



National Cartographic Center of Iran



BIM & 3D Web Services

By:
Alireza Amiri
GIS expert at the GIS office of NCC

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- **BIM**
- **Some Spatial formats**
- **Practical Examples**

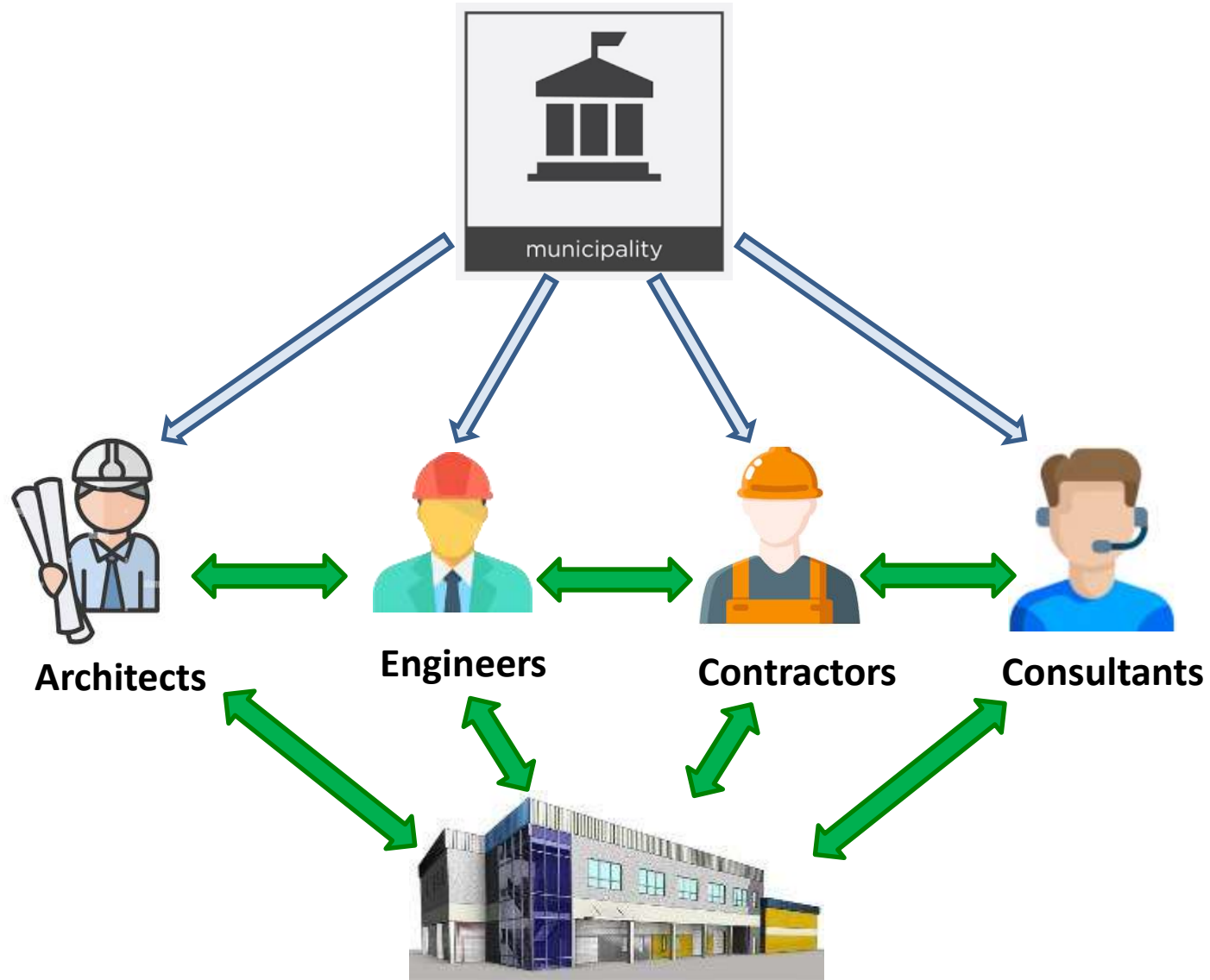
Benefits of BIM



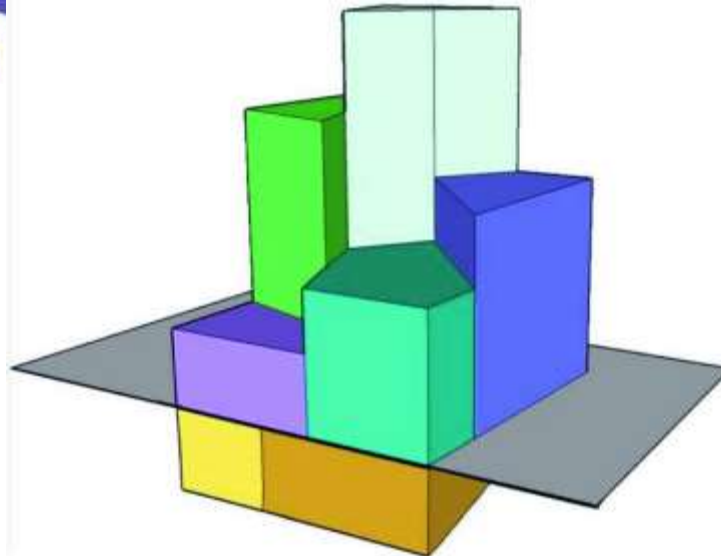
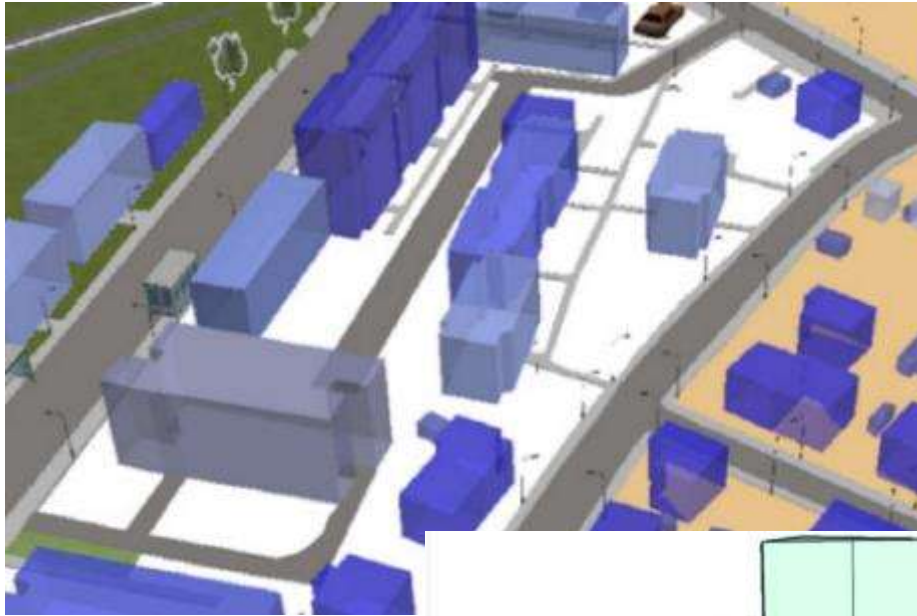
**Easier
Management**

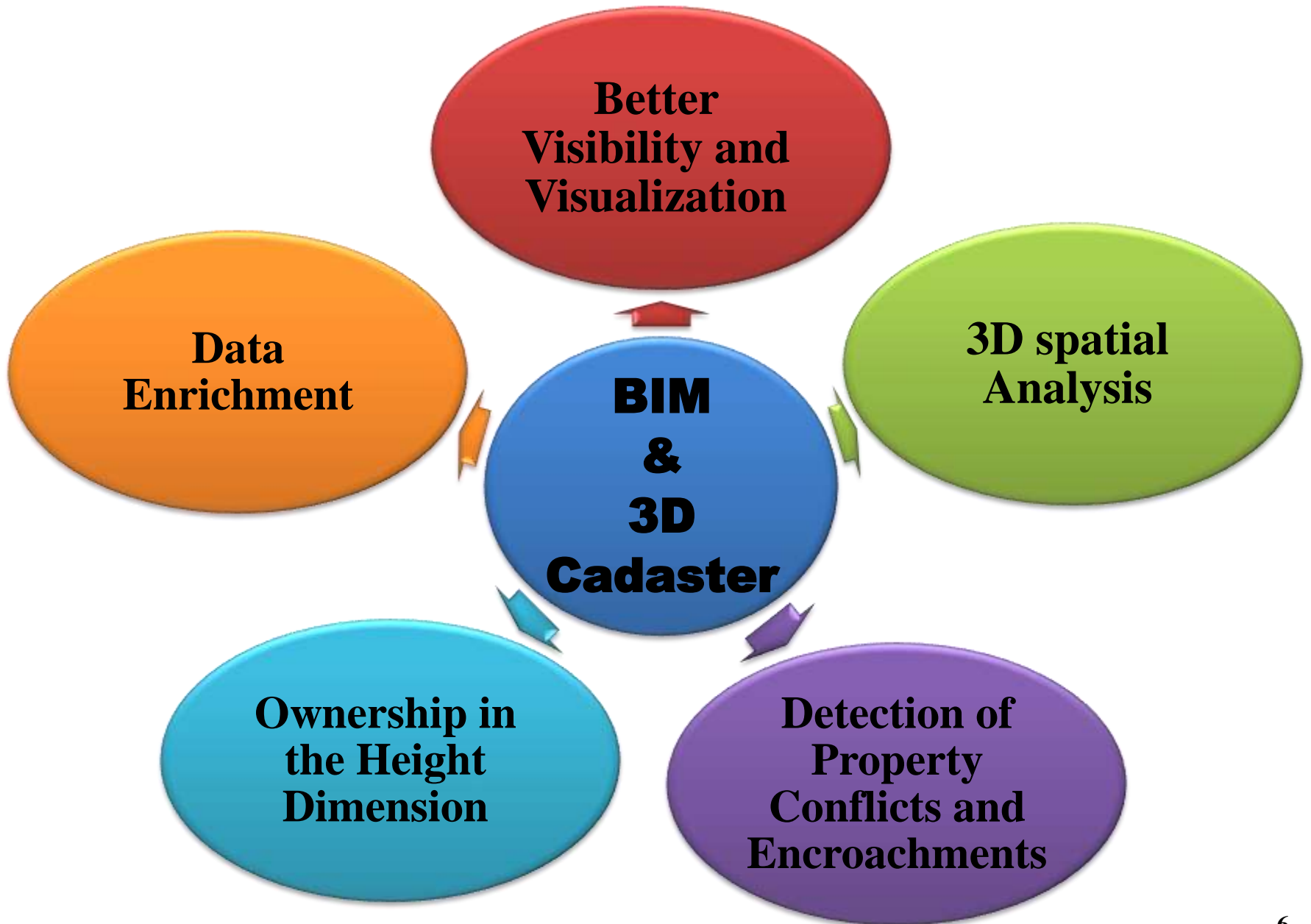


How municipalities manage cities?

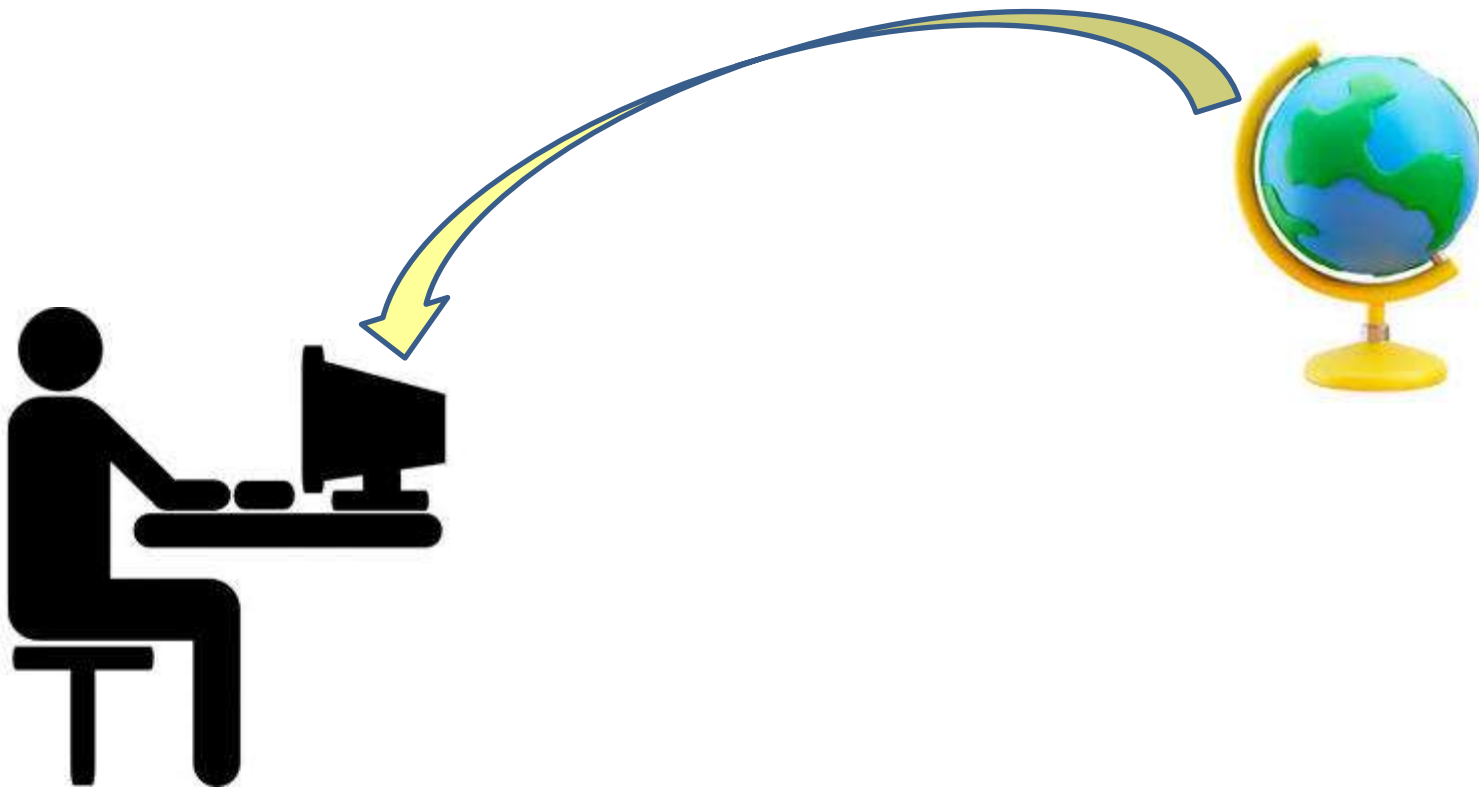


BIM & 3D Cadaster





3D Spatial Web Service



3D Spatial Web Service Characteristics

1- Online Access



2- 3D Visualization



3D Spatial Web Service Characteristics

3- Interactivity



4- Data Integration



3D Spatial Web Service Characteristics

5- Collaboration and Sharing



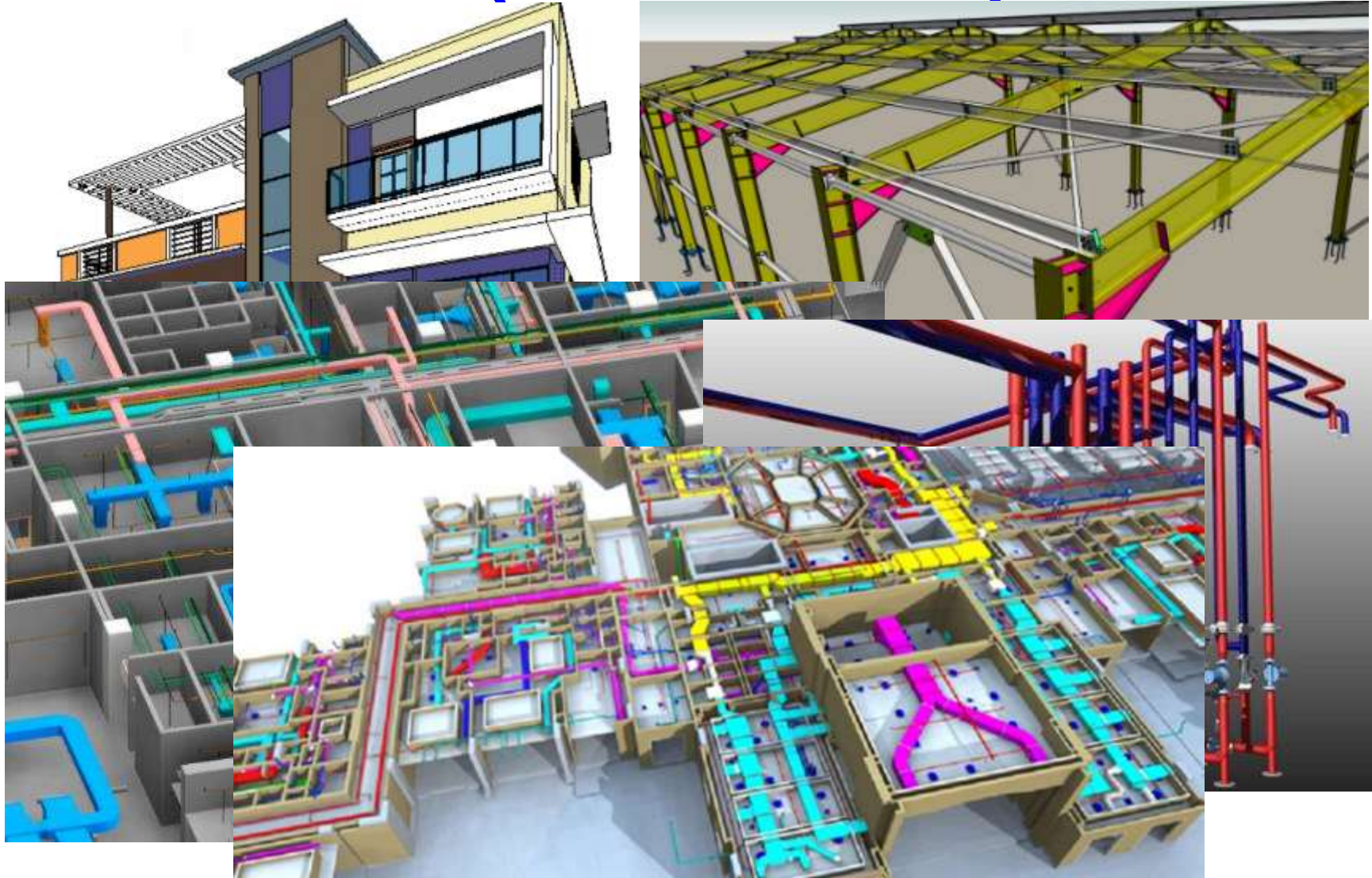


Getting to Know Some Spatial Formats

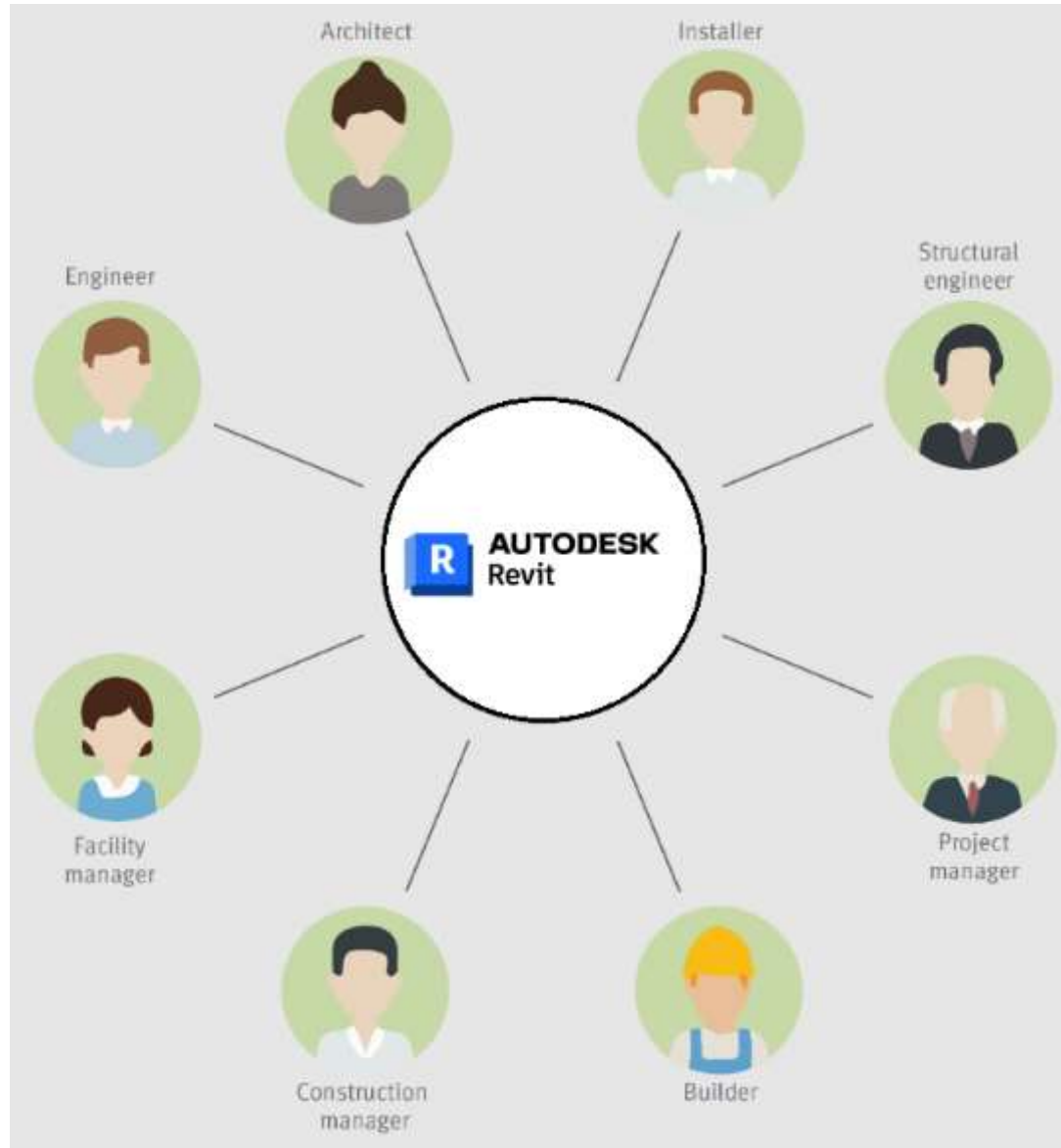
Some standard formats (RVT format)



Some standard formats (RVT format)



Some standard formats (RVT format)



Some standard formats (RVT format)



1- File Size

2- Performance Issue

3- Data Extraction and Data Editing

4- Higher Learning Curve

Sharing RVT format



IFC format

Industry Foundation Classes



```
#13204= IFCCARTESIANPOINT((0.817072413507,0.234291850232,0.293333333333));
#13206= IFCCARTESIANPOINT((0.774466560011,0.35028780656,0.293333333333));
#13208= IFCCARTESIANPOINT((0.774466560011,0.35028780656,0.353333333333));
#13210= IFCCARTESIANPOINT((0.817072413507,0.234291850232,0.353333333333));
#13212= IFCPOLYLOOP((#13204,#13206,#13208,#13210));
#13214= IFCFACEOUTERBOUND(#13212,.T.);
#13215= IFCFACE((#13214));
#13217= IFCCARTESIANPOINT((0.096126166295,0.0275637470862,0.293333333333));
#13219= IFCCARTESIANPOINT((0.0892039006313,0.0451958417575,0.293333333333));
#13221= IFCCARTESIANPOINT((0.0790809229718,0.0612062710997,0.293333333333));
#13223= IFCCARTESIANPOINT((0.715492052268,0.458880292823,0.293333333333));
#13225= IFCPOLYLOOP((#13204,#13217,#13219,#13221,#13223,#13206));
#13227= IFCFACEOUTERBOUND(#13225,.T.);
#13228= IFCFACE((#13227));
#13230= IFCCARTESIANPOINT((0.715492052268,0.458880292823,0.353333333333));
#13232= IFCPOLYLOOP((#13206,#13223,#13230,#13208));
#13234= IFCFACEOUTERBOUND(#13232,.T.);
```

IFC format

In Revit



In IFC



Project Information

Family: System Family: Project Information

Type:

Instance Parameters - Control selected or to-be-created instance

Parameter	Value
Identity Data	
Organization Name	
Organization Description	
Building Name	BIM Corner Building Name
Author	Ignacy Lozinski
Energy Analysis	
Energy Settings	Edit...
IFC Parameters	
IfcDescription	This is BIM Corner test model
IfcObjectType	Test
SiteName	Site 1
SiteDescription	This is BIM Corner site 1
SiteObjectType	This is Site 1 object type
SiteLongName	Site 1 Long Name
BuildingDescription	This is School Project
BuildingLongName	This is IfcBuilding Long Name
BuildingObjectType	Educational Project by BC
Route Analysis	
Route Analysis Settings	Edit...
Other	
Project Issue Date	02.02.2022

