MSc. Ing. Alexandru Nichersu (EIFER)
BSc. Isaac Boates (EIFER)
Dr. rer. nat. Tatjana Kutzner (TUM)

Nanaimo Water Pipes
Utility Network ADE Sample

Current stage of development

Table of Content

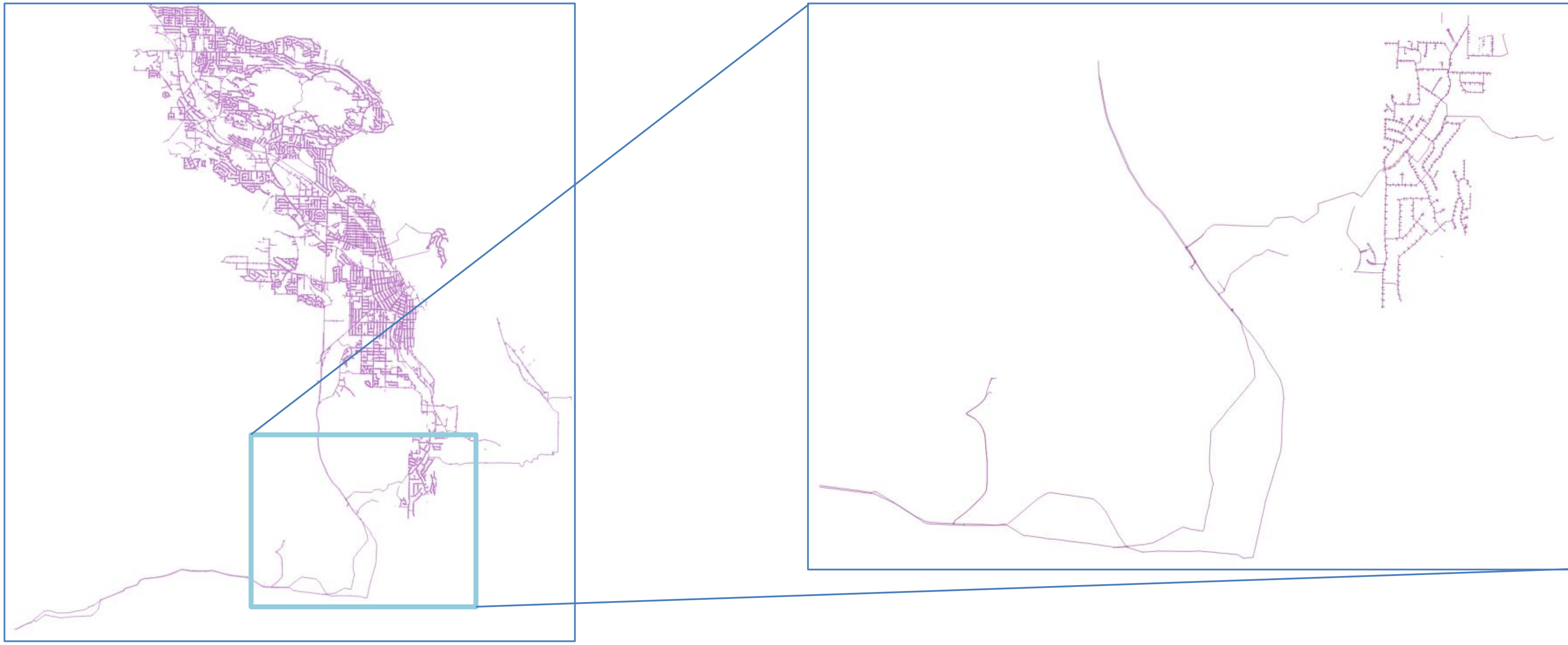
Nanaimo

Small coastal city in British Columbia, Canada.

They have recently published some of their utility network data on their website.

http://www.nanaimo.ca/EN/main/departments/Engineering-Public-Works/GIS/DigitalData.html

Study Area / Source Data



Preprocessing

Input 2 SHP files:

- PIPES.shp
- SERVICES.shp

Selection of small subsection, 3*3 km

Combined the 2 data sets, created attributes indicating type of line (e.g. service

Breaking main pipes in segments for service lines to be connected.

