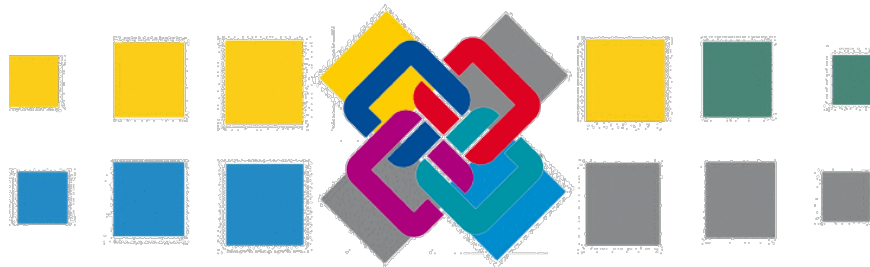




ISPRS EuroSDR GeoBIM benchmark<sup>1</sup>  
2019

# Task 4 - Options for conversion: IFC to CityGML and CityGML to IFC

Results of the tests delivered by participants



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<sup>1</sup> <https://3d.bk.tudelft.nl/projects/geobim-benchmark/>

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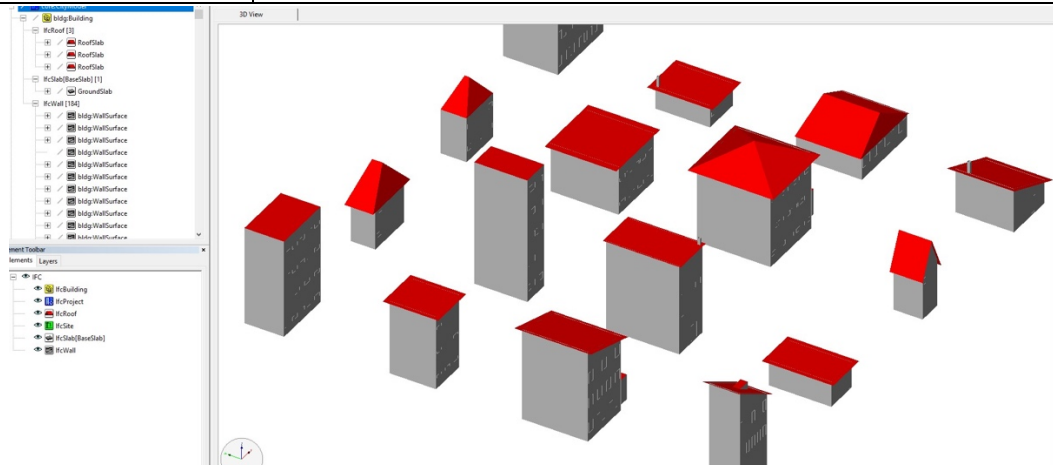
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## From CityGML to IFC

### CityGML2IFC

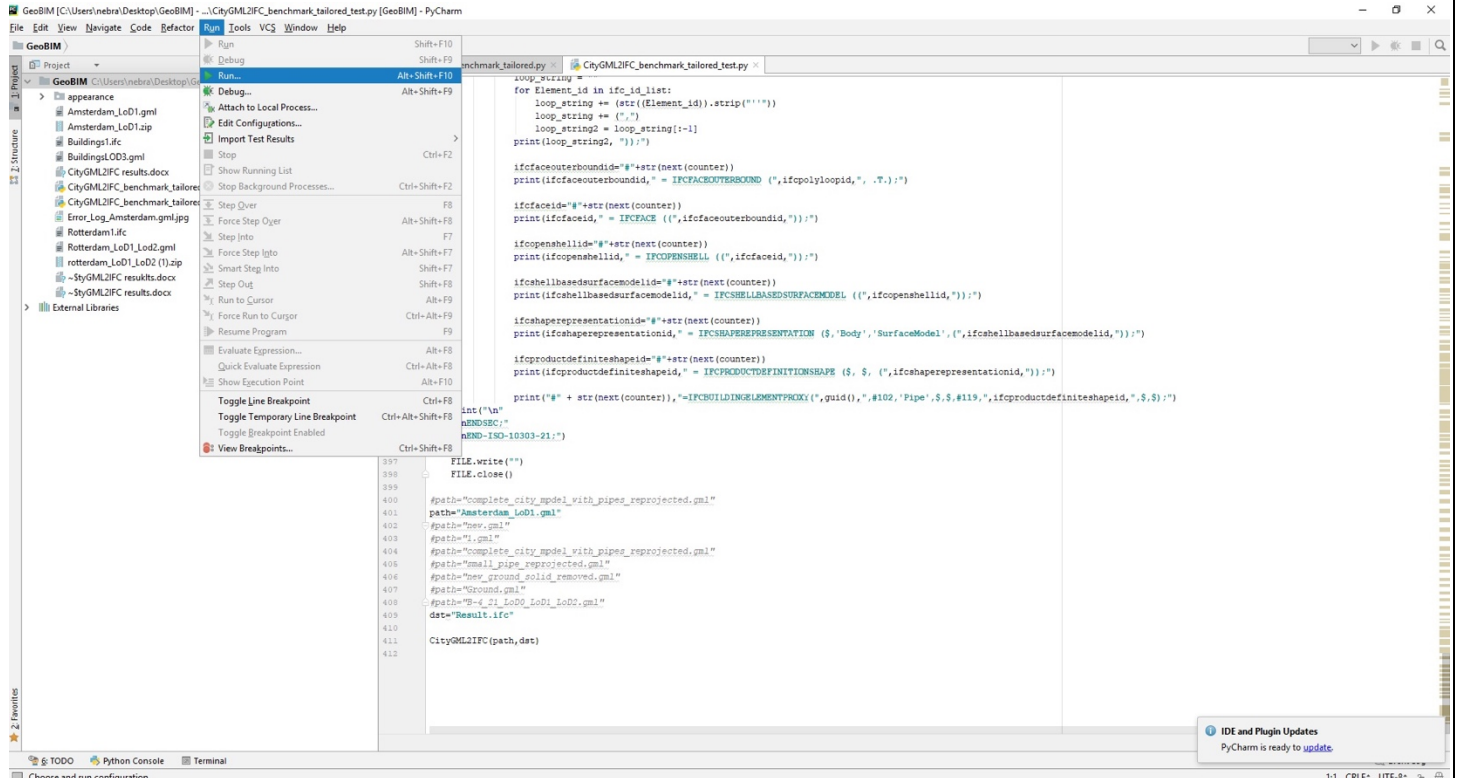
Software	Software Name [version]	CityGML2IFC [1]			Software house	<a href="https://github.com/nsalheb/CityGML2IFC">https://github.com/nsalheb/CityGML2IFC</a>	
	Proprietary or open source software?			Kind of software			
	open source			Extract/Transform/Load			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space

1) Are you making a conversion	From CityGML to IFC
2) What file are you using?	Buildings3D (CityGML)
2.1) What LOD(s) will result from your conversion?	LOD2
4) How long does it take for the data to be converted (computer time)?	less than a minute
6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?	CityGML2IFC is made to be able to convert CityGML LOD2 while the input data is in LOD3 hence they are incompatible to each other. and it is interesting to see the results.

<p>7) Attach other screenshots or files that you consider useful</p>	
--	--

1) Are you making a conversion	From CityGML to IFC
2) What file are you using?	Buildings3D (CityGML)
2.1) What LOD(s) will result from your conversion?	LOD2
3.1) Are you using an off-the-shelf tool?	No, I am using a bespoke piece of software (i.e. one developed by me or my company but not completely available to the public).
3.1.2) Give an extensive description about the <b>*tools*</b> , <b>*settings*</b> and <b>*workflow*</b> necessary to make the conversion.	<p>CityGML2IFC.py is a program written in Python 3. When compiled the program will convert a source file in CityGML to a destination file in IFC.</p> <p>It is an open-source program that is developed by Nebras Salheb and can be found here:  <a href="https://github.com/nsalheb/CityGML2IFC">https://github.com/nsalheb/CityGML2IFC</a></p> <p>more details about using the software can be found in the GitHub link.</p> <p>The aim of the program is to convert CityGML LOD2 to IFC2X3 in order to make 3D City models accessible in design &amp; construction software.</p>

**3.1.3) Attach screenshots / documentation related to the previous question**



**4) How long does it take for the data to be converted (computer time)?**

less than a minute

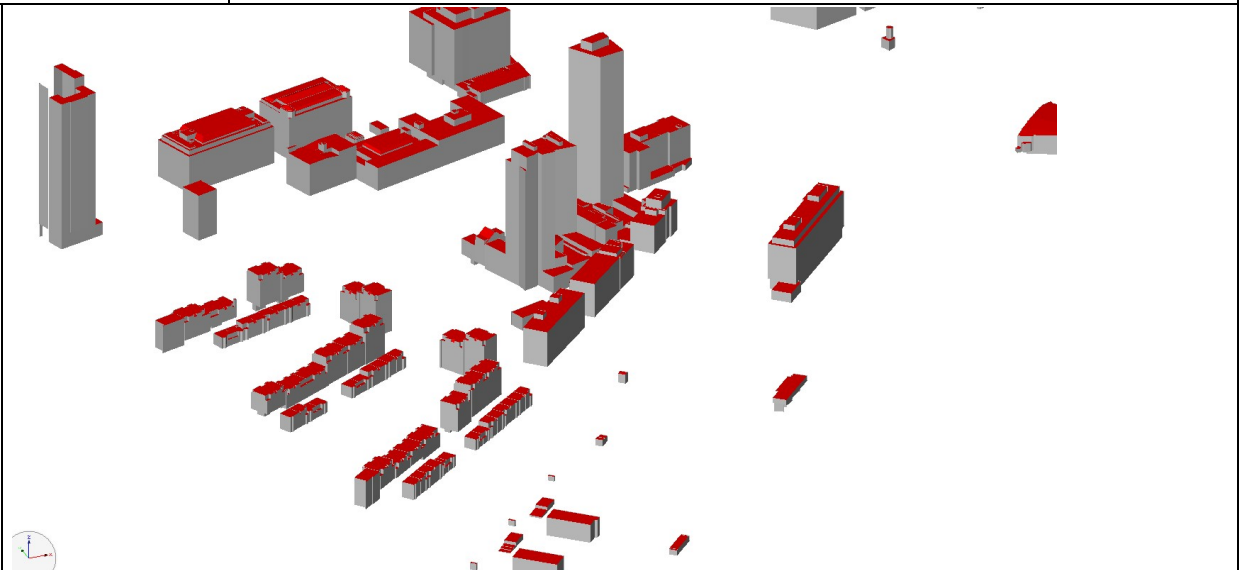
**5) Would you like to share any other comments or observations?**

The software has Totally ignored the LOD1 file. Successfully converted most parts of LOD2 data

**6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?**

It seems that there was a problem with converting parts of the data where LOD1 and LOD2 are overlapping.

**7) Attach other screenshots or files that you consider useful**



**1) Are you making a conversion**

From CityGML to IFC

## CityGML2IFC –

Open source

Extract/Transform/Load

4 - Developer of the tested software

<b>2) What file are you using?</b>	amsterdam (CityGML)
<b>2.1) What LOD(s) will result from your conversion?</b>	Error: No Results
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>	Amsterdam_LoD1.gml is too big to be processed by CityGML2IFC
<b>7) Attach other screenshots or files that you consider useful</b>	<pre>C:\Users\nebra\Desktop\CityGML2IFC\venv\Scripts\python.exe C:/Users/nebra/Desktop/GeoBIM/CityGML2IFC_benchmark_tailored.py Traceback (most recent call last):   File "C:/Users/nebra/Desktop/GeoBIM/CityGML2IFC_benchmark_tailored.py", line 411, in &lt;module&gt;     CityGML2IFC(path,dst)   File "C:/Users/nebra/Desktop/GeoBIM/CityGML2IFC_benchmark_tailored.py", line 82, in CityGML2IFC     tree = ET.parse(path)   File "C:\Program Files (x86)\Python36-32\Lib\xml\etree\ElementTree.py", line 1196, in parse     tree.parse(source, parser)   File "C:\Program Files (x86)\Python36-32\Lib\xml\etree\ElementTree.py", line 597, in parse     self._root = parser._parse_whole(source) MemoryError  Process finished with exit code 1</pre>

## FZKViewer

Software	Software Name [version]	<b>FZKViewer [V 5.1]</b>			Software house	<b>Karlsruhe Institute for Technology</b>	
	Proprietary or open source software?				Kind of software		
	proprietary				3D viewer		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL G5 5587, 2018	Microsoft Windows 10 Pro 10.0.18362 Build 18362	Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz	NVIDIA GeForce GTX 1060 with Max-Q Design	16	462	310

<b>1) Are you making a conversion</b>		From CityGML to IFC
<b>2) What file are you using?</b>		amsterdam (CityGML)
<b>2.1) What LOD(s) will result from your conversion?</b>		LOD 100
<b>3.1) Are you using an off-the-shelf tool?</b>		Yes
<b>3.1.1) Is a completely automatic procedure working?</b>		Yes
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	<ol style="list-style-type: none"> <li>1. Simple FZKViewer installation (freeware)</li> <li>2. Launch FZKViewer, Open GML file and browse data set (Amsterdam LoD1). Click Open (Spatial Reference System is already set)</li> <li>3. Click File &gt; Export &gt; IFC. Select destination folder and add file name. Click Save.</li> <li>4. Before SAVE, in Options you can choose format i.e. IFC2X3 or IFC4 (see 3.2 for details)</li> <li>5. Converted IFC file is created at output path.</li> </ol>	
<b>3.1.1.2) Attach screenshots</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/FZK_Automatic_Procedure_Steps_and_Screenshots.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/FZK_Automatic_Procedure_Steps_and_Screenshots.pdf</a>	
<b>3.2) Add short comments to the previous questions (optional)</b>	FZKViewer is a free application for viewing/displaying sematic data models, not an off-the-shelf conversion solution. However, you can export IFC file in IFC2x3 or IFC4 with EXPRESS based, XML (ifcXML) or Zipp format. For this dataset IFC4 format was selected.	
<b>4) How long does it take for the data to be converted (computer time)?</b>		5-20 minutes
<b>5) Would you like to share any other comments or observations ?</b>	<p>Amsterdam LoD1 is a very large CityGML dataset generally to check software and system's compatibility of handling large scale dataset. With current computer machine it wasn't just able to open the file, but also exporting the IFC file, without crashing. Zooming and Skewing this large multilayer data makes FZK unresponsive for a while but doesn't crash until multiple view related operations are performed at same time.</p> <p>The process of importing CityGML file in FZK took around 15-20 mins and exporting to IFC was faster, 7-10 mins. The export process makes software unresponsive but doesn't crash and completes without termination or errors.</p> <p>Since it was LoD1 data for CityGML, converting it to IFC resulted in LOD 100 with just the</p>	

	<p>building foot print as shown in attached additional visualization file in question 6. The semantics of building attributes were translated correctly and exported IFC file size was very large around 8 GB.</p> <p>Note: This process was only carried out for IFC4 format.</p>	
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>	<p>Amsterdam dataset is large with multiple layers. If the focus of conversion is only towards buildings layer, then other layers which make the conversion process slow and software unresponsive while handling dataset can be removed.</p>	
<b>7) Attach other screenshots or files that you consider useful</b>	<p><a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/AmsterdamLoD1_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/AmsterdamLoD1_Additional_Visualizations_and_Comments.pdf</a></p>	
<b>1) Are you making a conversion</b>	<p>From CityGML to IFC</p>	
<b>2) What file are you using?</b>	<p>Buildings3D (CityGML)</p>	
<b>2.1) What LOD(s) will result from your conversion?</b>	<p>LOD 200</p>	
<b>3.2) Add short comments to the previous questions (optional)</b>	<p>FZKViewer is a free application for viewing/displaying sematic data models, not an off-the-shelf conversion solution. However, you can export IFC file in IFC2x3 or IFC4 with EXPRESS based, XML (ifcXML) or Zip format.</p>	
<b>4) How long does it take for the data to be converted (computer time)?</b>	<p>it's almost immediate</p>	
<b>5) Would you like to share any other comments or observations?</b>	<p>Exported IFC file have correct semantics (schema, hierarchy and attributes) and geometry from CityGML file. Hierarchy is kept like it should be from CityGML to IFC conversion and correct mapping entities are assigned. GML Attributes as set as GML PropertySet in resultant file (check Additional Visualizations file in part 6).</p> <p>File exported from FZKViewer have same size even if we export multiple times using different format (unlike FME conversions, which shows there is diverging loss of semantic or geometric details in each transformation).</p> <p>Note: For IFC4 format the process is same, only checking option for IFC4 instead of IFC 2x3, before converting and saving the file. Also, you have to explicitly add extension .ifc to exported file. FZKViewer does add .ifc extension to IFC 2x3 format implicitly.</p>	
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>	<p>We find dataset very competent for testing CityGML LoD3 conversion to IFC LOD 200.</p>	
<b>7) Attach other screenshots or files that you consider useful</b>	<p><a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/BuildingsLoD3_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/BuildingsLoD3_Additional_Visualizations_and_Comments.pdf</a></p>	
<b>1) Are you making a conversion</b>	<p>From CityGML to IFC</p>	
<b>2) What file are you using?</b>	<p>Rotterdam 3D (CityGML)</p>	
<b>2.1) What LOD(s) will result from your</b>	<p>LOD 100</p>	

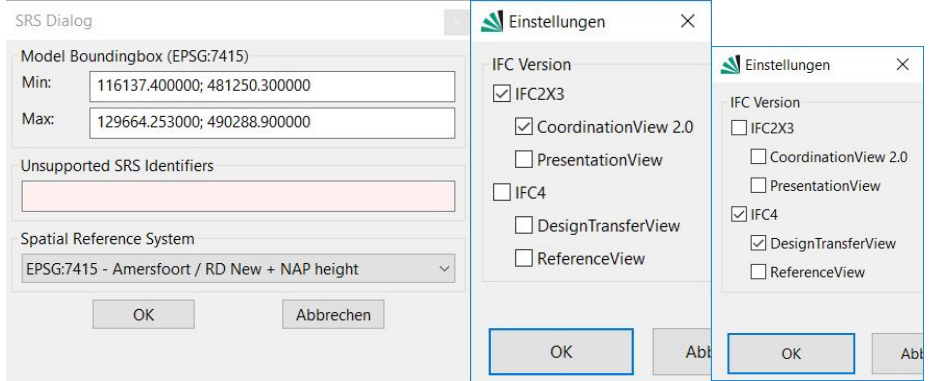
<b>conversion?</b>	
<b>3.2) Add short comments to the previous questions (optional)</b>	FZKViewer is a free application for viewing/displaying sematic data models, not an off-the-shelf conversion solution. However, you can export IFC file in IFC2x3 or IFC4 with EXPRESS based, XML (ifcXML) or Zip format.
<b>4) How long does it take for the data to be converted (computer time)?</b>	it's almost immediate
<b>5) Would you like to share any other comments or observations?</b>	<p>FZK Viewer was able to import CityGML file with multiple LoDs (LoD 1 and LoD 2) and export into IFC format. However, IFC visualization software (BIM Vision) was unable to open converted file. Reason being because multiple LoDs are exported in same file and IFC reader can't interpret multiple converted LODs in BIMVision.</p> <p>Visualization of such IFC file isn't supported by software. Thus, either support from software industry is required for evaluating such conversion or this process requires manual filtering of based on LOD from converted IFC file, which is very challenging considering the complexity of IFC model. Easier way to address this problem is to export multiple IFC files with different LODs based on LoDs of CityGML. However, such process is out of scope for this participation.</p> <p>For IFC4 format, you have to explicitly add extension .ifc to exported file.</p>
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/Rotterdam3D_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/Rotterdam3D_Additional_Visualizations_and_Comments.pdf</a>



## FZKViewer

Software	Software Name [version]	<b>FZKViewer [V 5.1]</b>		Software house	<b>Karlsruhe Institute for Technology. Institute for Automation and Applied Informatics</b>		
	Proprietary or open source software?	proprietary		Kind of software	3D viewer		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	HP ZBook Studio G3, 2015	Windows 10 Pro	Intel(R) Core(TM) i7-6700HQ CPU@2.60GHz 2.59GHz	NVIDIA Quadro M1000M	32 GB	218 GB	39 GB

