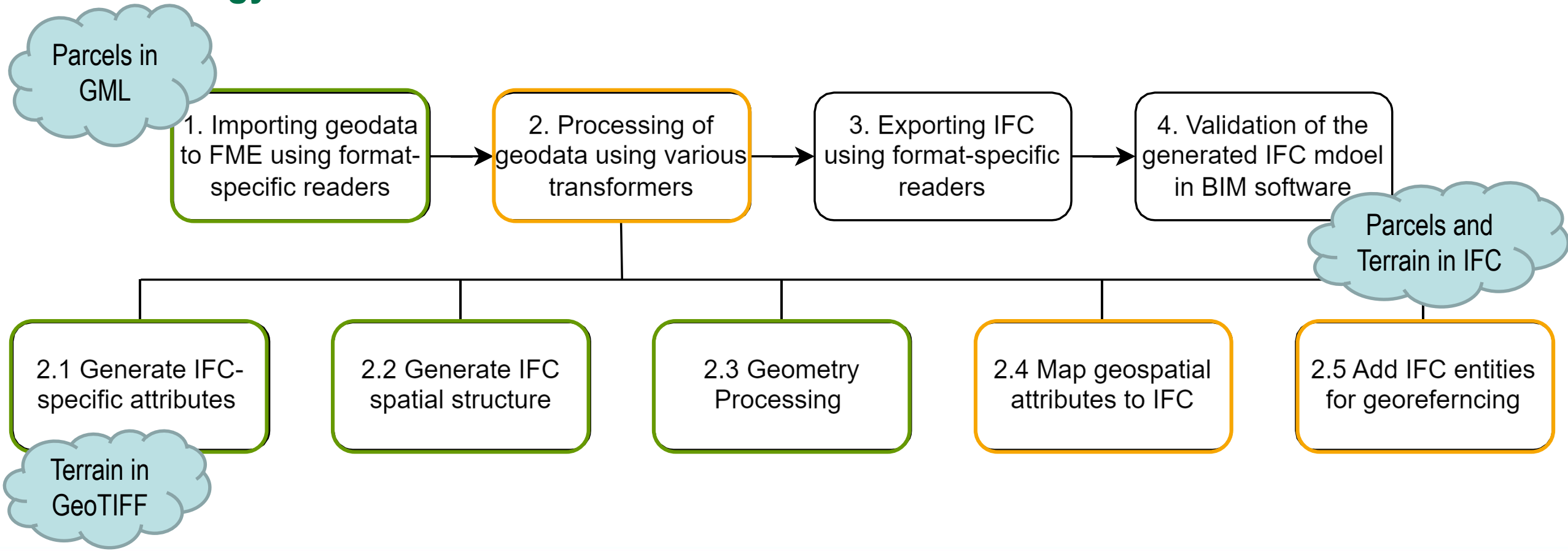
ShellBasedSurfaceModel



TriangulatedFaceSet

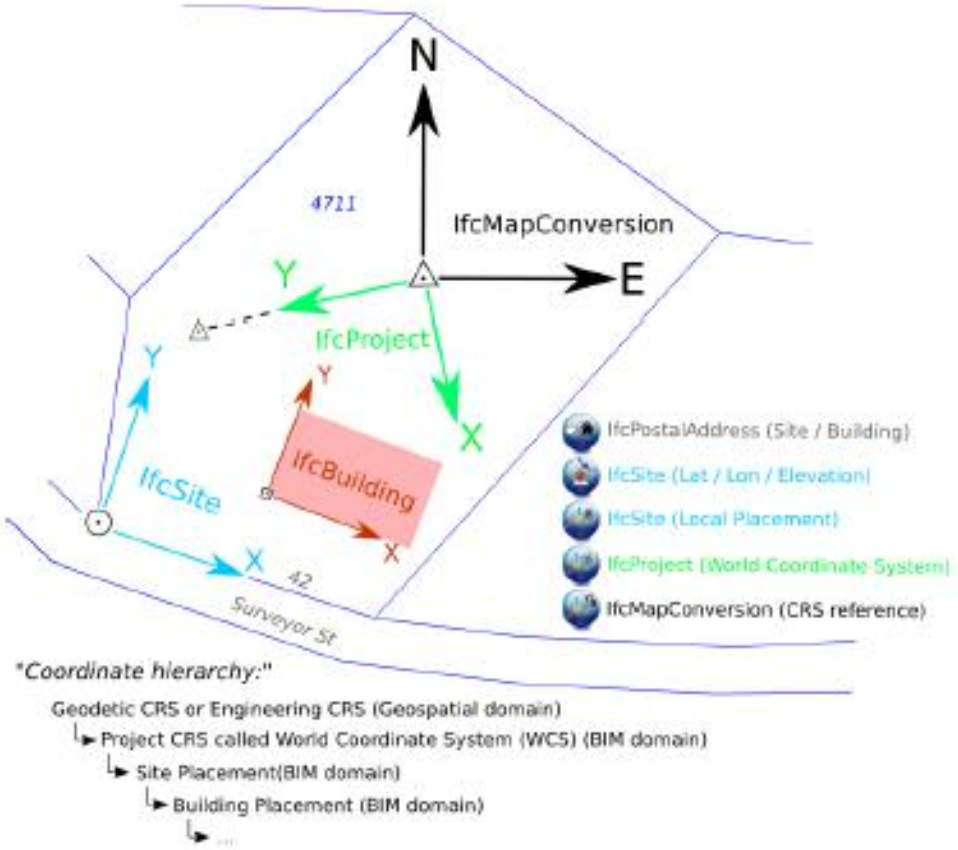