Connected to the cadastral data set so as to get the address and the property ID for the Terminal elements

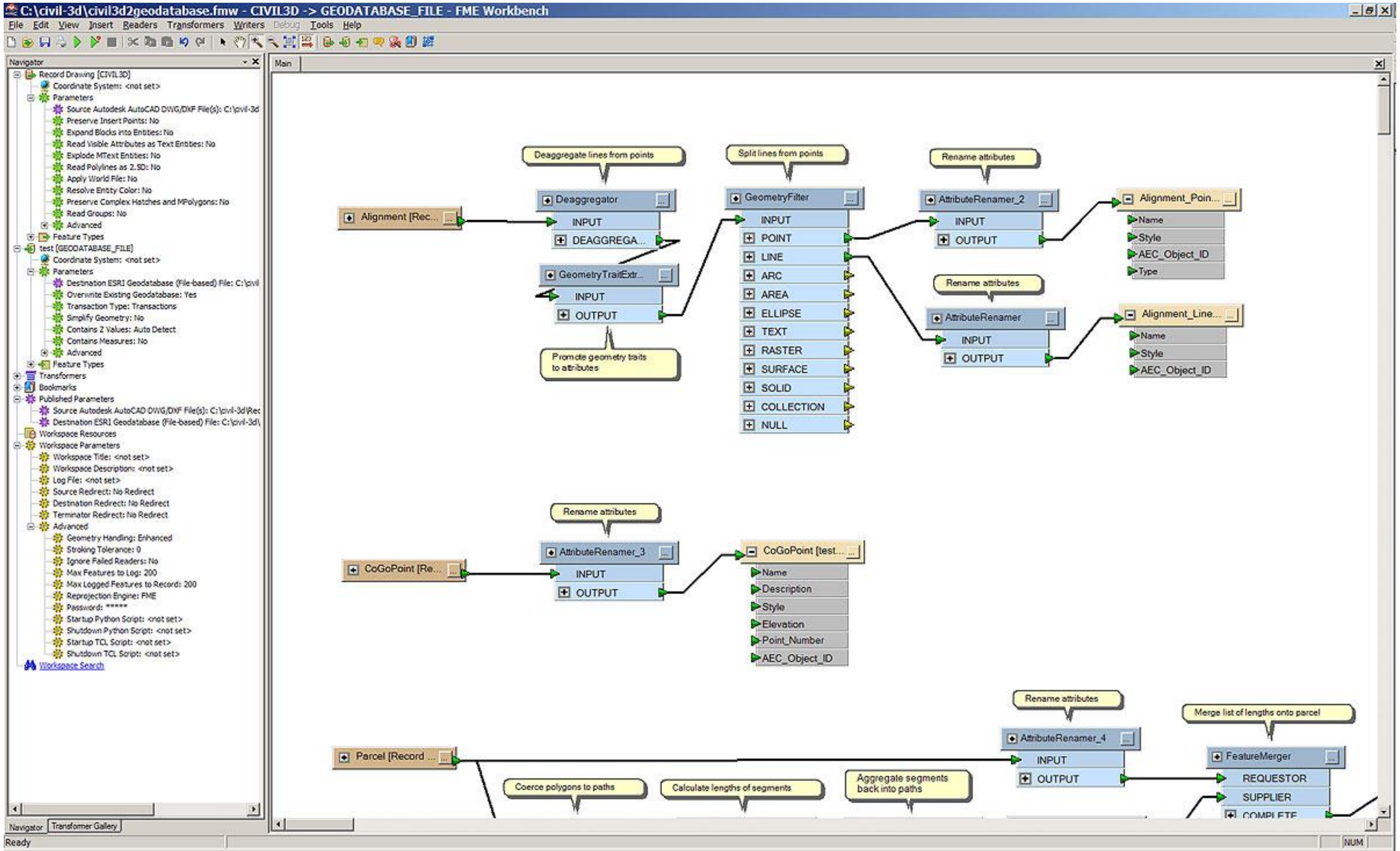
Feature Manipulation Engine (FME)

Proprietary (but flexible for students/researchers) software used to translate data from one format to another.