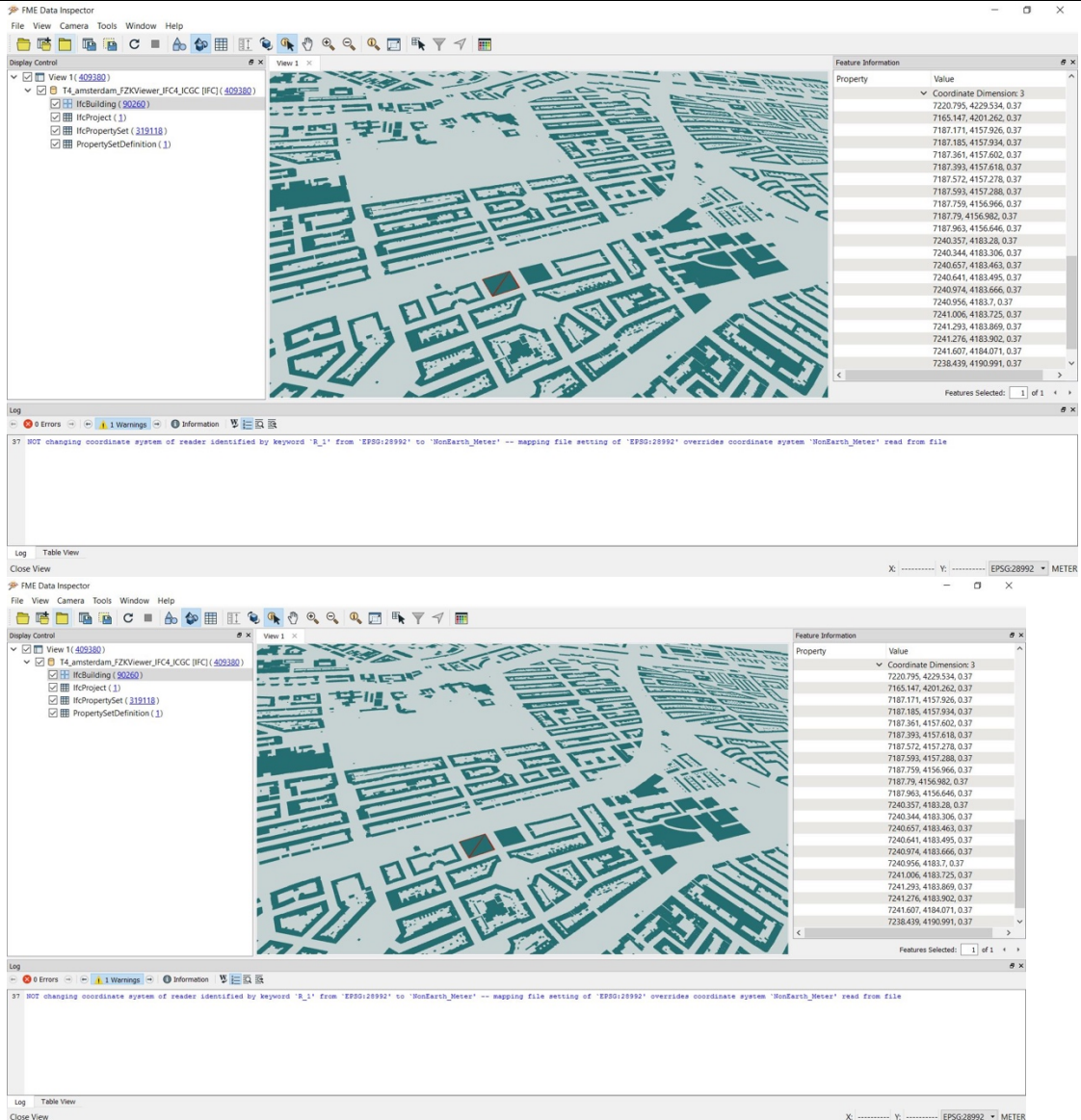
<b>1) Are you making a conversion</b>	From CityGML to IFC
<b>2) What file are you using?</b>	amsterdam (CityGML)
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD0
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	From File > Open > Open GML File we open the file (screenshot 1_GML_Parameters_Open.JPG) and export it in IFC2x3 and IFC4 using File > Export > IFC (screenshots 2_IFC2x3_Parameters_Export.JPG and 3_IFC4_Parameters_Export.JPG). Log of the open process in amsterdam.logxml.

<p><b>3.1.1.2) Attach screenshots</b></p> <p>In order: GML_parameters_open; IFC2x3 parameters export; IFC4 parameters export.</p>	 <p>Check in addition: <a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/amsterdam.logxml">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/amsterdam.logxml</a></p>
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<b>3.2) Add short comments to the previous questions (optional)</b>	We have already filled this form for another dataset, but we answered Not, in order to give some details about the procedure working.
<b>4) How long does it take for the data to be converted (computer time)?</b>	5-20 minutes
<b>5) Would you like to share any other comments or observations?</b>	Opening the output files using FZKViewer the system crashes due to lack of memory, its size is about 8.3 GB. Opening them using FME Data Inspector 2018 the buildings

don't have height on the 3D view (screenshots on amsterdam\_IFC\_OpenErrors.zip).

7) Attach other screenshots or files that you consider useful



7.5) In addition, attach this filled form in word format

See "68 - Task 4 – \_conversions\_FZKViewer51\_amsterdam\_ICGC\_delivered" in OSF

1) Are you making a conversion

From CityGML to IFC

2.1) What LOD(s) will result from your conversion?

In the previous question we have used de file BuildingsLOD3.gml (CityGML)

3.1) Are you using an off-the-shelf tool?

Yes

3.1.1) Is a completely automatic procedure working?

Yes

3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the

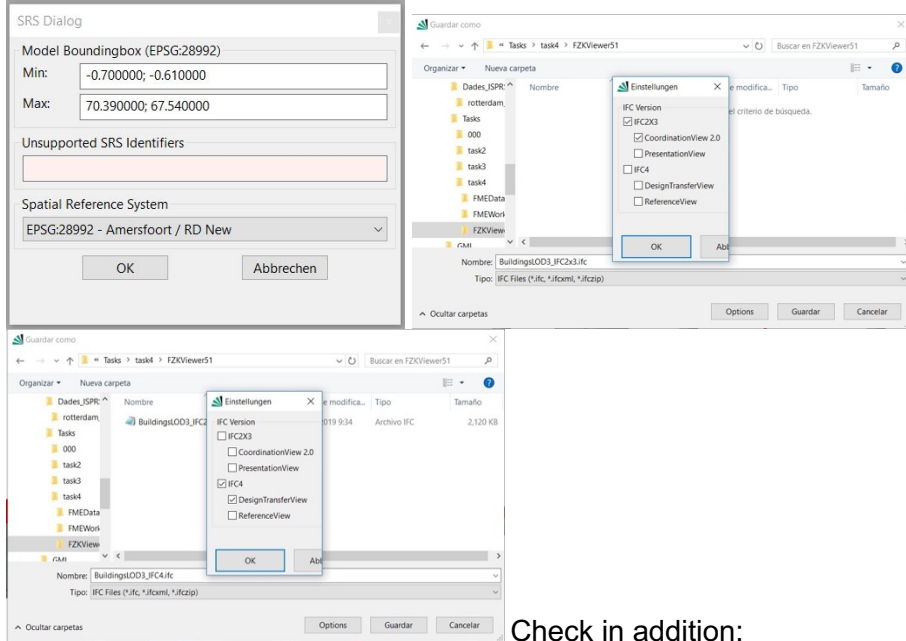
From File > Open > Open GML File we open the file (screenshot 1\_GML\_Parameters\_Open.JPG) and export it in IFC2x3 and IFC4 using File > Export > IFC (screenshots 2\_IFC2x3\_Parameters\_Export.JPG and 3\_IFC4\_Parameters\_Export.JPG).

conversion)?

Log of the open process in BuildingsLOD3.logxml.

**3.1.1.2) Attach screenshots**

In order:  
 GML\_parameters\_open;  
 IFC2x3 parameters export;  
 IFC4 parameters export.



Check in addition:

<https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/BuildingsLOD3.logxml>

**4) How long does it take for the data to be converted (computer time)?**

it's almost immediate

**5) Would you like to share any other comments or observations?**

Opening the output files using FZKViewer, the data seems ok but Query > Log Messages and also Query > IFC Schema Validation give errors.

**7) Attach other screenshots or files that you consider useful**

[https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/BuildingsLOD3\\_IFC\\_OpenErrors.zip](https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/BuildingsLOD3_IFC_OpenErrors.zip)

**7.5) In addition, attach this filled form in word format**

See "73 - Task 4 – \_conversions\_FZKViewer51\_BuildingsLOD3\_ICGC\_delivered" in OSF

## FME 2019.2

Software Name [version]	<b>FME [2019.2]</b>			Software house	<b>Safe Software</b>	
<b>Proprietary or open source software?</b>				<b>Kind of software</b>		
proprietary				Extract/Transform/Load		
<b>IFC Certification</b>				Not certified		
<b>Model and year</b>	<b>Operating system and version</b>	<b>CPU</b>	<b>GPU</b>	<b>Memory (RAM)</b>	<b>Hard drive capacity</b>	<b>Hard drive free space</b>
Dell Latitude 3400 x64 i7-8586U	MS Windows 10.0.18362	x64 i7-8586U	GeForce MX-130 NVidia	16	940	405
<b>2) What file are you using?</b>				RotterdamLOD12.gml (CityGML)		
<b>2.1) What LOD(s) will result from your conversion?</b>				LOD1, LOD2		
<b>3.1) Are you using an off-the-shelf tool?</b>					Yes	
<b>3.1.1) Is a completely automatic procedure working?</b>	FME is a spatial data integration and conversion tool. FME can perform default translations with little to no configuration for simple conversions such as DWG to SHAPE, or CSV to Excel. However, to convert between complex data models usually requires configuration to set up. There are a lot of automated functions that help with the configuration – schema scan etc – but there are also manual steps required. Once the data conversion / transform model is defined, then calling the transformation can be fully automated for source datasets that have a similar structure. FME can also be automated in a service oriented architecture via FME Server. Typically transformation services are accessed via the FME Server REST API.					
<b>brief description about where the tool can be found (e.g. on which menu) and how it works</b>	<p><b>Installation steps:</b></p> <ol style="list-style-type: none"> <li>Download is found here: <a href="https://www.safe.com/support/downloads/">https://www.safe.com/support/downloads/</a> and if you don't have a license, you can select the Free Trial for a 30 day full version trial</li> <li>In the setup wizard when running the.msi file, specify a directory to install FME. Instructions for installing FME on different operating systems: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop_Admin_Guide/FMEInstallation/Installing-FME-Desktop.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop_Admin_Guide/FMEInstallation/Installing-FME-Desktop.htm</a></li> <li>Open the Licensing Assistant (or FME Workbench will prompt the licensing assistant) and input your trial code, floating license, or serial code</li> </ol> <p>FME Workbench:</p> <ol style="list-style-type: none"> <li>Open FME Workbench to author your workspace</li> <li>Drag and drop IFC file or add a Reader pointing to the source file</li> <li>Build workspace (see below)</li> </ol> <p><b>Resources:</b></p> <ul style="list-style-type: none"> <li>AutoCAD to IFC Conversion Example: <a href="https://knowledge.safe.com/articles/595/autocad-to-ifc-conversion-example.html">https://knowledge.safe.com/articles/595/autocad-to-ifc-conversion-example.html</a></li> <li>IFC Reader / Writer doc: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/ifc/ifc.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/ifc/ifc.htm</a></li> <li>CityGML Reader / Writer doc: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/citygml/citygml.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/citygml/citygml.htm</a></li> <li>Safe.com/BIM: <a href="https://www.safe.com/data-types/bim/">https://www.safe.com/data-types/bim/</a></li> <li>Safe.com BIM webinars: <a href="https://www.safe.com/webinars/how-to-create-gis-and-bim-interoperability/">https://www.safe.com/webinars/how-to-create-gis-and-bim-interoperability/</a></li> <li>Article: Path to an Integrated Modelling between IFC and CityGML for Neighborhood Scale Modelling: <a href="https://www.mdpi.com/2413-8851/1/3/25/htm">https://www.mdpi.com/2413-8851/1/3/25/htm</a></li> </ul>					

brief description about where the tool can be found (e.g. on which menu) and how it works

The basic procedure for building a data conversion workflow in FME is as follows. Add the reader source format and dataset, specify the writer destination format and dataset, and then add the necessary transformation steps to convert the source data model to meet the requirements of the destination data model. The transformation steps are performed using FME functions called transformers. The whole transformation is built using a graphical user interface where the data source, transformers, and destination are all connected in a graphical representation of the transform model that looks like a data flow diagram.

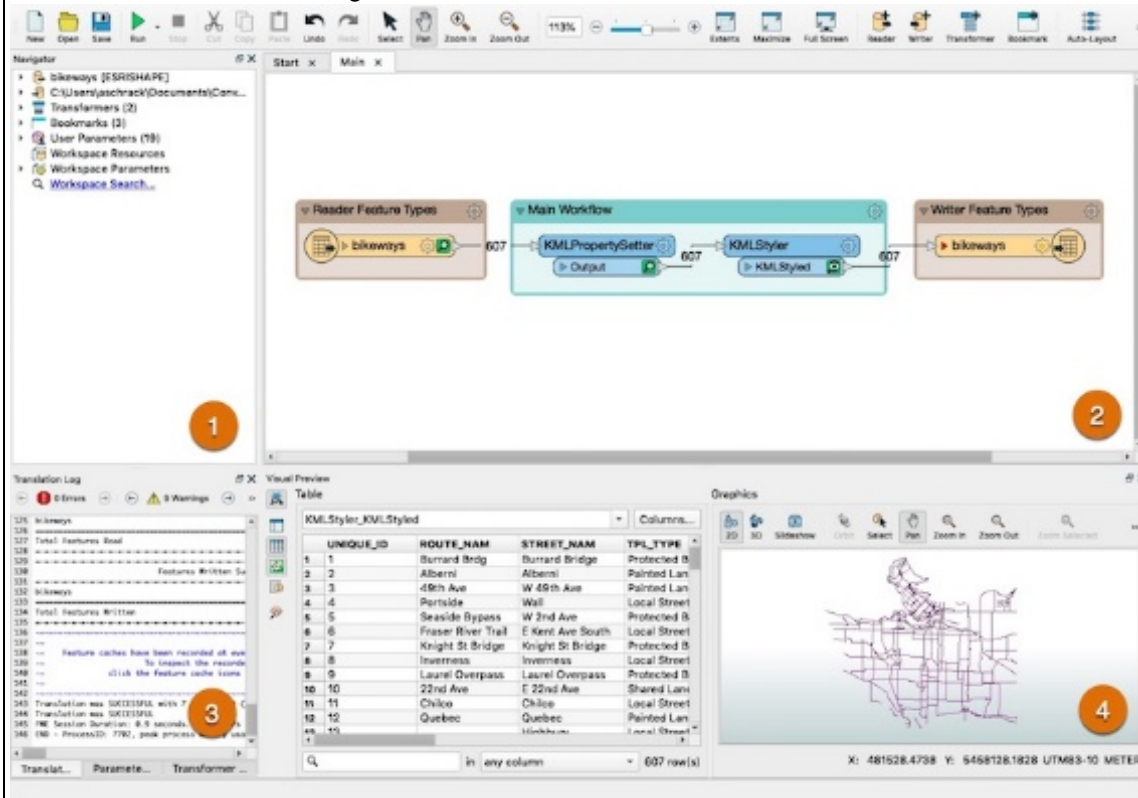


Fig 1. FME Workbench interface with data conversion Workspace

- 1. Navigator:** Provides a list of all workspace objects including readers, writers, transformers, and specific parameters.
- 2. Main Window (Canvas):** Where you build your workspace by adding a data source, transformers, and output data type.
- 3. Translation Log:** As a workspace runs, this pane updates to indicate the current status and the end result.
- 4. Visual Preview:** Displays 2D, 3D, or tabular data. View the data from your reader, writer, or at any transformation point.

brief description about where the tool can be found (e.g. on which menu) and how it works

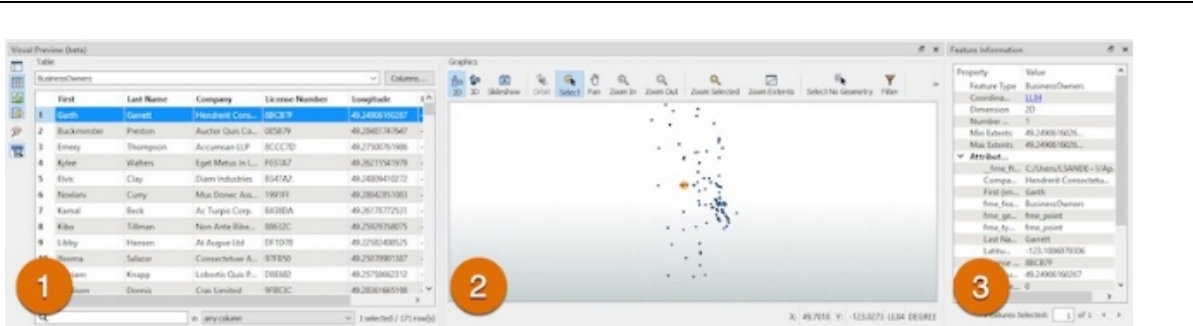


Fig 2. FME Data Inspector

1. **Table:** View your dataset's visible attributes. These attributes can be sorted or searched to explore your data.
2. **Graphics:** If your dataset contains graphics, geometry, or any spatial components, Visual Preview will display this data in the Graphics View. If there are no graphics or geometry, this view will not be available. (same as "View" in FME Data Inspector)
3. **Feature Information:** Where any additional information about a feature can be found, including format-specific attributes and coordinate systems.

description about the tools, settings and workflow necessary to make the conversion; description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same

CityGML to IFC Conversion with FME: Transformation Model Description

A starting point for converting to IFC was taken from this article on the FME Knowledge Base:

<https://knowledge.safe.com/articles/595/autocad-to-ifc-conversion-example.html>

**Limitations**

This discussion should be prefaced with the acknowledgement that this particular conversion has not been attempted before. While the author has extensive experience with FME (> 15 years) and with data transformations in general, including complex data models such as CityGML, AIXM and INSPIRE, the team had very little experience writing to IFC. Most typical workflows with FME in our experience have involved extraction from BIM such as IFC and writing to GIS.

One of the purposes of this exercise was to demonstrate the possibilities for conversion to IFC. However this test model is inherently only a starting point. The output generated is created without a deeper understanding of BIM and IFC norms or best practices. The output data should be compliant with the minimal requirements of the IFC standard, but is lacking in terms of the logical structure and relationships that a typical domain expert would know are desirable. That said, given the ease with which FME can be used to rapidly prototype conversions, as an iterative process, this model could easily be enriched with more content and logical relationships with feedback from a domain expert. Thus the FME results could readily be improved with the assistance of a BIM/IFC domain expert.

## Conversion Overview

The basic conversion model involves a pattern of 4 main steps that are repeated for every feature type group. For each output feature type FME needs to build the **feature attributes**, the **feature geometry**, the **property sets** and any required **property set definitions**. The feature attributes are built with a combination of schema mapping, constants and attribute functions. The geometries are constructed with a series of geometry manipulation functions. In this case, the source CityGML is composed predominantly of multi-surfaces, so these need to be converted to solid form before being written to IFC. Extruders were used to convert from multi-surface to solid. Also, FME uses a nested structure embedded in the FME feature geometry to model the nested properties of the IFC feature. So a series of geometry creation, naming, property setters and aggregators are needed to build up this structure. The geometry property setters use attributes defined on the feature, so AttributeCreators are used to feed GeometryPropertySetters with the required names and values.

Figure 3 shows the source Rotterdam CityGML dataset, Figure 4 shows an overview of the FME Workspace for the CityGML to IFC conversion, and Figure 5 shows the output IFC generated from the Rotterdam CityGML.

