FIG WORKING WEEK 2023
28 May - 1 June 2023 Orlando Florida USA
Protecting Our World, Conquering New Frontiers

TerrainTwin

Microservice Architecture for the Integration of Geodata (GIS) and Building Models (BIM) using Link Models

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Goals

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- make terrain models,

Digital Terrain Model (DTM)

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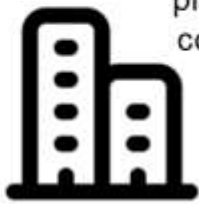
- make terrain models, building models

Digital Terrain Model (DTM)



openBIM for planning and construction

Goals

- make terrain models, building models and geodata

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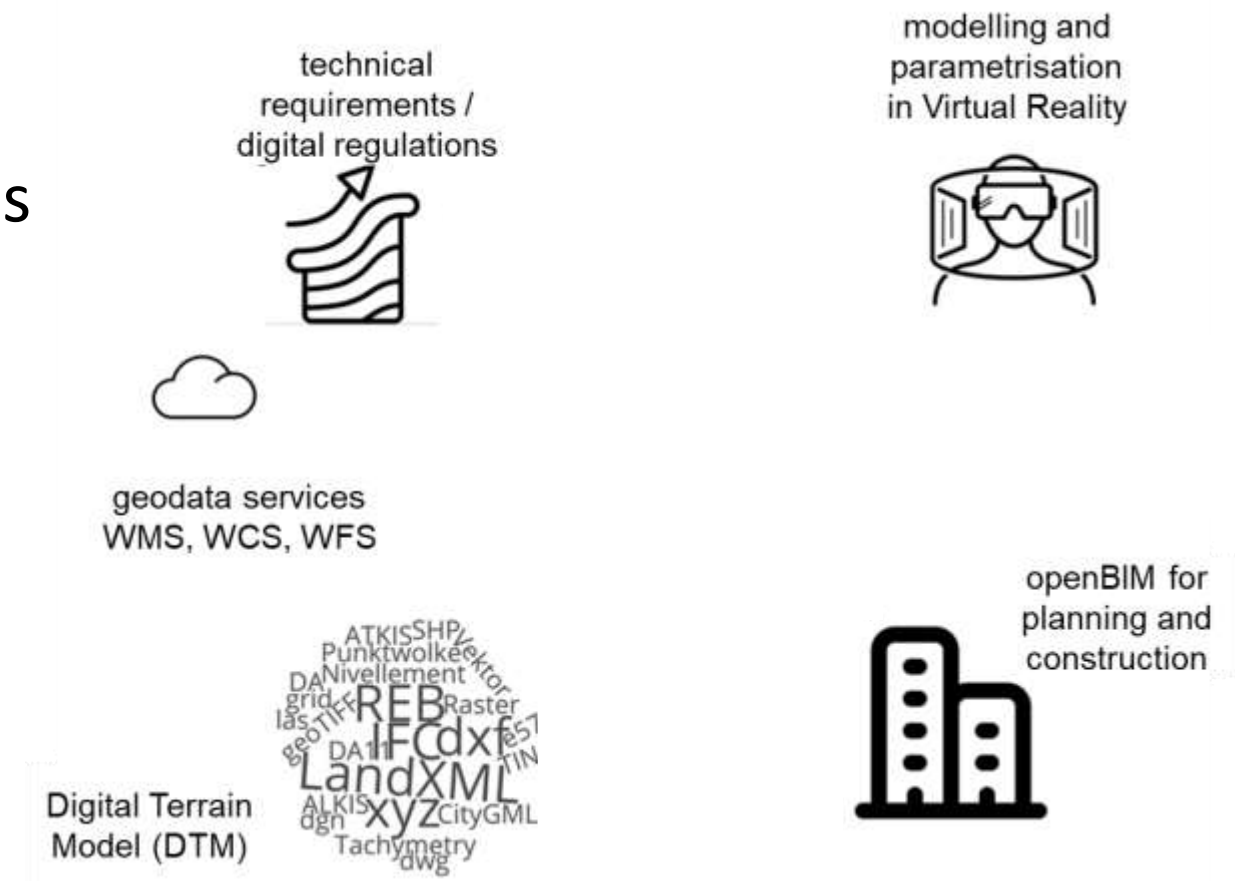
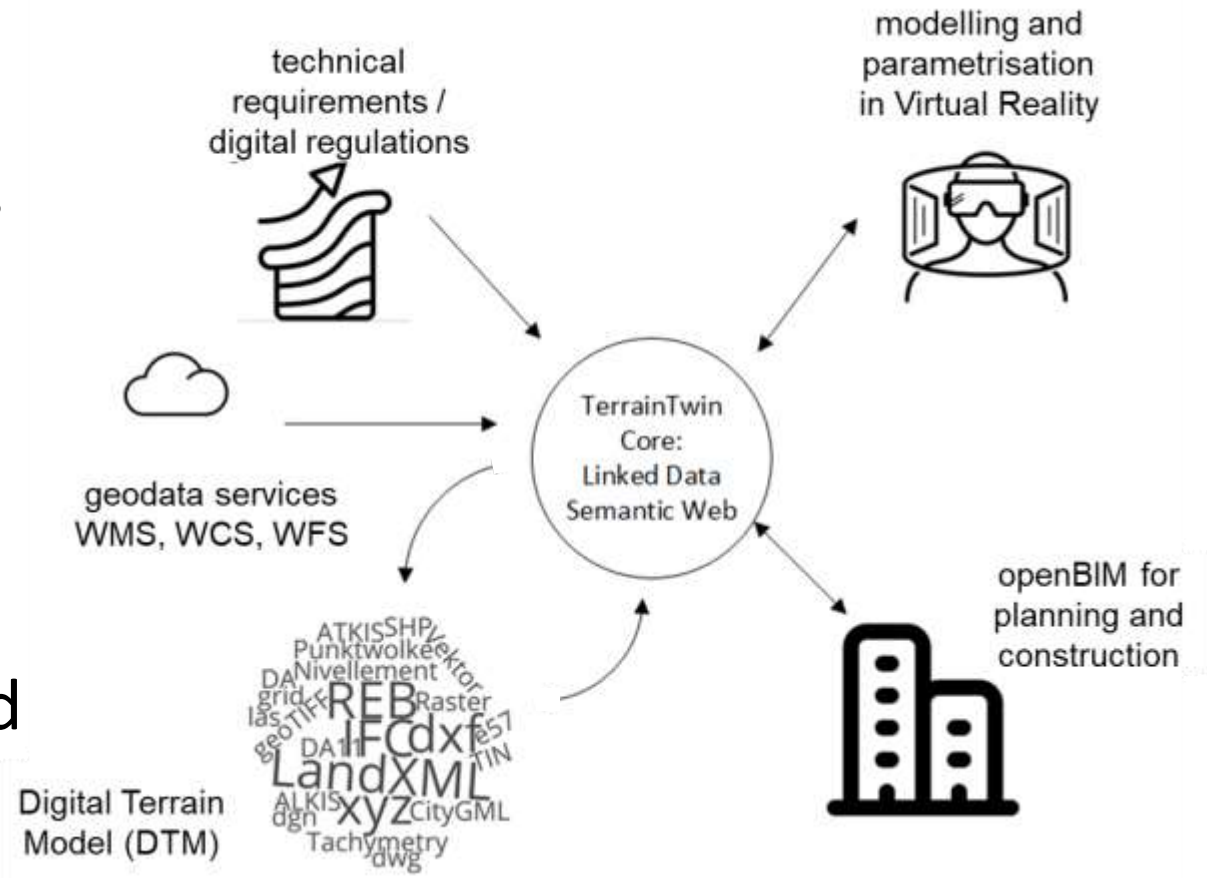
- make terrain models, building models and geodata interactively usable for AR/VR based landscape planning in a **common model**



Goals

- make terrain models, building models and geodata interactively usable for AR/VR based landscape planning in a **common model**
- demonstrate, how **Semantic Web** technologies and **microservices** can be used for the integration of BIM and GIS



BIM vs. GIS? – BIM & GIS!