Graphical programming, uses connected “transformers” to manipulate the data from input “readers” to output “writers”

Allows for highly-customizable workflows to solve complex transformation problems.

Feature Manipulation Engine (FME)



Example of FME workflow, called a “workbench”. Data is read on the left, passed through transformers in the middle, and then written on the right.

TUM workshop

Workshop organized by TUM, which allowed us to get started with FME to manipulate the data.

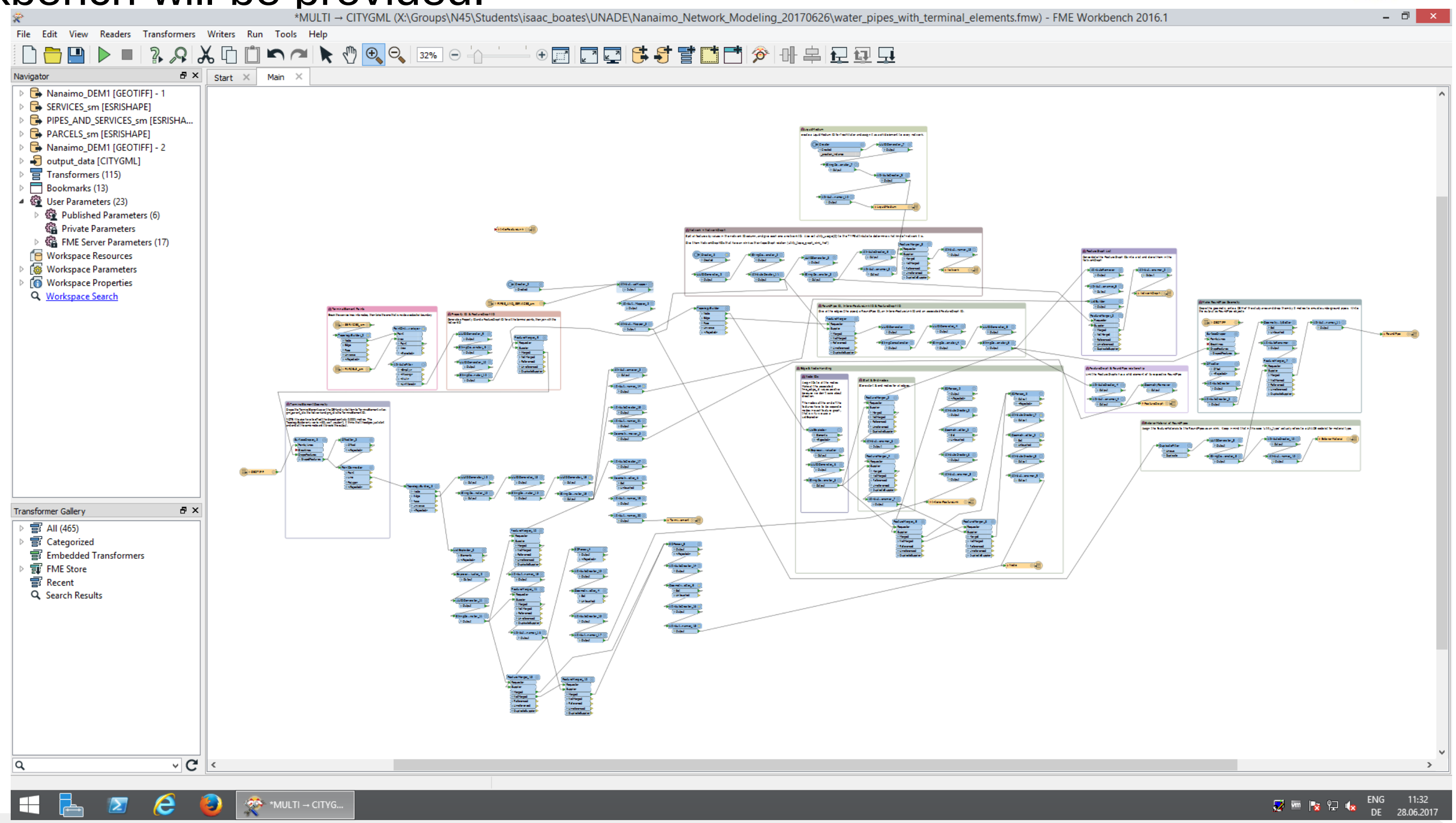
SAFE has developed a writer for FME that outputs CityGML files for which TUM has created a configuration file to write using the UtilityNetwork ADE schema.