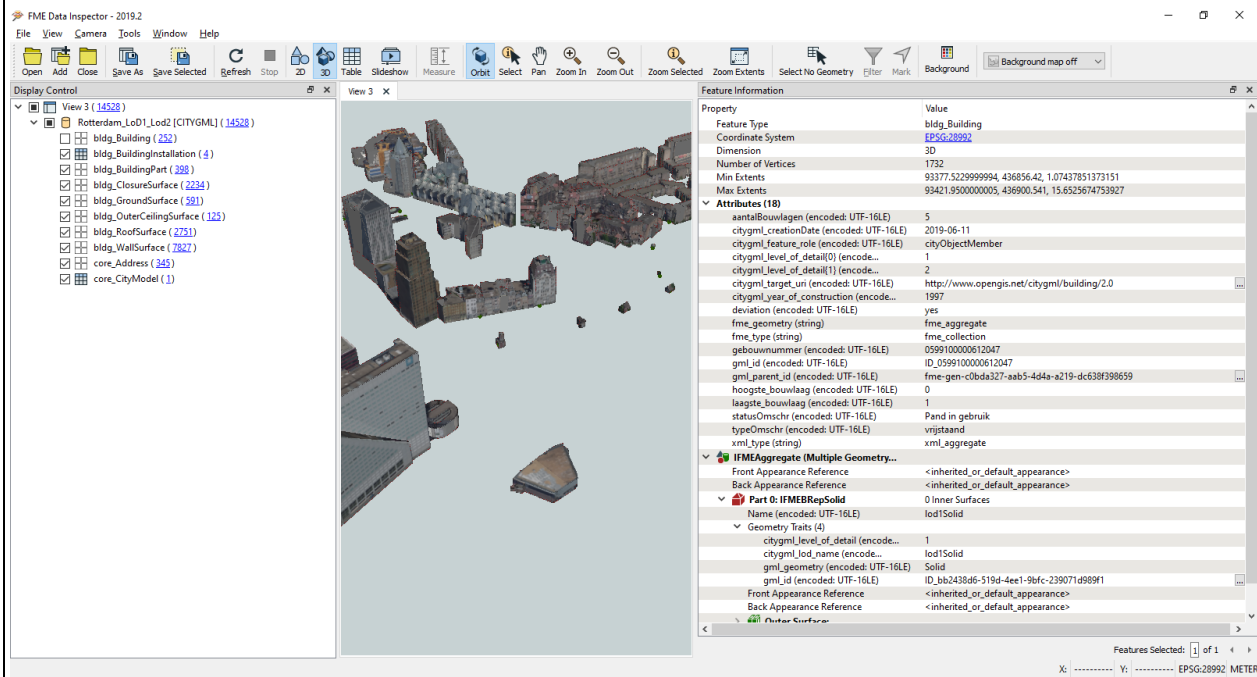
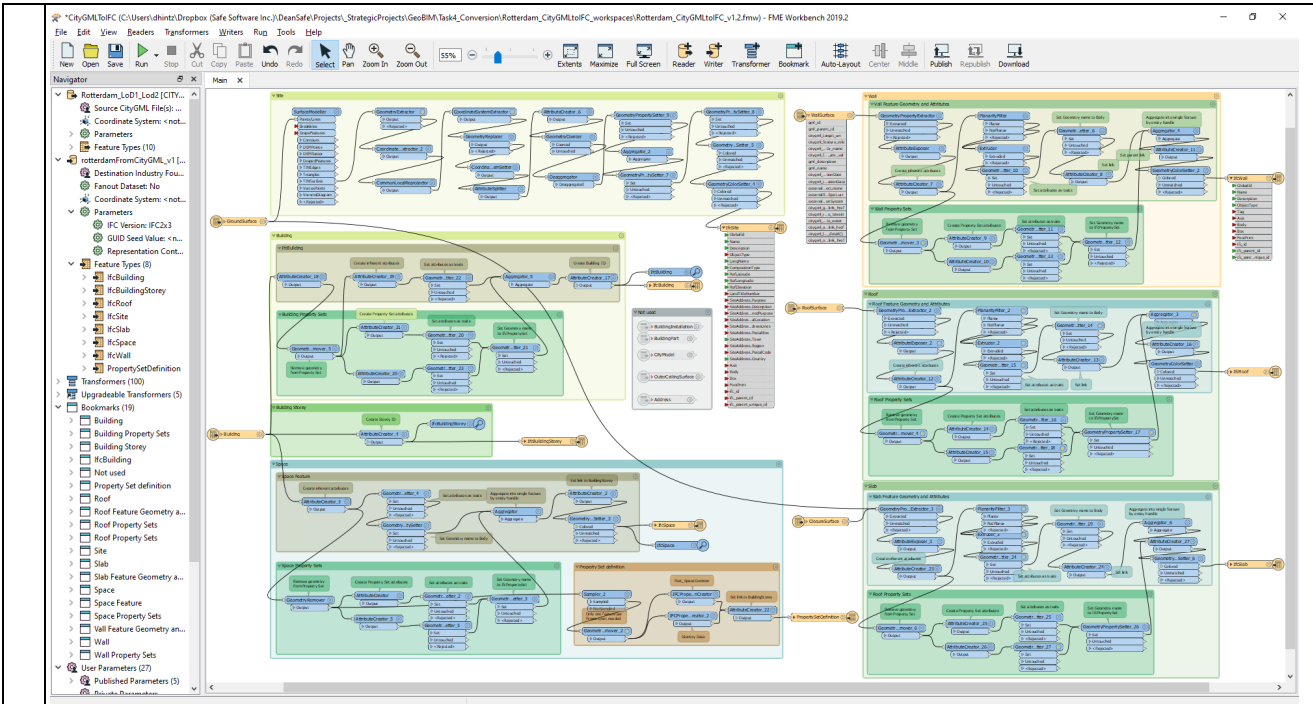
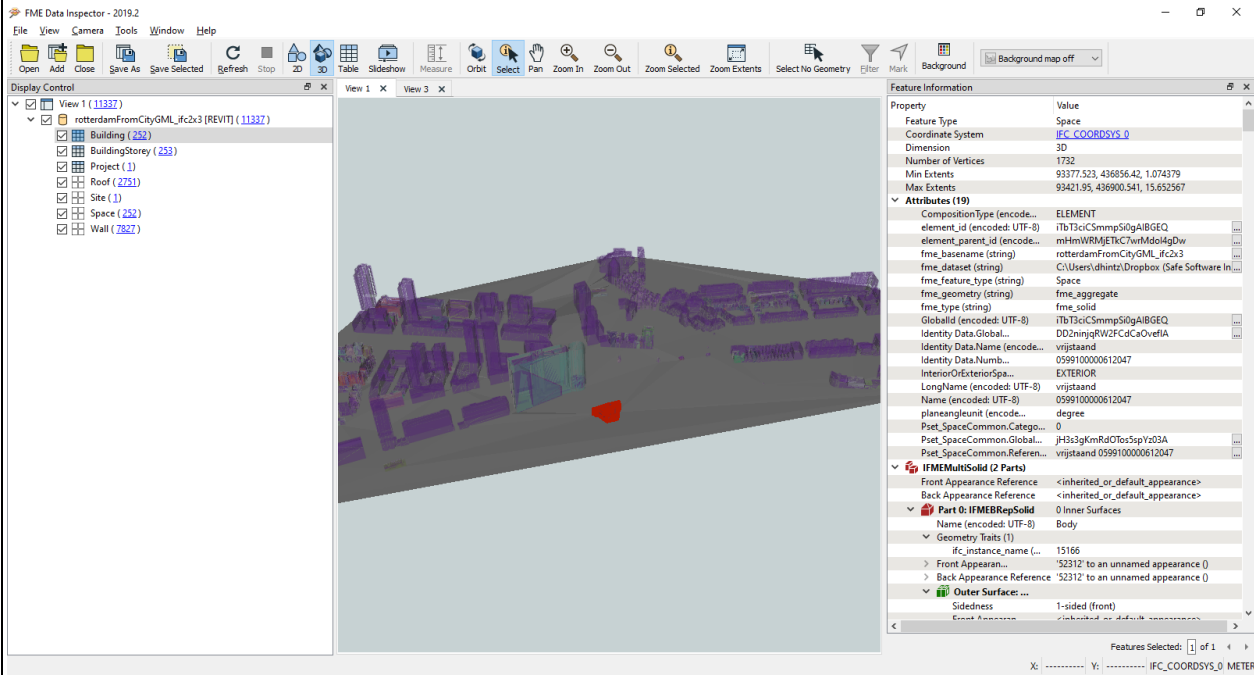


Fig 3. Source CityGML dataset Rotterdam\_LoD1\_Lod2.gml

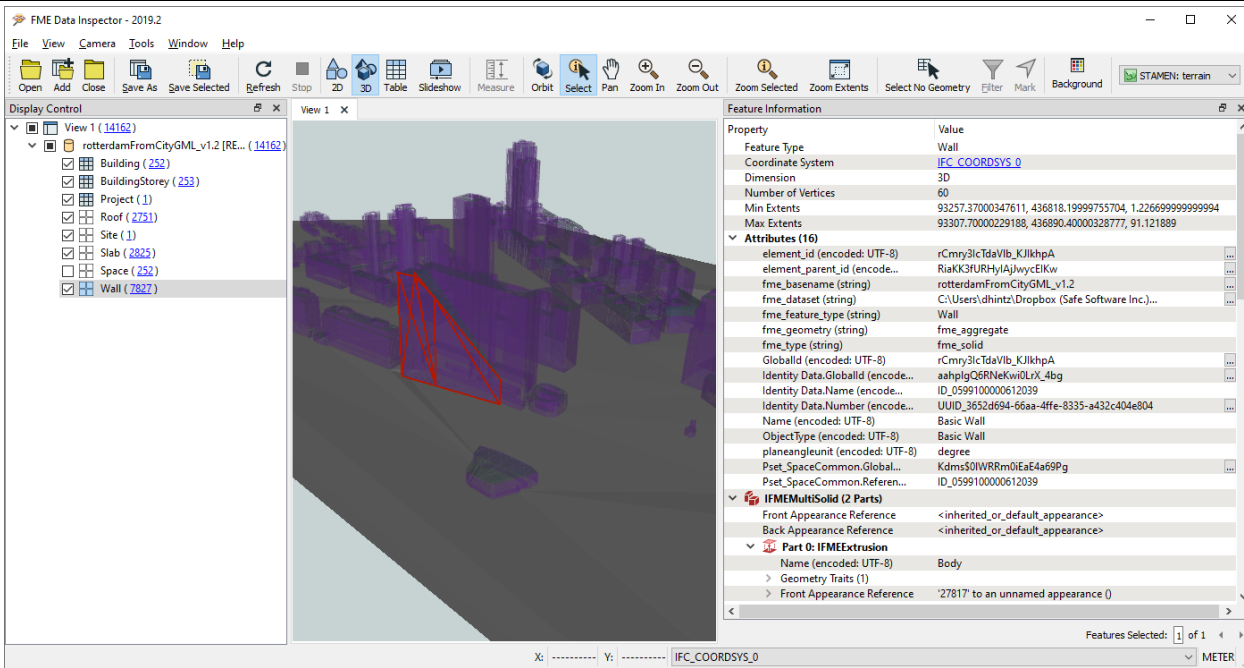


**Fig 4.** Data transformation model / FME workspace to convert from CityGML to IFC ([Rotterdam\\_CityGMLtoIFC\\_v1.2.fmw](#)). See the [log file](#).



**Fig 5.** Destination IFC dataset rotterdamFromCityGML\_ifc2x3.ifc using IFC with Data View reader.



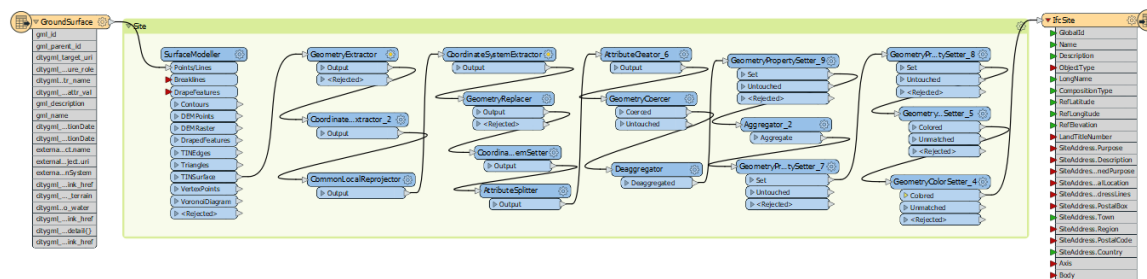


**Fig 6.** Destination IFC dataset rotterdamFromCityGML\_v1.2.ifc with Slab added

Each IFC output feature type has a section in the workspace called a Bookmark. These sections or bookmarks are as follows: Site, Building, BuildingStorey, Space, Wall, Roof.

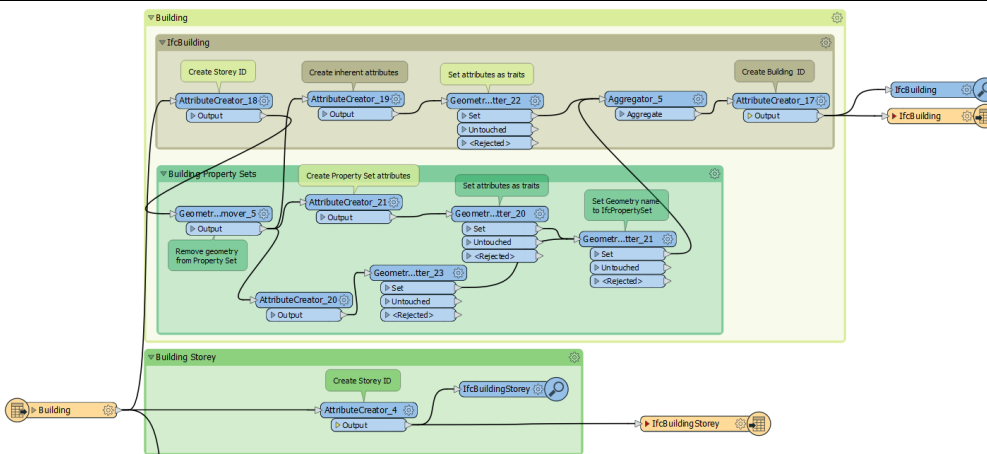
The following detail some unique aspects of each transform:

Site: Used CityGML GroundSurfaces from all the buildings of the source CityGML and fed these into a SurfaceModeller. The result is a TIN or mesh that was then converted into a composite surface required by the output IFCSite using a GeometryCoercer transformer. One challenge for IFCSite was the derivation of the values for RefLongitude and RefLongitude. The CommonLocalReprojector was used to move the dataset to a local coordinate system that is automatically named with the long, lat of the centroid of the dataset. String parsing was then used to extract these values from the local CRS name.



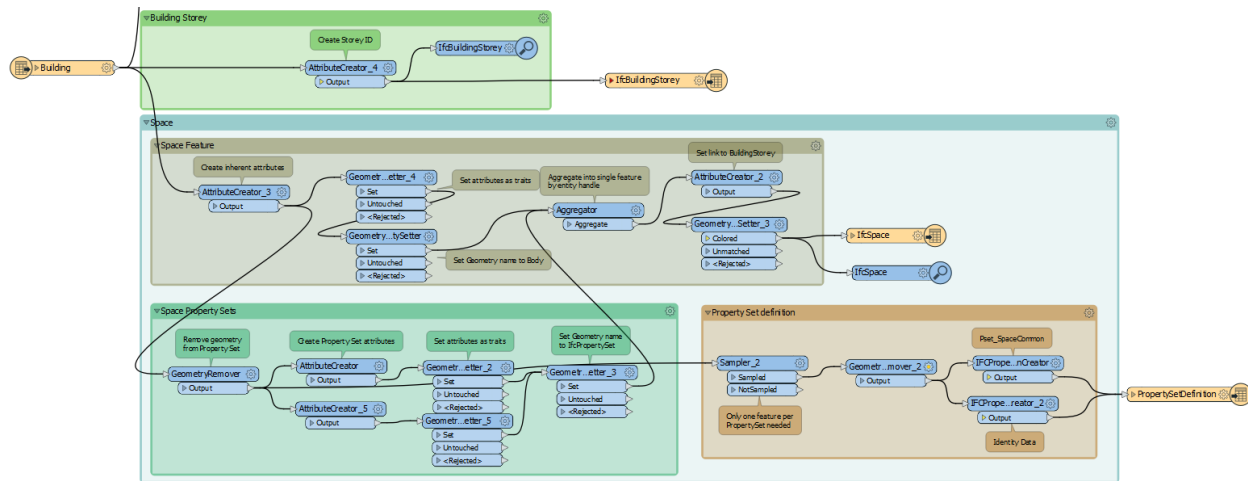
**Fig 7.** CityGML GroundSurface to IFC Site conversion workflow

The GlobalId for BuildingStorey was based on the source CityGML gml\_id. As the source dataset only had LOD1 and LOD2 building envelopes and Spaces, we only needed 1 storey per building. So the ifc\_parent\_id was set to Building\_<gml\_id>, the GlobalId of IFCBuilding was set to Building\_<gml\_id> and the ifc\_parent of IFCSpace was set to gml\_id. The idea was to create a relationship whereby IFCBuilding -> IFCBuildingStorey -> IFCSpace. That is, buildings are parent to building storey which are parents to spaces.



**Fig 8.** CityGML Building to IFCBuilding and IFCBuildingStorey conversion workflow

IFCSpaces were converted directly from CityGML Buildings. In this case the source feature type stored the building geometry as solid volumes, so no geometry transform was required either than the geometry naming and property settings.



**Fig 9.** CityGML Building to IFCSpace and PropertySetDefinition workflow

**Detailed Conversion Description**

In general, feature construction is accomplished as follows:

1. AttributeCreator to create IFC required fields from combination of source attributes and constants such as GlobalId, ifc\_parent\_id, Name, LongName, Description, ObjectType
2. GeometryPropertySetter to set required properties and IDs on the geometry (Name, Category)
3. GeometryPropertySetter to set the geometry name – often this value is ‘Body’
4. Aggregator to build the required nesting or hierarchy in the geometry.
5. For feature type property sets such as Pset\_SpaceCommon, a copy of the feature is made, followed by a GeometryRemover and a similar series of GeometryPropertySetters to build IFC property sets on a null geometry and add them to the feature’s geometry.

One of the more significant challenges converting from citygml to IFC is the challenge inherent in the different geometry representations inherent in related feature types. For example, in the source CityGML, the walls, doors and roofs are stored as multisurfaces, whereas IFC requires these as solids. To perform this conversion, we used a PlanarityFilter to extract the surface normal of each face and then an extruder to convert the face into a volume extruded in the direction of the normal. This is clearly a rough approximation of what the actual solids might be for any given roof or wall, but the results appear to line up well with the building envelopes. There are some surfaces for which this process did not perform well, such as for curved and cylindrical walls.az

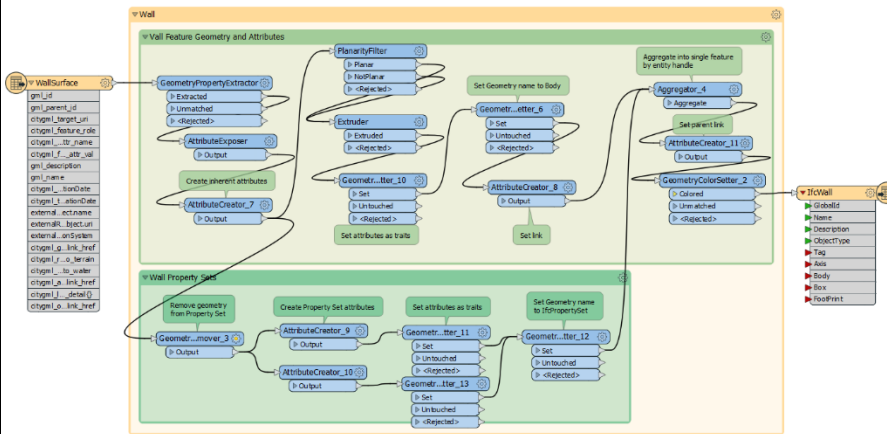


Fig 10. CityGML WallSurface to IfcWall conversion FME workflow

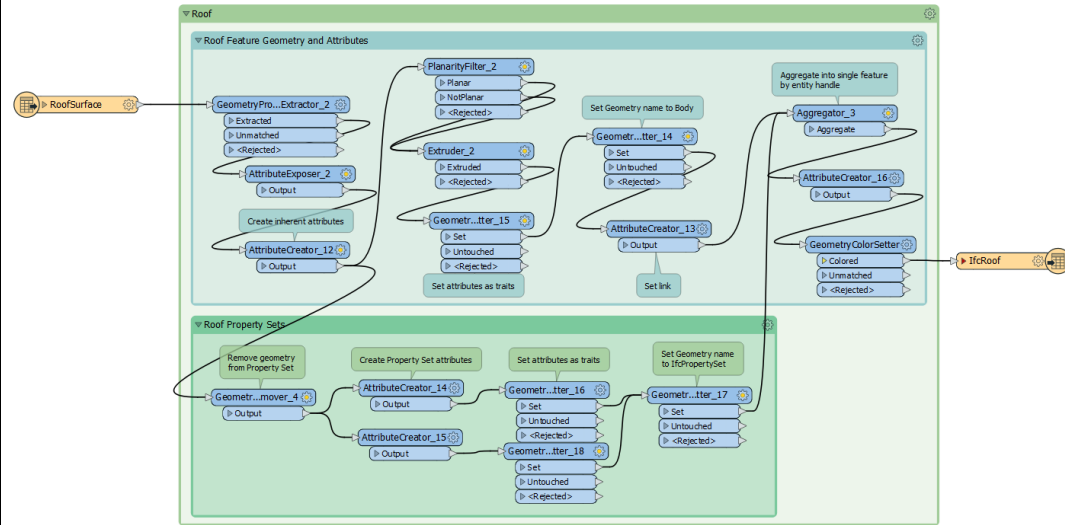


Fig 11. CityGML RoofSurface to IfcRoof conversion FME workflow

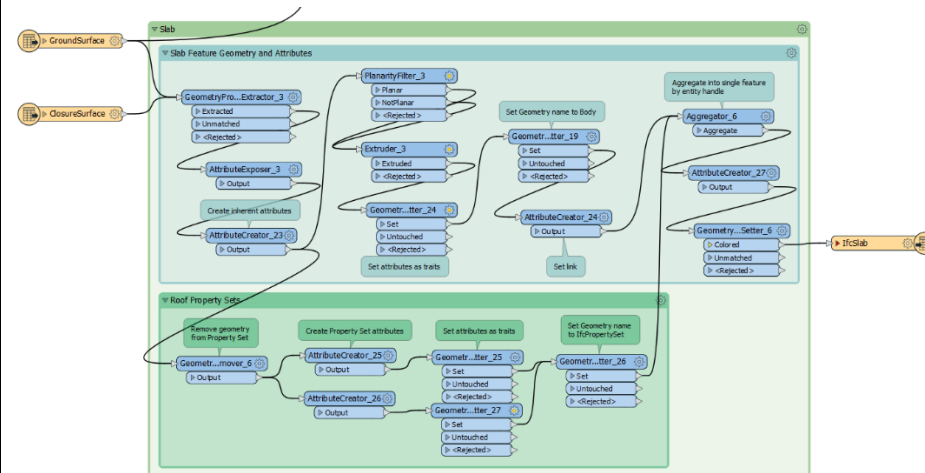


Fig 12. CityGML GroundSurface and ClosureSurface to IfcSlab conversion FME workflow

4) How long does it take for the data to be converted (computer time)?