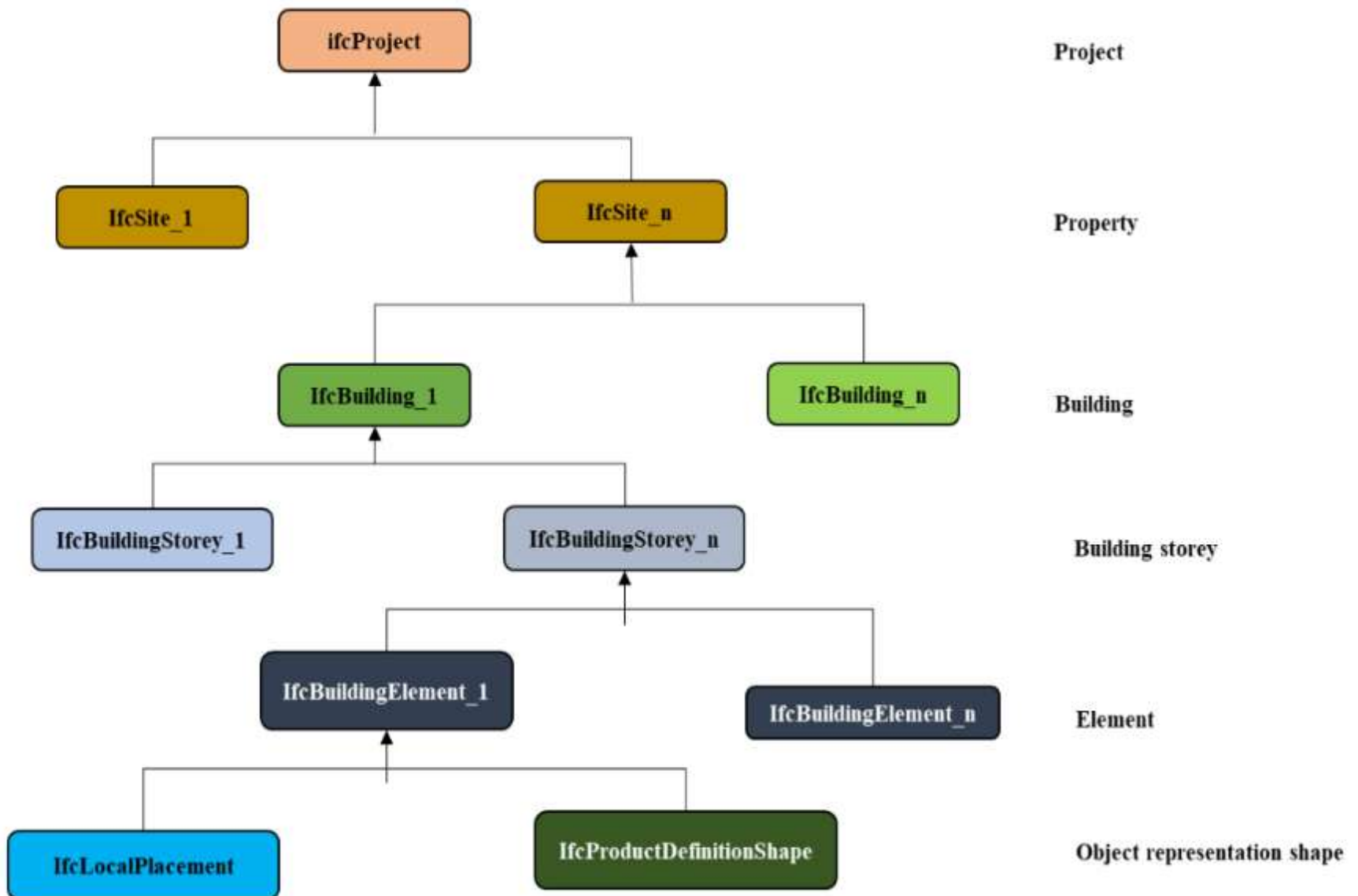
IFC Structure

Type	Name	Description
Project	112233	This is BIM Corner test model
Site	Site 1	This is BIM Corner site 1
Building	BIM Corner Building Name	This is School Project

Properties Location Classification Relations

Name	Value	Unit
Element Specific		
CompositionType	ELEMENT	
Description	This is School Project	
Guid	3bmyaIWCvEHuFvX1c33vn1	
IfcEntity	IfcBuilding	
LongName	This is IfcBuilding Long Name	
Name	BIM Corner Building Name	
ObjectType	Educational Project by BC	

IFC format



IFC format

The image shows a 3D architectural model of a building on the left. A red dashed box highlights a specific level of the building, which is highlighted in green. Two red arrows point from this highlighted level to the 'Building Storey' entry for 'Level 4' in the 'IFC Structure' tree on the right. The tree shows a hierarchy: Project (Project Name), Site (The site), Building (The building), and Building Storey (Level 4, Level 2, Level 3, Level 5, Level 6, Level 1). The 'Level 4' entry is selected and has a checkmark in the 'Active' column. Below the tree is a properties table with tabs for Properties, Location, Classification, and Relations. The 'Properties' tab is active, showing a table with columns for Value, Unit, and Name. The table contains three rows: 'ELEMENT' with 'CompositionType', '6' with 'm' and 'Elevation', and '2sipsYyLb8pP5DU\$Kkc...' with 'Guid'.

Active	Type	Name
<input type="checkbox"/>	Project	Project Name
<input type="checkbox"/>	Site	The site
<input type="checkbox"/>	Building	The building
<input checked="" type="checkbox"/>	Building Storey	Level 4
<input checked="" type="checkbox"/>	Building Storey	Level 2
<input type="checkbox"/>	Building Storey	Level 3
<input checked="" type="checkbox"/>	Building Storey	Level 5
<input checked="" type="checkbox"/>	Building Storey	Level 6
<input checked="" type="checkbox"/>	Building Storey	Level 1

Value	Unit	Name
Element Specific		
ELEMENT		CompositionType
6	m	Elevation
2sipsYyLb8pP5DU\$Kkc...		Guid

CityGML OGC format



CityGML

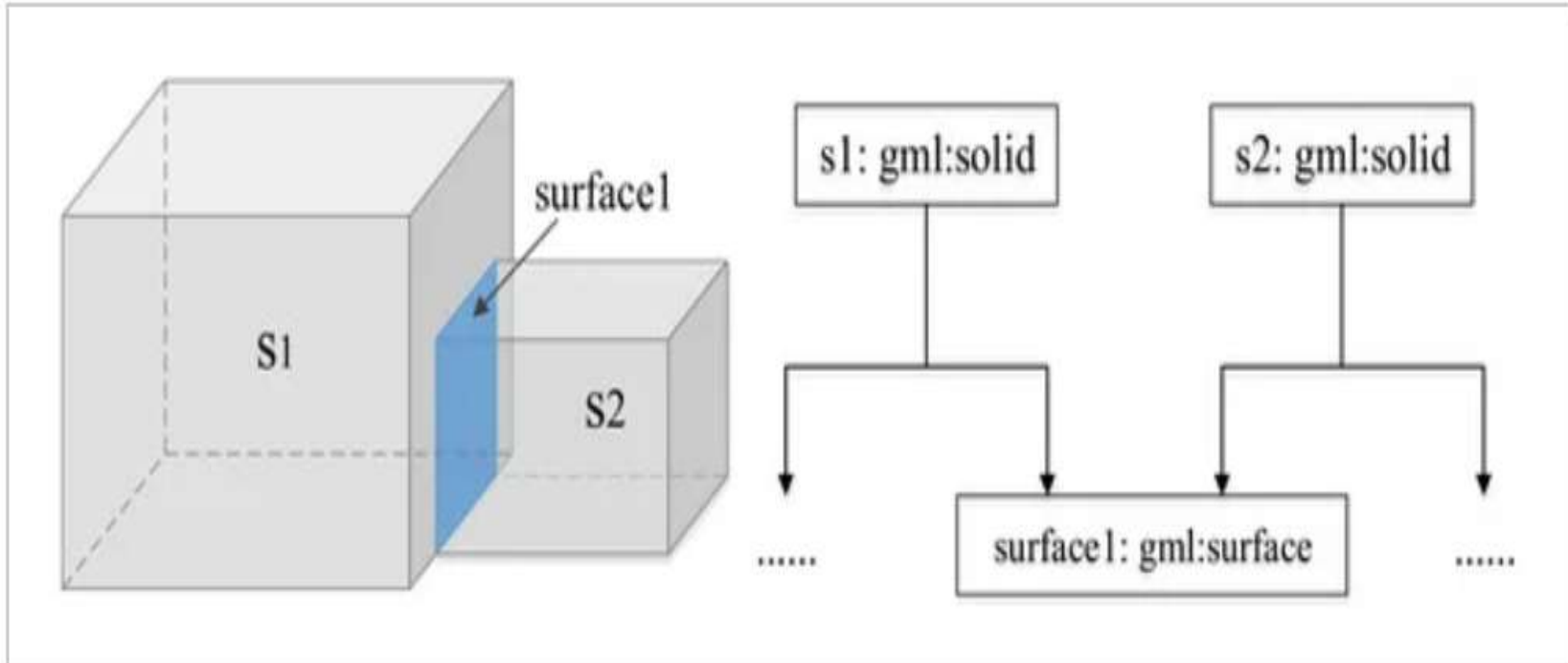
CityGML OGC format

```
<cityObjectMember>
  <Building gml:id="B1020_t2">
    <identifier>B1020</identifier>
    <consistsOfBuildingPart>
      <BuildingPart xlink:href="//identifier[text()='BP12']"/>
    </consistsOfBuildingPart>
    <creationDate>2013-10-10</creationDate>
    <function>Living</function>
  </Building>
</cityObjectMember>
<cityObjectMember>
  <BuildingPart gml:id="BP12_t1">
    <identifier>BP12</identifier>
    <creationDate>2012-08-02</creationDate>
    <terminationDate>2014-06-04</terminationDate>
    <roofType>Flat</roofType>
  </BuildingPart>
</cityObjectMember>
```

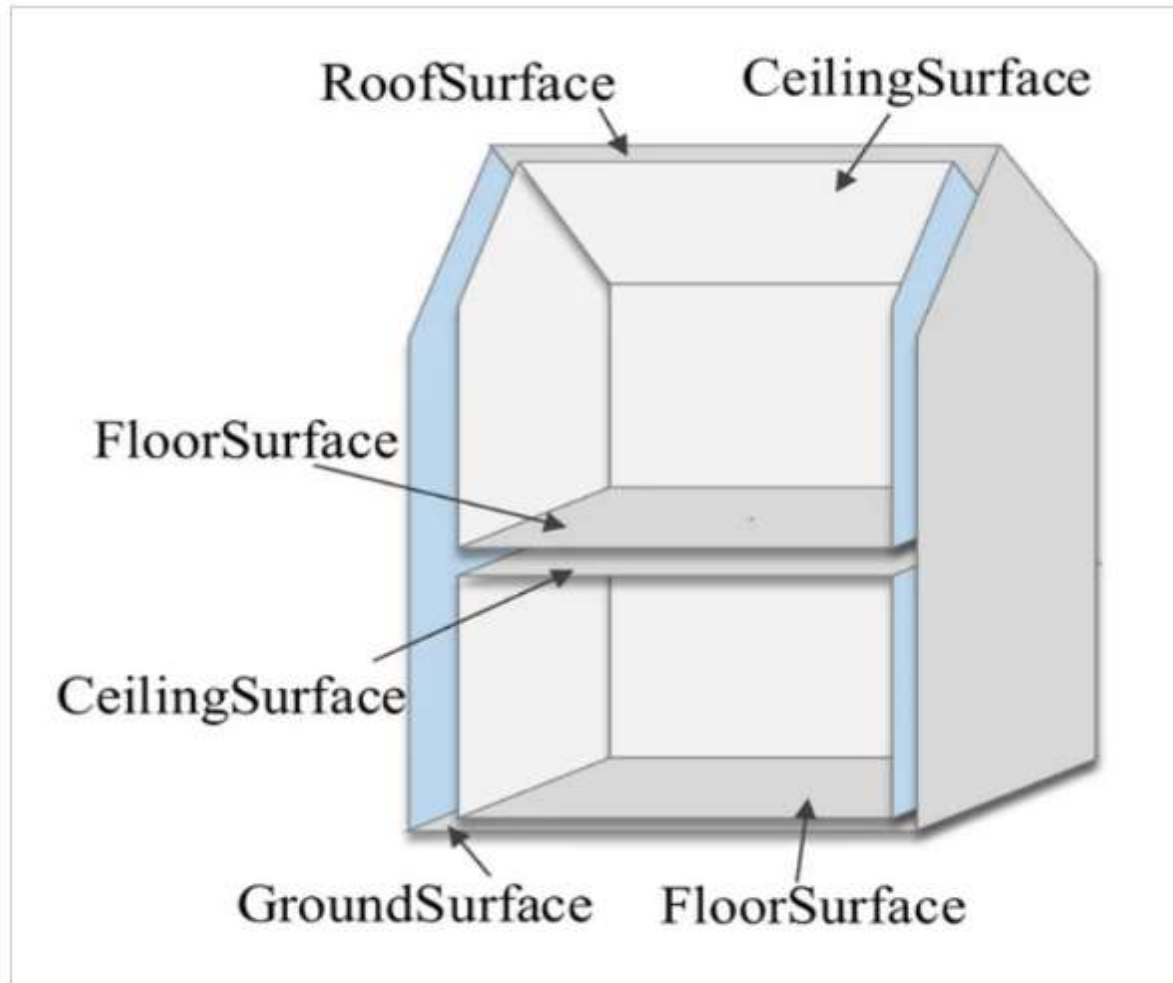
IFC format

IFC	CityGML
IfcBuilding	AbstractBuilding
IfcOpeningElement	Opening
IfcDoor	Door
IfcWindow	Window
IfcBeam	BuildingInstallation
IfcColumn	BuildingInstallation
IfcRailing	BuildingInstallation
IfcRamp	BuildingInstallation
IfcStair	BuildingInstallation
IfcStairCase	BuildingInstallation
IfcWall	WalSurface
	InteriorWallSurface
	ExteriorWallSurface
IfcRoof	RoofSurface
IfcSlab	GroundSurfcae
IfcFloor	FloorSurface

Topology in CityGML



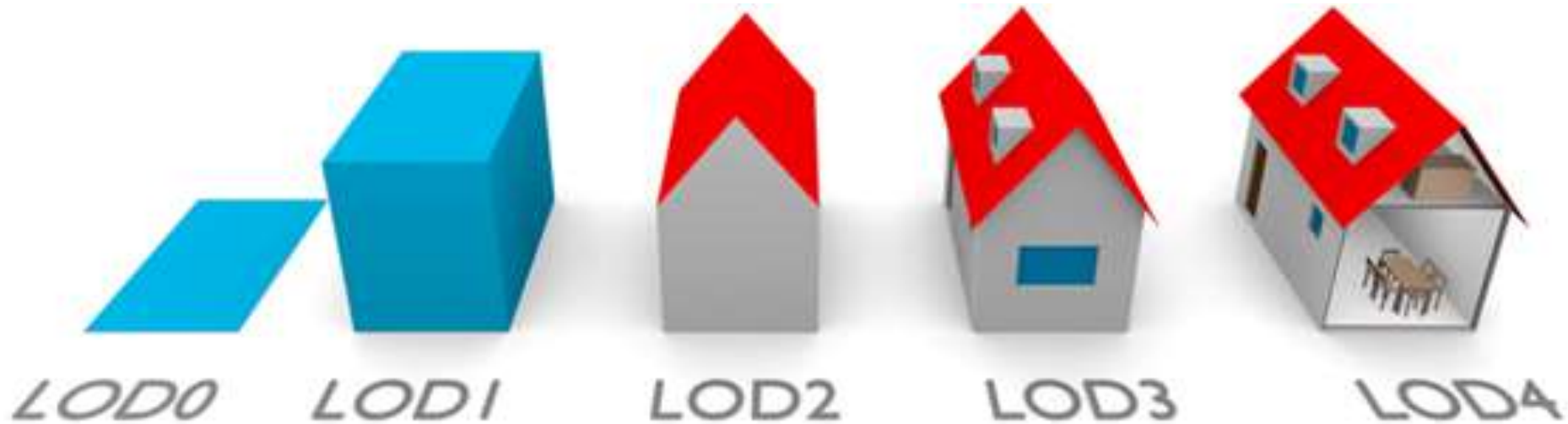
Representation of Building Elements in CityGML



Categories of Features in CityGML

- **Digital Terrain Models**
- **Sites (buildings, bridges, and tunnels)**
- **Vegetation**
- **Water bodies**
- **Transportation facilities**
- **Land use**
- **City furniture**

The Five Levels of Detail (LOD) Defined by CityGML

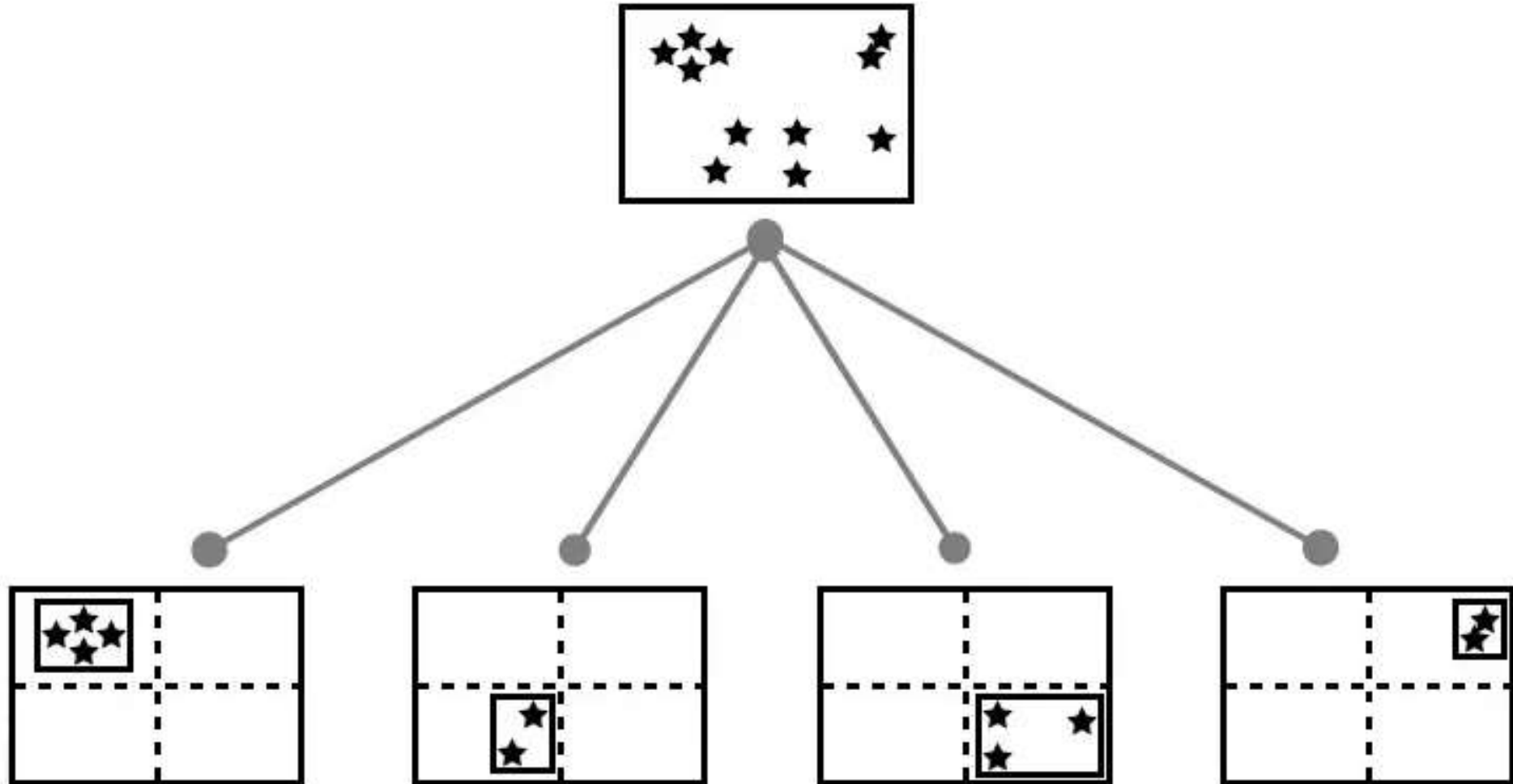


3D Tiles OGC format

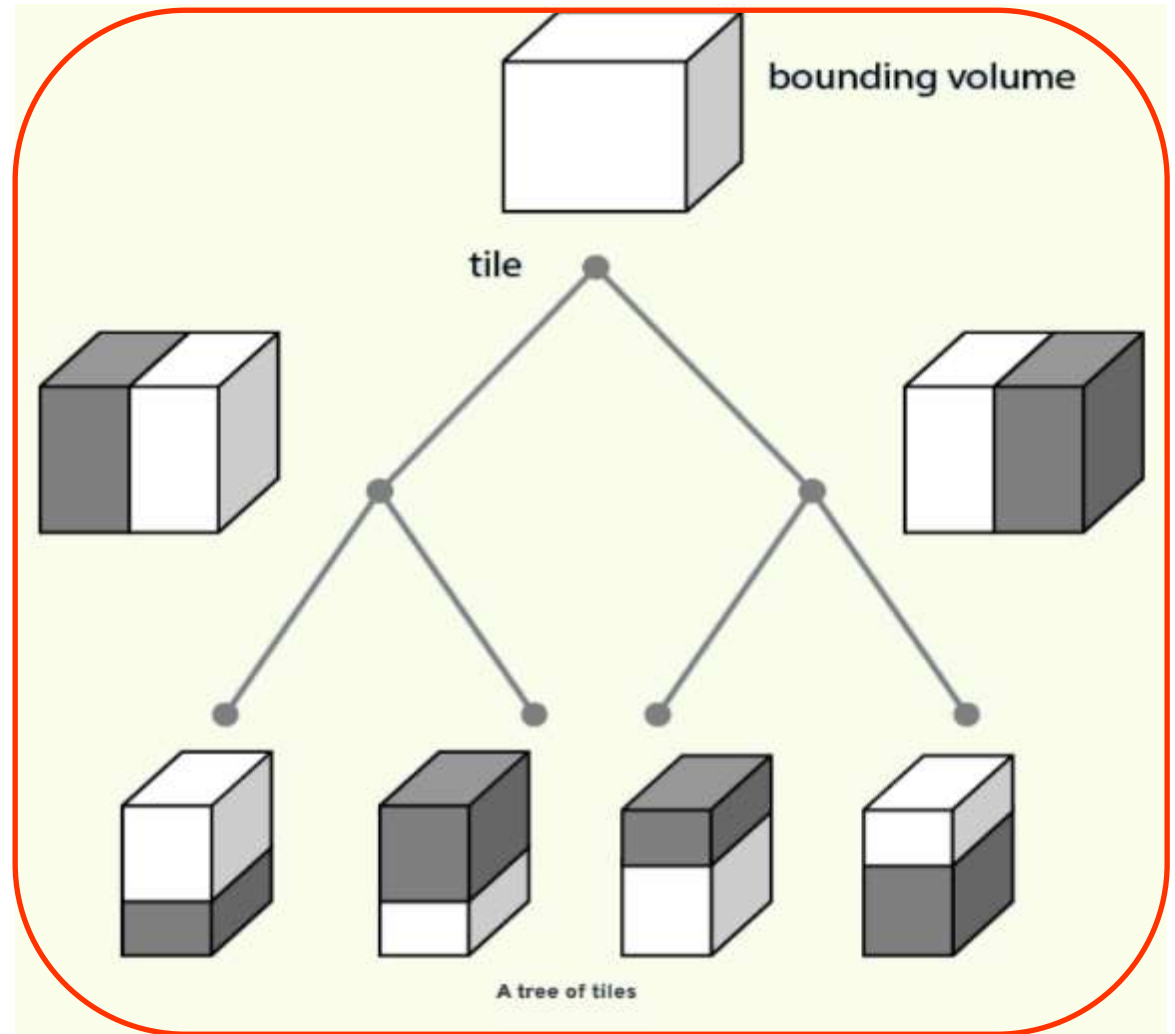


3DTiles

3D Tiles OGC format



3D Tiles OGC format

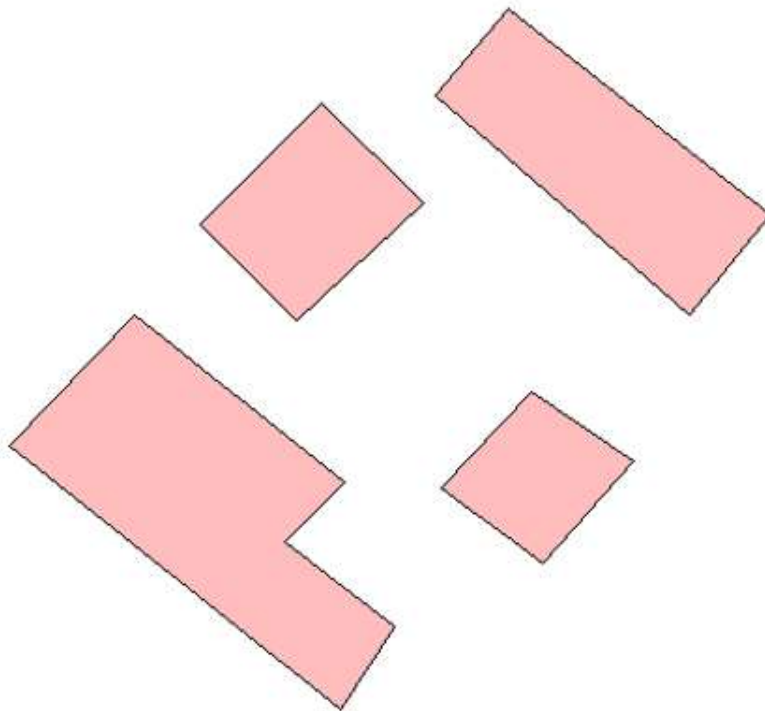




Implementation & Practical Examples

**3D Web Service
CityGML (LOD1)**

A Sample Shapefile



Table

Building_2D

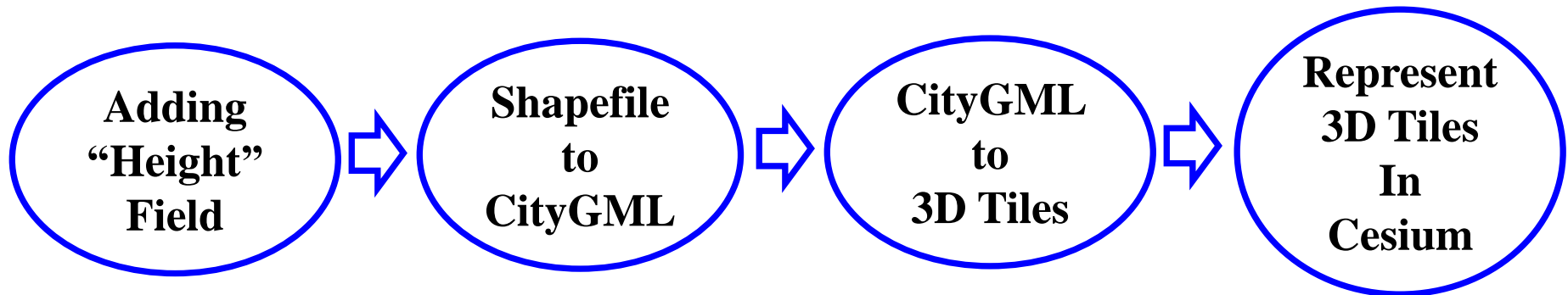
FID	Shape *	Storey	id
0	Polygon	10	1
1	Polygon	15	2
2	Polygon	20	3
3	Polygon	30	4
4	Polygon	10	5