Their work can be found on Github.
https://github.com/TatjanaKutzner/CityGML-UtilityNetwork-ADE
Includes necessary files, a setup guide and additional reading.

Result

An FME workbench has been created that translates water pipes and service lines into UtilityNetwork ADE Features.

There was some pre-processing done on the shapefile data to make the process smoother. The final input data to the workbench will be provided.



Data sample

A UNADE data sample has been created from the Nanaimo source data using FME. 3D information has also been interpolated via a DEM downloaded from Geogratis.

The data sample (will) contains:

1. A Network Element
2. A NetworkGraph Element
3. LiquidMedium Element
4. ExteriorMaterial Elements
5. RoundPipe Elements
6. TerminalElements
7. Node Elements
8. InteriorFeatureLink Elements
9. FeatureGraph Elements
10. InterFeatureLink Elements

Data sample

–A Network element

–Contains RoundPipe Elements and TerminalElements

–References a TransportedMedium Element (freshWater)

–References a NetworkGraph

–A NetworkGraph element

–Contains references to all FeatureGraphElements from the RoundPipe and TerminalElements

–LiquidMedium Element

–Contains basic properties about water

–ExteriorMaterial Elements

–Contains the name of the material from the source data. These values are not standardized to UNADE norms because some do not exist in UNADE code lists

Data sample

–RoundPipe Elements

–Generated from the lines in the “PIPES.shp” source data

–Contain a FeatureGraph Element

–Contains semantic data pulled from the source data (usage, year of construction, location quality, material)

–References an ExternalMaterial Element

–TerminalElements

–Generated from the lines in the “SERVICES.shp” source data. Also has a vertical addition sticking up to the surface level.

–Contain a FeatureGraph Element

Data sample

–FeatureGraph Elements

–Contain Node and InteriorFeatureLink Elements

–Derived from the source data geometry (identical to real-world geometry)

–Node Elements

–3D points, associated with FeatureGraph Elements and InteriorFeatureLink Elements

–InteriorFeatureLink Elements

–3D Linestrings, associated FeatureGraph Elements and Node Elements

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FME moves features through transformers along with their attributes as native “FME Feature Services”, then writes them in the desired format.

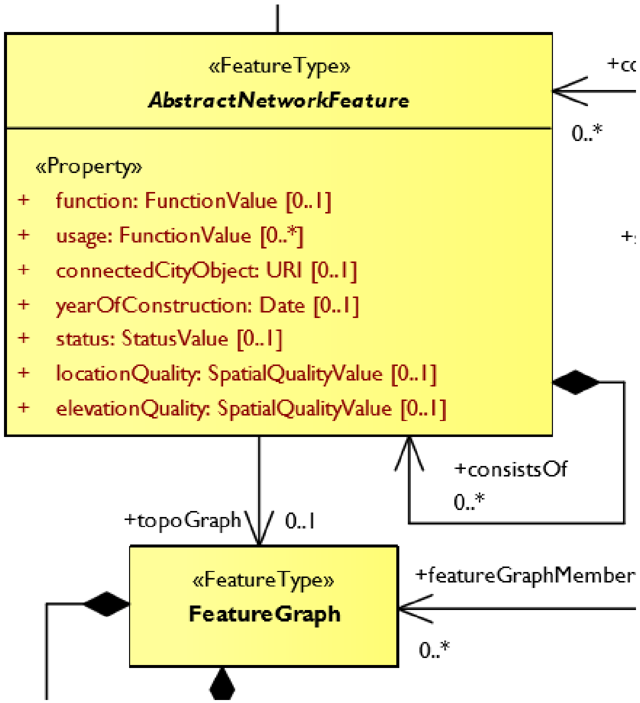
These attributes are also used to specify special relationships between CityGML features, with regards to its schema.