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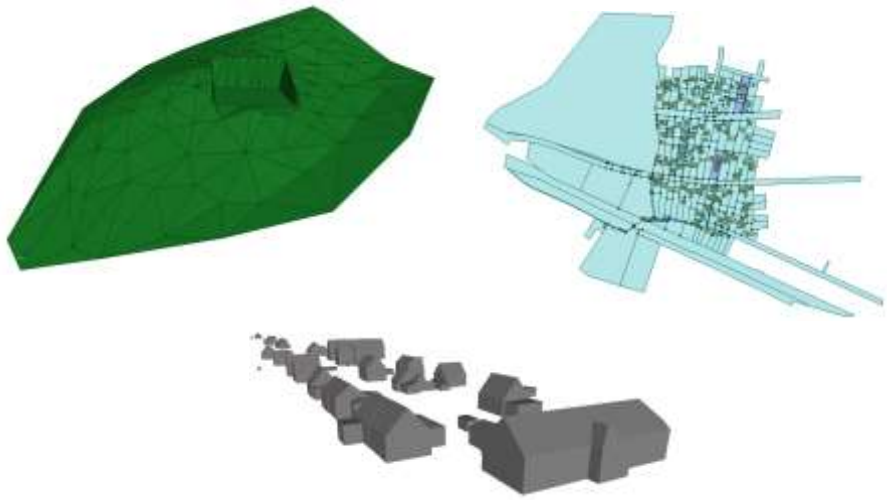
GIS



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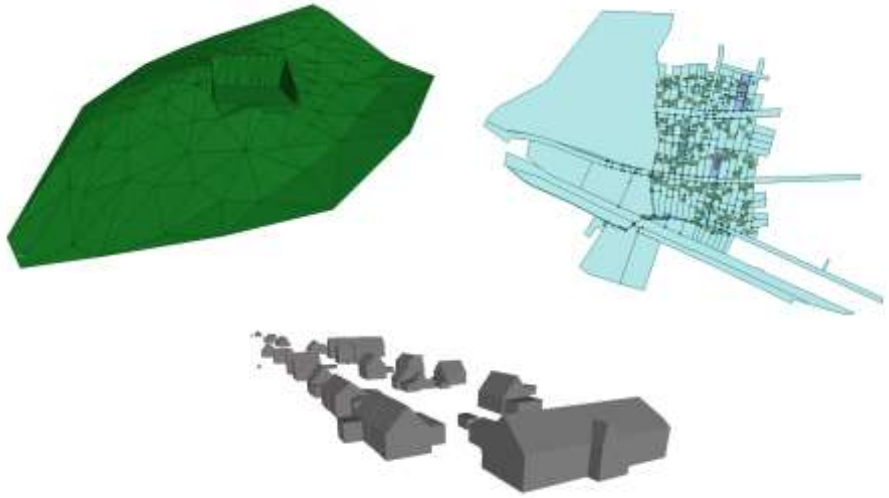
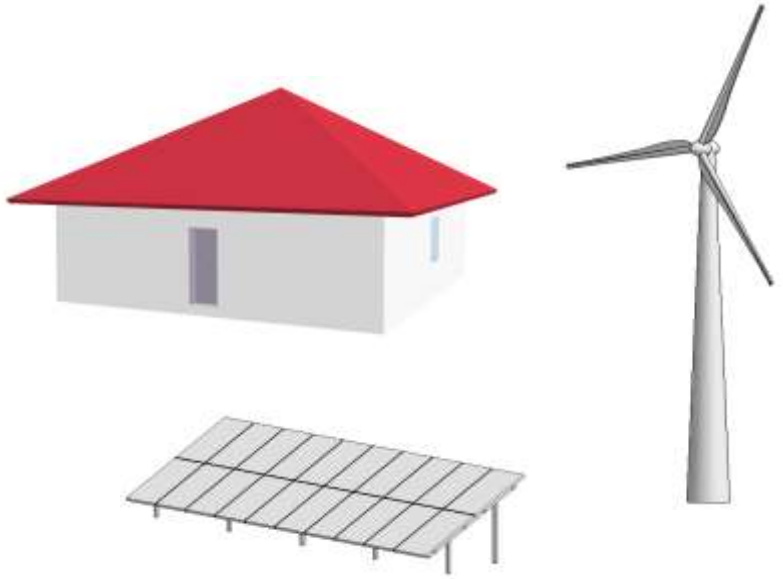