(0 out of 5 Selected)

Building_2D

Preparing Data

- **Adding a Field to Shapefile as Height of Building**
- **Converting Shapefile to CityGML (LOD1)**
- **Converting CityGML (LOD1) to 3D Tiles**
- **Representing 3D Tiles in Cesium**



Shapefile to CityGML Conversion

ESRI Shapefile

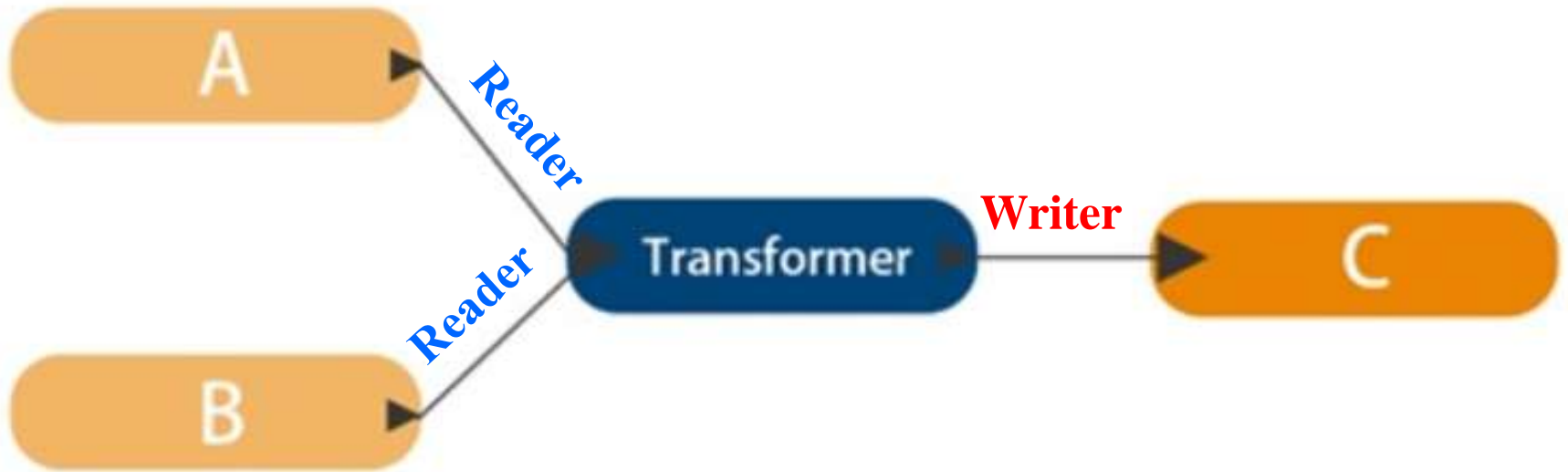


Conversion by FME

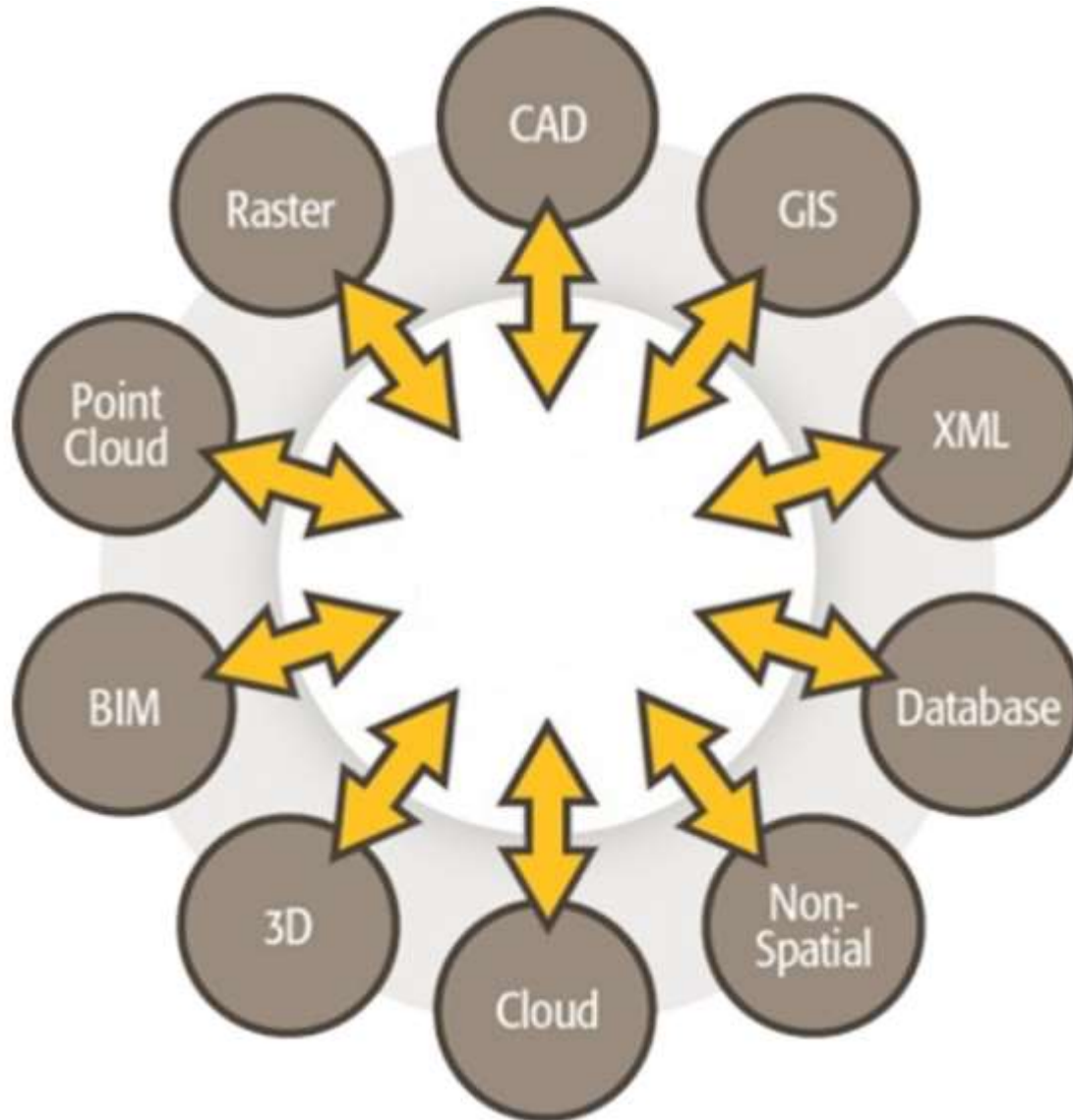


Feature Manipulation Engine

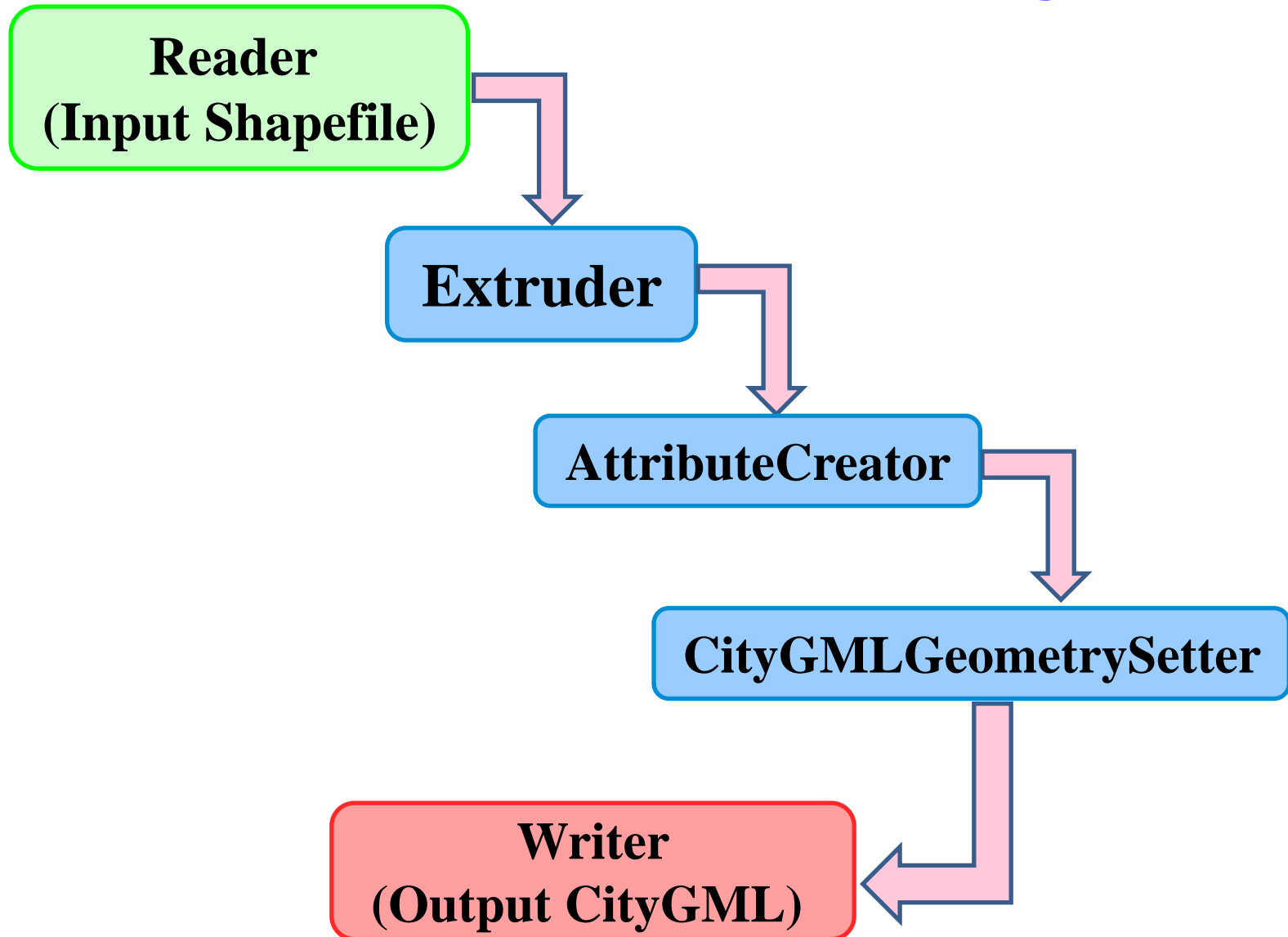
FME



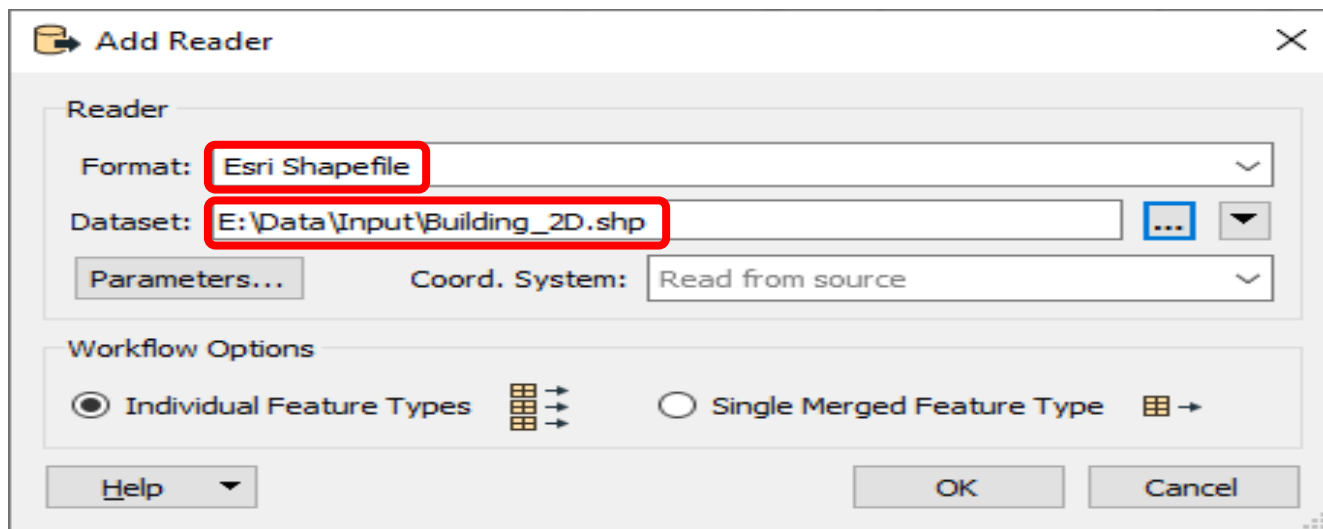
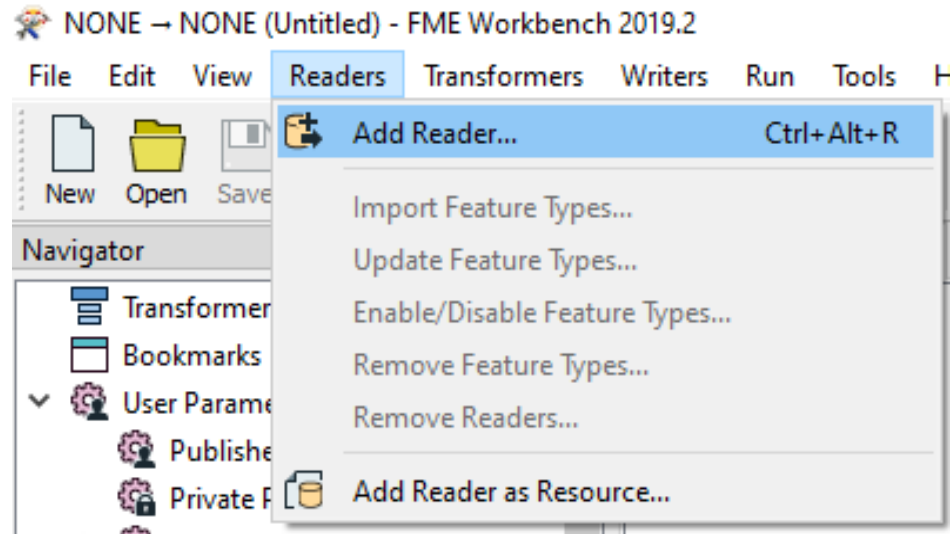
FME



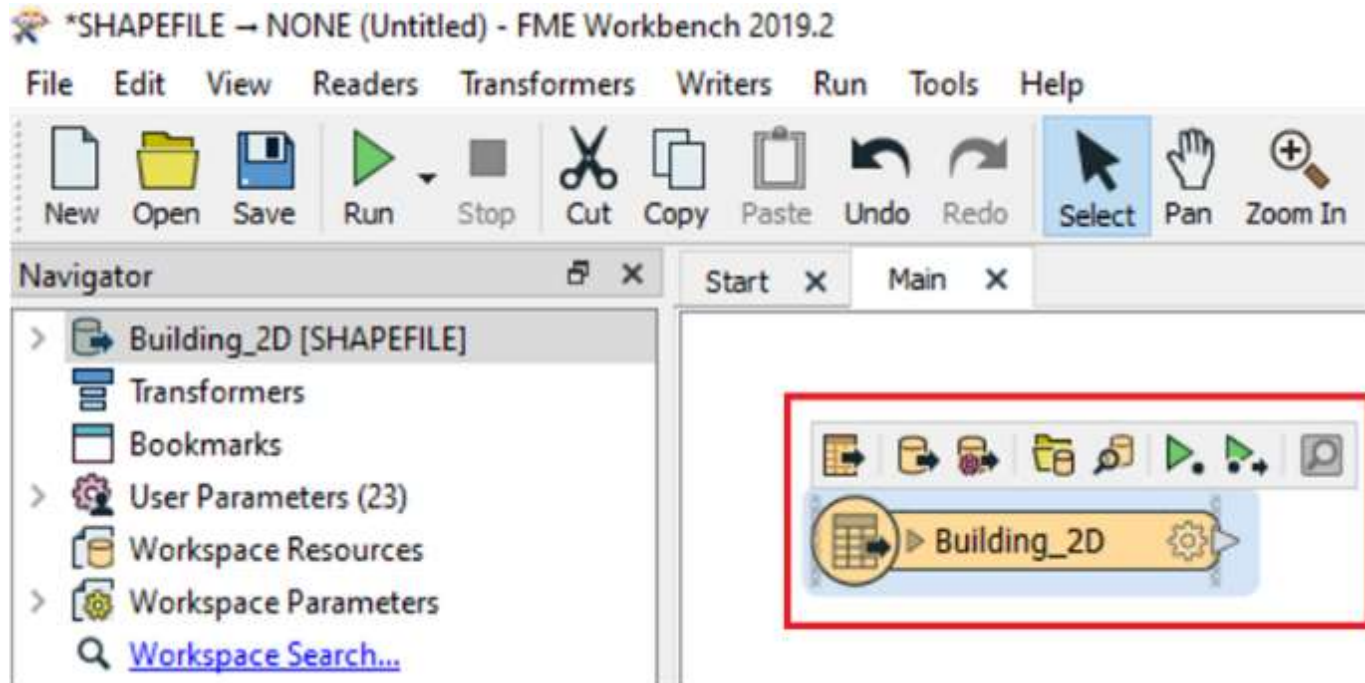
Minimum Transformers in FME to Convert Shp to CityGML



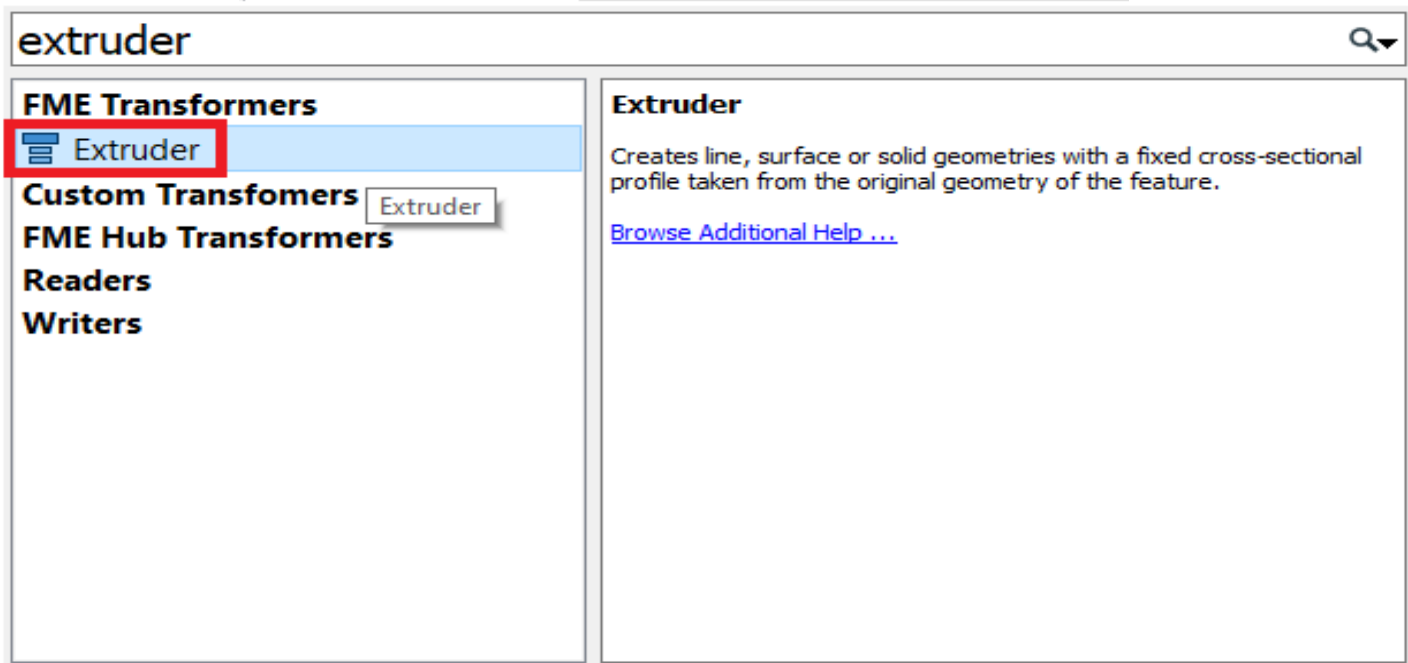
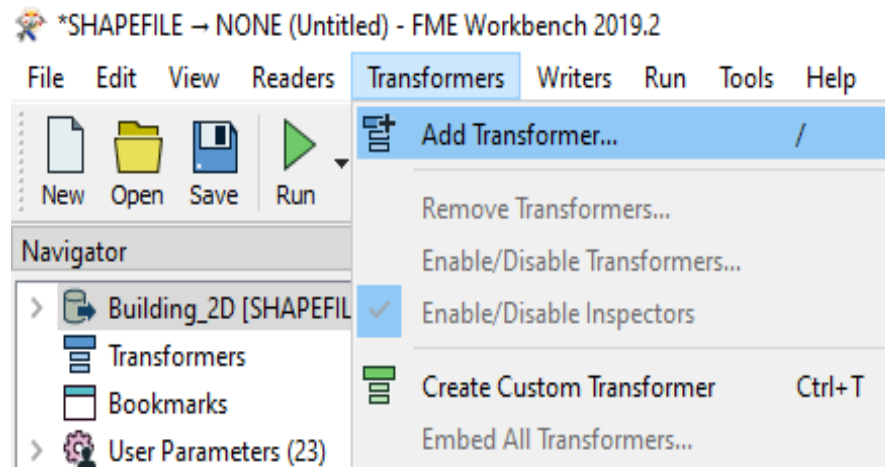
Minimum Transformers in FME to Convert Shp to CityGML