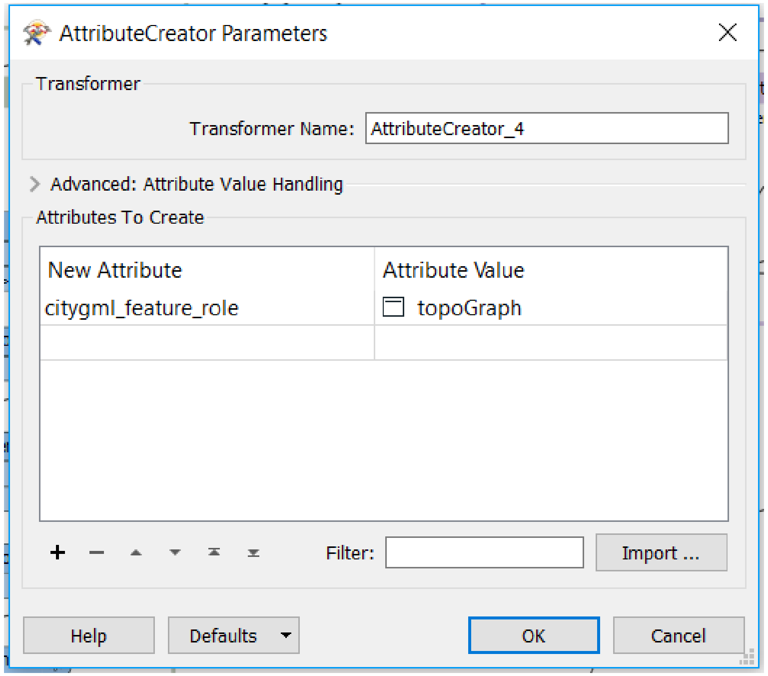
All the information in the sample data was written in one of two ways:

- **Storing information as a child element of its parent element.**
- **Storing information as an independent element, and then referencing it via an xlink.**

Storing information as a child element of its parent element.

A named relationship in the UML diagram is specified by setting an FME feature attribute called "citygml_feature_role"



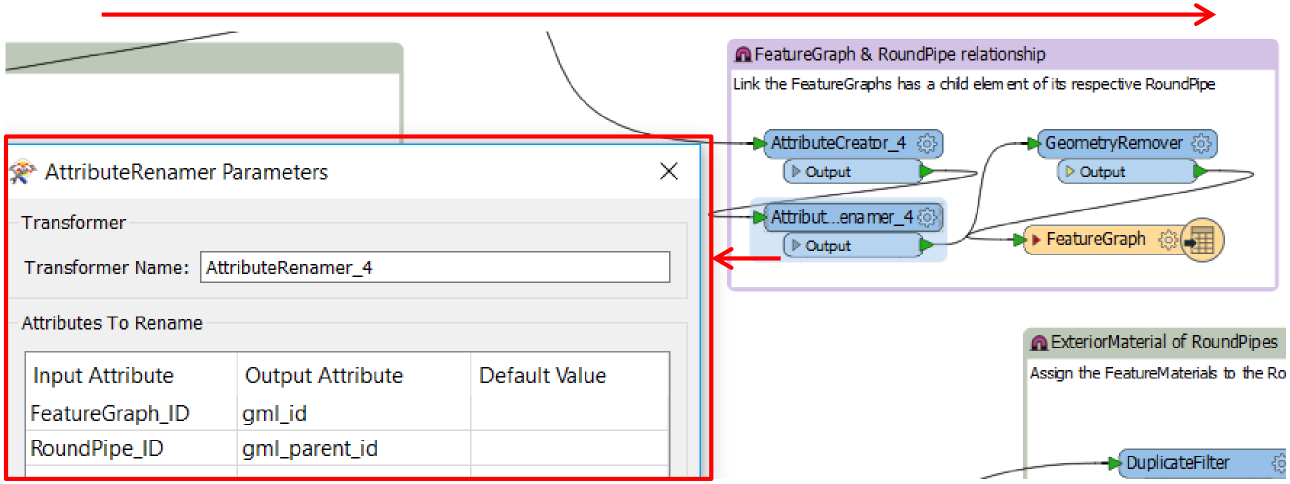


Child element storage

Storing information as a child element of its parent element.