ExtrudedAreaSolid

Methodology and Realization



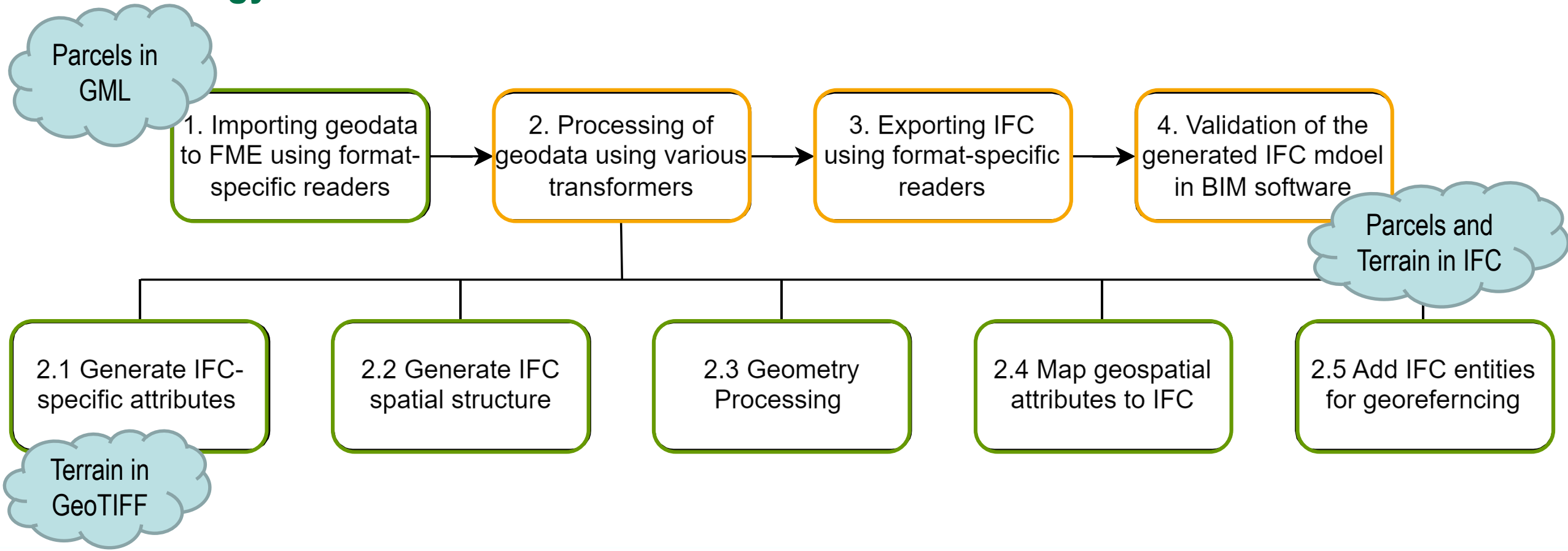
Excursus: Georeferencing in IFC4 and options in IFC2x3