BIM



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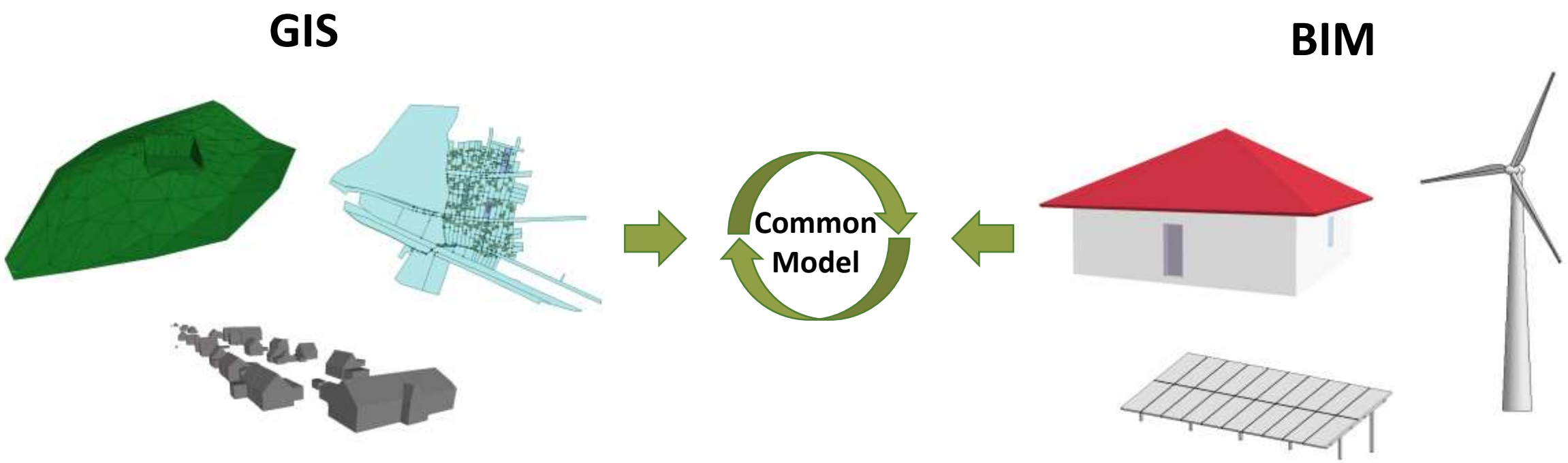