This information can be stored directly in a parent tag by specifying the GML ID as the FeatureGraph ID and the parent GML ID as the RoundPipe ID.

FeatureGraph elements being written as child elements of their associated RoundPipe element



Child element storage

Storing information as a child element of its parent element.

Result:

```
<utility:RoundPipe gml:id="RoundPipeID_8925e5bf-4ad7-46c0-bc00-47b53b2e4bdf">
           …
           <utility:FeatureGraph gml:id="FeatureGraphID_699ecfbf-5133-48fc-94a9-93b3c87a32b1">
                      …
           </utility:FeatureGraph>
           …
</utility:RoundPipe>
```

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Storing Information Independently and Referencing via xlink.

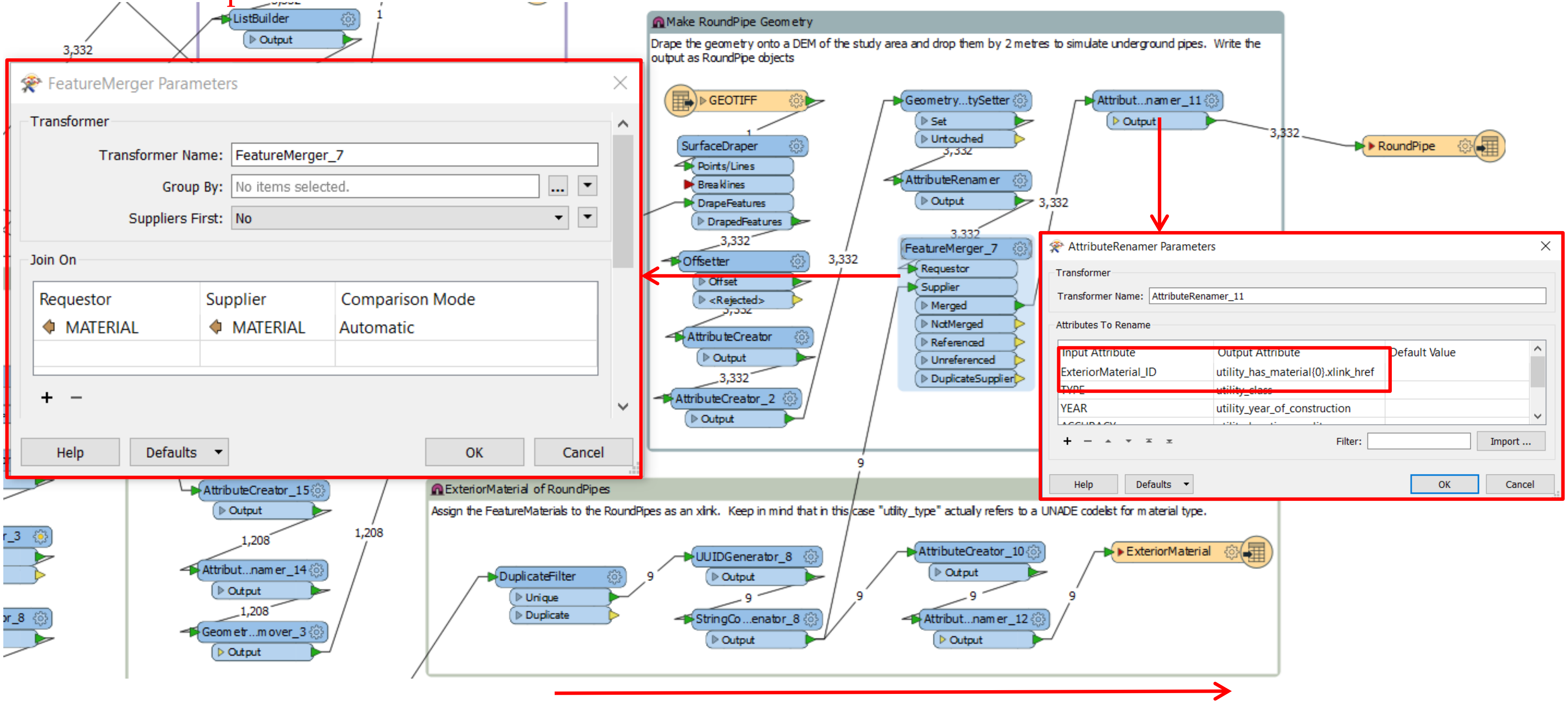
The same information can be stored elsewhere via an xlink.