The conversion takes about 5 minutes to complete for the Rotterdam CityGML to IFC conversion.

**5) Would you like to share any other comments or observations?**

Given our late start to the GeoBIM benchmark, and the amount of time taken on Task 1, we spent comparatively little time on Task 4. As it is, this CityGML to IFC conversion model was built with less than 2.5 days of total effort. We expect that with another week or so of effort we should be able to improve the quality of output significantly. If we had access to a similar IFC dataset to what we are trying to generate, say for another city, it would be relatively easy to configure the property sets, relationships, and feature properties to better align with typical values for a city scale, LOD2 dataset.

This activity generated a number of enhancement requests. Many of these are performance and usability related. The hope is to improve FME's overall support for IFC and IFC related conversions.

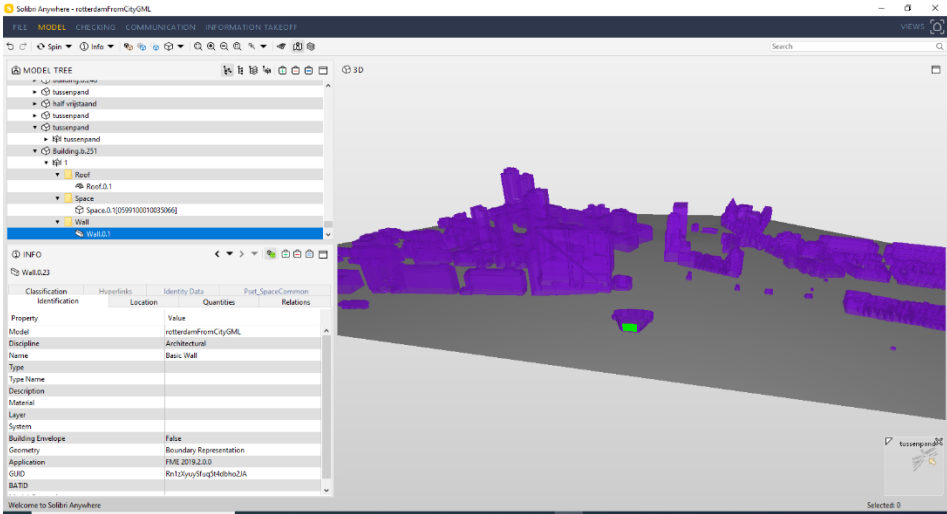
The IFC related Tasks were chosen because available information indicated that no other party was using FME for this purpose. Safe Software has made significant investments recently to improve support for BIM, 3D and indoor mapping. FME's support for complex GML profiles such as CityGML and INSPIRE are more well known. One of the purposes of our participation was to both conduct tests that will improve our support for IFC and to raise awareness of FME's support for IFC and BIM in general.

**6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency the conversion?**

The CityGML specification supports both solid and surface representations for most feature types. If the CityGML was generated with more solid representations, this would make the conversion to IFC easier.

The source CityGML dataset had relatively little information relevant to typical BIM requirements. For example, no material type, wall thickness, or other classification information was found. Ideally it would be help a lot if a BIM ADE was available which could extend CityGML to include support for BIM related information, and these values were populated appropriately. If that were the case then it would take a lot of guess work out of the process of populating properties and property sets in the destination IFC model.

**7) Attach other screenshots or files that you consider useful**



**Fig 13. Output Rotterdam IFC in Solibri**

## From IFC to CityGML

### IFC2CityGML

Software	Software Name [version]	IFC2CityGML [1.0]		Software house	<a href="https://ifc2citygml.github.io/">https://ifc2citygml.github.io/</a>		
	Proprietary or open source software?			Kind of software			
	proprietary			Extract/Transform/Load			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Custom 2017	Windows 10 Home, version 1903, OS Build 18362.418	Intel(R) Core(TM) i7-7700 CPU @ 3.60 GHz	NVIDIA GeForce GTX 1050 Ti	16	1920	1524

1) Are you making a conversion		From IFC to CityGML
2) What file are you using?		Savigliano.ifc (IFC)
2.1) What LOD(s) will result from your conversion?		LOD3/4
3.1) Are you using an off-the-shelf tool?	No, I am using a bespoke piece of software (i.e. one developed by me or my company but not completely available to the public).	
3.1.2) Give an extensive description about the <b>_tools_, _settings_ and _workflow_ necessary to make the conversion;</b>	<a href="https://ifc2citygml.github.io/files/UserGuide.docx">https://ifc2citygml.github.io/files/UserGuide.docx</a>	
<b>⚠ your description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same results.</b>		
4) How long does it take for the data to be converted (computer time)?	less than a minute	
5) Would you like to share any other comments or observations?	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/IFC2CityGMLGeoBIMBenchmarkDataSetConversion.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/IFC2CityGMLGeoBIMBenchmarkDataSetConversion.pdf</a>	
6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?	Addition of spaces in the IFC model would have improved the quality of the output, not the efficiency	
1) Are you making a conversion		From IFC to CityGML
2) What file are you using?		IFC4geometries (IFC)
2.1) What LOD(s) will result from your conversion?		LOD3
4) How long does it take for the data to be converted (computer time)?	it's almost immediate	
5) Would you like to share any other comments or observations?	see <a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/IFC2CityGMLGeoBIMBenchmarkDataSetConversion.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/IFC2CityGMLGeoBIMBenchmarkDataSetConversion.pdf</a>	
6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?	No	

**FME 2019.2**

Software Name [version]		<b>FME [2019.2]</b>	Software house		<b>Safe Software</b>	
<b>Proprietary or open source software?</b>			<b>Kind of software</b>			
proprietary			Extract/Transform/Load			
<b>IFC Certification</b>			Not certified			
<b>Model and year</b>	<b>Operating system and version</b>	<b>CPU</b>	<b>GPU</b>	<b>Memory (RAM)</b>	<b>Hard drive capacity</b>	<b>Hard drive free space</b>
Dell Latitude 3400 x64 i7-8586U	MS Windows 10.0.18362	x64 i7-8586U	GeForce MX-130 NVidia	16	940	405
<b>2) What file are you using?</b>				Myran.ifc		
<b>2.1) What LOD(s) will result from your conversion?</b>				LOD4		
<b>3.1) Are you using an off-the-shelf tool?</b>					Yes	
<b>3.1.1) Is a completely automatic procedure working?</b>	FME is a spatial data integration and conversion tool. FME can perform default translations with little to no configuration for simple conversions such as DWG to SHAPE, or CSV to Excel. However, to convert between complex data models usually requires configuration to set up. There are a lot of automated functions that help with the configuration – schema scan etc – but there are also manual steps required. Once the data conversion / transform model is defined, then calling the transformation can be fully automated for source datasets that have a similar structure. FME can also be automated in a service oriented architecture via FME Server. Typically transformation services are accessed via the FME Server REST API.					

<p>brief description about where the tool can be found (e.g. on which menu) and how it works</p>	<p><b>Installation steps:</b></p> <ol style="list-style-type: none"> <li>4. Download is found here: <a href="https://www.safe.com/support/downloads/">https://www.safe.com/support/downloads/</a> and if you don't have a license, you can select the Free Trial for a 30 day full version trial</li> <li>5. In the setup wizard when running the.msi file, specify a directory to install FME. Instructions for installing FME on different operating systems: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop_Admin_Guide/FMEInstallation/Installing-FME-Desktop.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_Desktop_Admin_Guide/FMEInstallation/Installing-FME-Desktop.htm</a></li> <li>6. Open the Licensing Assistant (or FME Workbench will prompt the licensing assistant) and input your trial code, floating license, or serial code</li> </ol> <p>FME Workbench:</p> <ol style="list-style-type: none"> <li>4. Open FME Workbench to author your workspace</li> <li>5. Drag and drop IFC file or add a Reader pointing to the source file</li> <li>6. Build workspace (see below)</li> </ol> <p><b>Resources:</b></p> <ul style="list-style-type: none"> <li>• AutoCAD to IFC Conversion Example: <a href="https://knowledge.safe.com/articles/595/autocad-to-ifc-conversion-example.html">https://knowledge.safe.com/articles/595/autocad-to-ifc-conversion-example.html</a></li> <li>• IFC Reader / Writer doc: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/ifc/ifc.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/ifc/ifc.htm</a></li> <li>• CityGML Reader / Writer doc: <a href="https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/citygml/citygml.htm">https://docs.safe.com/fme/html/FME_Desktop_Documentation/FME_ReadersWriters/citygml/citygml.htm</a></li> <li>• Safe.com/BIM: <a href="https://www.safe.com/data-types/bim/">https://www.safe.com/data-types/bim/</a></li> <li>• Safe.com BIM webinars: <a href="https://www.safe.com/webinars/how-to-create-gis-and-bim-interoperability/">https://www.safe.com/webinars/how-to-create-gis-and-bim-interoperability/</a></li> <li>• Article: Path to an Integrated Modelling between IFC and CityGML for Neighborhood Scale Modelling: <a href="https://www.mdpi.com/2413-8851/1/3/25/htm">https://www.mdpi.com/2413-8851/1/3/25/htm</a></li> </ul>
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## FME Approach to Data Conversion

The basic procedure for building a data conversion workflow in FME is as follows. Add the reader source format and dataset, specify the writer destination format and dataset, and then add the necessary transformation steps to convert the source data model to meet the requirements of the destination data model. The transformation steps are performed using FME functions called transformers. The whole transformation is built using a graphical user interface where the data source, transformers, and destination are all connected in a graphical representation of the transform model that looks like a data flow diagram.

brief description about where the tool can be found (e.g. on which menu) and how it works

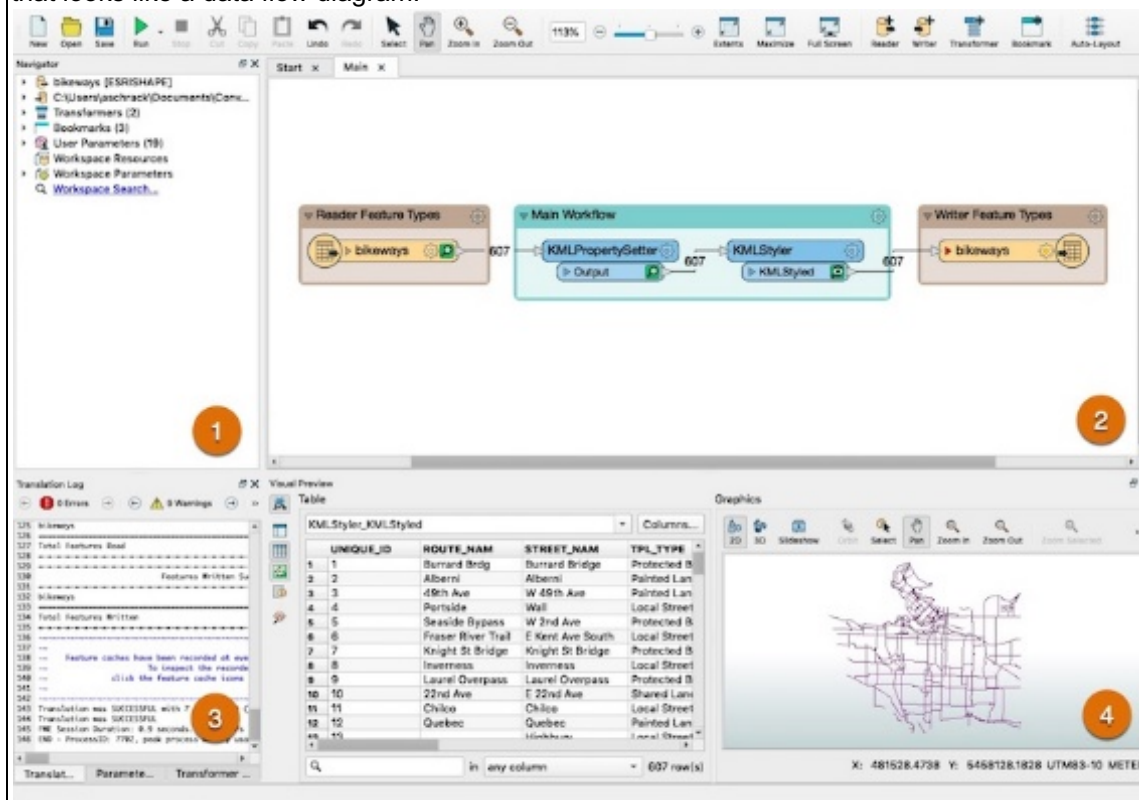


Fig 1. FME Workbench interface with data conversion Workspace

- Navigator:** Provides a list of all workspace objects including readers, writers, transformers, and specific parameters.
- Main Window (Canvas):** Where you build your workspace by adding a data source, transformers, and output data type.
- Translation Log:** As a workspace runs, this pane updates to indicate the current status and the end result.
- Visual Preview:** Displays 2D, 3D, or tabular data. View the data from your reader, writer, or at any transformation point.



brief description about where the tool can be found (e.g. on which menu) and how it works

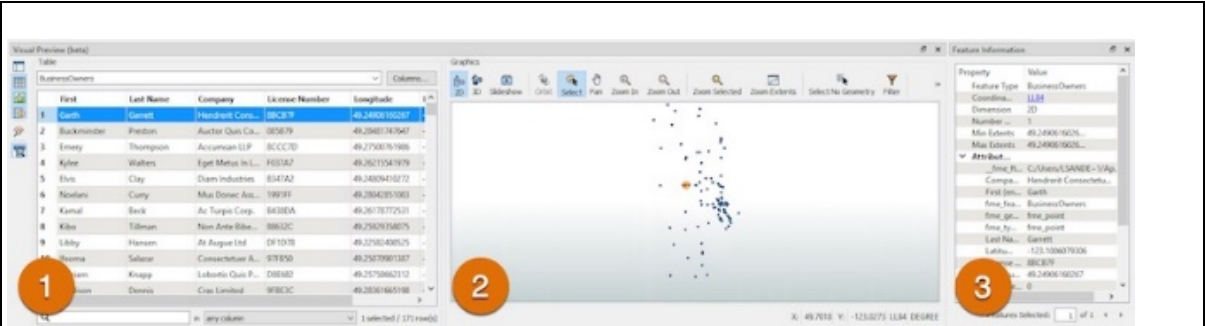


Fig 2. FME Data Inspector

4. **Table:** View your dataset's visible attributes. These attributes can be sorted or searched to explore your data.
5. **Graphics:** If your dataset contains graphics, geometry, or any spatial components, Visual Preview will display this data in the Graphics View. If there are no graphics or geometry, this view will not be available. (same as "View" in FME Data Inspector)
6. **Feature Information:** Where any additional information about a feature can be found, including format-specific attributes and coordinate systems.

detailed description about the tools, settings and workflow necessary to make the conversion; description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same

**Conversion Overview**

Both IFC and CityGML have a hierarchical data structure. However, IFC's structure is more complex, and contains intermediate features not required in CityGML. For example, in IFC Doors are the children of Openings, which in turn are the children of Walls, while in CityGML, Doors are children of Walls. As well, the features are grouped somewhat differently. For example, parts of windows and stairs are contained in the IFC Member feature and must be added to their parent feature when converting to CityGML. This model shows how to convert from a high detail IFC model to a CityGML with a Level of Detail (LOD) of four. This FME IFC to CityGML workspace is comprehensive enough to handle most Architectural IFC datasets.

The basic conversion model involves a pattern of 3 main steps that are repeated for every feature type group. For each output feature type FME needs to build the **feature attributes**, the **feature geometry**, the **relationships**. The feature attributes are built with a combination of schema mapping, constants and attribute functions. The **geometries** are constructed with a series of geometry manipulation functions which usually start with a filter to simplify the complex, nested, multipart IFC geometries. In this case, the source IFC is composed predominantly of solids, so these need to be simplified to surfaces before being written to CityGML. The ConvertGeometry custom transformer is used in most cases for this simplification and is explained under the Custom Transformers section. **Attribute** schema mapping and are set using AttributeRenamer transformers, and feature filtering is done with Testers.

The feature **relationships** are built in 2 ways. Values are joined across related features using FeatureMergers, such as when values from a parent feature are required. However, in many cases IFC has a deeper hierarchy than CityGML. For example, in IFC doors belong to openings which belong to walls, whereas in CityGML doors belong directly to walls. To build the necessary relationships, grandparent ids need to be found. For this purpose the GetGrandParentID custom transformer, combined with the Parent/Child lookup bookmark is used to resolve grandparent relationships. In fact, the entire dataset is read twice, first just to find all the ids and generate a lookup using FME variables, and then the second time to read the full feature attributes and geometries. Note that the lookup table must be created first before referring to it. Thus the readers in the Navigator need to be ordered such that the single feature type reader <All> is read first.

Figure 3 shows the source Myran IFC dataset, Figure 4 shows an overview of the FME Workspace for the IFC to CityGML conversion, and Figure 5 shows the output CityGML generated from the Myran IFC.

3.1. 2) Give an extensive description about the tools, settings and workflow necessary to make the conversion.

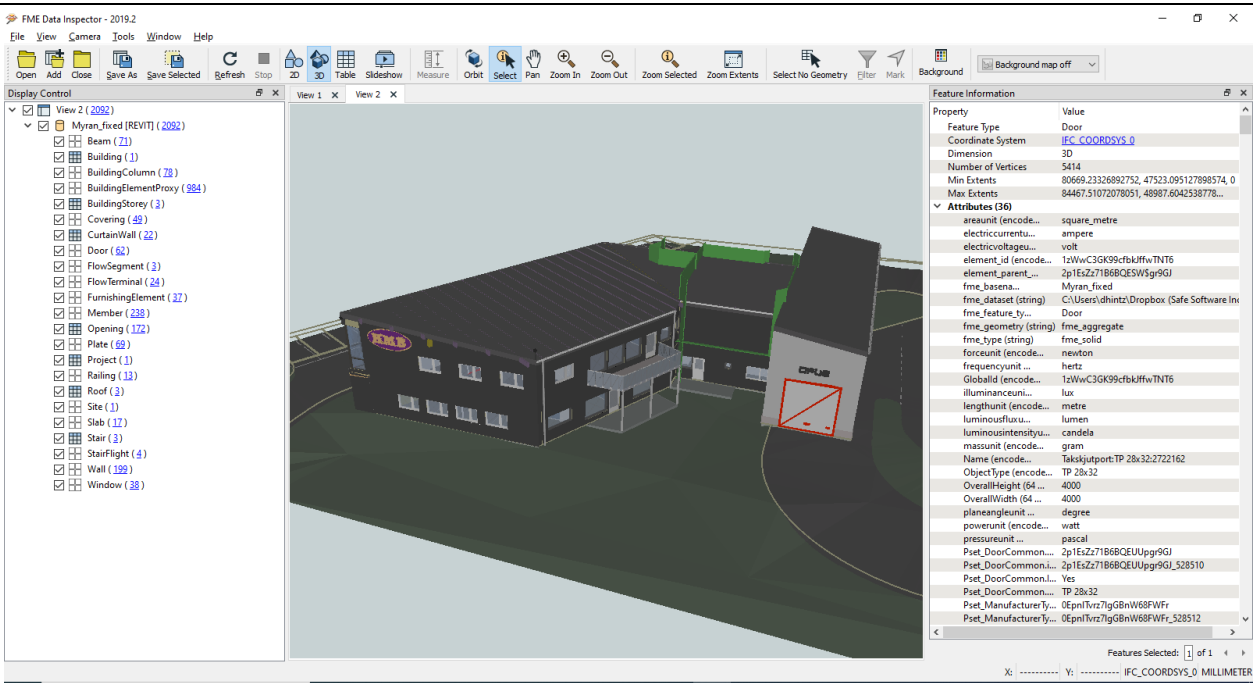


Fig 3. Source IFC 2x3 dataset: Myran\_fixed.ifc

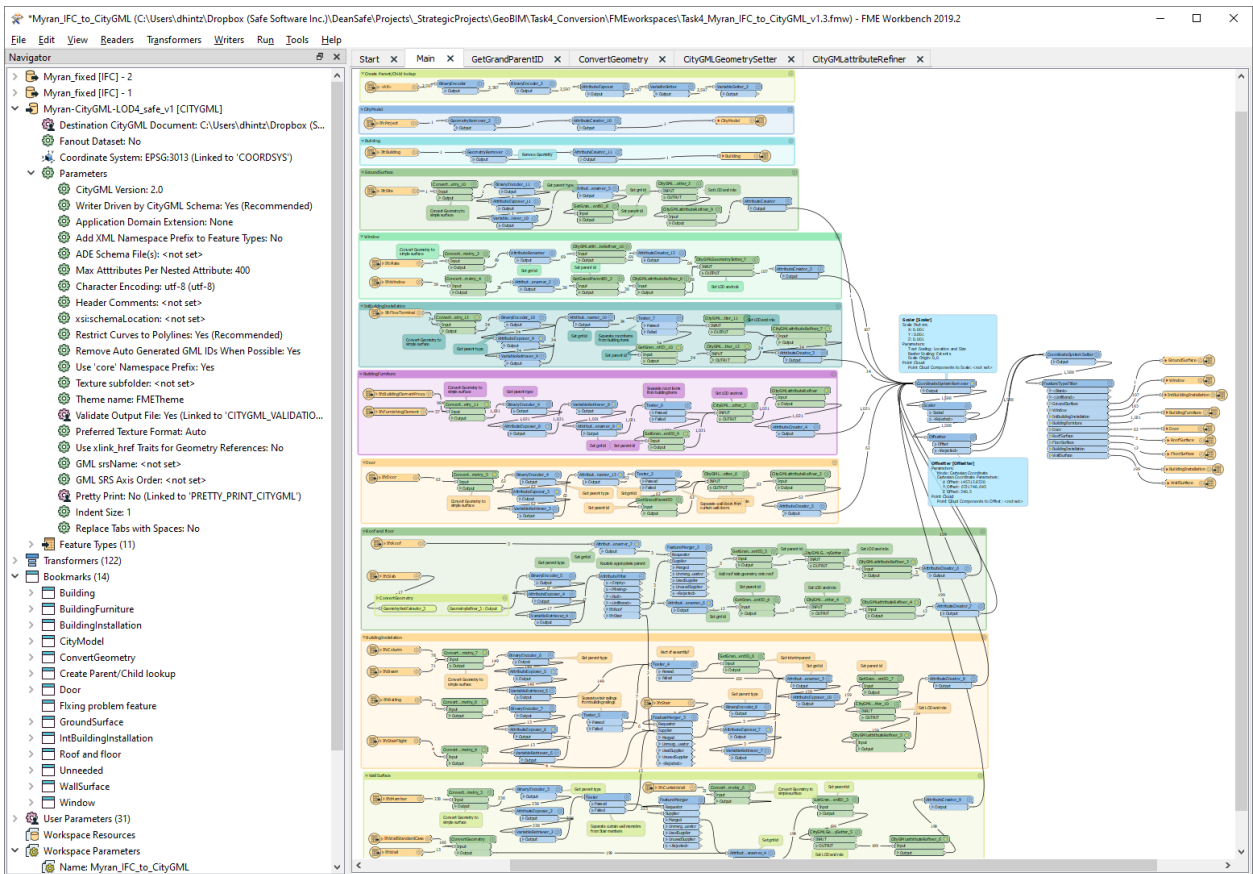


Fig 4. Data transformation model / FME workspace to convert from IFC to CityGML (Task4\_Myran\_IFCtoCityGML\_v1.3.fmw). See log file.