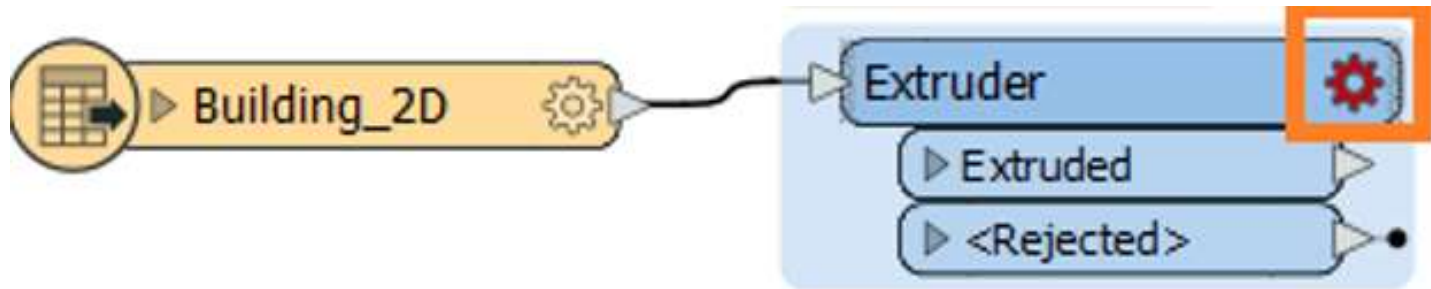
Minimum Transformers in FME to Convert Shp to CityGML



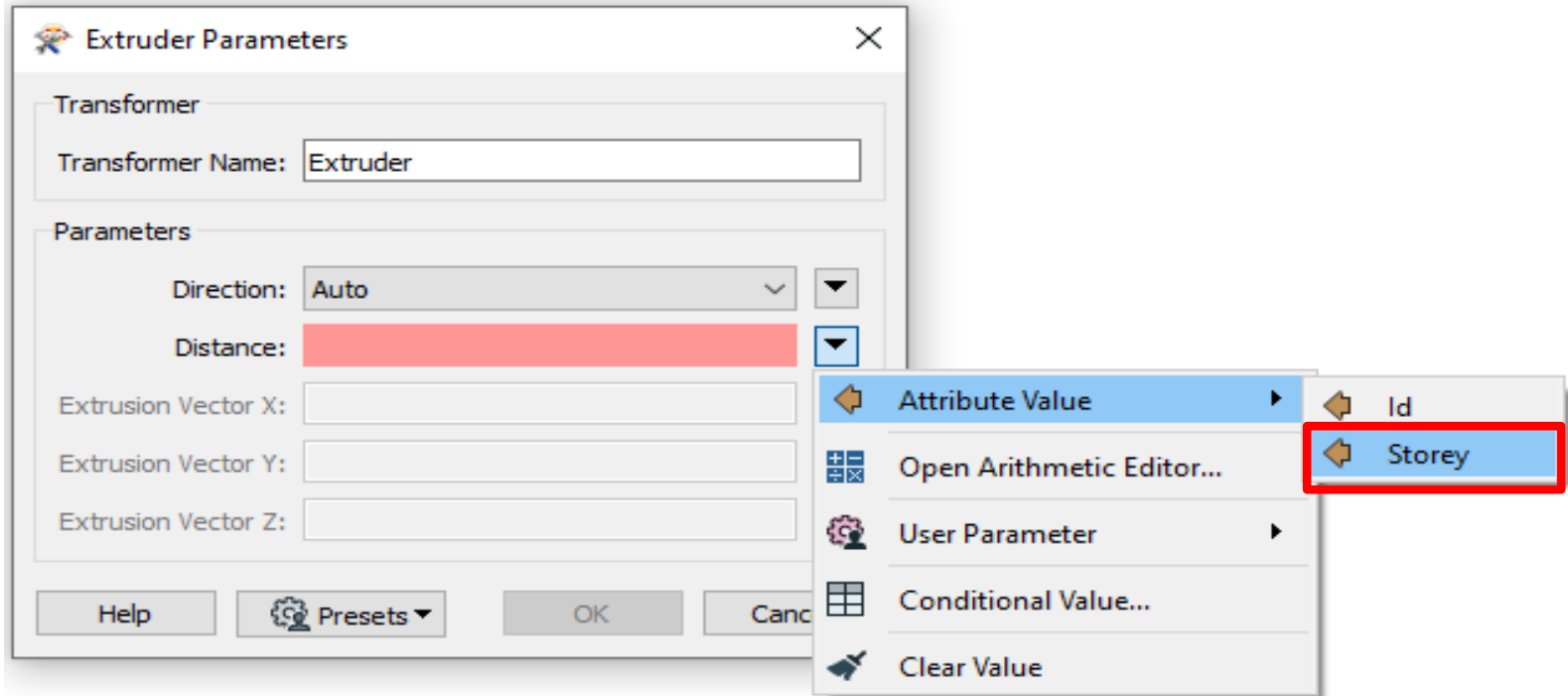
Minimum Transformers in FME to Convert Shp to CityGML



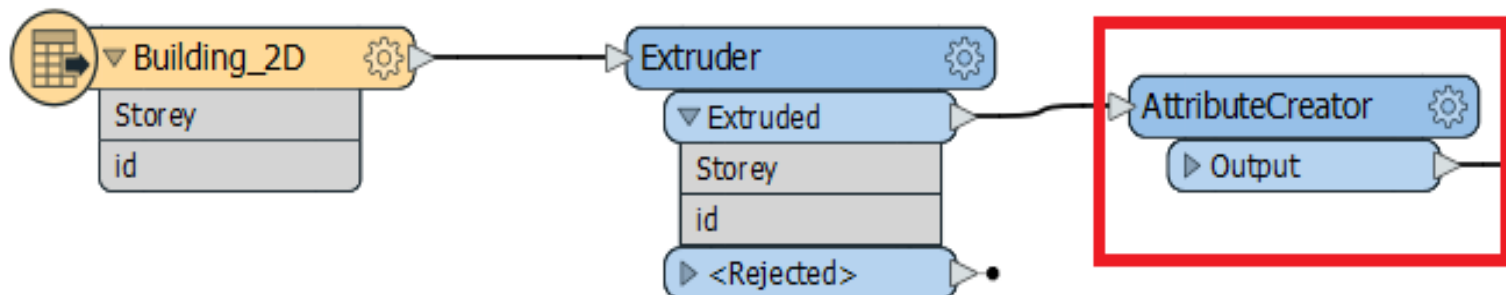
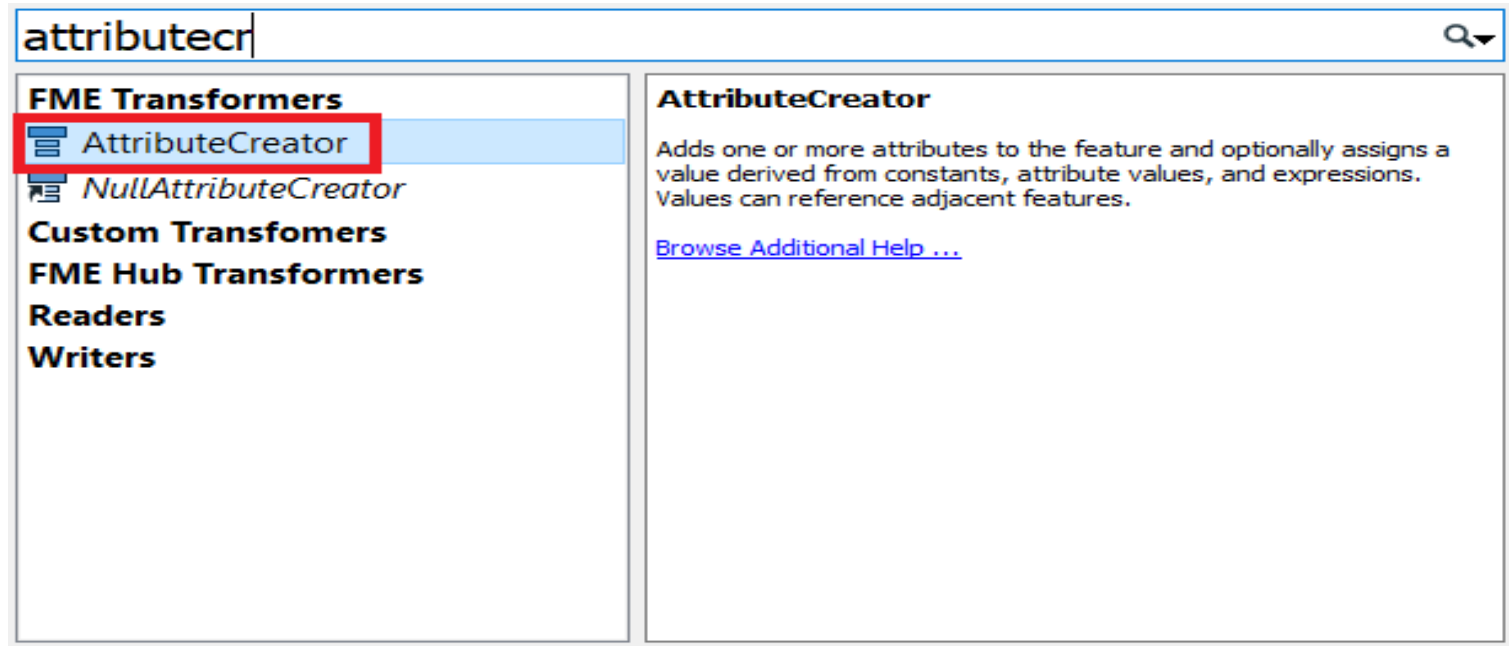
Minimum Transformers in FME to Convert Shp to CityGML



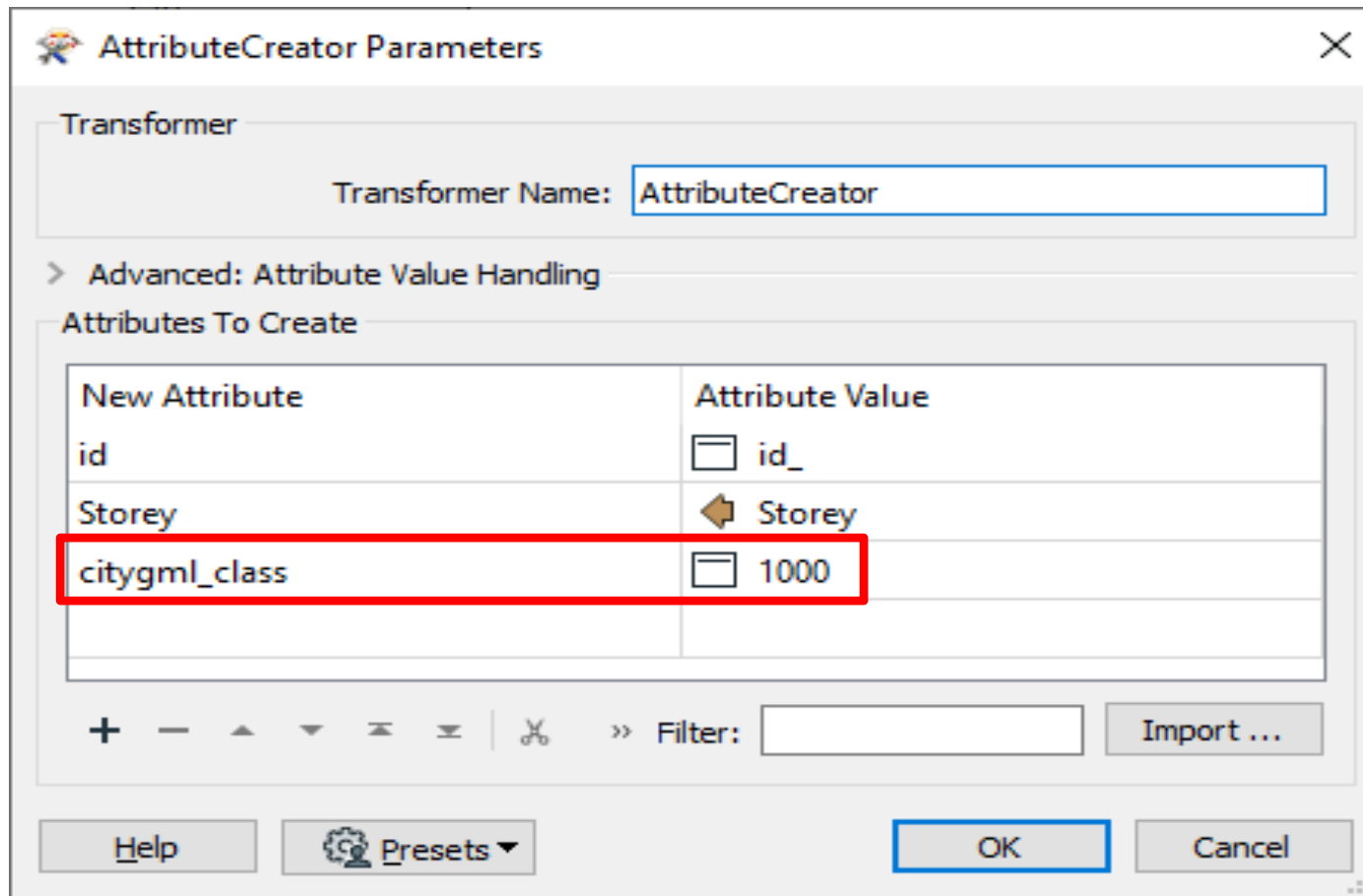
Minimum Transformers in FME to Convert Shp to CityGML



Minimum Transformers in FME to Convert Shp to CityGML



Minimum Transformers in FME to Convert Shp to CityGML

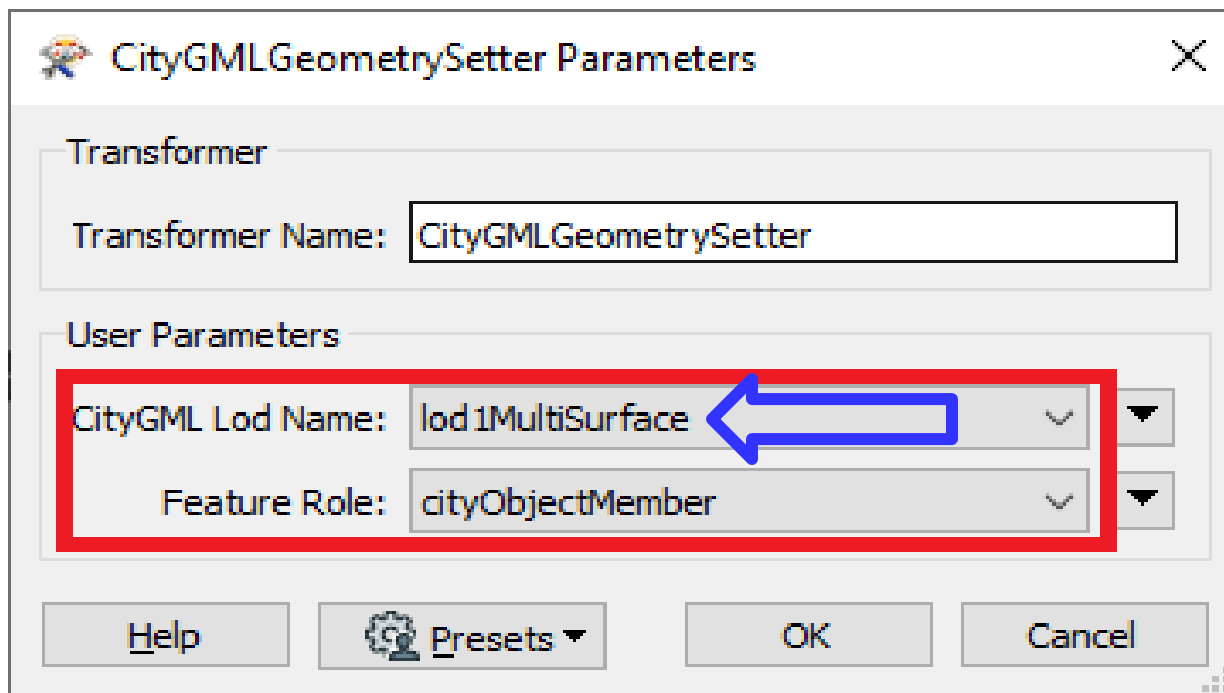
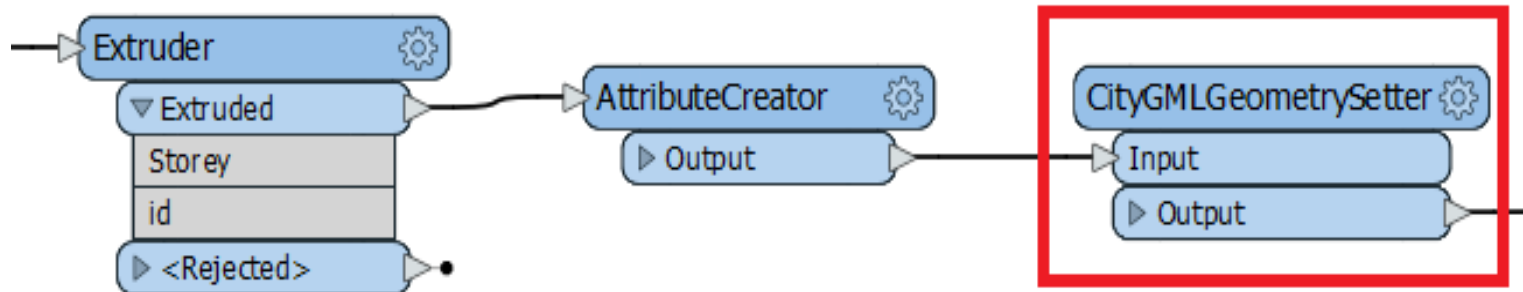


Minimum Transformers in FME to Convert Shp to CityGML

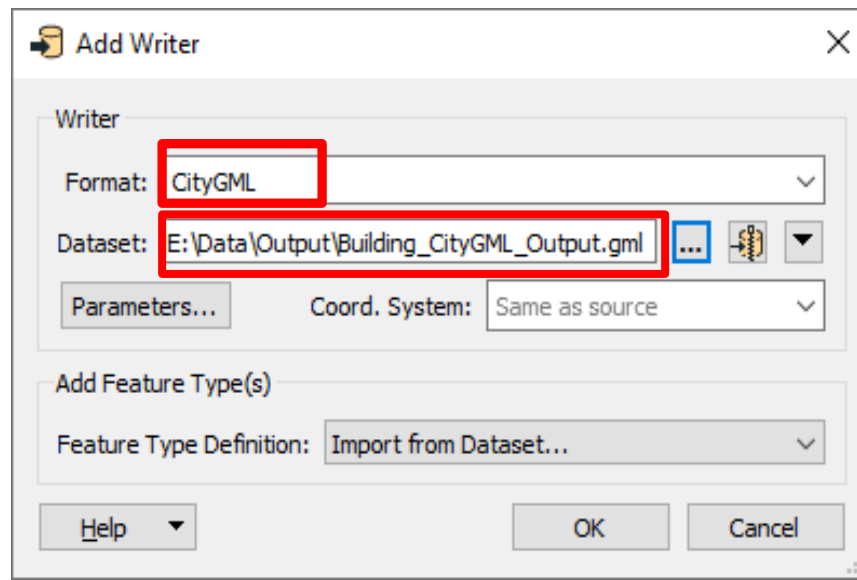
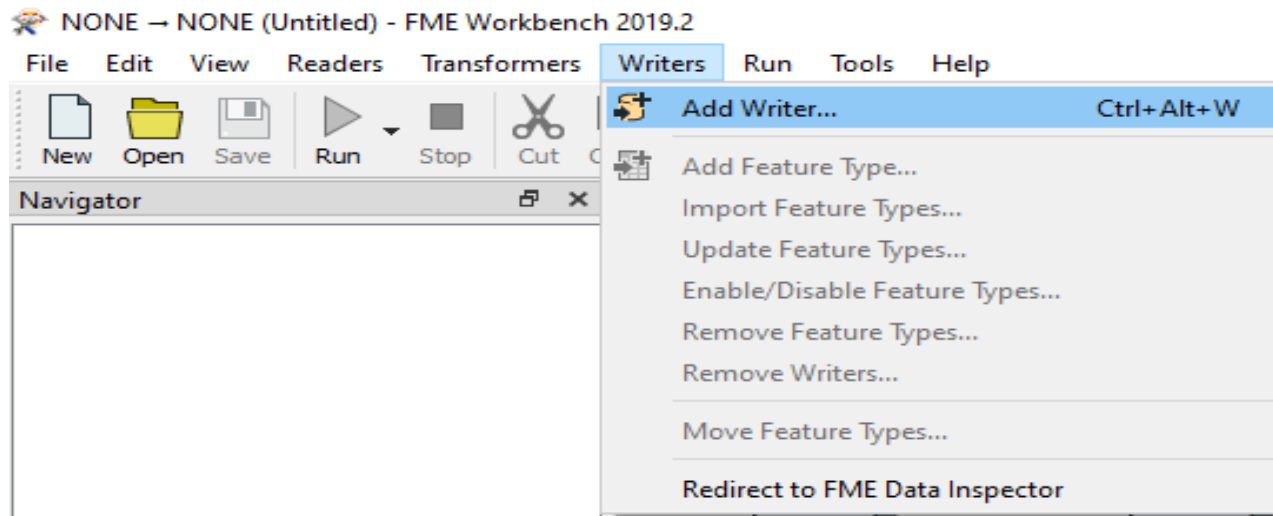
C.1 Building module

Code list of the <i>AbstractBuilding</i> attribute class			
http://www.sig3d.org/codelists/standard/building/2.0/AbstractBuilding_class.xml			
1000	habitation	1100	schools, education, research
1010	sanitation	1110	maintainence and waste management
1020	administration	1120	healthcare
1030	business, trade	1130	communicating
1040	catering	1140	security
1050	recreation	1150	storage
1060	sport	1160	industry
1070	culture	1170	traffic
1080	church institution	1180	function
1090	agriculture, forestry		

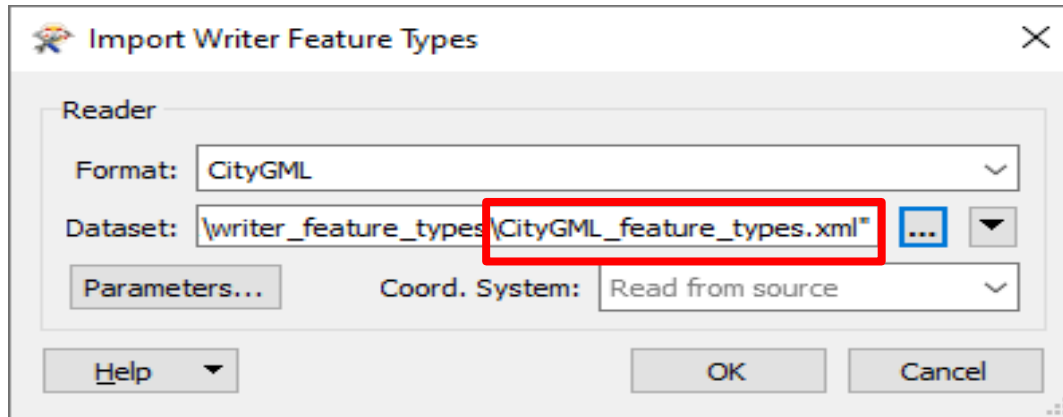
Minimum Transformers in FME to Convert Shp to CityGML



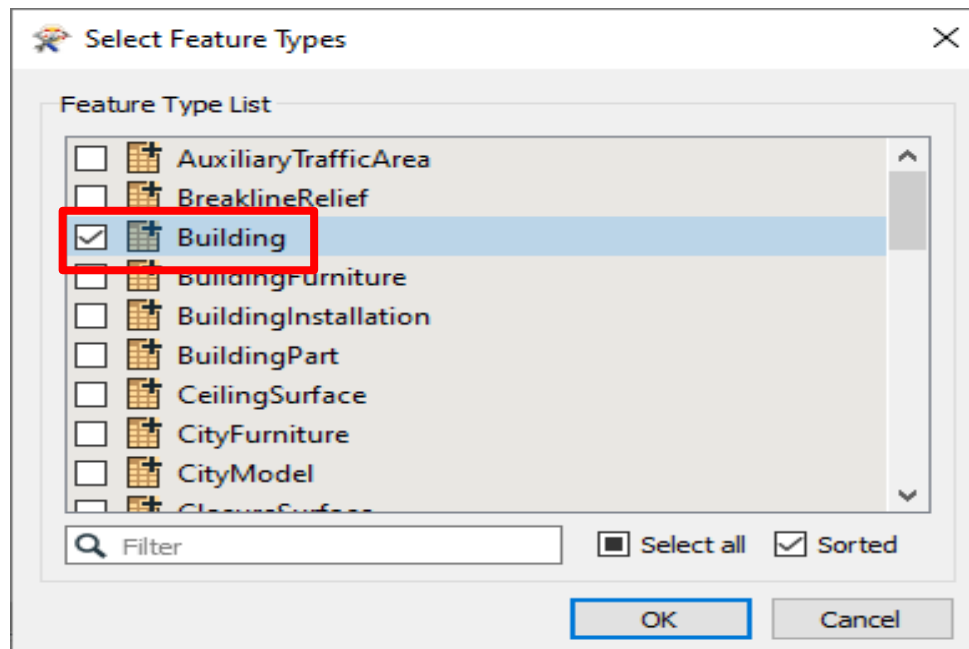
Minimum Transformers in FME to Convert Shp to CityGML