In the sample dataset, ExteriorMaterial elements are stored independently and then referenced via xlink in the RoundPipe elements.

This is done via a “FeatureMerger” transformer.

Independent storage and Referencing via xlink

Writing RoundPipe elements as independent elements. They store an xlink pointing to the gml_id of their respective material.



Writing ExteriorMaterial elements as independent elements (They each have their own unique gml_id along with their properties)

Storing Information Independently and Referencing via xlink.

Result:

```
<utility:RoundPipe gml:id="RoundPipeID_584c0e0c-513b-4032-98d3-c81e3e19cc82">
          …
          <utility:hasMaterial xlink:href="ExteriorMaterialID_235110be-fd07-42cc-848a-a13b5045ca89"/>
          …
</utility:RoundPipe>
```

Elsewhere in the file:

```
<core:cityObjectMember>
          <utility:ExteriorMaterial gml:id="ExteriorMaterialID_235110be-fd07-42cc-848a-a13b5045ca89">
                    <utility:type>AC</utility:type>
          </utility:ExteriorMaterial>
</core:cityObjectMember>
```

Elements can be written anywhere you want, but you still have to specify their named relation from the UML diagram!

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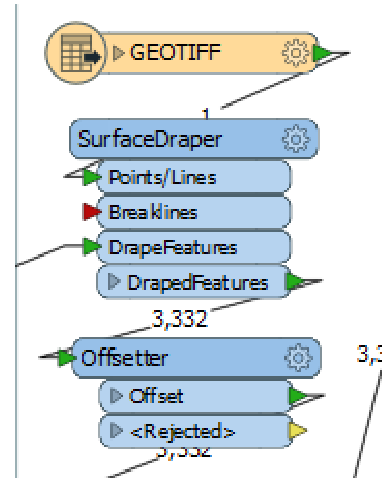
Storing Information Independently and Referencing via xlink.

3D Information is interpolated with a DEM for the area and draping the feature onto it.

The features are then offset by -2 metres on the vertical (z) axis.

Done via a “SurfaceDraper” and a “Offsetter” transformer.

Incoming 2D features to be draped & offset



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Conclusions

- FME is a good solution for creating CityGML UtilityNetwork ADE data from source data.