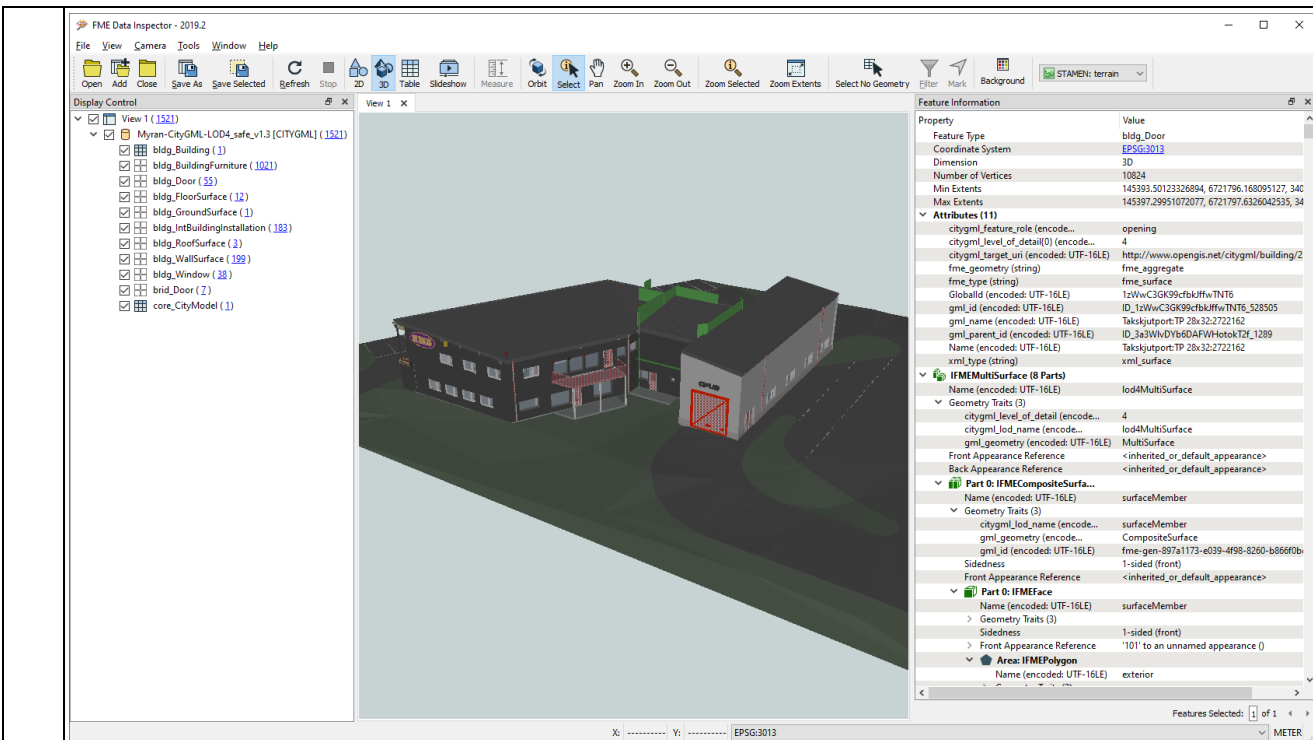


Fig 5. Output Myran CityGML dataset: Myran-CityGML-LOD4\_safe\_v1.3.gml

**Detailed Steps**

Each CityGML output feature type has a section in the workspace called a Bookmark. These sections or bookmarks are as follows: Building, BuildingFurniture, BuildingInstallation, Door, FloorSurface, IntBuildingInstallation, RoofSurface, WallSurface, and Window.

The following detail some unique aspects of each transform:

Parent/Child lookup: IFC has grandparent / grandchild relationships that need to be resolved as parent/child. To build the necessary relationships, a complete dataset wide parent/child lookup table is required. The GetGrandParentID custom transformer then uses this global lookup to retrieve grandparent ids as needed.

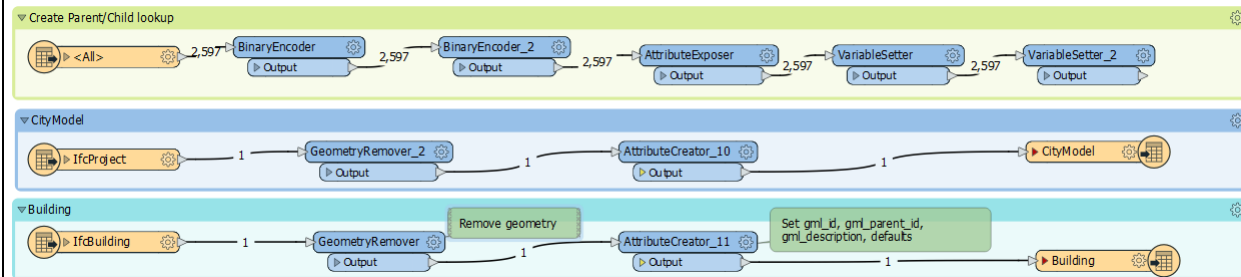


Fig 6. Create Parent/Child Lookup for parent IDs, CityModel, Building

**Create Parent / Child Lookup:** IFC features hold links to their parent features, but to remove unneeded intermediate features (like Openings) we also need links to the grandparent features. To do this we use two separate Industry Foundation Class STEP (IFC) readers. This first reader shown in Fig 6 reads all the IFC features and populates a lookup table of feature and parent IDs as variables, and also a lookup table of parent types. Because this first reader does not use the IFC geometry, it runs quickly. FME runs its readers sequentially so that this reader will finish, and the lookup tables will be completely populated before the second reader starts. The second IFC reader is used for the data conversion.

**CityModel:** CityModel is created from IfcProject. This serves as the dataset document container object and also as the root element for the entire model.

**Building:** Generating CityGML Building is quite simple. IfcBuilding is read from the source IFC. The geometry is removed with GeometryRemover, and the ifc\_unique\_id is renamed to gml\_id using AttributeRenamer. Note that all Ifc features have a geometry associated with them, even if they are only aggregates of null geometry containing property set geometry traits. This is why we remove the geometry when writing to citygml feature types that have no or null geometry.

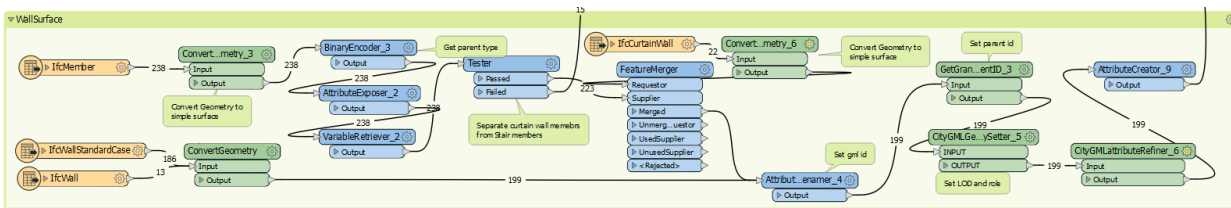


Fig 7. WallSurface – typical IFC to CityGML transform workflow.

**WallsSurface:** CityGML WallSurface generation follows a typical workflow for IFC to CityGML features. The first step is geometry simplification with **ConvertGeometry**. Next, the gml\_id is mapped to ifc\_unique\_id. Then the ifc\_parent\_unique\_id with is passed to the **GetGrandParentID** transformer to find the gml\_parent\_id. **FeatureMerger** is used to join properties from related feature types. The **CityGMLGeometrySetter** is used to set the WallSurface geometry to lod4MultiSurface with a boundedBy feature role. Finally the **CityGMLAttributeRefiner** is used to prefix the ifc\_ids with an alpha character ('ID' in this case) and clean up the attributes before writing.

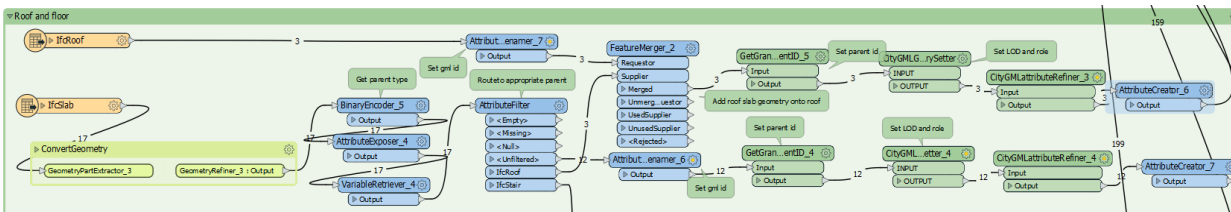


Fig 8. Roof and Floor workflow

A similar sequence is used to convert IfcRoof and IfcSlab to CityGML RoofSurface and FloorSurface, namely: geometry conversion, ID retrieval, feature joins, citygml property/geometry setting and citygml attribute refinement. IfcSlab is similar to IfcMember from Walls above, in that they both use the BinaryDecoder > VariableRetriever sequence to query the global Parent/Child lookup table stored as FME variables and retrieve the \_parent\_type from the parent feature. In the case of IfcSlab this is used to decide if the slab is a roof, stair or floor feature.

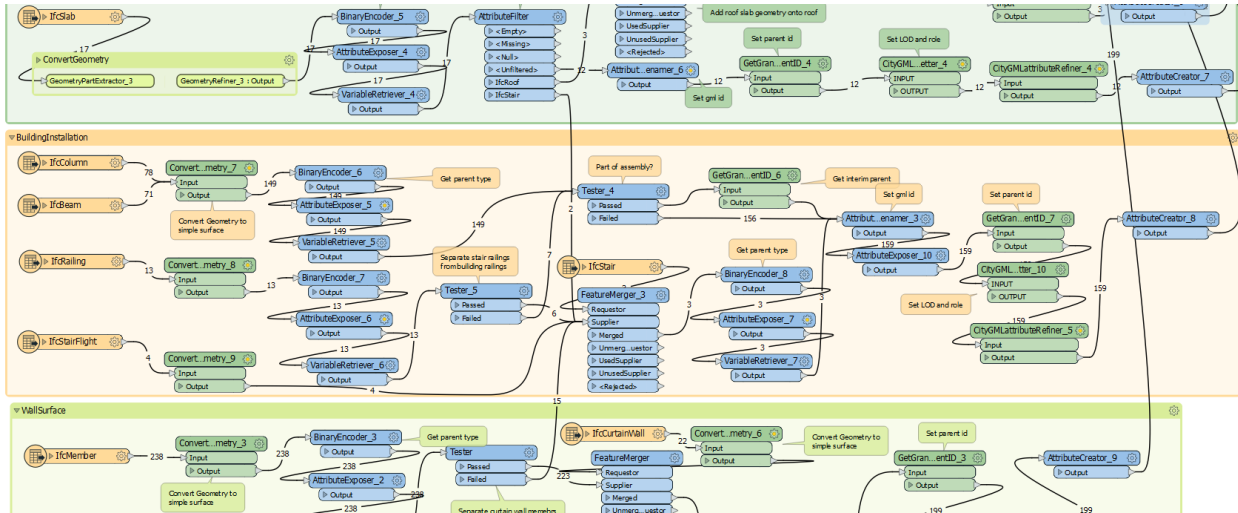


Fig 9. Building Installation workflow

### Building Installation

**BuildingInstallation** looks more complicated, but the main difference between this workflow and the others for Walls etc is simply the feature type mapping. IFC has IfcColumn, IfcBeam, IfcRailing, and IfcStairFlight that all are mapped to CityGML BuildingInstallation. Beyond that, and some filtering to handle these different installation types, the basic workflow of geometry simplification, parent type lookup, ID retrieval, and CityGML property setting and attribute refinement remains the same.

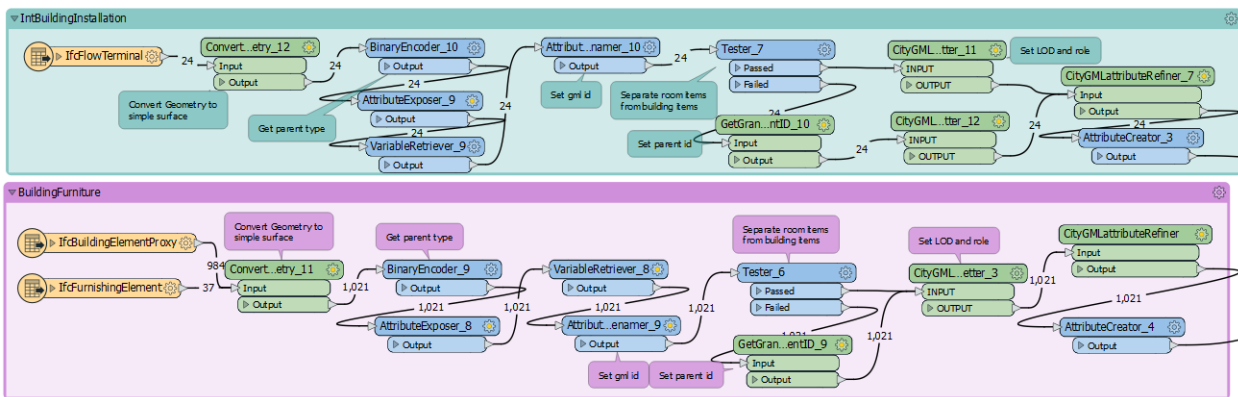


Fig 10. InteriorBuildingInstallation and BuildingFurniture workflows

IntBuildingInstallation and BuildingFurniture workflows follow much the same pattern as BuildingInstallation, except that in this case no FeatureMerger joins are required.

### Windows & Doors

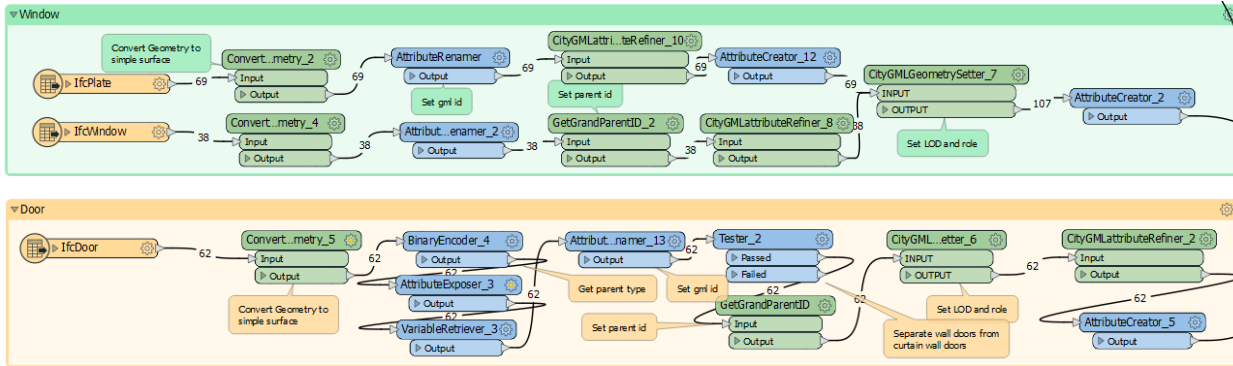


Fig 11. Windows and Doors from IfcDoor, IfcPlate and IfcWindow

Windows and Doors have a similar workflow since they are both children of Openings. However, there is no equivalent to Opening in CityGML. This is why we need to use the GetGrandParentID transformer to find the gml\_parent\_id related to the Wall that the Door or Window is a child of.

IFC: Doors/Windows > Openings > Walls

CityGML: Doors/Windows > Walls

The rest of the workflow is similar to that of Walls and Roofs, with geometry conversion and citygml property setting.

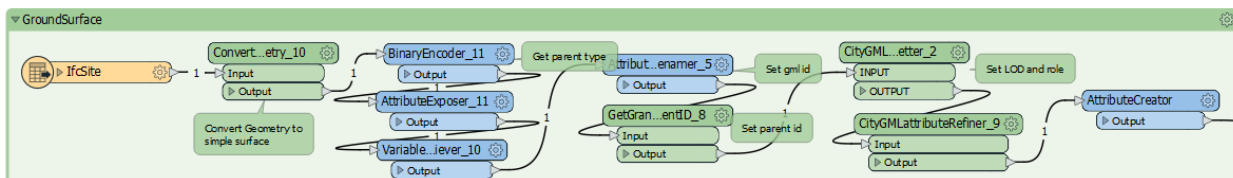


Fig 12. GroundSurface from IfcSite

IfcSite has the surface geometry of the site around the building, so this is the logical choice from which to derive citygml GroundSurface. We still need to refine the geometry and set the appropriate citygml LOD name and feature role.

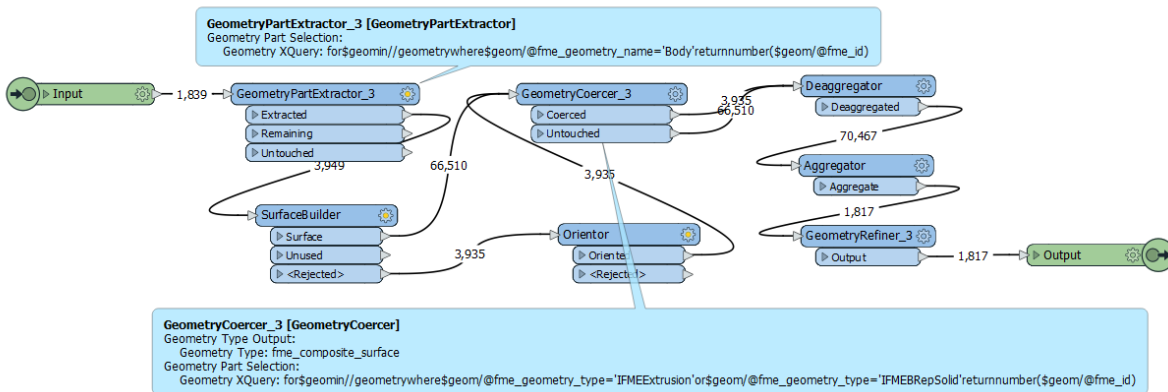
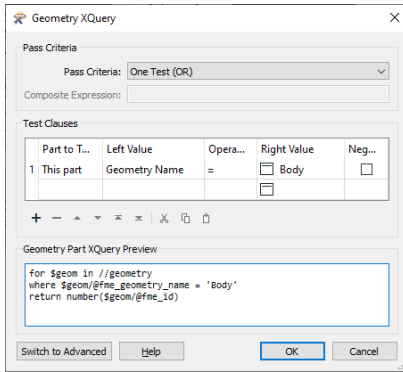


Fig 13. ConvertGeometry custom transformer

The **ConvertGeometry** custom transformer is critical to the overall IFC to CityGML translation.