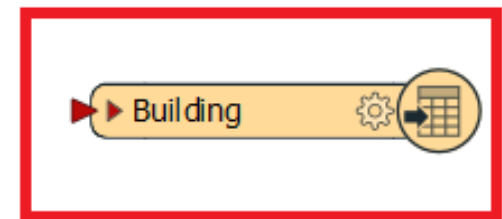
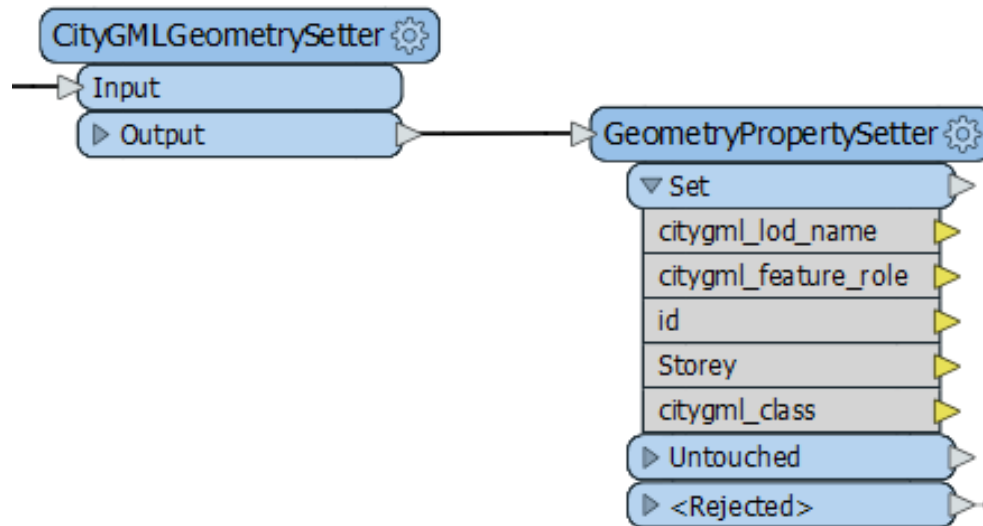
Minimum Transformers in FME to Convert Shp to CityGML



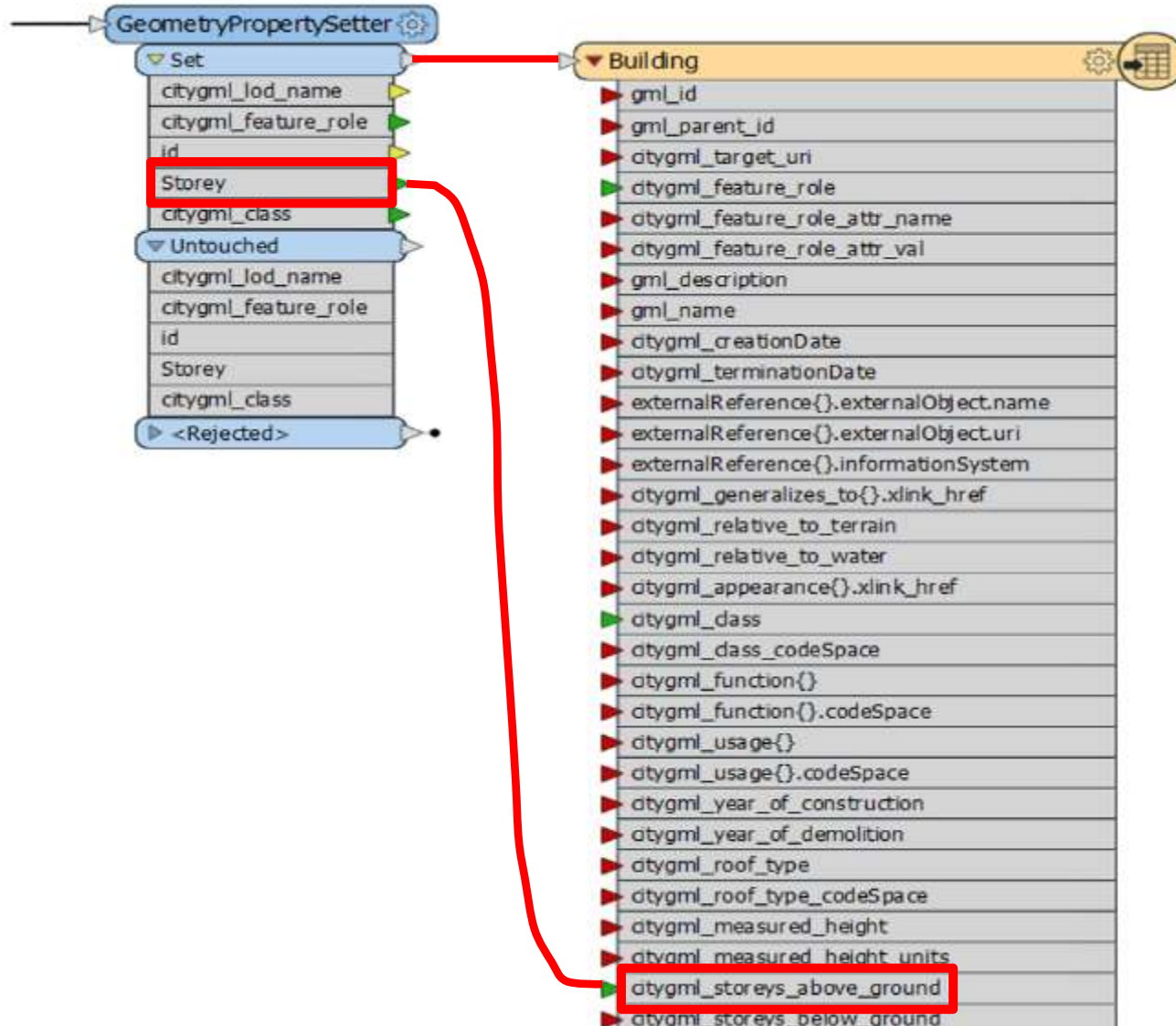
C:\Program Files\FME\xml\CityGML\writer_feature_types\CityGML_feature_types.xml



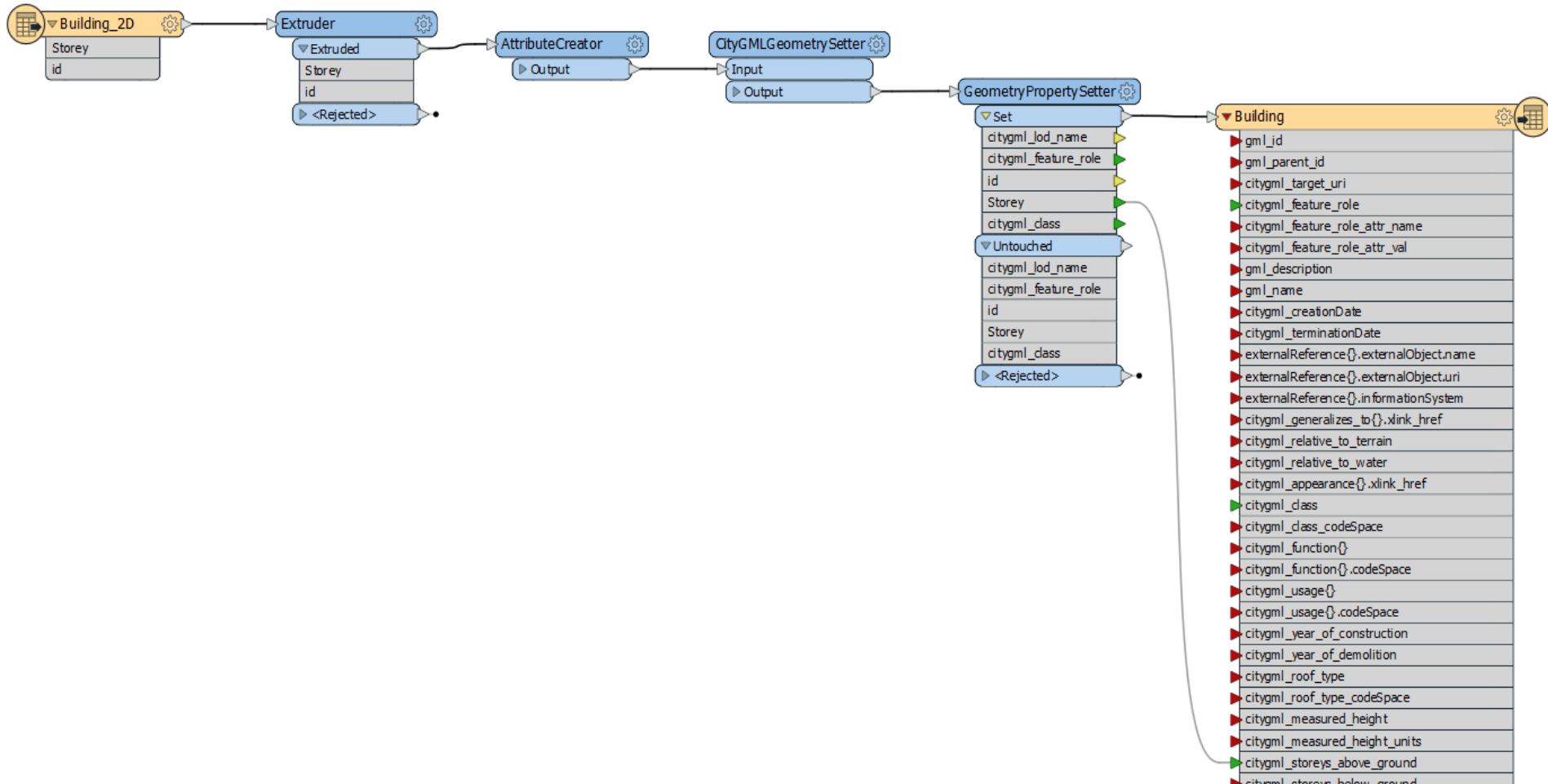
Minimum Transformers in FME to Convert Shp to CityGML



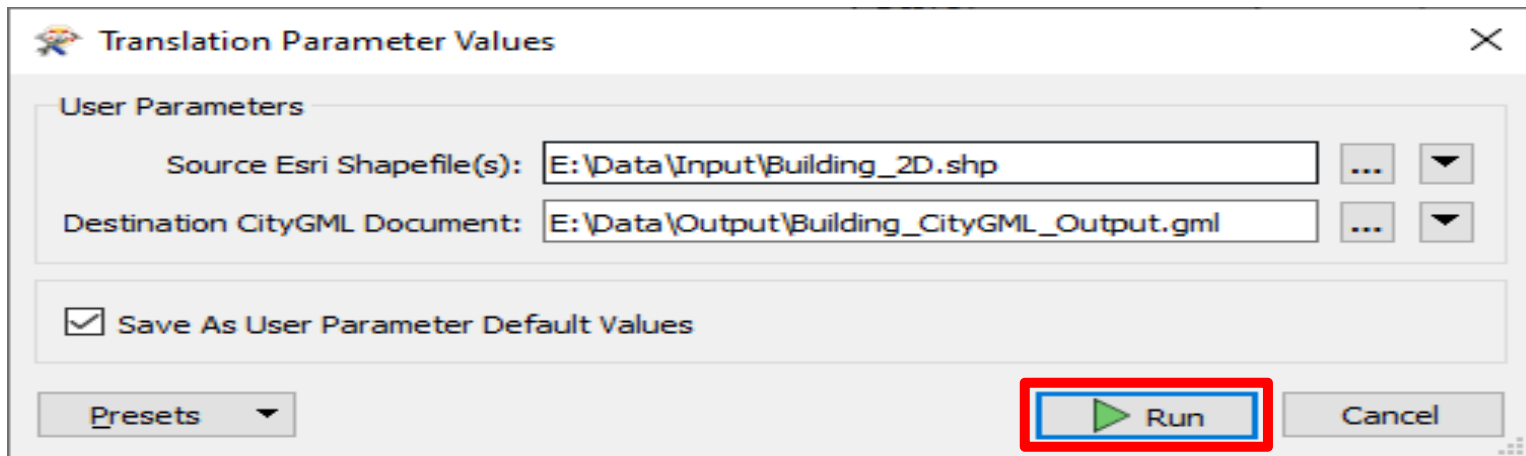
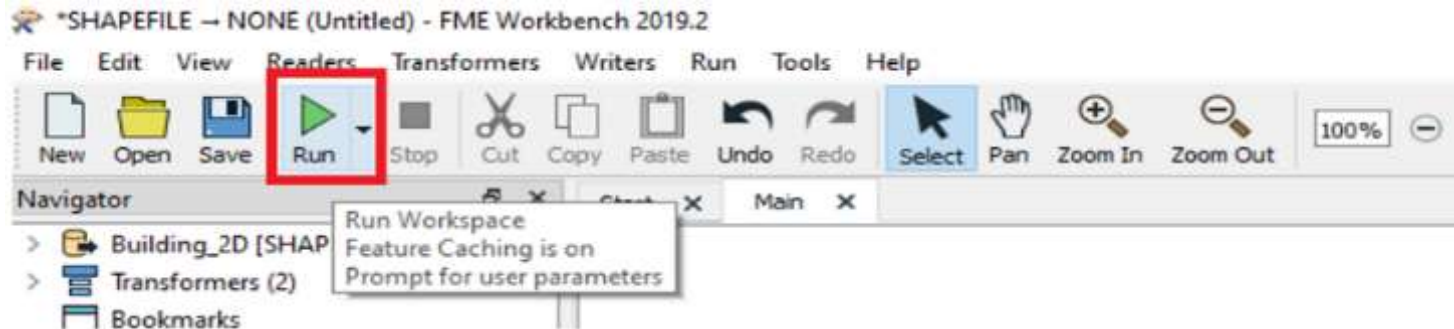
Minimum Transformers in FME to Convert Shp to CityGML



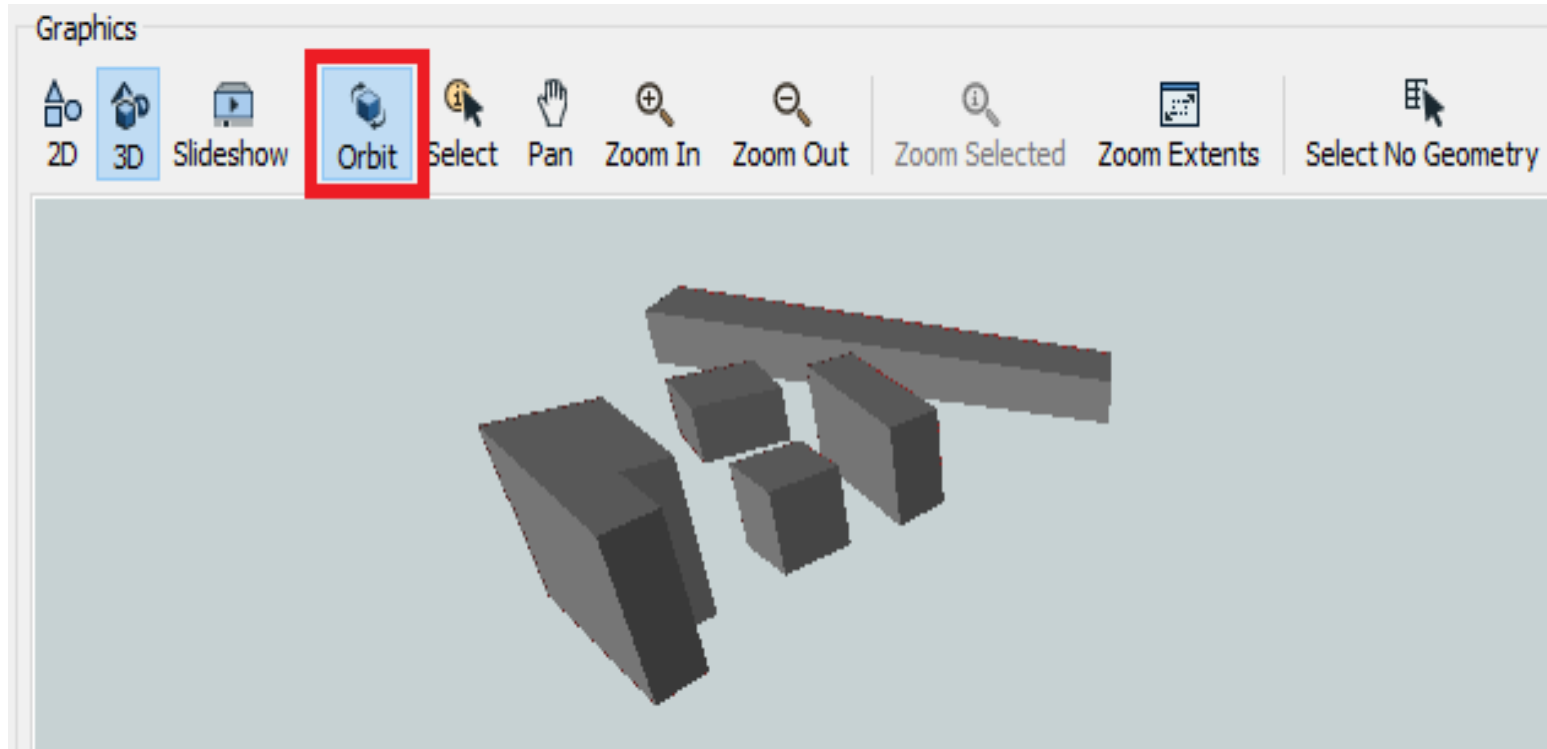
The Whole Model to Convert Shp to CityGML in FME



Minimum Transformers in FME to Convert Shp to CityGML



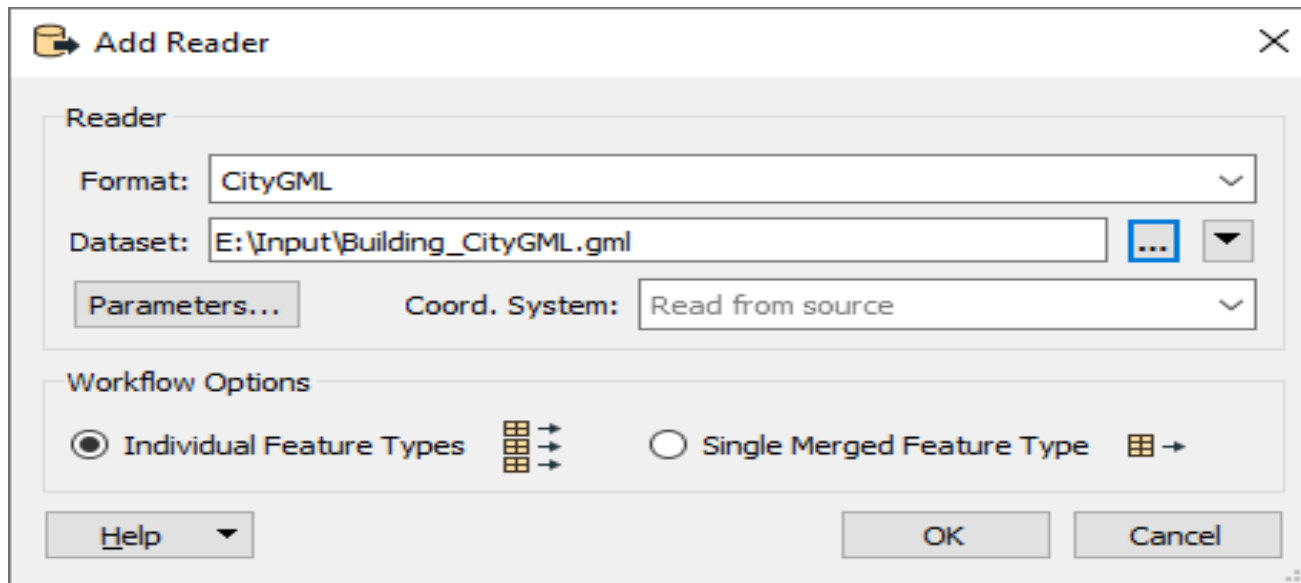
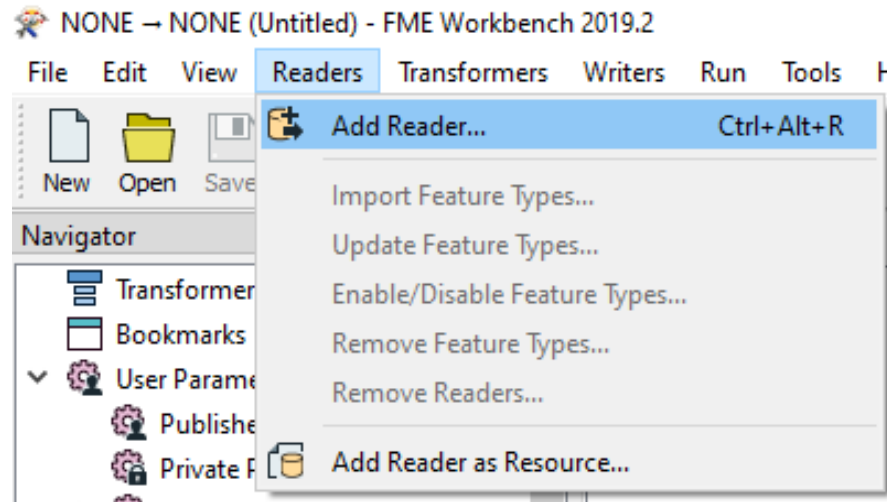
Preview of Created CityGML in FME



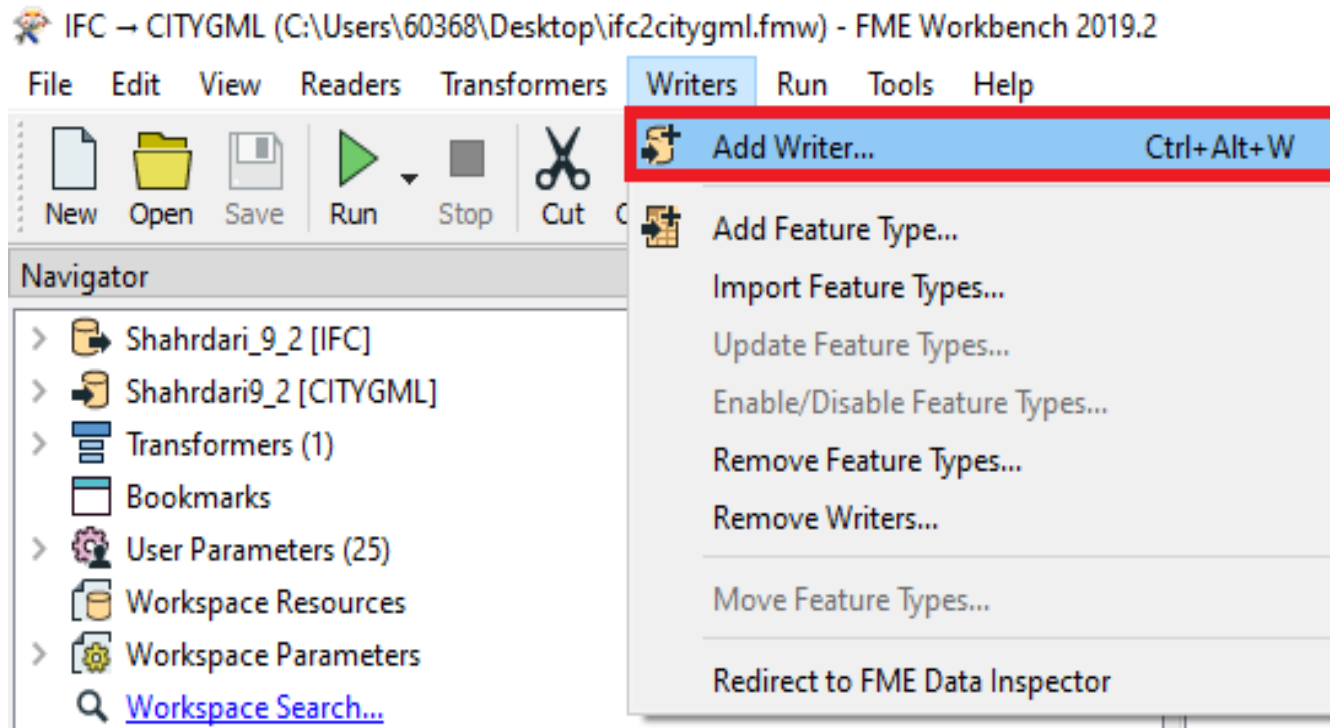
Preview of Created CityGML in FME

```
<?xml version="1.0" encoding="UTF-8"?>
<core:CityModel xmlns:brid="http://www.opengis.net/citygml/bridge/2.0" xmlns:tran="ht
<gml:boundedBy>
<gml:Envelope srsName="EPSG:32639" srsDimension="3">
<gml:lowerCorner>528027.2483553989 3953291.0040660817 0</gml:lowerCorner>
<gml:upperCorner>528124.5262990175 3953366.3009359 30</gml:upperCorner>
</gml:Envelope>
</gml:boundedBy>
<core:cityObjectMember>
<bldg:Building>
<bldg:class>1000</bldg:class>
<bldg:storeysAboveGround>10</bldg:storeysAboveGround>
<bldg:lod1MultiSurface>
<gml:MultiSurface srsName="EPSG:32639" srsDimension="3">
<gml:surfaceMember>
<gml:CompositeSurface>
<gml:surfaceMember>
<gml:Polygon>
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<gml:LinearRing>
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</gml:LinearRing>
</gml:exterior>
</gml:Polygon>
</gml:surfaceMember>
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<gml:Polygon>
<gml:exterior>
<gml:LinearRing>
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</gml:LinearRing>
</gml:exterior>
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</core:cityObjectMember>
</gml:boundedBy>
</core:CityModel>
```