- **LoGeoRef10**
  - postal address in **IfcPostalAddress**
  - referenced by **IfcSite** or **IfcBuilding**
- **LoGeoRef20**
  - geographic coordinate → **RefLatitude, RefLongitude** and **RefElevation** in **IfcSite**
- **LoGeoRef50**
  - offset between project coordinate system and global origin of a coordinate reference system in **IfcMapConversion** (with Easting, Northing, Orthogonal Height and rotation of XY-plane)
  - **IfcProjectedCRS** for metadata

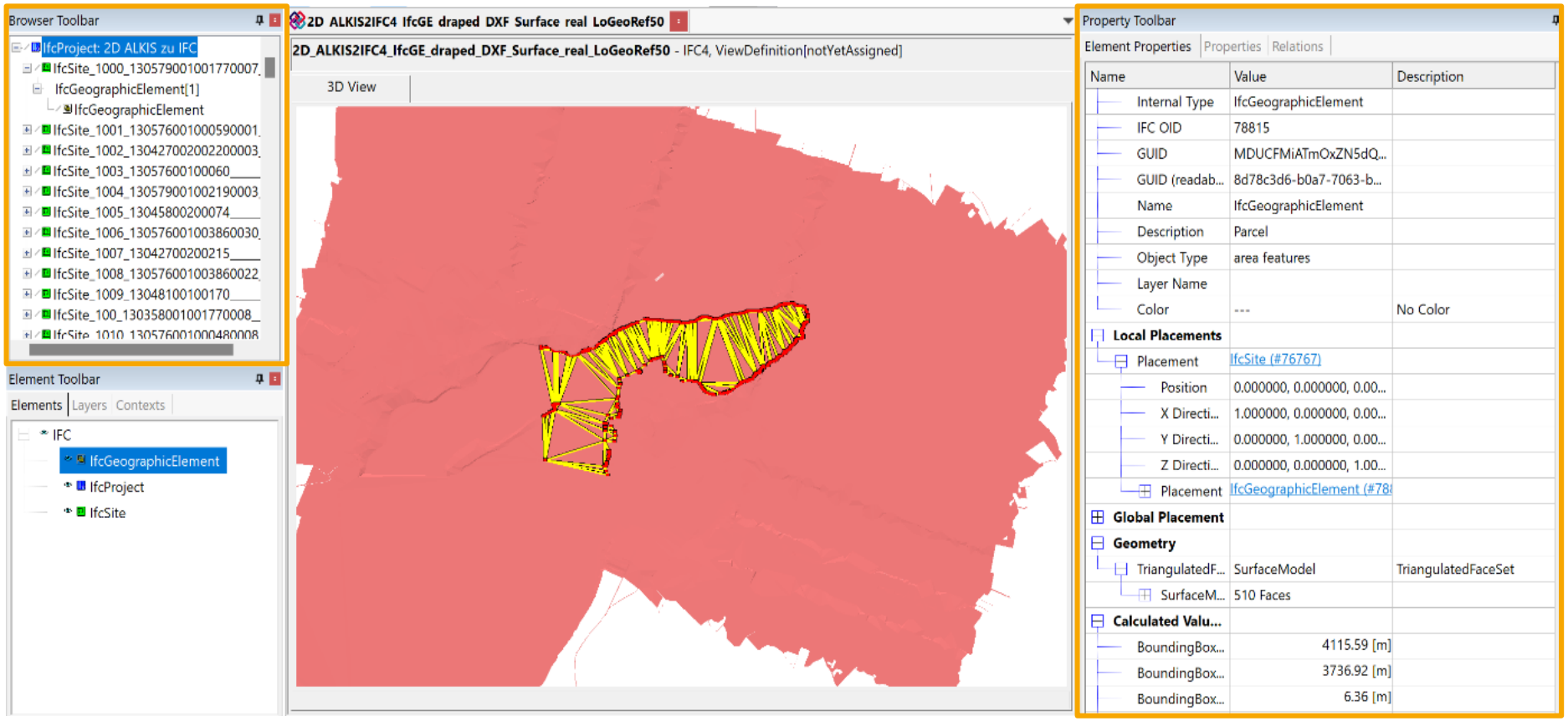


C. Clemen & H. Görne, 2019

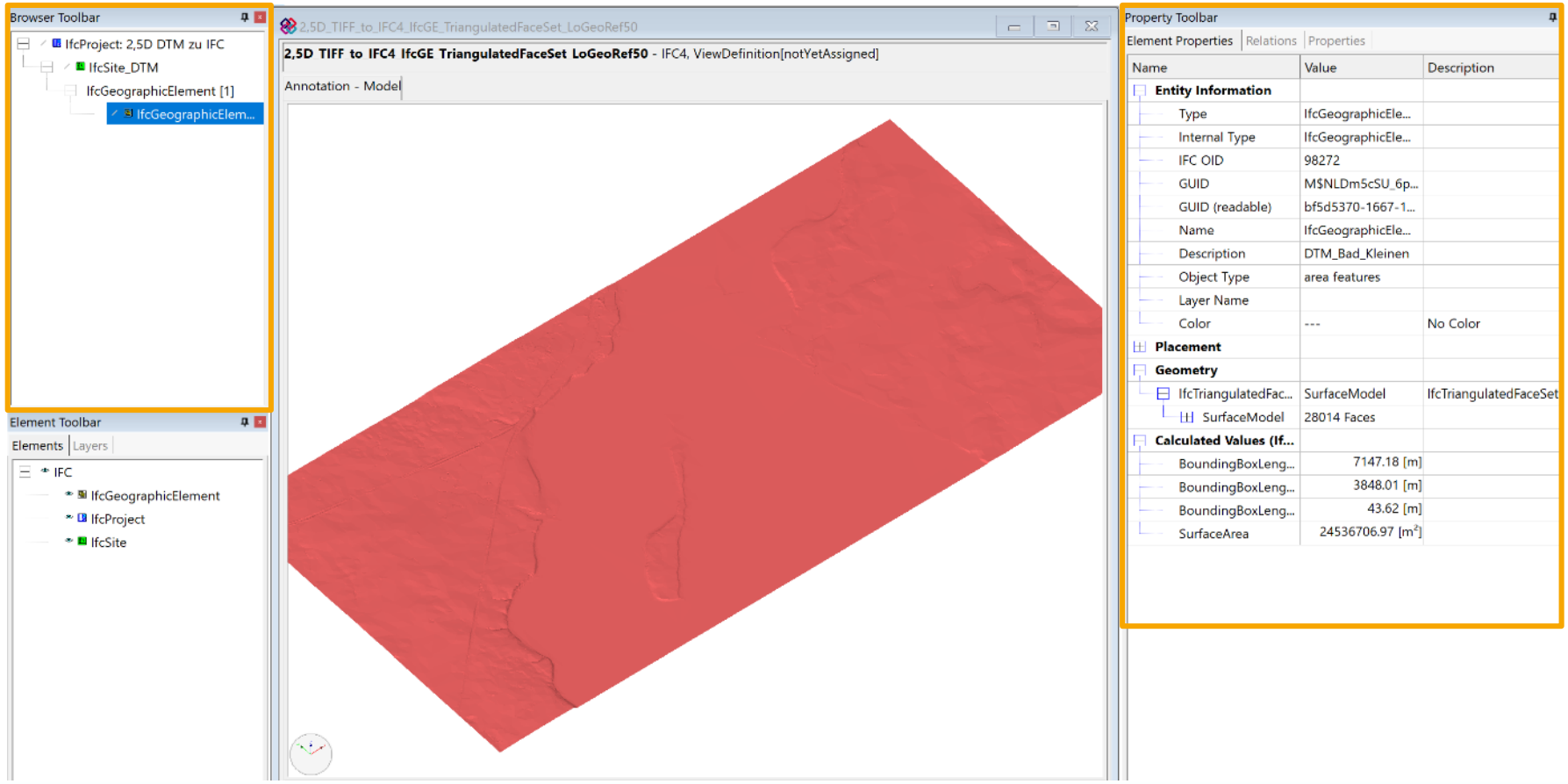
Methodology and Realization



Results – 2D cadastral data to IFC4



Results – 2.5D terrain model to IFC4



Summary

- our FME Workspace **offers**:
  - **automated** workflows for transforming geospatial data into **high-quality** IFC4 files
  - operates **without static** values
  - easily **adjustable** → enables use of **future** IFC versions
  - preserves **semantics** and **spatial structure**

- **limitations**:
  - currently relies on external Python-based transformer for LoGeoRef50

Outlook

- automated **calculation** of **rotation** component for LoGeoRef50
- implementation of **LoGeoRef 30** and **40**
- **more** geometry representations e.g. CSG
- **more** data formats

- entire FME process is provided by con terra as **Software as a Service**
  - can be used to **extend** other existing processes

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