ConvertGeometry converts the geometry from a complex IFC solid to MultiSurface that can be written to CityGML. Within the ConvertGeometry custom transformer, the IFC solid geometry is separated from the property sets with a GeometryPartExtractor transformer, then converted to surfaces with a GeometryCoercer transformer. Then to flatten multi-level geometry, it was disaggregated using the Deaggregator transformer and setting the Mode to Flatten All. Then the geometry is re-aggregate into MultiSurfaces using the Aggregator transformer with the Mode set to Geometry - Assemble One Level and a GeometryRefiner transformer.



**Fig 14.** GeometryPartExtractor: Interface settings to select geometry name = 'Body'

for \$geom in //geometry

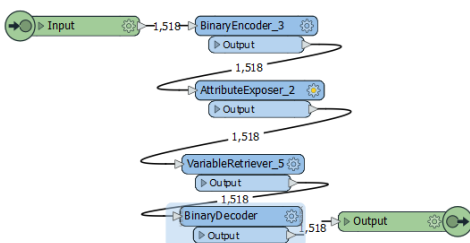
where \$geom/@fme\_geometry\_name = 'Body'

return number(\$geom/@fme\_id)

**Fig 15.** Resulting GQuery expression

The GeometryPartExtractor uses GQuery which is a form of XQuery adapted for performing queries and updates on complex geometries. In this case, there are multiple nested geometries on the IFC feature, included null PropertySet geometries. In this case, we want to select all the geometries that have geometry name = 'Body'. This allows us to simplify the geometry and keep only the 3D geometries we want while dropping the nulls and aggregates that contain IFC property sets etc.

The **GeometryCoercer** transformer is used to convert BrepSolids and Extrusions to multi-surfaces. However, initially problems with geometry conversions caused fatal errors in the translation. It was discovered that problem geometries were causing processing to fail. To alleviate this we added a SurfaceBuilder and Orienter to clean up the geometries before attempting to convert them to multisurface. This allowed the translation to complete.



**Fig 16.** GetGrandParentID custom transformer

Almost all features have their parent link set to the IFC Building Story, instead of the Building, so we need to move up one link to create the CityGML parent link to the Building, using the lookup tables stored in the variables. Since this will be repeated throughout the workspace, another custom transformer called GetGrandParentID is created.

A BinaryEncoder transformer is used with a User Parameter created for Attribute to Encode. Then a VariableRetriever transformer is added to set the `_gparent_id`. Finally, the `_gparent_id` is decoded, and another User Parameter is created for Destination Attribute using the BinaryDecoder transformer.

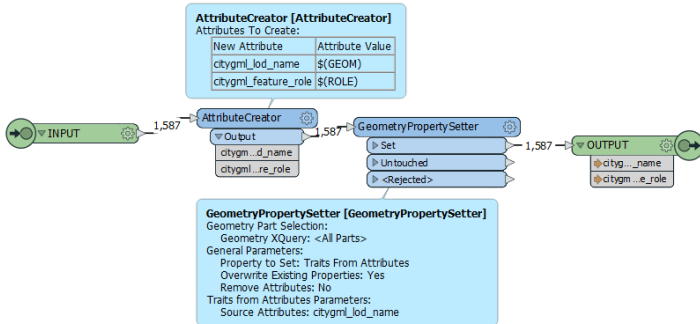


Fig 17. CityGMLGeometrySetter custom transformer

Before writing out to CityGML, a couple of attributes always need to be set following a strict naming convention. A CityGMLGeometrySetter custom transformer has been created to prevent data entry errors and can be found on the FME Hub. This transformer sets the CityGML Lod Name and the Feature Role.

### CityGMLAttributeRefiner Custom Transformer

After the first version of the workspace was published, it was found that the Myran-CityGML-LOD4\_safe\_v1.0.gml output did not validate fully against the CityGML application schemas. Because the `gml_ids` were derived from `ifc_unique_id`, there were 2 problems. First, many `gml_ids` started with a number which is not valid. Second, many contained special characters such as '\$'. To address this, **CityGMLAttributeRefiner** was added to prefix all IDs with `ID_`, and to use a StringReplacer to replace all occurrences of '\$' with 'S'. This custom transformer also removes unnecessary IFC fields to keep the output size more manageable.

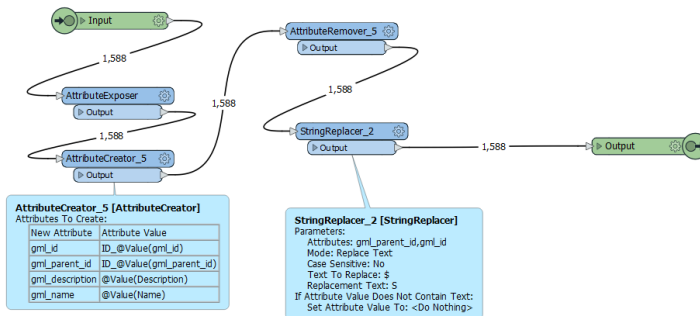


Fig 18. CityGMLAttributeRefiner Custom Transformer



3.1.3) Attach screenshots / documentation related to the previous question

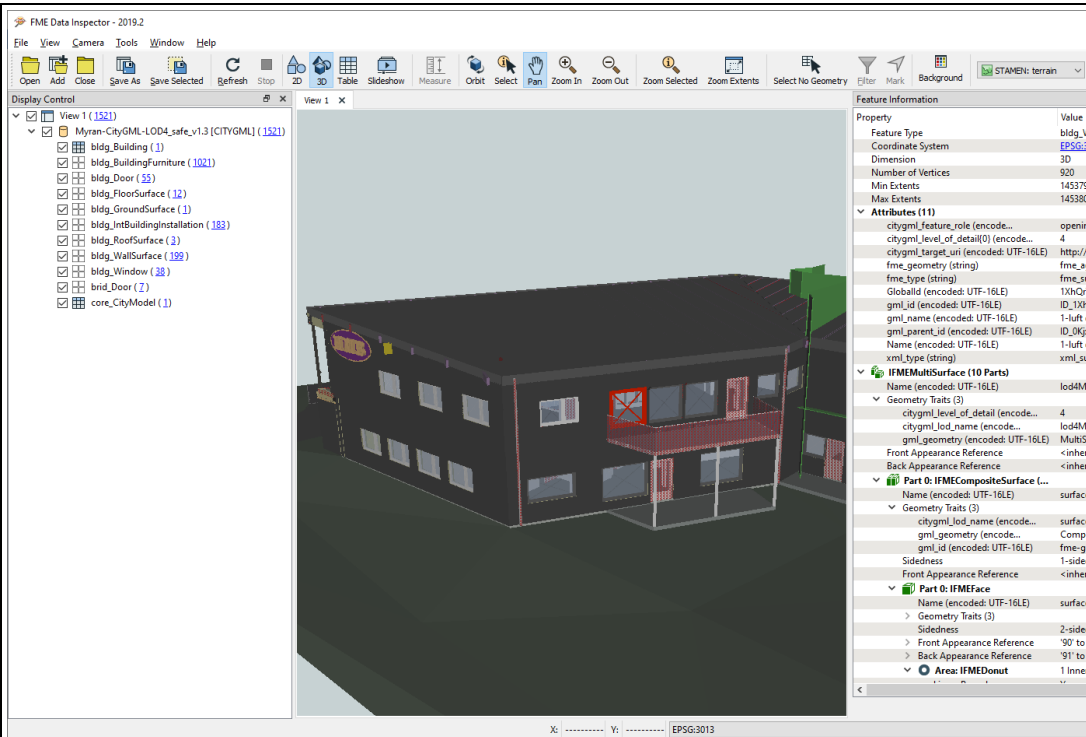


Fig 19. Output Myran CityGML dataset: Myran-CityGML-LOD4\_safe\_v1.3.gml showing Window opening

4) How long does it take for the data to be converted (computer time)?

About 5 minutes

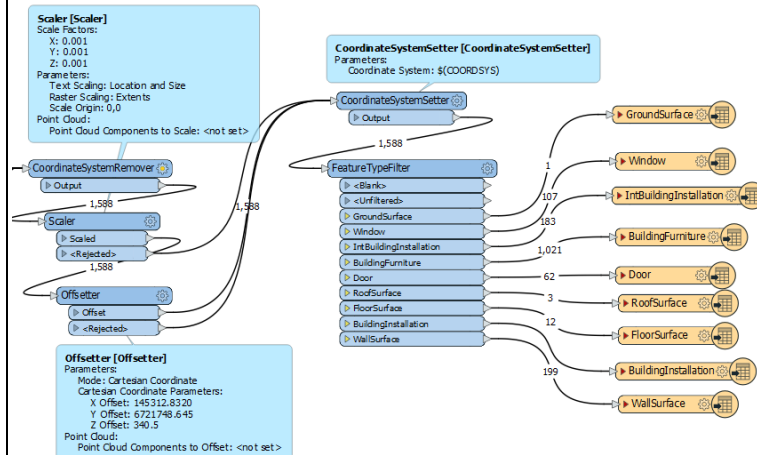
<p>5) Would you like to share any other comments or observations?</p>	<p><b>FME IFC to CityGML Conversion Considerations</b></p> <p>Clearly, we have significantly more experience with IFC to CityGML conversions than with CityGML to IFC, and the quality of the results reflect this. Nevertheless, FME has the capacity to perform both conversions well if configured correctly. Also, the starting point for this workspace was an example with the same source and destination formats. Total effort to adapt this conversion model for the Myran dataset was about 2.5 days. Much of this was testing time to isolate problems with reader order (the parent id lookup needs to be built first), problems with geometry conversion and finally problems with model hierarchy and validation. Geometry conversion is a typical issue than can arise when using an existing conversion template on a new dataset. Often there are complex geometries or perhaps bad data particular to a new dataset that can pose challenges for simpler conversion templates.</p> <p>Simple conversions require minimal filtering if any at all before writing out to CityGML. The main workflow goes as follows:</p> <ol style="list-style-type: none"> <li>1) Read in IFC data</li> <li>2) ConvertGeometry</li> <li>3) Set the gml_id</li> <li>4) GetGrandparentID</li> <li>5) CityGMLGeometrySetter</li> <li>6) CityGMLAttributeRefiner</li> <li>7) Write out to CityGML</li> </ol> <p><b>CityGML Writer Considerations</b></p> <p>CityGML BuildingInstallation and WallSurface features are made up of many IFC feature types, and some IFC features may be part of both. IFC Members, StairFlights, Slabs, and Railings are combined into Stairs, which are then written as BuildingInstallations, along with Columns and Beams. Other Members are combined into CurtainWalls, which are written out to WallsSurfaces, as are IFC features Wall and WallStandardCase.</p> <p>These separations and combinations can require several lookups of parent type and grandparent IDs from the variables created by the first IFC reader.</p> <p>The specification for building installations and building parts are different depending on their selected geometry and feature roles. It is crucial that the correct <b>geometry name</b>, <b>citygml LOD name</b>, <b>feature role</b>, <b>gml_id</b> and <b>gml_parent_id</b> are set as appropriate for a feature's feature type according to the CityGML data model, in order to write a valid CityGML document. The geometry name, feature role and parent id define how the features are nested in the overall CityGML document.</p> <p>Not setting these correctly can cause a number of problems with writing. The first problem might be that the feature may not be written at all. Secondly, with Validation set to 'Yes', you might get validation errors. Finally, if you read the data back with add namespace prefix set to 'feature types' you may notice that some feature types have the wrong namespace. For example, in this dataset there are some feature types where there was a problem finding the correct parent_id, and these show up in the brid_Door feature type. 'brid' is that bridge namespace. Most feature types in this dataset should be under the 'bldg' namespace.</p> <p>Building installation is an example of one of the least restrictive geometry roles in CityGML. An arbitrary GML geometry can represent the lod3Geometry whereas building parts are limited to lod3Solid, lod3Multisurface, lod3Multicurve, and lod3TerrainIntersection. For an IFC to CityGML translation, lod3Mulitsurface might be the safest choice, because some features might not build valid solid geometries if lod3Solid is used.</p>
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**Summary**

Overall we were quite happy with the quality of the results for the IFC to CityGML conversion. It should be noted that the CityGML dataset is significantly larger – by perhaps an order of magnitude – due to the overhead inherent with GML/XML. The style and transparency information seems to be well preserved. In workspace version 1.3 we used the IFC georeferencing approach from Tasks 1 and 2 to georeference this citygml model for EPSG 3013. We also added the IfcSite to generate a GroundSurface layer in CityGML. Finally, we made corrections to the citygml\_feature\_role, gml\_id and gml\_parent\_id to make corrections to the model hierarchy and to allow the CityGML output to validate fully against the CityGML 2.0 application schemas. In the end, the final IFC to CityGML FME workspace could be used to automate conversion of an updated Myran IFC dataset with little to no reconfiguration. In fact this workspace should work fine with for converting a wide range of IFC building datasets to CityGML while requiring minimal reconfiguration.

**6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?**

If the RefLatitude and RefLongitude were set correctly, this would make it a lot easier for us to automate the georeferencing of the output CityGML. Also, if there was texturing information stored by feature id, it may be possible to automate the texturing of the 3D model for CityGML.



**Fig 20.** Georeferencing all features before writing, then fanout to CityGML destination feature types to write CityGML output

7) Attach other screen shots or files that you consider useful

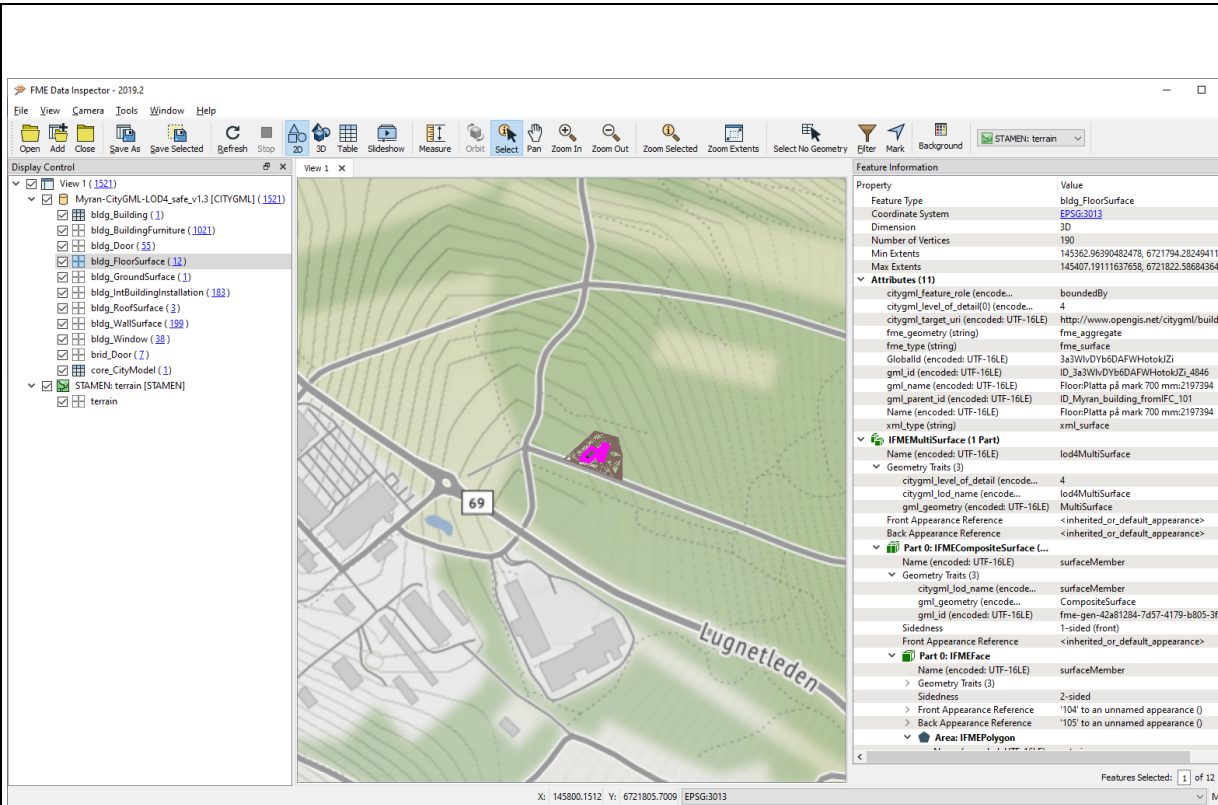


Fig 21. 2D view showing correct georeferencing of CityGML output using EPSG:3013

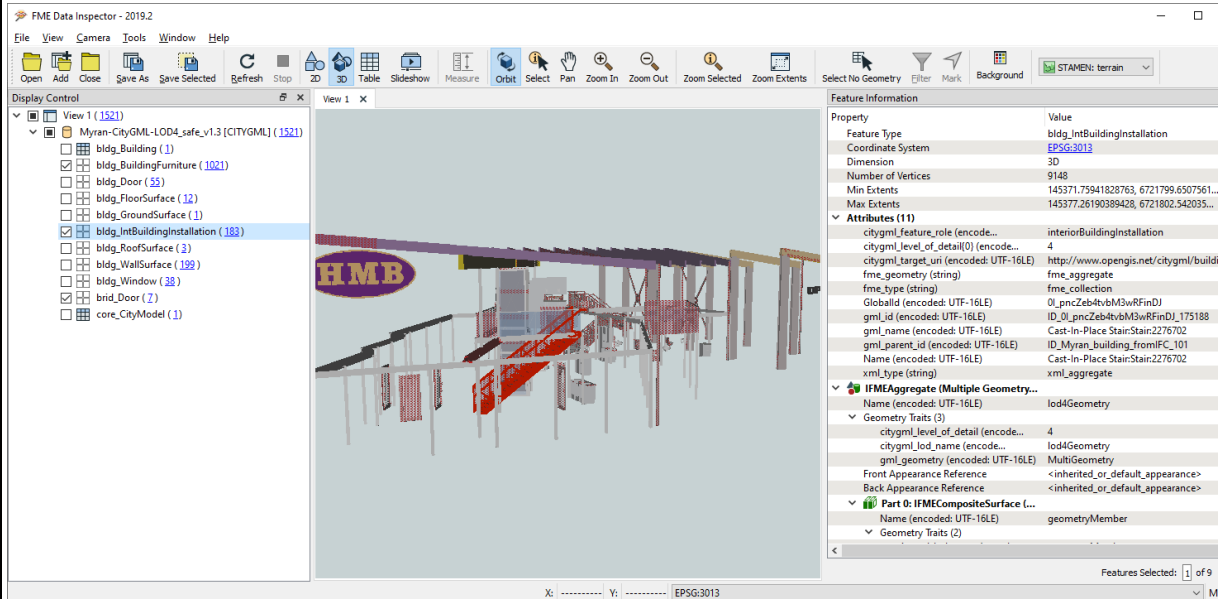


Fig 22. Output Myran CityGML dataset: Myran-CityGML-LOD4\_safe\_v1.3.gml showing Interior Building Installations such as stairs, fixtures and doors

## FME Quick Translator – Windows 10 Pro

Proprietary

Extract/Transform/Load

1 - Very beginner user (it is nearly the first time he/she use the software)

## FME Quick Translator

Software	Software Name [version]	<b>FME Quick Translator [2019.0.2.0]</b>			Software house	<b>Safe Software</b>	
	Proprietary or open source software?				Kind of software		
	proprietary				Extract/Transform/Load		
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	DELL G5 5587, 2018	Microsoft Windows 10 Pro 10.0.18362 Build 18362	Intel(R) Core(TM) i7-8750H CPU @ 2.20GHz	NVIDIA GeForce GTX 1060 with Max-Q Design	16	462	319