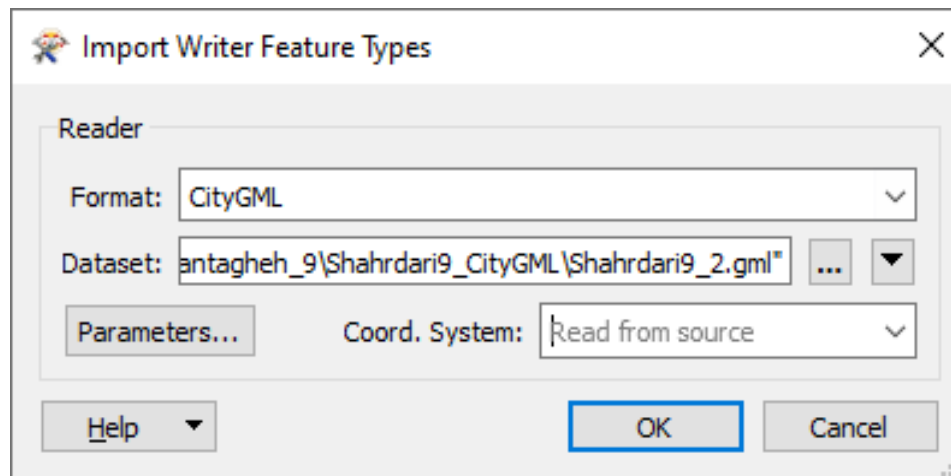
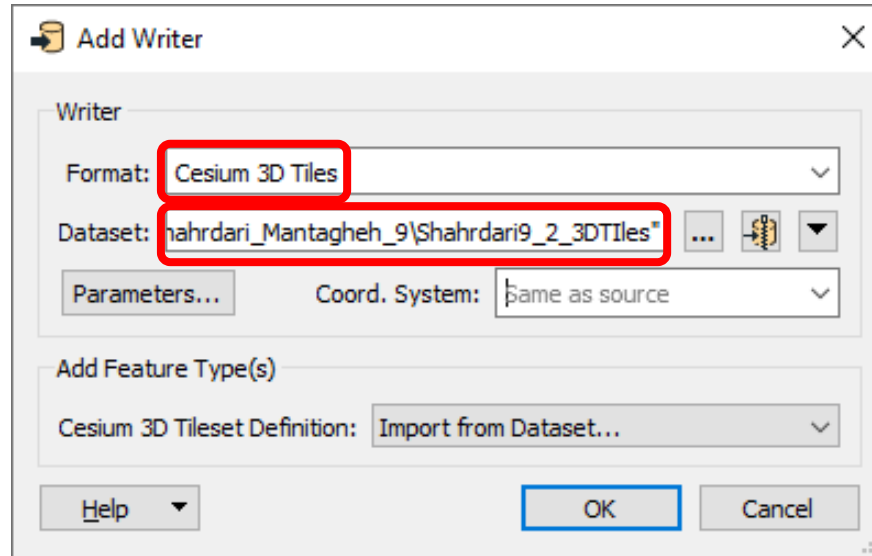
Converting CityGML to 3D Tiles in FME



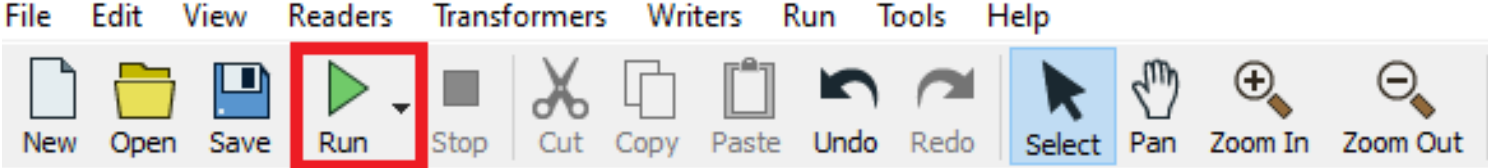
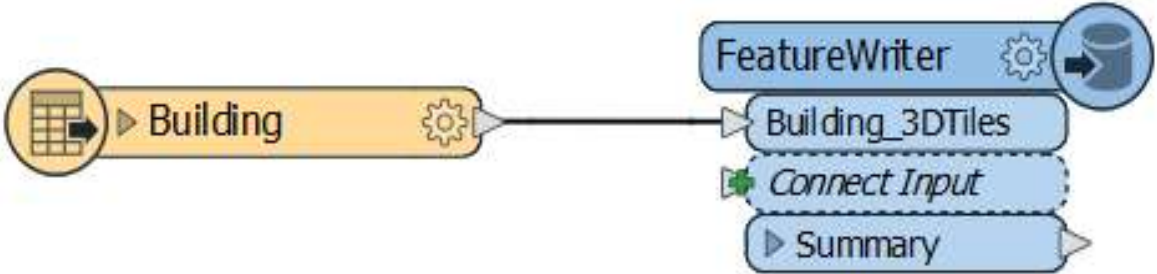
Converting CityGML to 3D Tiles in FME



Converting CityGML to 3D Tiles in FME

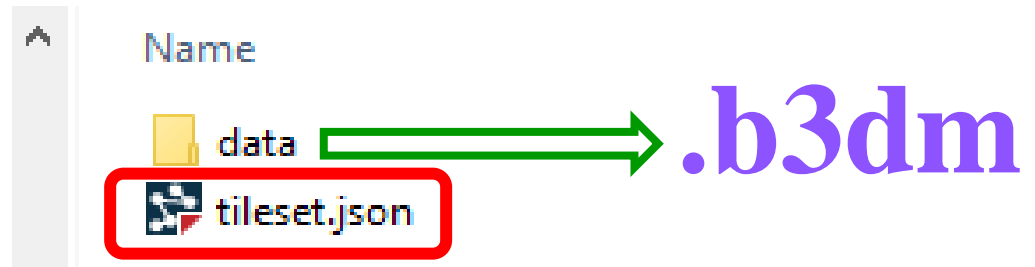


Converting CityGML to 3D Tiles in FME



Converting CityGML to 3D Tiles in FME

This PC > B (E:) > Output > Building_3DTiles



Representing 3D Tiles in CesiumJS

Installing CesiumJS



<https://cesium.com/downloads/>

CesiumJS

An open source JavaScript library for world-class 3D globes and maps. [Learn more.](#)

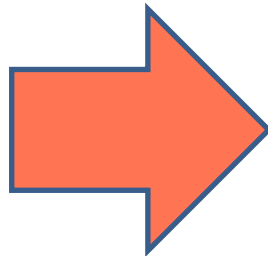
DOWNLOAD CESIUMJS 1.96

63 MB Aug 2, 2022

Representing 3D Tiles in CesiumJS

Installing CesiumJS

- Apps
- Build
- Source
- Specs
- ThirdParty
- .eslintignore
- .eslintrc.json
- .gulp.json
- .prettierrignore
- build.cjs
- CHANGES.md
- favicon.ico
- gulpfile.cjs
- index.cjs
- index.html
- LICENSE.md
- package.json
- README.md
- server.cjs
- web.config



MyCesiumJS

Representing 3D Tiles in CesiumJS

Installing CesiumJS



MyCesiumJS




Apache Tomcat/9.0.19

localhost:8090

Home Documentation Configuration Examples Wiki Mailing Lists Find Help

Apache Tomcat/9.0.19

If you're seeing this, you've successfully installed Tomcat. Congratulations!

 Recommended Reading:

- [Security Considerations How-To](#)
- [Manager Application How-To](#)
- [Clustering/Session Replication How-To](#)

Server Status
Manager App
Host Manager

Developer Quick Start

- [Tomcat Setup](#)
- [Realms & AAA](#)
- [Examples](#)
- [Servlet Specifications](#)
- [First Web Application](#)
- [JDBC DataSources](#)
- [Tomcat Versions](#)

Managing Tomcat

For security, access to the `manager.webapp` is restricted. Users are defined in `$CATALINA_HOME/conf/tomcat-users.xml`.

In Tomcat 9.0 access to the manager application is split between different users. [Read more](#).

[Release Notes](#)
[Changelog](#)
[Migration Guide](#)
[Security Notices](#)

Documentation

[Tomcat 9.0 Documentation](#)
[Tomcat 9.0 Configuration](#)
[Tomcat Wiki](#)

Find additional important configuration information in `$CATALINA_HOME/README.txt`.

Developers may be interested in:
[Tomcat 9.0 Run Database](#)
[Tomcat 4.0 Headlines](#)
[Tomcat 3.0 SVN Repository](#)

Getting Help

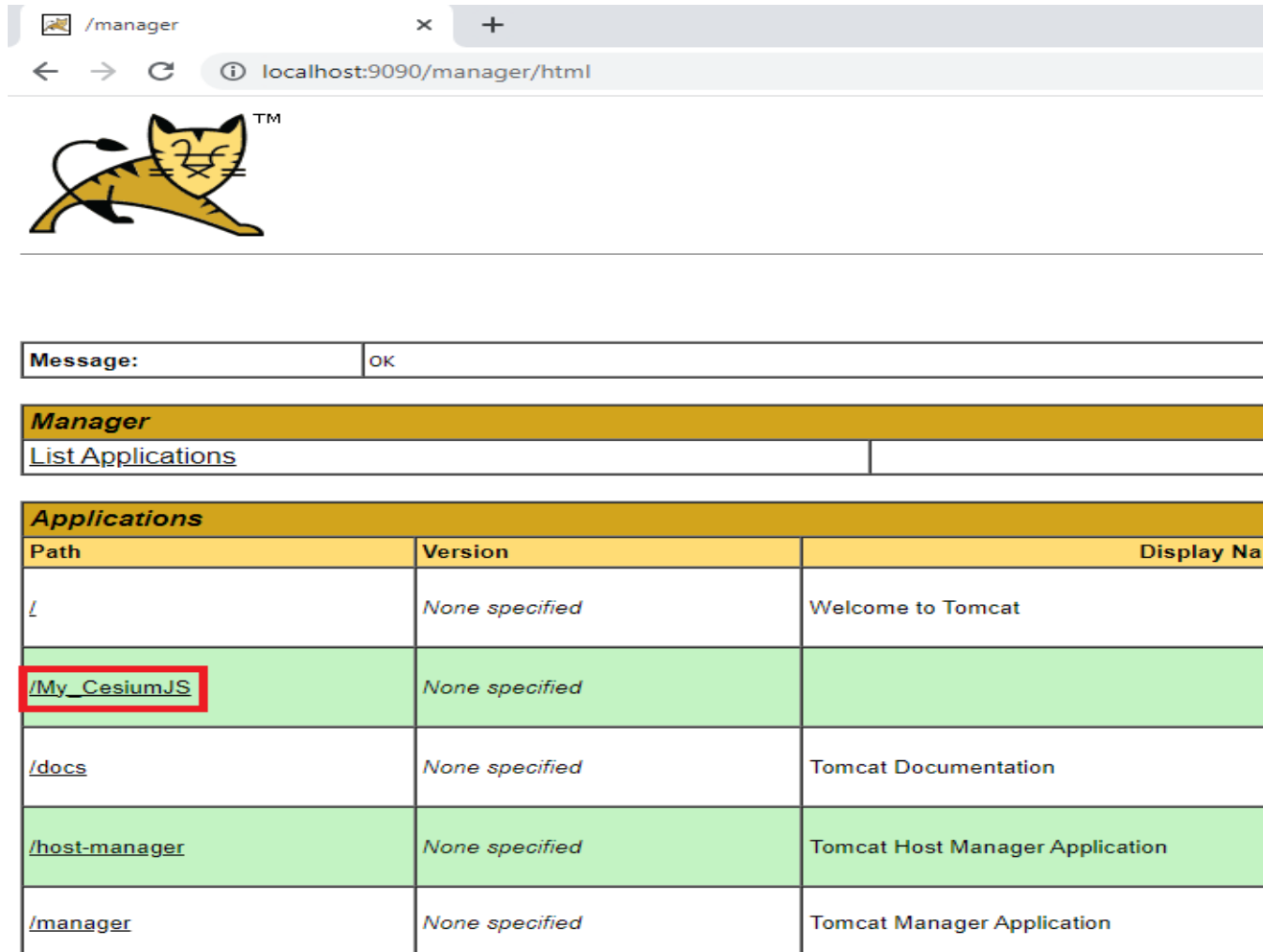
FAQ and Mailing Lists

The following mailing lists are available:

- [tomcat-announce](#)
Important announcements, releases, security vulnerability notifications. (Low volume)
- [tomcat-user](#)
User support and discussion
- [tomcat-dev](#)
User support and discussion for [Apache Tomcat](#)
- [tomcat-dev](#)
Development mailing list, including commit messages

Representing 3D Tiles in CesiumJS

Verifying CesiumJS Installation



Message: OK

Manager

List Applications

Applications

Path	Version	Display Name
/	None specified	Welcome to Tomcat
/My_CesiumJS	None specified	
/docs	None specified	Tomcat Documentation
/host-manager	None specified	Tomcat Host Manager Application
/manager	None specified	Tomcat Manager Application

Representing 3D Tiles in CesiumJS

Verifying CesiumJS Installation

https://localhost:9090/My_CesiumJS



Cesium ion

Cesium ion is your hub for discovering 3D content and tiling your own data for streaming. CesiumJS and ion work together to enable you to build world class 3D mapping applications.

[Sign up for a free account](#) to get your access token required for using ion's Bing Maps global imagery and Cesium World Terrain assets.

Local links

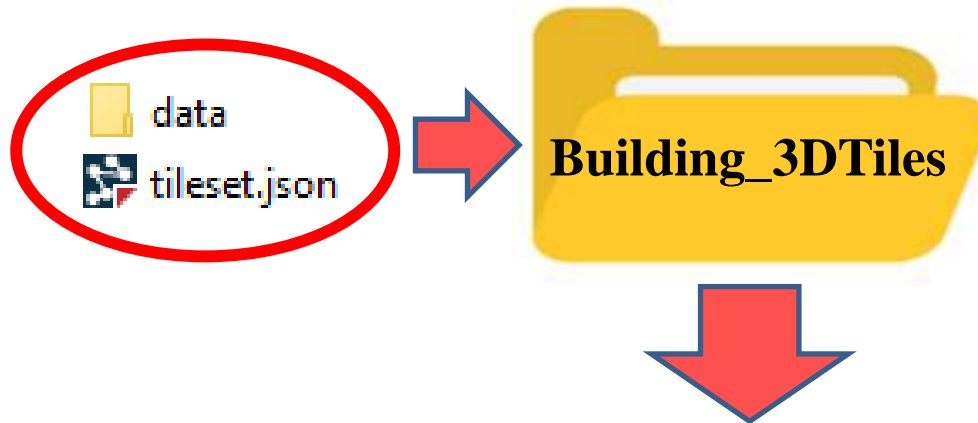
[Documentation](#) The complete API documentation and reference.

[Hello World](#) The simplest possible Cesium application.

[Cesium Viewer](#) A sample Cesium reference application which allows you to browse the globe and select from

Representing 3D Tiles in CesiumJS

Inserting 3D Tiles data into CesiumJS



...\webapps\My_CesiumJS\Specs\Data\Cesium3DTiles

Representing 3D Tiles in CesiumJS

Inserting 3D Tiles data into CesiumJS

Create an HTML file

...\webapps\My_CesiumJS\Apps   HelloWorld.html

Copy and Rename

 Building_from_CityGML.html

Representing 3D Tiles in CesiumJS

Create an HTML file

 Building_from_CityGML.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <!-- Use correct character set. -->
    <meta charset="utf-8" />
    <!-- Tell IE to use the latest, best version. -->
    <meta http-equiv="X-UA-Compatible" content="IE=edge" />
    <!-- Make the application on mobile take up the full browser screen
-->
    <meta
      name="viewport"
      content="width=device-width, initial-scale=1, maximum-scale=1
scalable=no"
    />
    <title>Hello World!</title>
    <script src="../../Build/CesiumUnminified/Cesium.js"></script>
    <style>
      @import url(../../Build/CesiumUnminified/Widgets/widgets.css);
      html,
      body,
      #cesiumContainer {
        width: 100%;
        height: 100%;
        margin: 0;
        padding: 0;
        overflow: hidden;
      }
    </style>
  </head>
  <body>
    <div id="cesiumContainer"></div>
    <script>
      const viewer = new Cesium.Viewer("cesiumContainer");
    </script>
  </body>
</html>
```

Replaced by Piece of Code

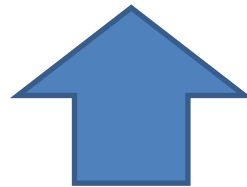


Representing 3D Tiles in CesiumJS

Create an HTML file

 Building_from_CityGML.html

```
    }  
  </style>  
</head>  
<body>  
  <div id="cesiumContainer"></div>  
  <script>  
    const viewer = new Cesium.Viewer("cesiumContainer");  
  </script>  
</body>  
</html>
```



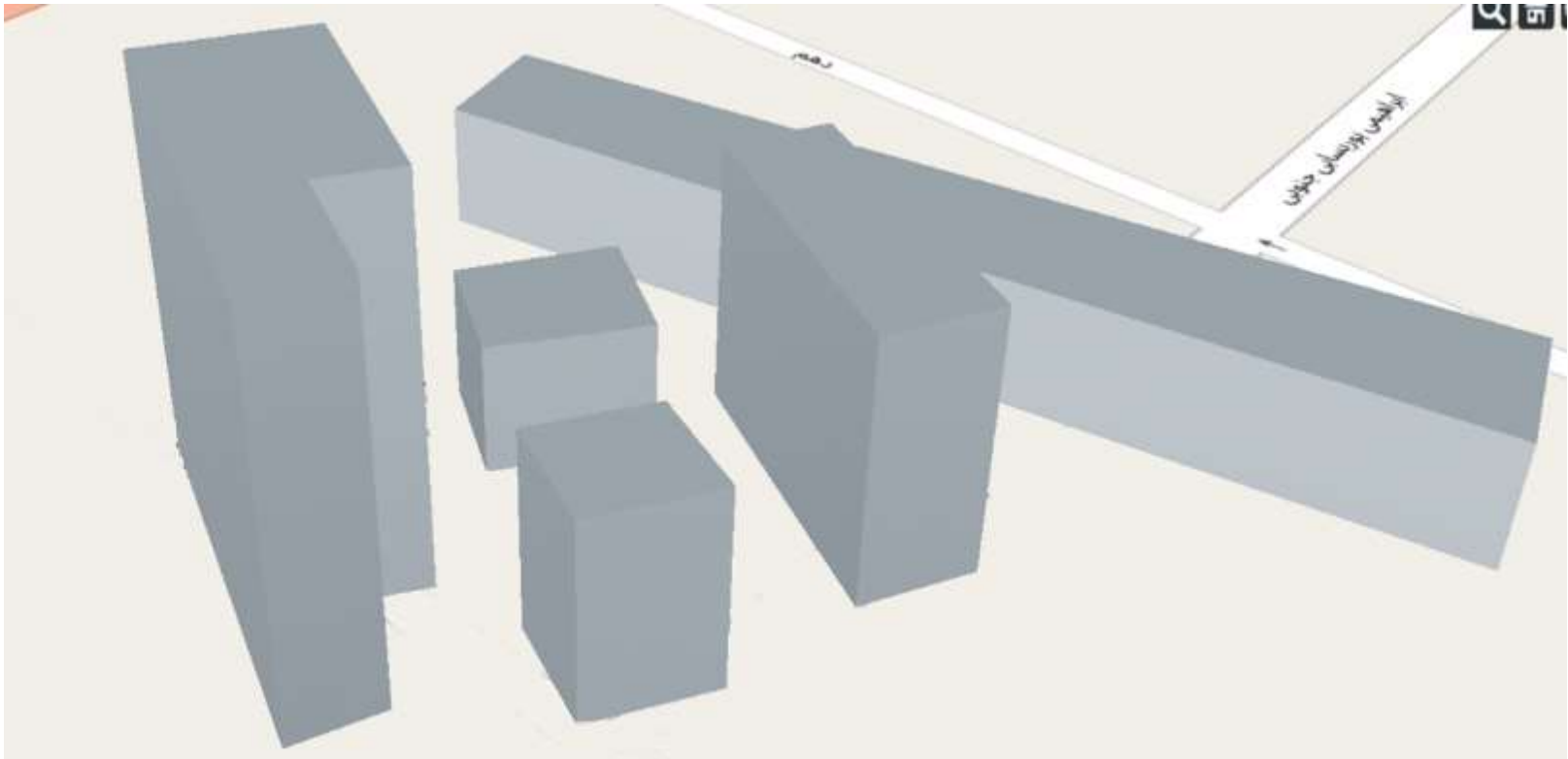
Replace