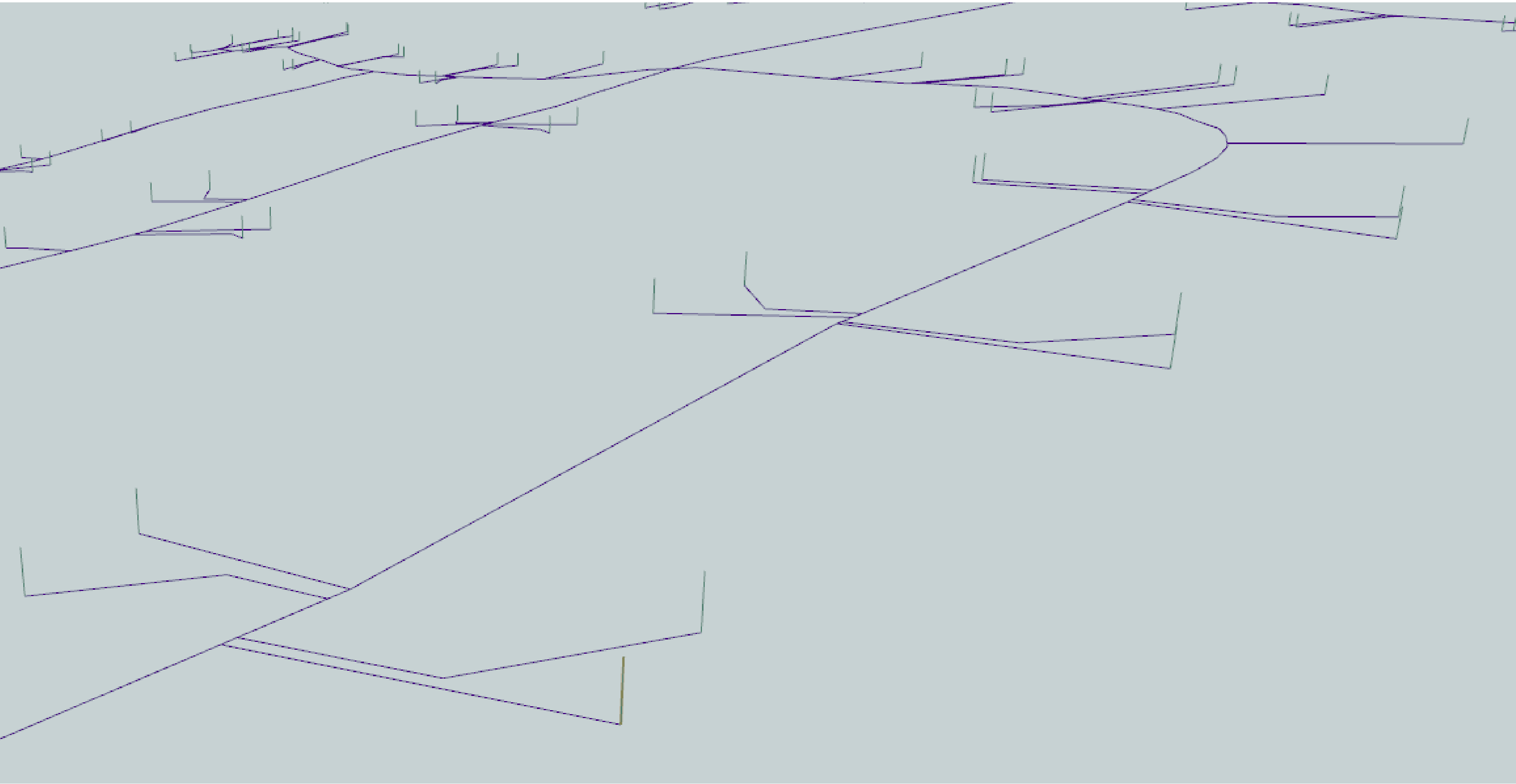
- This is because utility network source data varies in schema, and FME allows for complex custom solutions.

- The sample dataset and its associated workbench can serve as a general guideline on the basics of writing CityGML UtilityNetwork ADE data.

- The need for a LOD type concept depending on use case (e.g. inventory vs network analysis) is more apparent then ever (not to be confused with geometry LOD, the writer only writes in LOD1).

- For ease of use we inserted the element type in the gml:id, as the standard is just very large

Conclusions



Further work

- Finish working sample with all associated input/output data onto the UNADE github.

  Still need to add information for InterFeatureLinks.

- Visualisation of the data in other interfaces.

  e.g. in FZKViewer

- Further enrichment of the data sample.

  Add additional networks (electric? Need to find data source, contact the local electricity supplier)

  Add buildings as connected objects

  Add appurtenances as network elements (valves, reservoirs, pumps, etc.)

- Possible integration into AR app and web browser

Thank you…

Contact

Alexandru Nichersu
nichersu@eifer.org
+49 (0)721 - 6105 1379

EIFER
Emmy-Noether-Straße 11
76131 Karlsruhe
Germany
www.eifer.org