<b>1) Are you making a conversion</b>		From IFC to CityGML
<b>2) What file are you using?</b>		Up:town building (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>		LoD4
<b>3.1) Are you using an off-the-shelf tool?</b>		Yes
<b>3.1.1) Is a completely automatic procedure working?</b>		Yes
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>		<ol style="list-style-type: none"> <li>1. Simple steps for FME Desktop Installation with floating licensing</li> <li>2. Open FME Quick Translator 2019 &gt; Getting Started &gt; Translate</li> <li>3. Select IFC file (UpTown) in Reader's dataset. Select CityGML as Writer's format and browse to select dataset output path and enter filename. click OK.</li> <li>4. Converted CityGML file is created at output path.</li> </ol>
<b>3.1.1.2) Attach screenshots</b>		<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/3 - Automatic Procedure Steps and Screenshots.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/3 - Automatic Procedure Steps and Screenshots.pdf</a>
<b>3.2) Add short comments to the previous questions (optional)</b>		Off-the-shelf, FME Quick translation, tool has a lot of parameters for reader and writer for translation but they weren't found useful. As example setting Coord. System for CityGML writer results in deformed geometries in CityGML (Check results for Myran IFC to CityGML Experiment 1 with Coord System settings).
<b>4) How long does it take for the data to be converted (computer time)?</b>		20 minutes-1 hour
<b>5) Would you like to share any other comments or observations?</b>		<p>UpTown IFC file was very large but BIMVision, without crashing, was able to open, visualize and select IFC structure in semantic and geometric detail along with respective element's properties, location, classification and relations.</p> <p>Conversion of IFC to CityGML also took considerable time but FME Quick Translator didn't crash during the process.</p> <p>All of the converted objects are GenericCityObject with different Geometry Type. Many geometries are not transformed. Solids maybe too complex, not closed or not orientable. Some solids maybe missing traits, appearance, measure or attributes. Visualization of converted CityGML file is different among software. For instance, FME Data Inspector doesn't render geometries of Wall Surface and Slabs as FZK Viewer (check screenshots)</p>
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>		No improvements for this dataset.
<b>7) Attach other screenshots or files that you consider useful</b>		<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/28-UpTown Additional Visualizations and Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/28-UpTown Additional Visualizations and Comments.pdf</a>
<b>1) Are you making a conversion</b>		From IFC to CityGML
<b>2) What file are you using?</b>		Savigliano.ifc (IFC)
<b>2.1) What LOD(s) will result from your</b>		LoD4

<b>conversion?</b>		
<b>4) How long does it take for the data to be converted (computer time)?</b>		1-5 minutes
<b>5) Would you like to share any other comments or observations?</b>	<p>Roof and Window features are missing after transformation (reference in Additional Visualizations and Comments file).</p> <p>Savigliano was a considerable size IFC dataset and thus was really easy to import/open, look around, visualize each component with semantic and geometric details with their properties, location, classification and relations in BIMVision software.</p> <p>Conversion of IFC to CityGML didn't take much time and FME Quick Translator didn't crash during the process. All of the objects are GenericCityObject with different Geometry Type.</p> <p>All of the transformed objects are GenericCityObject with different Geometry Type. Process was not terminated and transformation completed with few features not transformed. However, many similar elements were not translated by Quick Translator. For instance, some Slab elements of same floor are converted while adjacent one aren't (check geometries in screenshot files).</p> <p>Visualization of converted CityGML file is different among software. For instance, FME Data Inspector doesn't render geometries of Wall Surface and Slabs as FZK Viewer (check screenshots)</p>	
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/27-Savigliano_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/27-Savigliano_Additional_Visualizations_and_Comments.pdf</a>	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LoD4	
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes	
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes	
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	<ol style="list-style-type: none"> <li>1. Simple steps for FME Desktop Installation with floating licensing</li> <li>2. Open FME Quick Translator 2019 &gt; Getting Started &gt; Translate</li> <li>3. Select IFC file (Myran) in Reader's dataset and set parameters for ReadTypeObjects as Separate Features Type</li> <li>4. Select CityGML as Writer's format and browse to enter output path and filename for dataset. Enter Cord. system for CityGML writer format as EPSG:3013. Click OK</li> <li>5. Converted CityGML file is created at output path.</li> </ol>	
<b>3.1.1.2) Attach screenshots</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/2-Myran_Exp1_Automatic_Procedure_Steps_and_Screenshots.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/2-Myran_Exp1_Automatic_Procedure_Steps_and_Screenshots.pdf</a>	
<b>3.2) Add short comments to the previous questions (optional)</b>	In this transformation experiment different parameters are adjusted to compare output with other IFC to CityGML conversion results using FME Quick Translator.	
<b>4) How long does it take for the data to be converted (computer time)?</b>		less than a minute
<b>5) Would you like to share any other comments or observations?</b>	<p>When transformed CityGML file imported in FZKViewer no geometry or city elements are shown in hierarchy, even if EPSG 3013 is selected or unselected while importing converted dataset in FZK Viewer.</p> <p>Geometric deformation is observed when converted CityGML file is imported in FME Data Inspector (see attached additional visualization in 6). It could possibly be because of incorrect approach of Coord System parameter, causing incorrect translation from local to global coordinate system.</p> <p>All objects are classified as GenericCityObject with different Geometry Types. Reverse conversions don't work for transformed file i.e. CityGML to IFC (using FME Quick Translator). It was also tried for other IFC data sets to CityGML conversions using FME Quick Translator but since it only keeps geometry information and no semantic information, it wasn't possible.</p>	
<b>6) Could you see any improvement of the input data (IFC or CityGML) that</b>	Myran dataset has correct semantic information w.r.t attributes but not with the relation among entities i.e. Roof of one storey is part of another storey.	

<b>could improve the quality and/or efficiency of the conversion?</b>	Also, a whole storey is defined for just plumbing and beam elements which aren't just problematic for analysis but also semantically incorrect.
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/26-Myran_Exp1_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/26-Myran_Exp1_Additional_Visualizations_and_Comments.pdf</a>
<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	Myran (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	LoD4
<b>3.2) Add short comments to the previous questions (optional)</b>	After Myran conversion experiment 1, it was observed that changing Read Type Objects as Separate Feature Type doesn't affect much on conversion as IfcTypeObject are not translated by FME Quick Translator. However, setting Coord. System prior to conversion leads to geometrical distortions.
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>5) Would you like to share any other comments or observations?</b>	<p>Detail level geometry is translated (LoD4) but very less semantic information is kept while conversion. For instance, no hierarchy or relation of objects is kept with in the dataset except referenced parent ID. In order to construct hierarchy manual work is required, but, type of the objects are still not available which makes it almost impossible to re-translate the converted CityGML data.</p> <p>If same translation experiment is repeated using FME Quick Translation, each transformation results in different file size. Which is either addition or removal of semantics and geometry with respect to other conversions.</p> <p>Myran data set also shares that even the lightest model might have architectural level issues (see in attached file for question 6). It can be observed that geometries have correct semantics but incorrect relation with other elements at same floor. Also, few building elements are considered as separate storey which makes the analysis of the structure difficult, as it has to explicitly link with related storey.</p>
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/25-Myran_Exp2_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/25-Myran_Exp2_Additional_Visualizations_and_Comments.pdf</a>
<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	IFC4geometries (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	LoD4
<b>3.2) Add short comments to the previous questions (optional)</b>	The IFCGeometries_IFC4 dataset is IFCGeometries 2x3 with different format and has less semantic details so no parameters are adjusted to test geometric conversion ability of FME Quick Translate.
<b>4) How long does it take for the data to be converted (computer time)?</b>	it's almost immediate
<b>5) Would you like to share any other comments or observations?</b>	<p>Features read from IFCGeometries with IFC4 format are less compared to IFCGeometries with IFC2x3 format (see table below and table in IFC2x3 file submission). However, geometries converted with IFC4 format compared to IFC2x3 are similar (see attached screenshot file in 6). IFC 2X3 format data set had more and complex geometries compared to IFC4 data set.</p> <p>IFC Building elements that are read, all of them are translated to GenericCityObject with different Geometry Type. Similar geometric elements were transformed for IFCGeometries_IFC4 compared to IFCGeometries with IFC 2x3 format. However, transformed geometries have similar rendering issues for normal surfaces which varies among different softwares (FZKViewer vs FME Data Inspector). More importantly, different heights of the transformed geometry's dimension is still observed regardless of IFC format (check for screenshots in 6).</p> <p>Geometries with type IfcRevolvedAreaSolid and IfcSweptDiskSolid were not transformed. Also, few attributes are not clearly mapped; like Element Properties but object Properties are mapped (check screenshots in 6). Attributes like gml_id and gml_parent_id are regenerated each time file is opened in a software FME Data inspector. Similarly, GUID and gml:id for each element in FZKViewer are regenerated as these attributes aren't defined in converted CityGML file.</p>

<p><b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b></p>	<p>Many geometries are overlapping in this dataset. Visualization and thus a resultant comparison of these geometries in a grid gets difficult with such narrow space. Adding more padding between geometries will help in visualization and analysis.</p>
<p><b>7) Attach other screenshots or files that you consider useful</b></p>	<p><a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/24-IFCGeometries_IFC4_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/24-IFCGeometries_IFC4_Additional_Visualizations_and_Comments.pdf</a></p>
<p><b>1) Are you making a conversion</b></p>	<p>From IFC to CityGML</p>
<p><b>2) What file are you using?</b></p>	<p>IFCgeometries (IFC)</p>
<p><b>2.1) What LOD(s) will result from your conversion?</b></p>	<p>LoD4</p>
<p><b>3.2) Add short comments to the previous questions (optional)</b></p>	<p>The IFCGeometries dataset has less semantic details so no parameters are adjusted to test geometric conversion ability of FME Quick Translate.</p>
<p><b>4) How long does it take for the data to be converted (computer time)?</b></p>	<p>it's almost immediate</p>
<p><b>5) Would you like to share any other comments or observations?</b></p>	<p>Not all geometric features were read by FME Quick Translator and feature that were converted were visualized differently across software. For example, surface of geometries has rendering/visualization issue in FME Data Inspector (shown in screenshot file attached in 6), while only few of the surface normal are not rendered by FZK Viewer.</p> <p>Converted geometries have different dimension (height) compared with original geometries, see file attached in 6.</p> <p>Stats show that all of the read objects are translated as GenericCityObject with different Geometry Type. However, many geometries were not read and transformed including of Type: IfcSweptDiskSolid, IfcRevolvedAreaSolid and IfcExtrudedAreaSolid (see attached screenshot file in 6).</p>
<p><b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b></p>	<p>Since IFCGeometries dataset was about similar complex geometries type but different IFC format, the count and placement of geometrical elements should've been kept identical to match different format conversion. Because of the mentioned difference, early presumptions become that more geometries are transformed in one format than another.</p>
<p><b>7) Attach other screenshots or files that you consider useful</b></p>	<p><a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/23-IFCGeometries_Additional_Visualizations_and_Comments.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/23-IFCGeometries_Additional_Visualizations_and_Comments.pdf</a></p>



## ArcGIS Pro –

Proprietary

GIS

2 - Current user

## ArcGIS Pro

Software	Software Name [version]	<b>ArcGIS Pro</b>			Software house	<b>Esri</b>	
	Proprietary or open source software?				Kind of software		
mp ute	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	proprietary				GIS		

<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	Savigliano.ifc (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	The exported CityGML file has the same LOD of the IFC file.
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	Quick export tool from the Geoprocessing toolbox. You can easilier put all layers on the toolbox, after that the software asks which format you want to export and at the end you have to save the file in a proper directory.
<b>3.1.1.2) Attach screenshots</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/4-T4_Tool_and_workflow_SaviglianofromIFCtoCityGML.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/4-T4_Tool_and_workflow_SaviglianofromIFCtoCityGML.pdf</a>
<b>3.2) Add short comments to the previous questions (optional)</b>	no comments
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>5) Would you like to share any other comments or observations?</b>	I don't have any other comments.
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>	I don't have any suggests.

## FMEDataInspector-FME Desktop –

Proprietary

Extract/Transform/Load

1 - Very beginner user (it is nearly the first time he/she use the software)

## FMEDataInspector-FME Desktop

Software	Software Name [version]	<b>FMEDataInspector-FME Desktop [2018.1]</b>		Software house	<b>Safe Software</b>		
	Proprietary or open source software?			Kind of software			
	proprietary			Extract/Transform/Load			
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space

<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	IFCgeometries (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD2	
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes	
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes	
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	From File we open the file using Open Dataset and export it using Save Data As in version 1 and 2 of CityGML. Log of the full process in LOG.txt, the open process in fmedatainspector_2019-06-18T11-04-36.log, and an open image in 1_IFCopen.JPG.	
<b>3.1.1.2) Attach screenshots</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/5-IFCgeometries_conversion.zip">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/5-IFCgeometries_conversion.zip</a>	
<b>3.2) Add short comments to the previous questions (optional)</b>	We have already filled this form for another dataset, but we answered Not, in order to give some details about the procedure working. Opening IFC does not support some solids, which are not converted to CityGML.	
<b>4) How long does it take for the data to be converted (computer time)?</b>	it's almost immediate	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes	
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes	
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	From File we open the file using Open Dataset (screenshots 1_IFC_Parameters_OpenDataset.JPG and 2_IFC_OpenDataset.JPG) and export it using Save Data As in version 1 and 2 of CityGML (screenshots (3_CityGML2_Parameters_SaveDataAs.JPG, 4_CityGML2_SaveDataAs.JPG, 5_CityGML1_Parameters_SaveDataAs.JPG and 6_CityGML1_SaveDataAs.JPG). Log of the full process in fmedatainspector_2019-07-22T14-31-38.log .	
<b>3.1.1.2) Attach screenshots</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/9-Myran_fixed_conversion.ZIP">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/9-Myran_fixed_conversion.ZIP</a>	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	

## ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

1 - Very beginner user (it is nearly the first time he/she use the software)

## ArcGIS Pro Data Interoperability extension

Software	Software Name [version]	<b>ArcGIS Pro Data Interoperability extension [FME(R) 2018.1.1.0]</b>			Software house	<b>Esri</b>	
	Proprietary or open source software? proprietary				Kind of software GIS/ETL		
mp	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Up:town building (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	FME 2018.1 workbench
4) How long does it take for the data to be converted (computer time)?	more than one hour
7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/31-lodstoup018.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/31-lodstoup018.fmw</a>
1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Up:town building (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	IFC reader
4) How long does it take for the data to be converted (computer time)?	more than one hour
7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/32-log47.txt">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/32-log47.txt</a>
1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Up:town building (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	Revit reader
4) How long does it take for the data to be converted (computer time)?	more than one hour

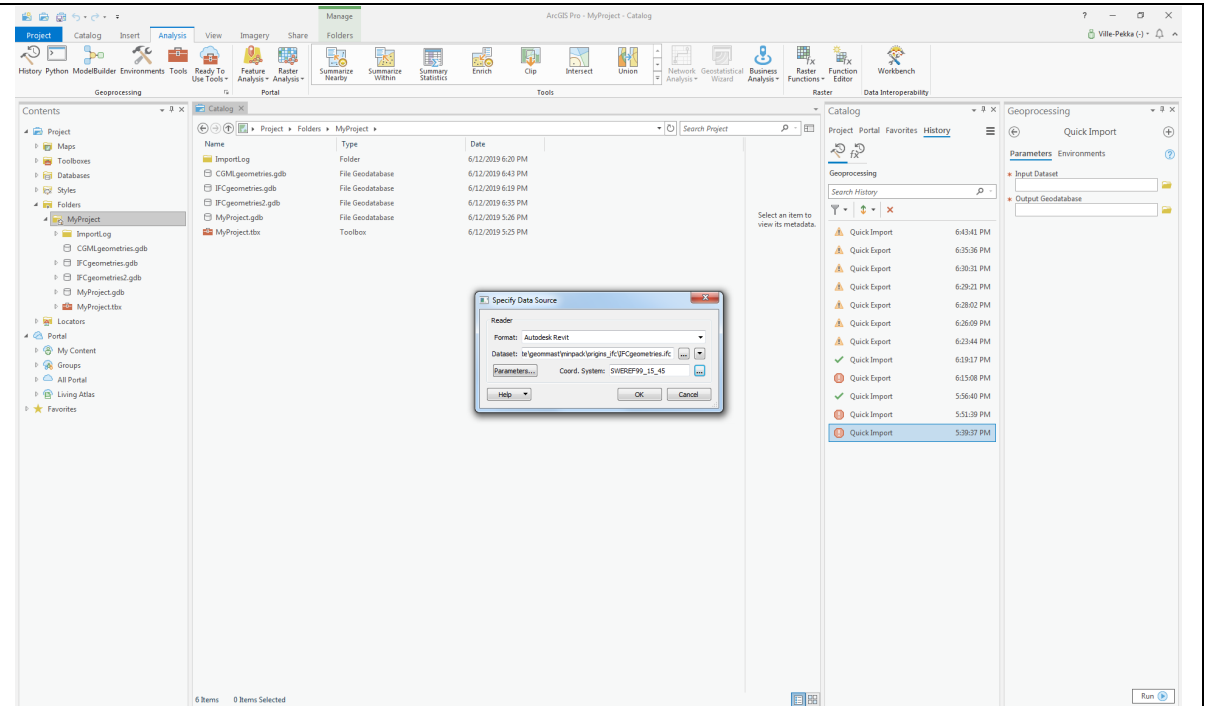
# ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

1 - Very beginner user (it is nearly the first time he/she use the software)

**7) Attach other screenshots or files that you consider useful**



<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	IFC4geometries (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4
<b>3.2) Add short comments to the previous questions (optional)</b>	Revit reader, FME workbench (in ArcGIS PRO)
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/35-ifc_lod4_geomdraft2fin_ifc4revit.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/35-ifc_lod4_geomdraft2fin_ifc4revit.fmw</a>
<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	IFC4geometries (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4
<b>3.2) Add short comments to the previous questions (optional)</b>	IFC reader, FME workbench (in ArcGIS PRO)
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/36-ifc_lod4_geomdraft2fin_ifc4.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/36-ifc_lod4_geomdraft2fin_ifc4.fmw</a>
<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	IFC4geometries (IFC)
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4
<b>3.2) Add short comments to the previous questions (optional)</b>	Revit reader
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute
<b>5) Would you like to share any other comments or observations?</b>	ifcBooleanClippingResult_1 missing.

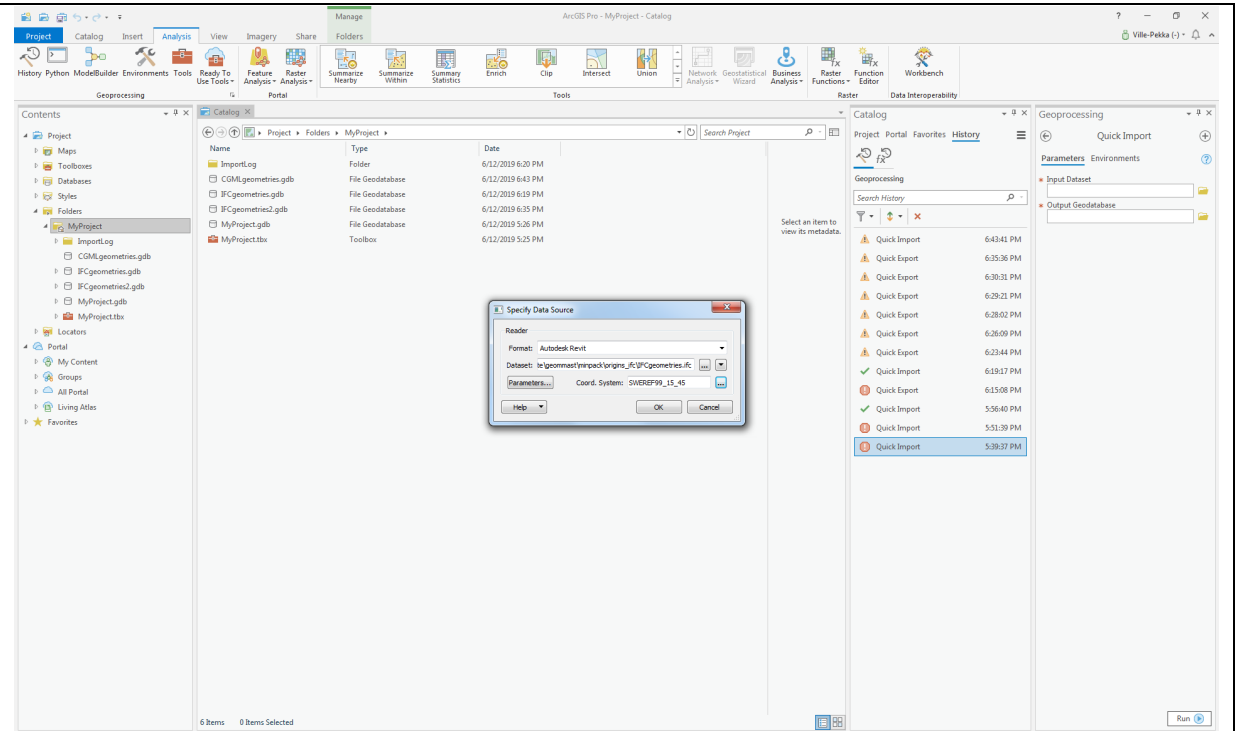
# ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