```
>div id="cesiumContainer"></div<  
>  script<  
  var viewer = new Cesium.Viewer('cesiumContainer');  
  var tileset = viewer.scene.primitives.add(new Cesium.Cesium3DTileset({  
    url : "../Specs/Data/Cesium3DTiles/Building_3DTiles/tileset.json" // URL from  
`Starting the Server` section.  
  }));  
  viewer.zoomTo(tileset);  
</script>
```

Representing 3D Tiles in CesiumJS

Representing the HTML file in a Web Browser

http://localhost:9090/My_CesiumJS/Apps/Building_from_CityGML.html



Representing 3D Tiles in CesiumJS (LOD1)

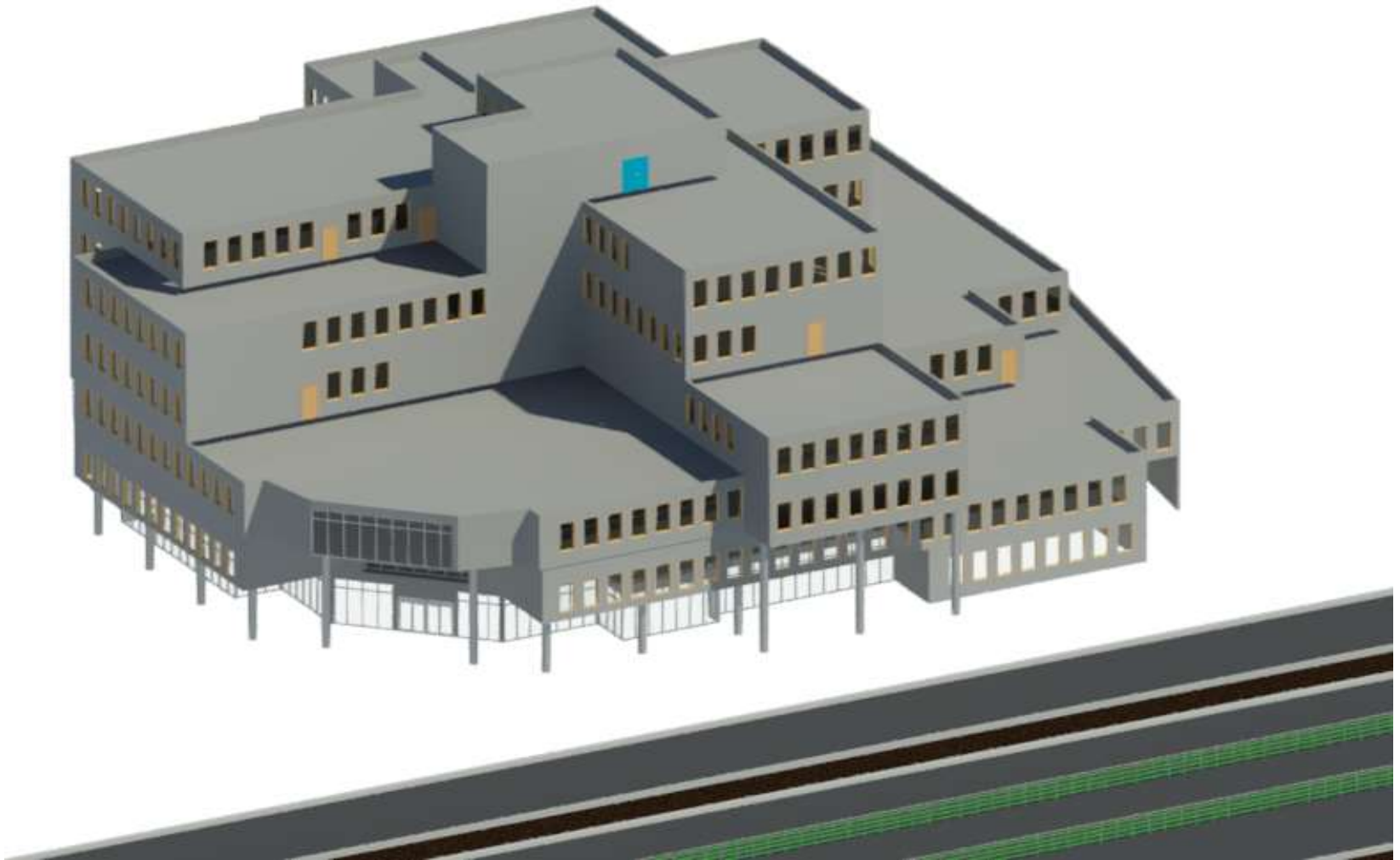




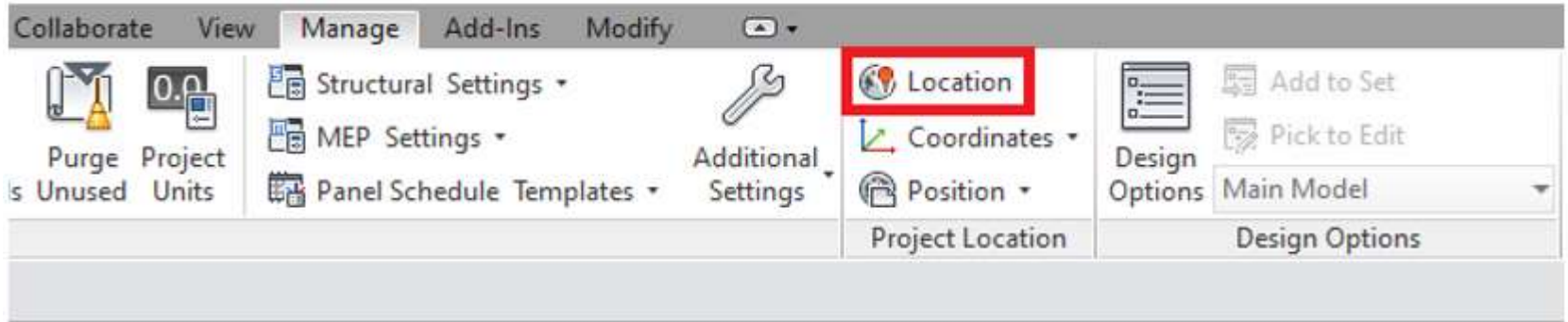
Implementation & Practical Examples

**3D Web Service
CityGML (LOD3)**

Municipal Building of District 9 In Tehran Drawn By Revit



Introducing the Location



Location Weather and Site

Location Weather Site

Define Location by:
Default City List

There is a single location for each Revit project that defines where the project is placed in the world.

City : Tehran, Iran

Latitude : 35.6667°

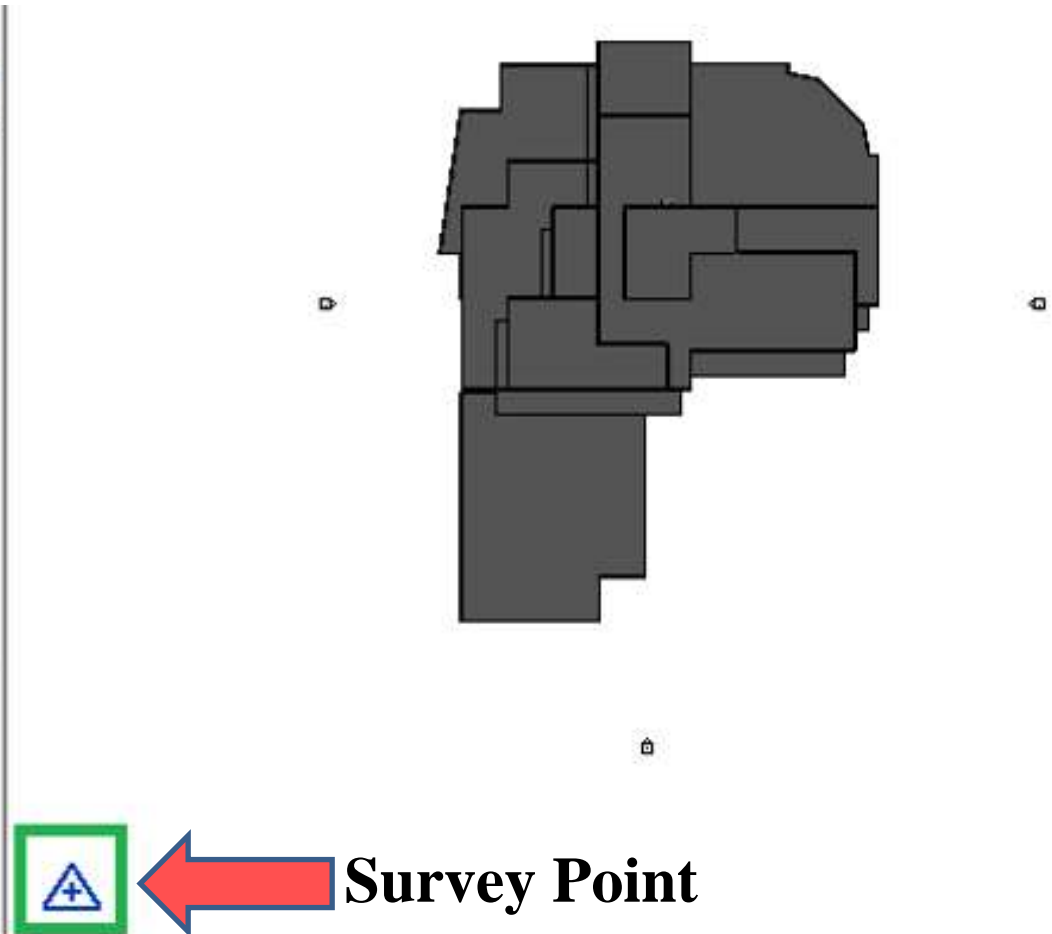
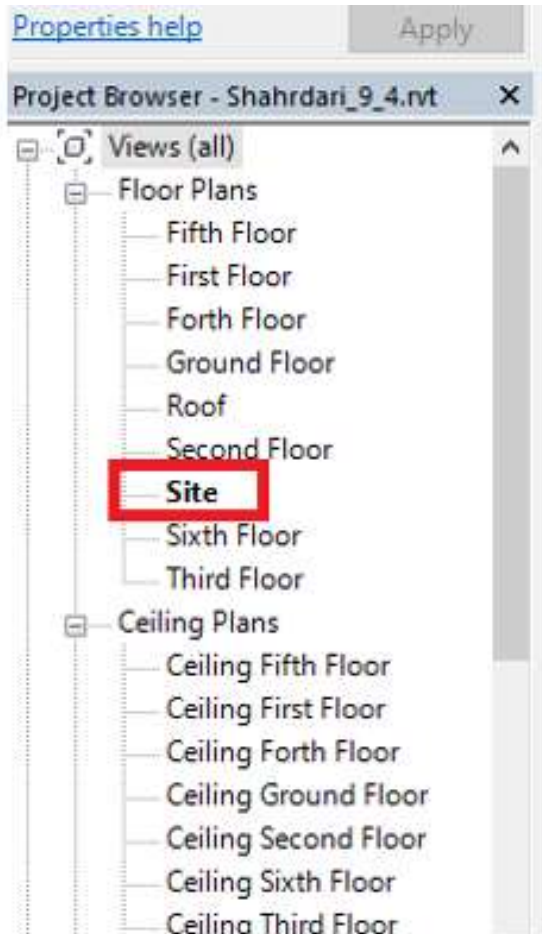
Longitude : 51.4333°

Time Zone : (UTC+03:30) Tehran

Use Daylight Saving time

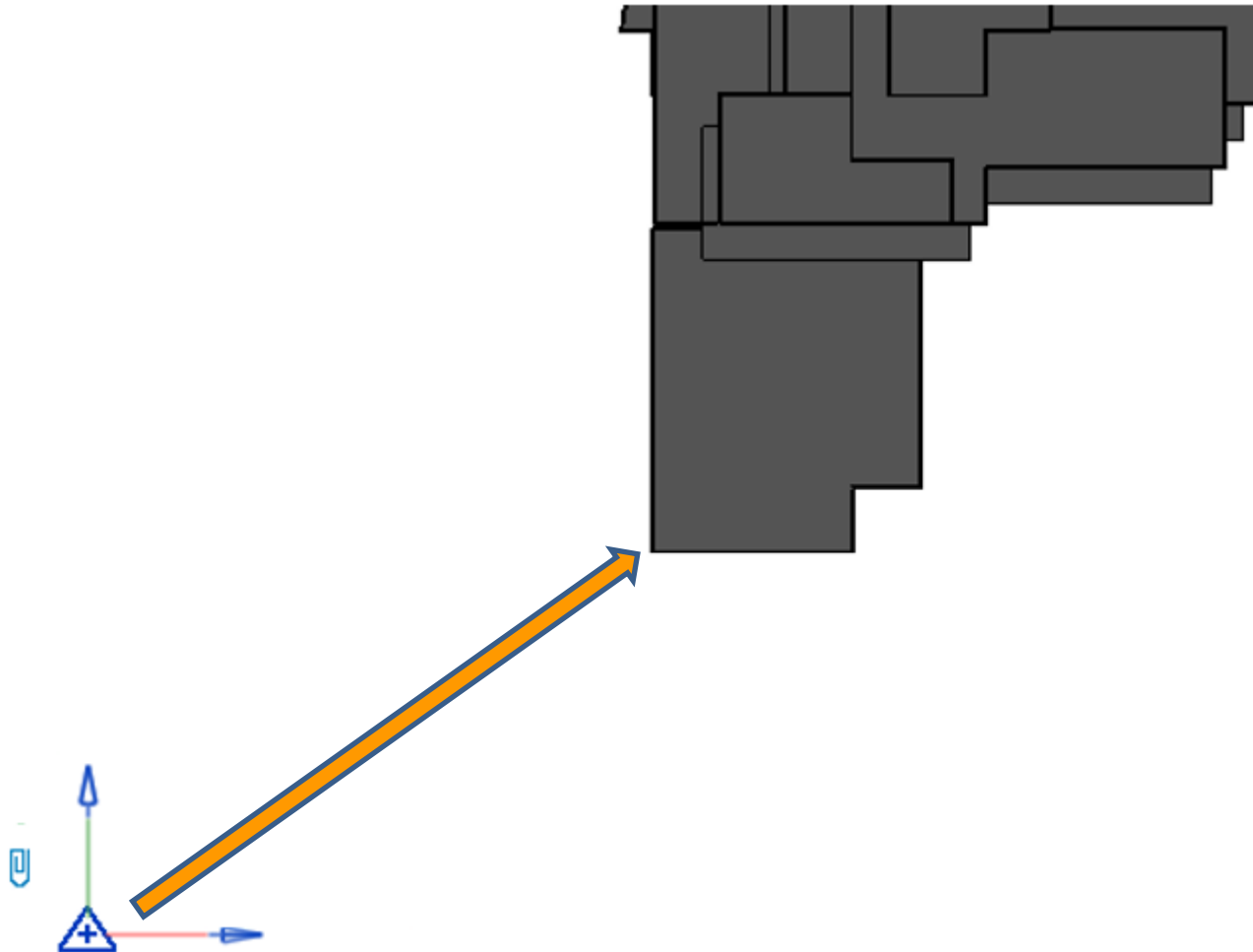
OK Cancel Help

Georeferencing the Building in Revit

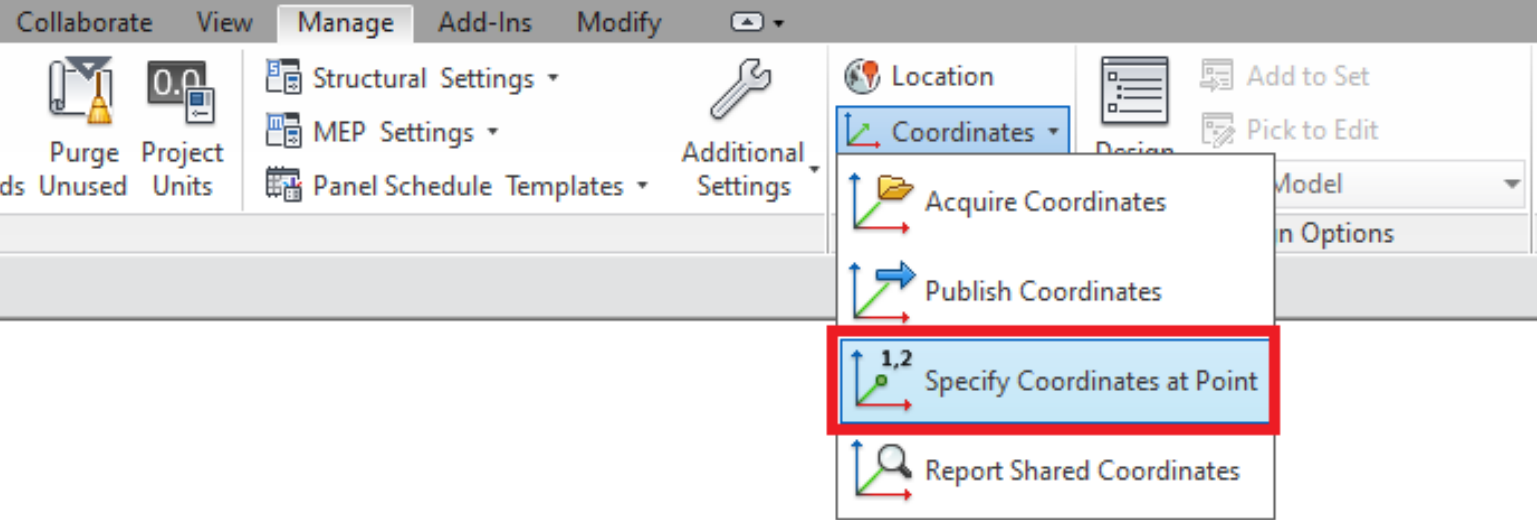


Survey Point

Transfer Survey Point to the Correct Position



Transfer the Building to the Correct Position



Insert the Correct Coordinates of Corner of Building

Specify Shared Coordinates ✕

Relocate this project in Shared Coordinates by specifying known values at the point you selected. Current project will move relative to globally positioned links.

New Coordinates

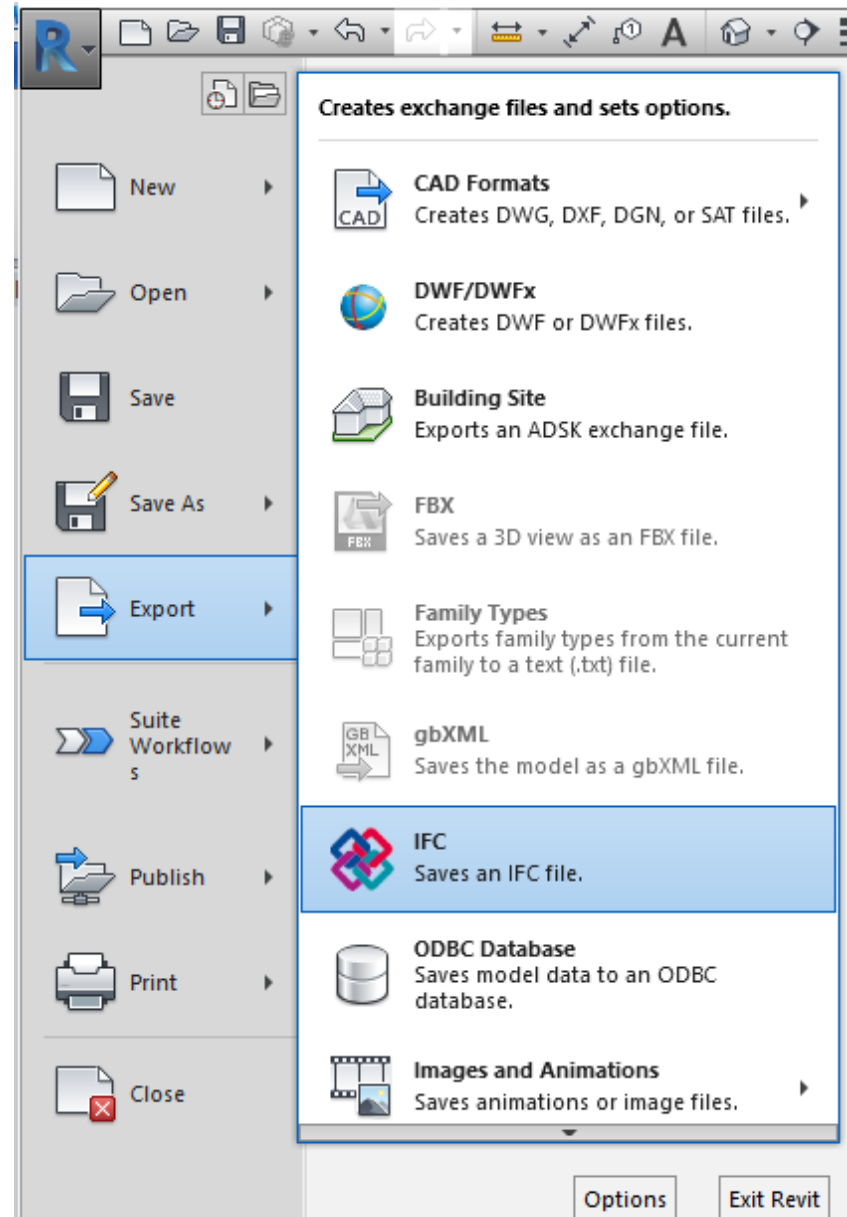
North/South:	3950606.9309
East/West:	531337.5150
Elevation:	1007.2000

Angle from Project North to True North

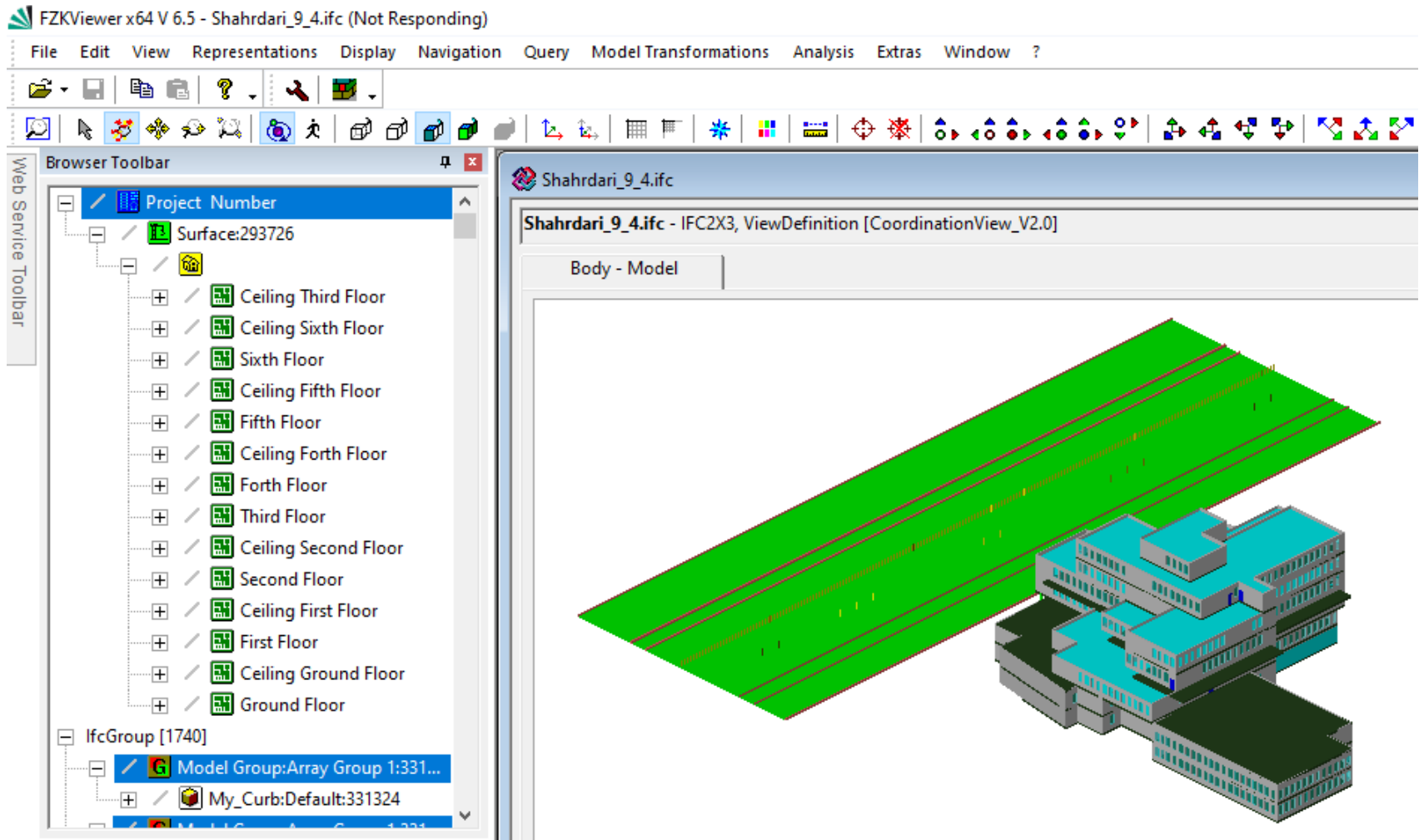
0° 00' 00"	East
------------	------

OK Cancel

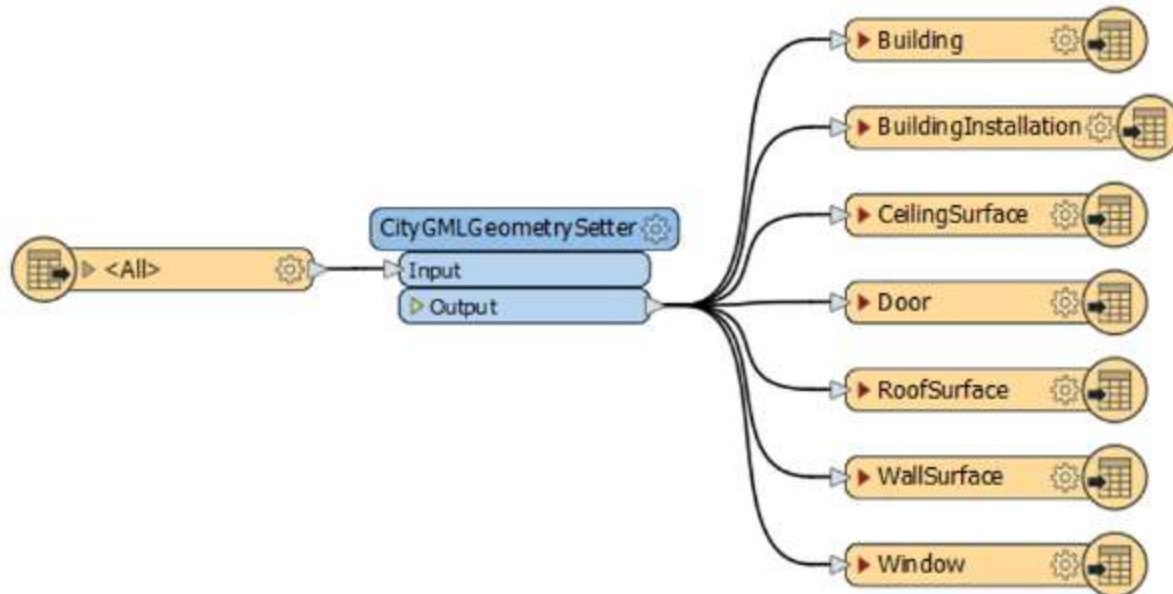
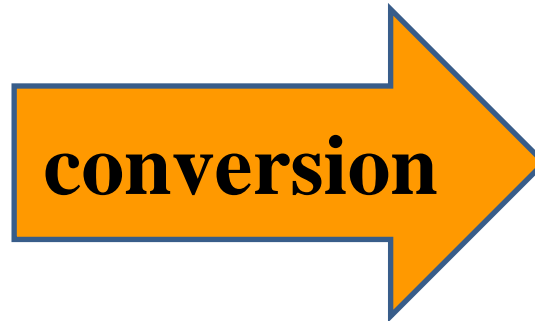
Export the RVT format to IFC format



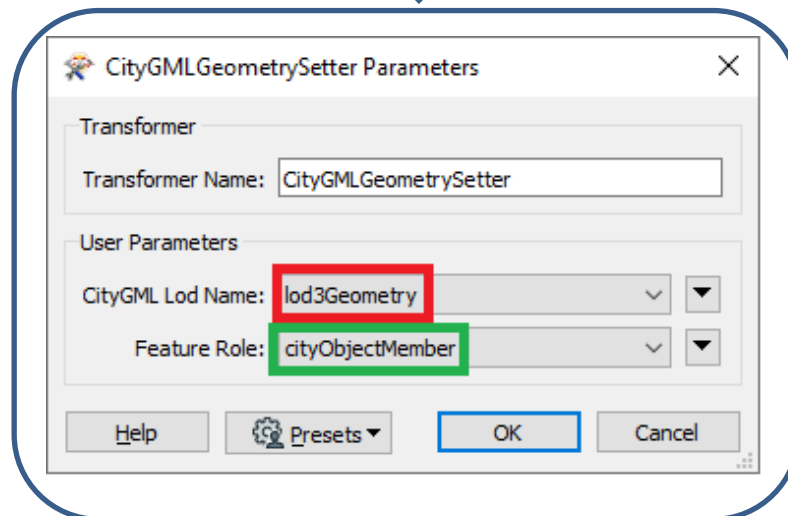
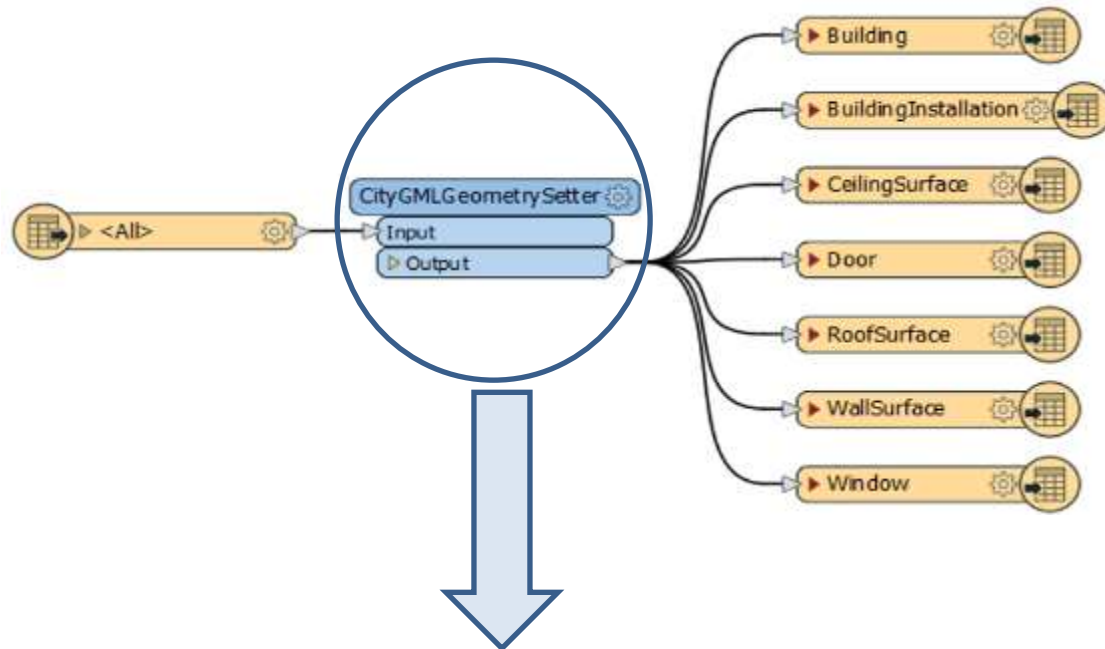
Verifying the Conversion of RVT to IFC



Convert IFC to CityGML



Convert IFC to CityGML



Preview CityGML in FME

View Menu>Windows>Visual Preview

Visual Preview

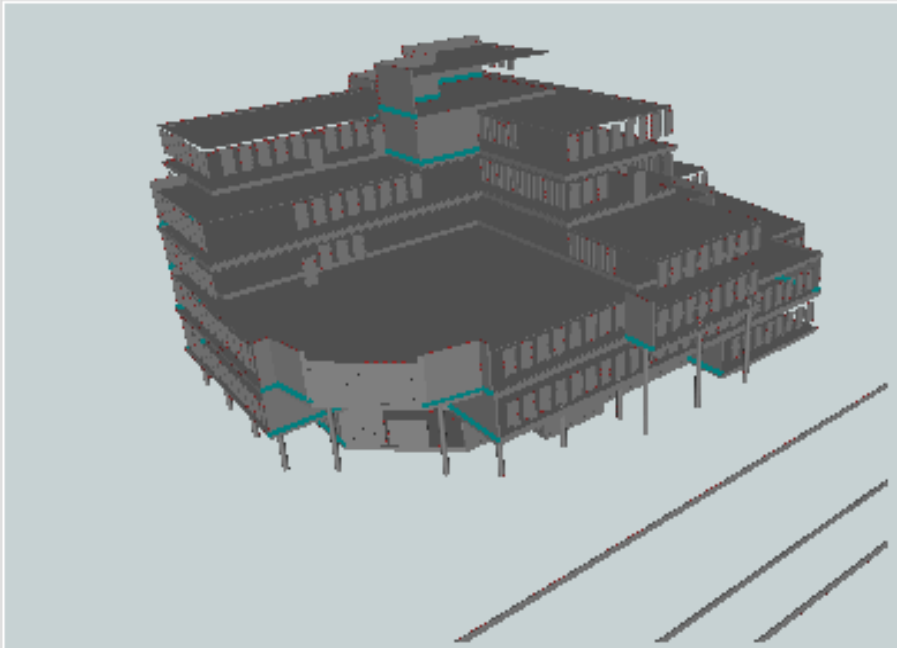
Table

Building Columns...

	gml_id	gml_parent_id ^
1	fme-gen-f47e4...	fme-gen-e427a
2	fme-gen-31e98...	fme-gen-e427a
3	fme-gen-afbe4...	fme-gen-e427a
4	fme-gen-7ef30...	fme-gen-e427a
5	fme-gen-73450...	fme-gen-e427a
6	fme-gen-f5839...	fme-gen-e427a
7	fme-gen-ffcfeb...	fme-gen-e427a
8	fme-gen-bb8aa...	fme-gen-e427a
9	fme-gen-7c5f4...	fme-gen-e427a
10	fme-gen-77640...	fme-gen-e427a
11	fme-gen-a4280...	fme-gen-e427a

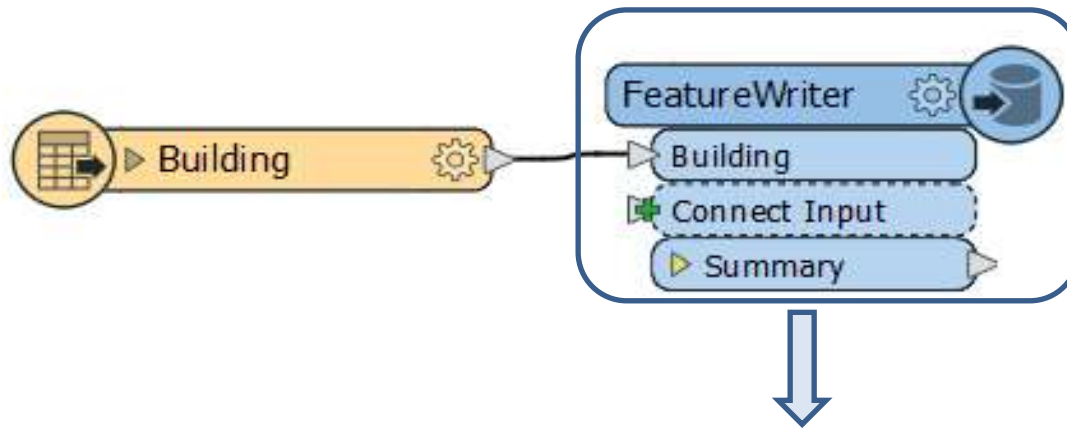
Graphics

2D 3D Slideshow Orbit Select Pan Zoom In Zoom Out Zoom S



The image shows a screenshot of the FME Visual Preview window. On the left, a table lists 11 building objects with their gml_id and gml_parent_id. The main area displays a 3D perspective view of a complex, multi-story building model. The building is rendered in a dark grey color with some red and blue highlights. The interface includes a toolbar with various navigation and viewing options like 2D, 3D, Slideshow, Orbit, Select, Pan, Zoom In, Zoom Out, and Zoom S.

Convert CityGML to 3D Tiles



FeatureWriter Parameters

Transformer Name: FeatureWriter

Writer

Format: Cesium 3D Tiles

Dataset: "H:\Projects\GEODB\OGC standards_research\Data\Wcc_Data"

Parameters...

Coord. System: Same as source

Feature Types

Building

Parameters User Attributes Format Attributes

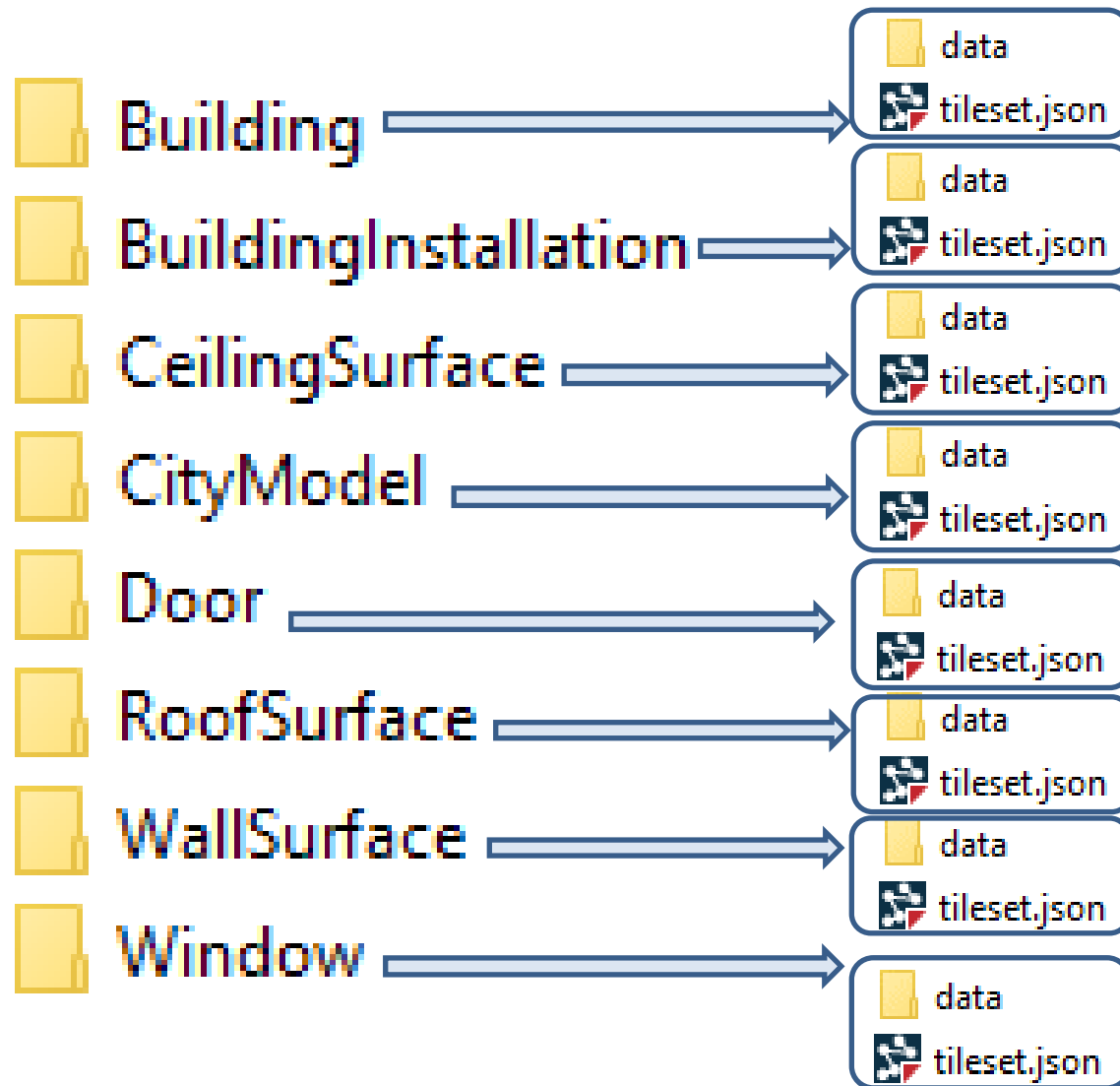
General

Cesium 3D Tileset Name: Building

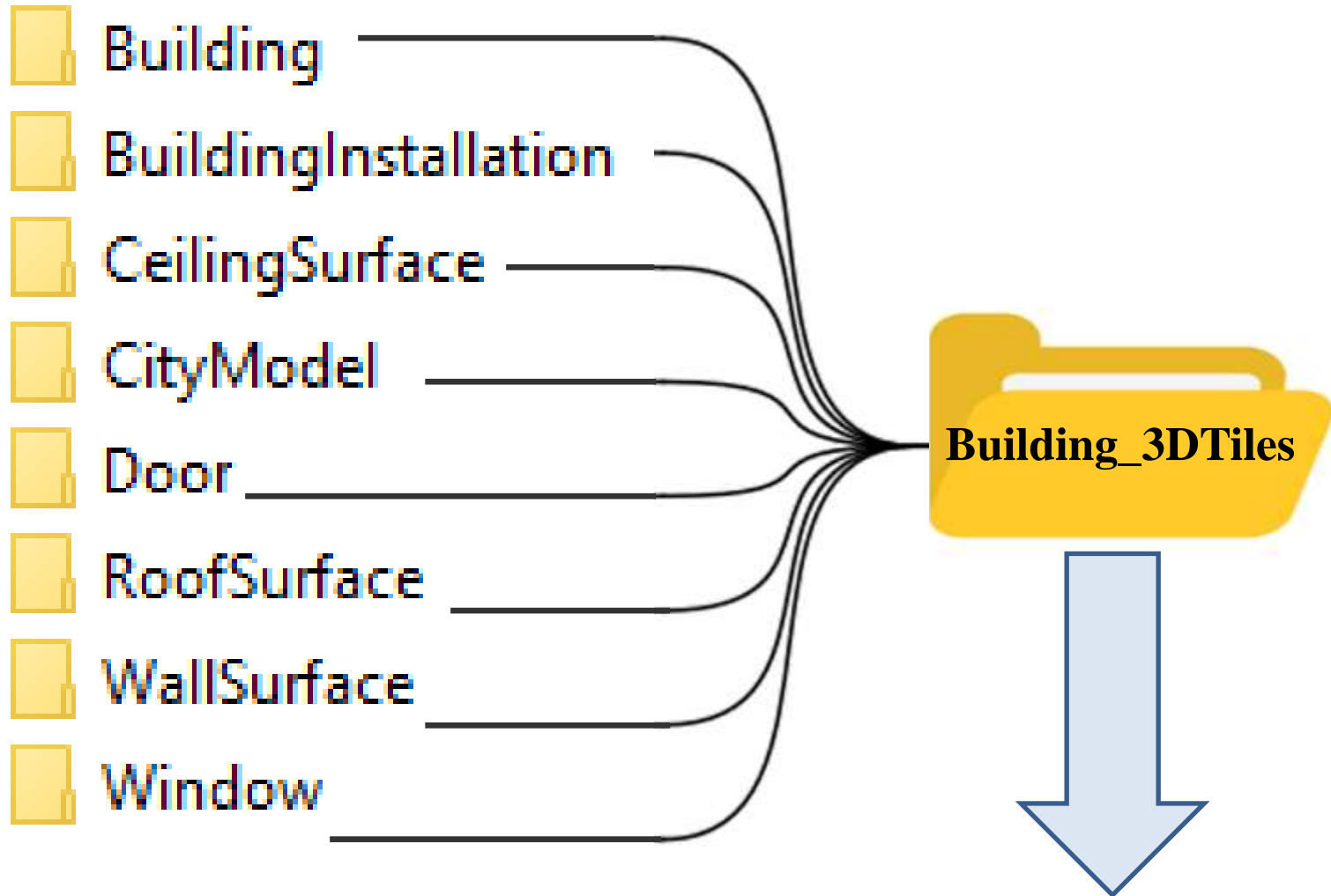
Dynamic Schema Definition

Help Presets OK Cancel

Convert CityGML to 3D Tiles

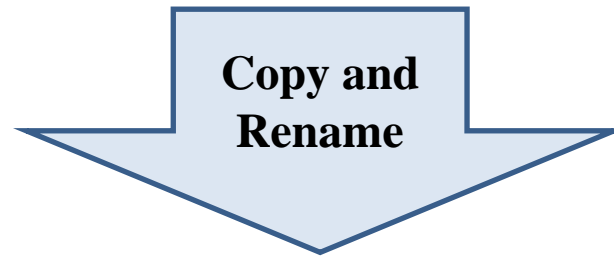


Representing 3D Tiles in CesiumJS



...\Tomcat 9.0_Tomcat9_9090\webapps\My_CesiumJS\Specs\Data\Cesium3DTiles

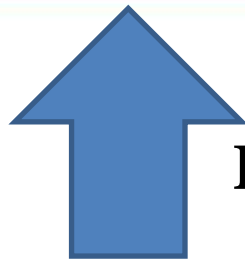
Representing 3D Tiles in CesiumJS



...\Tomcat 9.0_Tomcat9_9090\webapps\My_CesiumJS\Apps

Representing 3D Tiles in CesiumJS