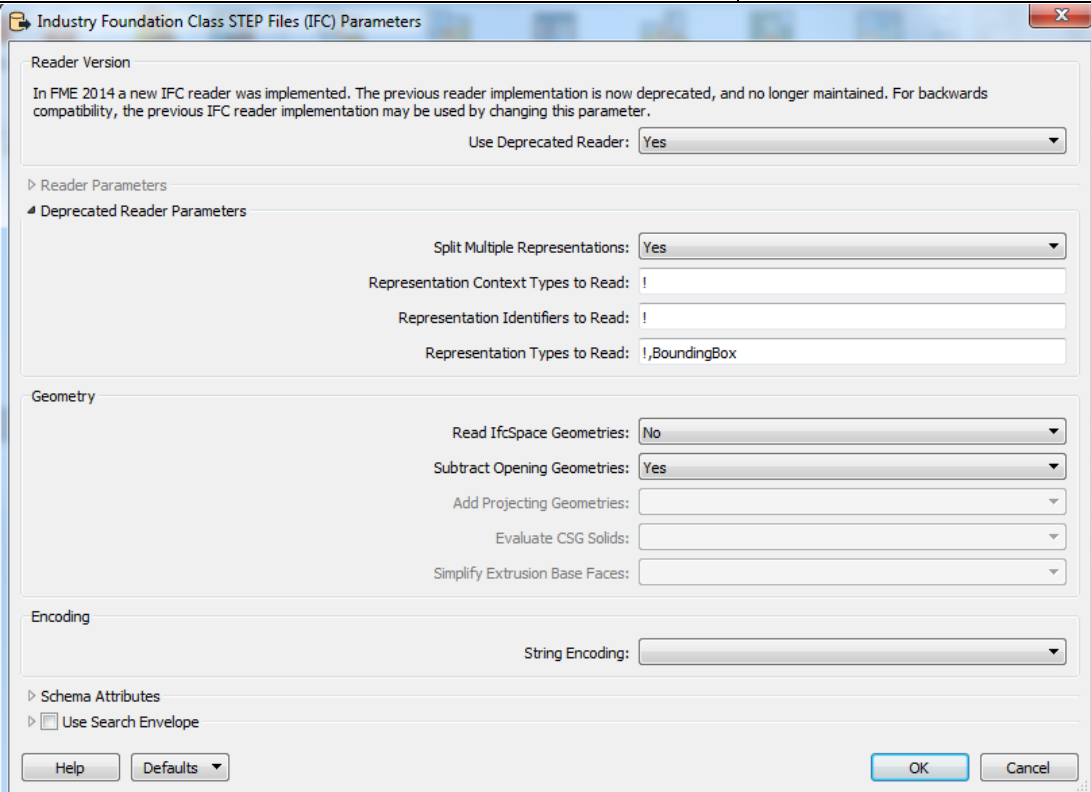
1 - Very beginner user (it is nearly the first time he/she use the software)

7) Attach other screenshots or files that you consider useful



1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	IFC4geometries (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	Reader IFC OLD
4) How long does it take for the data to be converted (computer time)?	less than a minute

7) Attach other screenshots or files that you consider useful



1) Are you making a conversion	From IFC to CityGML
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ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

1 - Very beginner user (it is nearly the first time he/she use the software)

<b>2) What file are you using?</b>	IFCgeometries (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>3.2) Add short comments to the previous questions (optional)</b>	Revit reader, FME workbench (in ArcGISPRO)	
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute	
<b>7) Attach other screenshots or files that you consider useful</b>		
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	IFCgeometries (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>3.2) Add short comments to the previous questions (optional)</b>	IFC reader, FME workbench (in ArcGIS PRO)	
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	IFCgeometries (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>3.2) Add short comments to the previous questions (optional)</b>	Revit reader	
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute	
<b>5) Would you like to share any other comments or observations?</b>	IfcBooleanClippingResult_1 missing.	

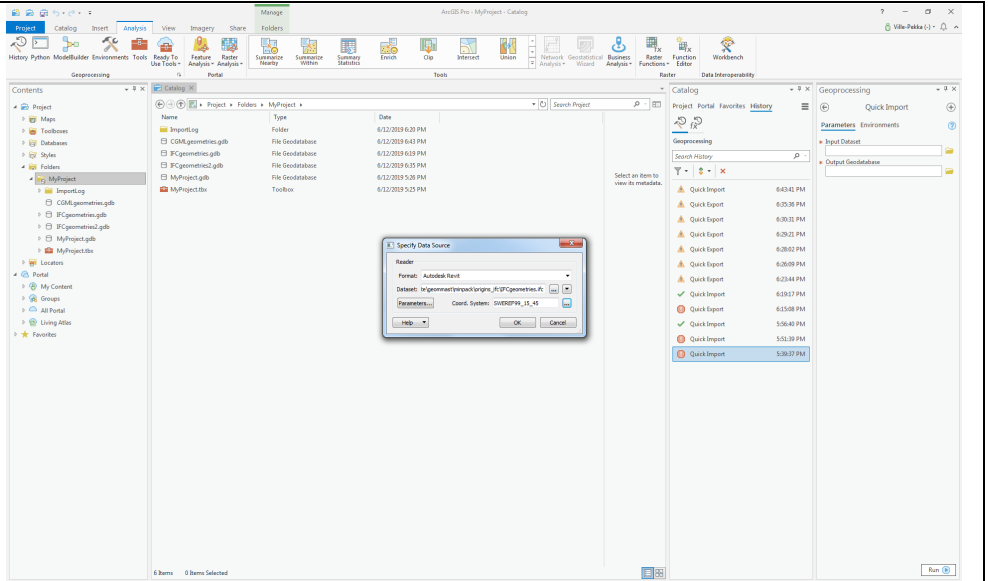
# ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

1 - Very beginner user (it is nearly the first time he/she use the software)

7) Attach other screenshots or files that you consider useful



1) Are you making a conversion From IFC to CityGML

2) What file are you using? IFCgeometries (IFC)

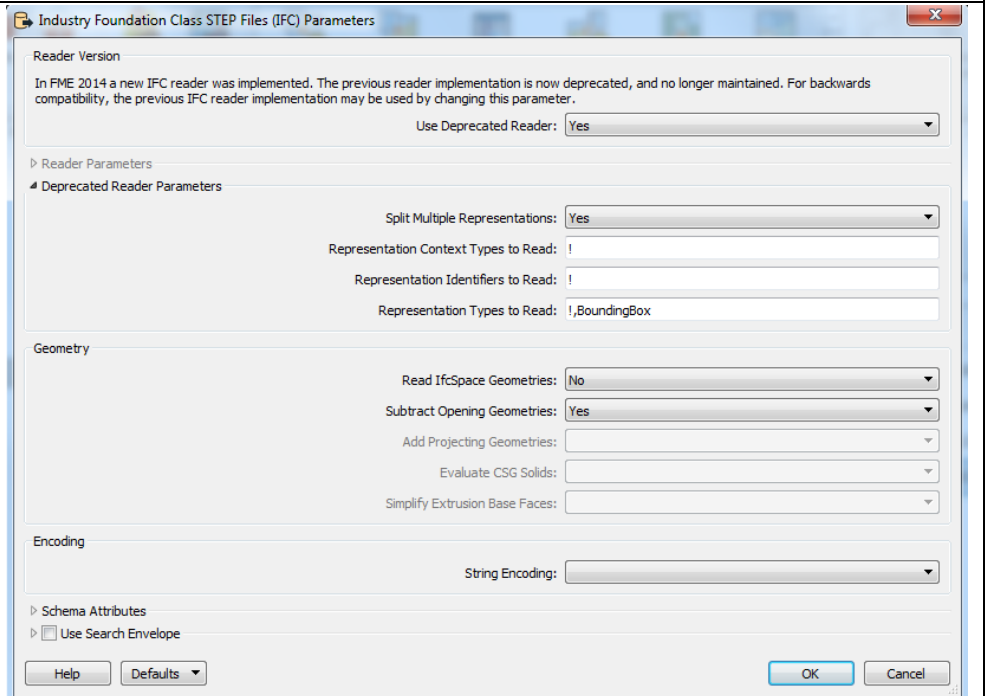
2.1) What LOD(s) will result from your conversion? LOD4

3.2) Add short comments to the previous questions (optional) IFC OLD reader

4) How long does it take for the data to be converted (computer time)? less than a minute

5) Would you like to share any other comments or observations? IFC OLD reader required for esri geodatabase to export entities into CityGML.

7) Attach other screenshots or files that you consider useful



1) Are you making a conversion From IFC to CityGML

2) What file are you using? Myran (IFC)

2.1) What LOD(s) will result from your conversion? LOD3

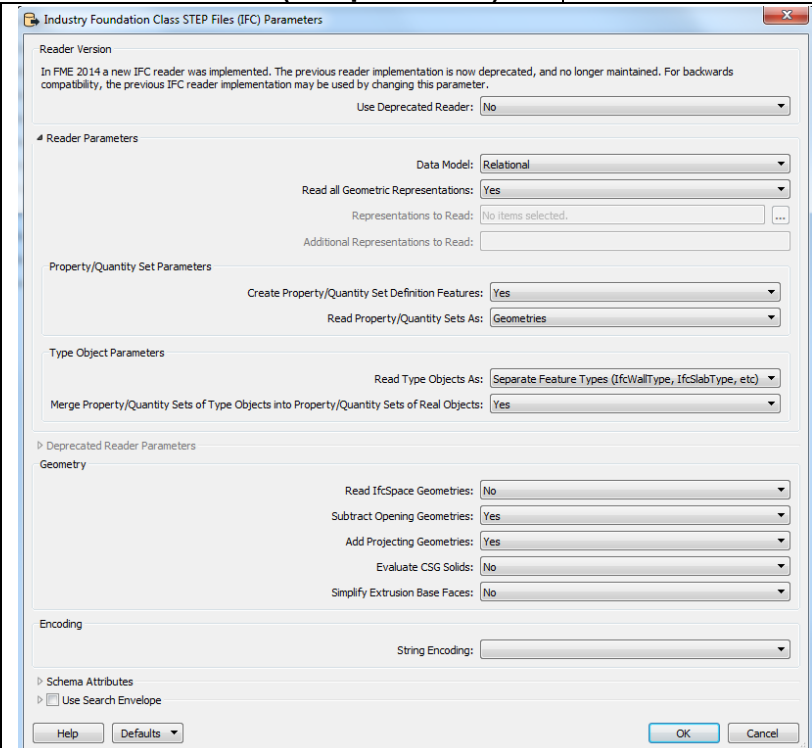
4) How long does it take for the data to be converted (computer time)? 1-5 minutes

ArcGIS Pro Data Interoperability extension –

Proprietary

GIS/ETL

1 - Very beginner user (it is nearly the first time he/she use the software)

<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/47-geobimt4_report.7z">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/47 - geobimt4_report.7z</a>	
<b>7.5) In addition, attach this filled form in word format</b>	See "70 - datainterfme2018" in OSF	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD3, SIG3D	
<b>3.2) Add short comments to the previous questions (optional)</b>	SolidBuilder fixed to not destroy geometry traits and appearances in FME 2018 transformers.	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/48-geobimt4_report.7z">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/48 - geobimt4_report.7z</a>	
<b>7.5) In addition, attach this filled form in word format</b>	See "71 - datainterfme2018" in OSF	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/49-ArcGISPROex.7z">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/49 - ArcGISPROex.7z</a>	
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	
<b>7) Attach other screenshots or files that you consider useful</b>		



FME –

Proprietary

Extract/Transform/Load

1 - Very beginner user (it is nearly the first time he/she use the software)

FME 2017

Software	Software Name [version]	FME [2017]			Software house	Safe Software	
	Proprietary or open source software?				Kind of software		
Computer	proprietary			Extract/Transform/Load			
	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space

**Test with Up:town building (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Up:town building (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.1.1.3) Give an extensive description about the <b>*tools*</b> , <b>*settings*</b> and <b>*workflow*</b> necessary to make the conversion;  ⚠ your description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same results.	BIM to GIS (Intermediate) \ IFC LOD 300 to LOD 4 CityGML. URL: <a href="https://knowledge.safe.com/articles/1025/bim-to-gis-intermediate-ifc-lod-300-to-lod-4-cityg.html">https://knowledge.safe.com/articles/1025/bim-to-gis-intermediate-ifc-lod-300-to-lod-4-cityg.html</a>
4) How long does it take for the data to be converted (computer time)?	more than one hour
7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/34 - lodstoup018.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/34 - lodstoup018.fmw</a>

**Test with IFC4geometries (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	IFC4geometries (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	Revit reader
4) How long does it take for the data to be converted (computer time)?	less than a minute
7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/38 - ifc_lod4_geomdraft2fin_ifc4revit.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/38 - ifc_lod4_geomdraft2fin_ifc4revit.fmw</a>

**Test with IFC4geometries (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	IFC4geometries (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	IFC reader
4) How long does it take for the data to be converted (computer time)?	less than a minute

**Test with IFC4geometries (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	IFCgeometries (IFC)
2.1) What LOD(s) will result from your conversion?	LOD4
3.2) Add short comments to the previous questions (optional)	Revit reader
4) How long does it take for the data to be converted (computer time)?	less than a minute
7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/44 - ifc_lod4_geomdraft2fin_revit.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/44 - ifc_lod4_geomdraft2fin_revit.fmw</a>

**Test with IFC4geometries (IFC)**

1) Are you making a conversion	From IFC to CityGML
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FME –

Proprietary

Extract/Transform/Load

1 - Very beginner user (it is nearly the first time he/she use the software)

<b>2) What file are you using?</b>	IFCgeometries (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD4	
<b>3.1) Are you using an off-the-shelf tool?</b>	No, I am using a bespoke piece of software (i.e. one developed by me or my company but not completely available to the public).	
<b>3.1.2) Give an extensive description about the <i>_tools_</i>, <i>_settings_</i> and <i>_workflow_</i> necessary to make the conversion;</b> <b>⚠ your description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same results.</b>	<a href="https://knowledge.safe.com/articles/591/bim-tutorial.html">https://knowledge.safe.com/articles/591/bim-tutorial.html</a>	
<b>3.2) Add short comments to the previous questions (optional)</b>	IFC reader	
<b>4) How long does it take for the data to be converted (computer time)?</b>	less than a minute	
<b>5) Would you like to share any other comments or observations?</b>	Conversion times improve after firing up the workflows in FME once.	
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/46-ifc_lod4_geomdraft2fin.fmw">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/46-ifc_lod4_geomdraft2fin.fmw</a>	
<b>Test with Myran (IFC)</b>		
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD3	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	
<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/51-geobimt4_report.7z">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/51-geobimt4_report.7z</a>	
<b>7.5) In addition, attach this filled form in word format</b>	See "72 - myranifclod2_indevrevits17p43slabf_counts" in OSF	
<b>Test with Myran (IFC)</b>		
<b>1) Are you making a conversion</b>	From IFC to CityGML	
<b>2) What file are you using?</b>	Myran (IFC)	
<b>2.1) What LOD(s) will result from your conversion?</b>	LOD3, SIG3D	
<b>3.1) Are you using an off-the-shelf tool?</b>	No, I am using a bespoke piece of software (i.e. one developed by me or my company but not completely available to the public).	
<b>3.1.2) Give an extensive description about the <i>_tools_</i>, <i>_settings_</i> and <i>_workflow_</i> necessary to make the conversion;</b> <b>⚠ your description should be detailed enough to allow (non-expert) others to follow the same steps and obtain the same results.</b>	FME website. URL: <a href="https://www.safe.com/fme">https://www.safe.com/fme</a>	
<b>3.1.3) Attach screenshots / documentation related to the previous question</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/15-geobimt4_report.7z">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/15-geobimt4_report.7z</a>	
<b>3.2) Add short comments to the previous questions (optional)</b>	Workflow and transformer screenshots	
<b>4) How long does it take for the data to be converted (computer time)?</b>	1-5 minutes	
<b>5) Would you like to share any other comments or observations?</b>	Relations are missing between individual glass screens (windows) and steel frames.	
<b>6) Could you see any improvement of the input data (IFC or CityGML) that could improve the quality and/or efficiency of the conversion?</b>	Corrected or cleaned georeference. Volumetric or surface property for entities. Modelling separate interior and exterior. Property for floors above ground. Openings included in wall and slab entities.	

## FME –

Proprietary

Extract/Transform/Load

1 - Very beginner user (it is nearly the first time he/she use the software)

**7) Attach other screenshots or files that you consider useful**

[https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/52 - myranifclod2\\_indev17p43slabf\\_fixcount.fmw](https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/52 - myranifclod2_indev17p43slabf_fixcount.fmw)

**FME 2018.1**

Software	Software Name [version]	<b>FME [2018.1]</b>		Software house	<b>Safe Software</b>		
	Proprietary or open source software?			Kind of software			
proprietary			Extract/Transform/Load				
Computer	Model and year	Operating system	CPU	GPU	Memory (RAM)	Hard drive capacity	Hard drive free space
	Lenovo Legion Y720, 2017	Windows Pro 10	Intel Core i7 7700HQ	GTX1060	16	256 SSD	73

**Test with Myran (IFC)**

<b>1) Are you making a conversion</b>	From IFC to CityGML
<b>2) What file are you using?</b>	Myran (IFC)
<b>3.1) Are you using an off-the-shelf tool?</b>	Yes
<b>3.1.1) Is a completely automatic procedure working?</b>	Yes
<b>3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?</b>	FME Quick Translator, Get Started, Translate

**3.1.1.2) Attach screenshots**

<b>4) How long does it take for the data to be converted (computer time)?</b>	it crashes without completing the operation
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<b>7) Attach other screenshots or files that you consider useful</b>	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/54 - T4_Myran_FME_CityGML_.pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/54 - T4_Myran_FME_CityGML_.pdf</a>
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**Test with Myran (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Myran (IFC)
3.1) Are you using an off-the-shelf tool?	Yes
3.1.1) Is a completely automatic procedure working?	Yes
3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?	FME Quick Translator, Get Started, Translate

<p><b>3.1.1.2) Attach screenshots</b></p>	
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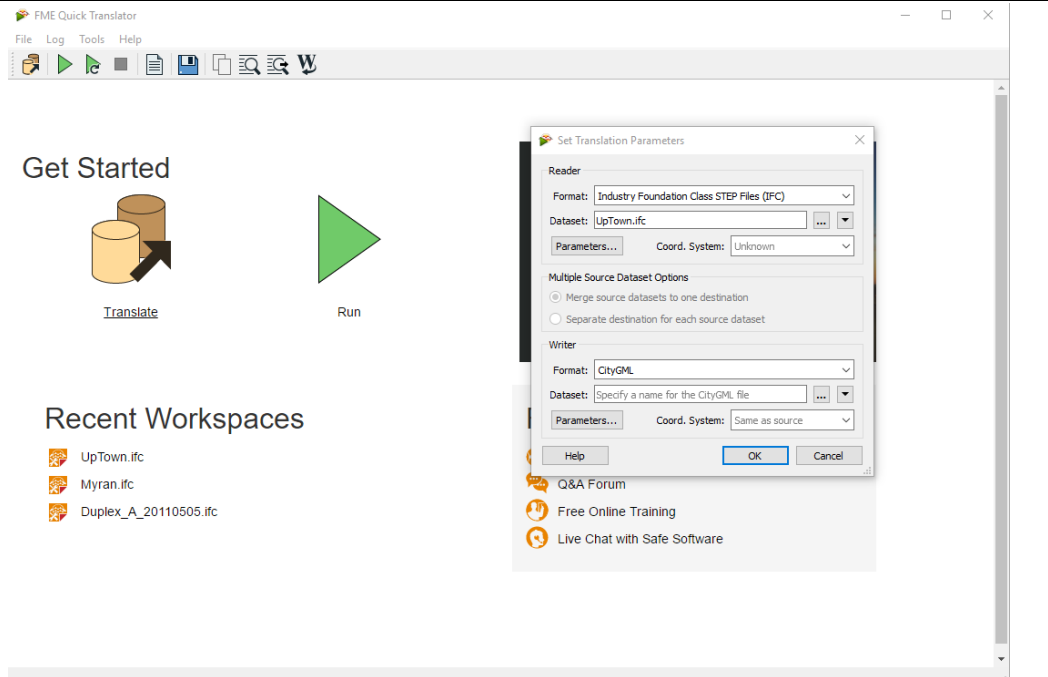
4) How long does it take for the data to be converted (computer time)?	it's almost immediate
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7) Attach other screenshots or files that you consider useful	<a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/55 - T4 IFCgeometries FME CityGML .pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/55 - T4 IFCgeometries FME CityGML .pdf</a>
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**Test with Up:town building (IFC)**

1) Are you making a conversion	From IFC to CityGML
2) What file are you using?	Up:town building (IFC)
3.1) Are you using an off-the-shelf tool?	Yes
3.1.1) Is a completely automatic procedure working?	Yes
3.1.1.1) Give a brief description about where the tool can be found (e.g. on which menu) and how it works (from the installation to the end of the conversion)?	FME Quick Translator, Get Started, Translate

**3.1.1.2) Attach screenshots**



<p><b>4) How long does it take for the data to be converted (computer time)?</b></p>	<p>more than one hour</p>
<p><b>5) Would you like to share any other comments or observations?</b></p>	<p>The converted data was not visualized in the FME Data Inspector software.</p>
<p><b>7) Attach other screenshots or files that you consider useful</b></p>	<p><a href="https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/56 - T4 UpTown FME CityGML .pdf">https://3d.bk.tudelft.nl/projects/geobim-benchmark/linkedfiles/T4/56 - T4 UpTown FME CityGML .pdf</a></p>