```
    }  
    </style>  
</head>  
<body>  
  <div id="cesiumContainer"></div>  
  <script>  
    const viewer = new Cesium.Viewer("cesiumContainer");  
  </script>  
</body>  
</html>
```

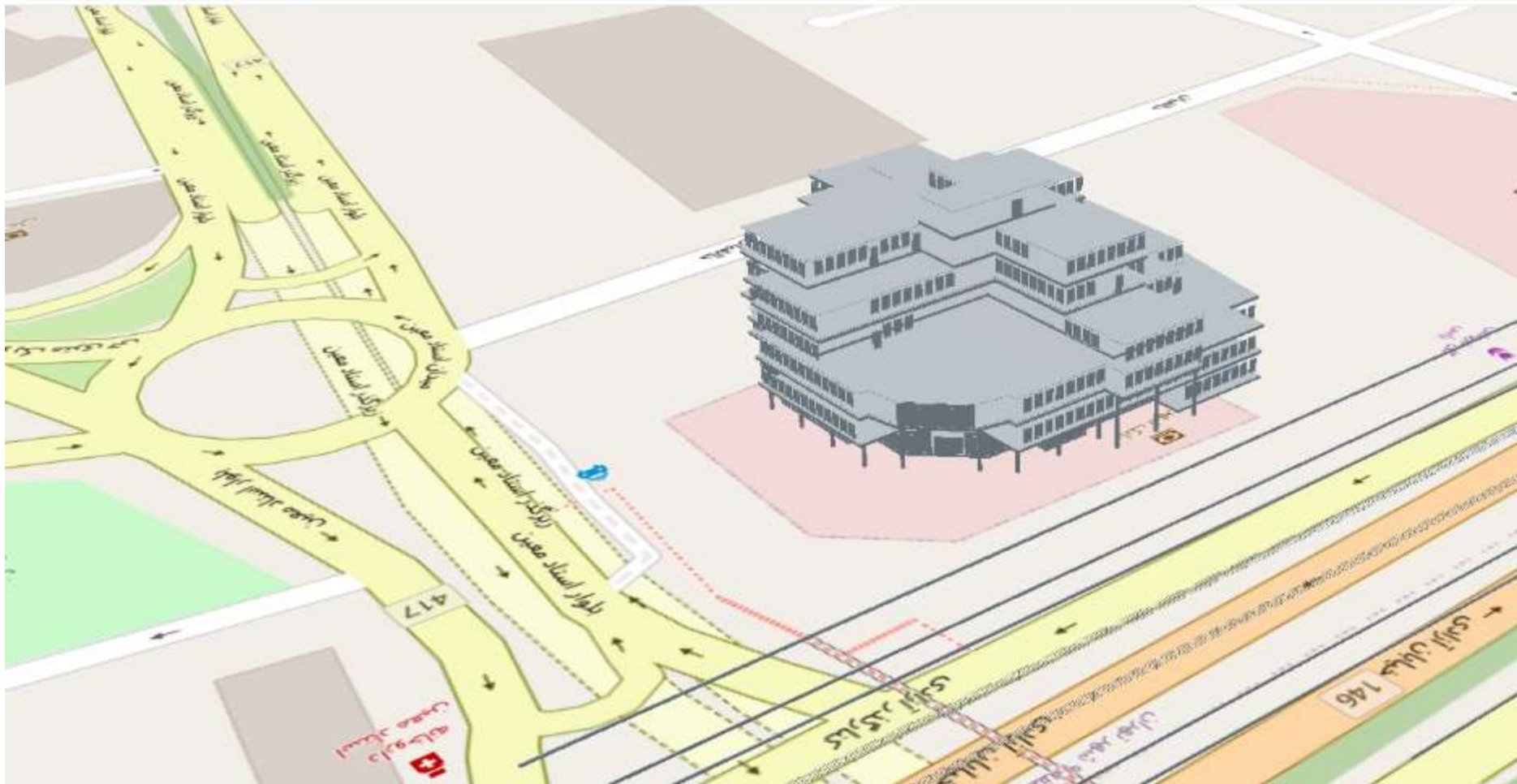


Replace

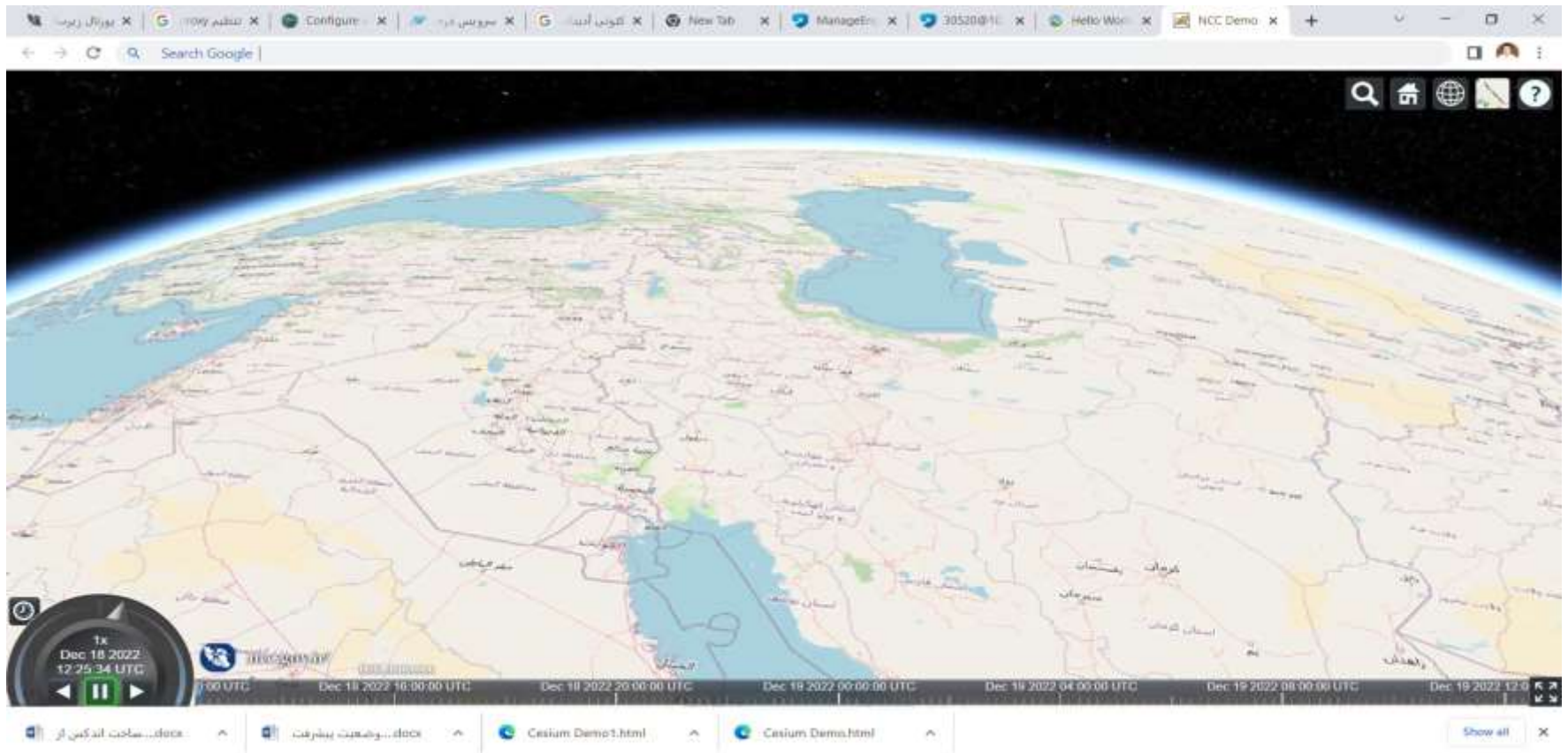
```
>div id="cesiumContainer"></div<  
>  script<  
  var viewer = new Cesium.Viewer('cesiumContainer');  
  var tileset = viewer.scene.primitives.add(new Cesium.Cesium3DTileset({  
    url : "../Specs/Data/Cesium3DTiles/Building/tileset.json", // URL from `Starting  
the Server` section.  
  }));  
  viewer.zoomTo(tileset);  
</script>
```


Representing 3D Tiles in CesiumJS

localhost:9090/My_CesiumJS/Apps/Building_from_CityGML_LOD3_7_FeatureTypes.html



Representing 3D Tiles in CesiumJS (LOD3) (Main Building of NCC)



A signpost with a central vertical pole and four horizontal arms extending outwards. The arms are white and appear to be blank. The background is a clear blue sky. The text "Thanks for your attention" is written in a white, serif font on the right side of the signpost.

Thanks
for
your
attention