Our approach

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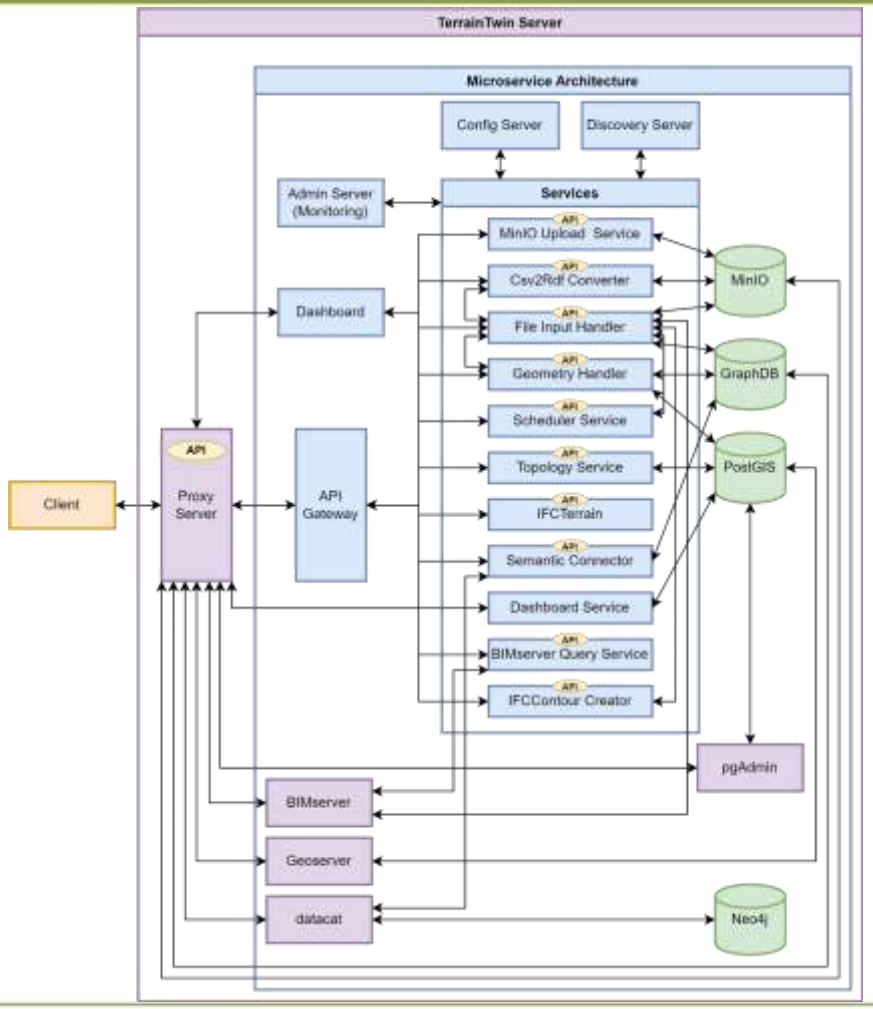
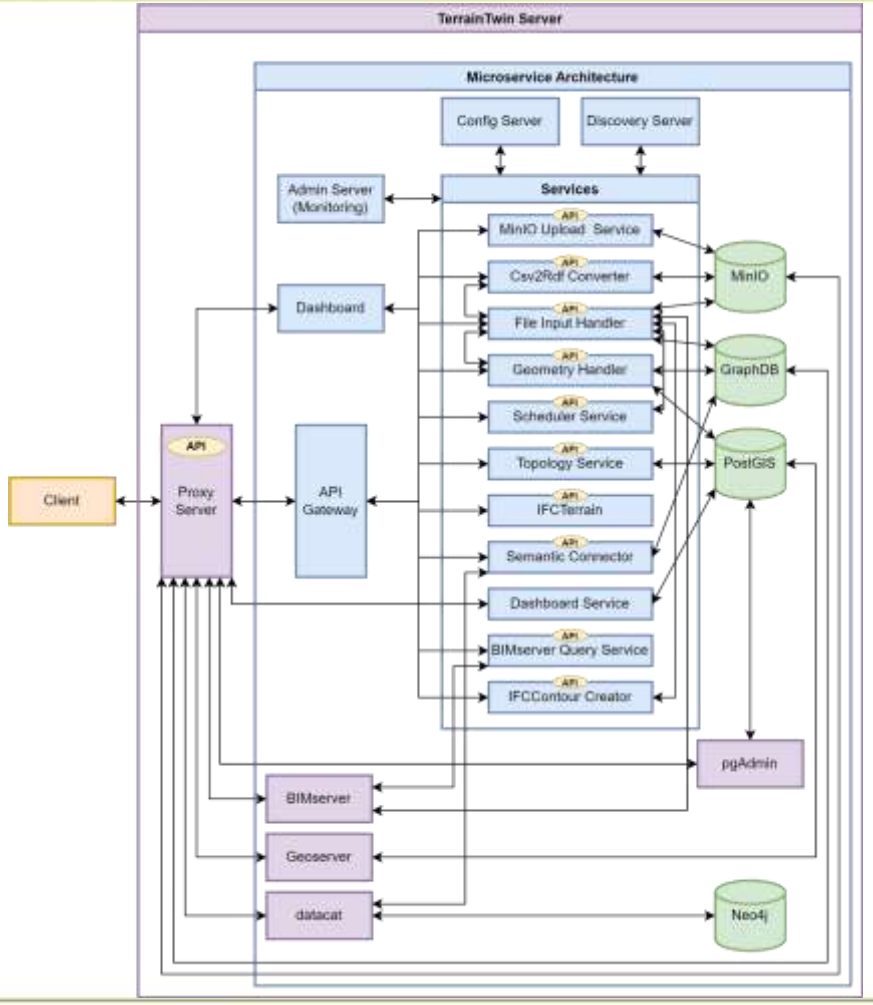
- **links** data by using Semantic Web technologies
- **minimizes** information loss
- **modularizes** services
- **communicates** over API's

Resulting system architecture



Resulting system architecture

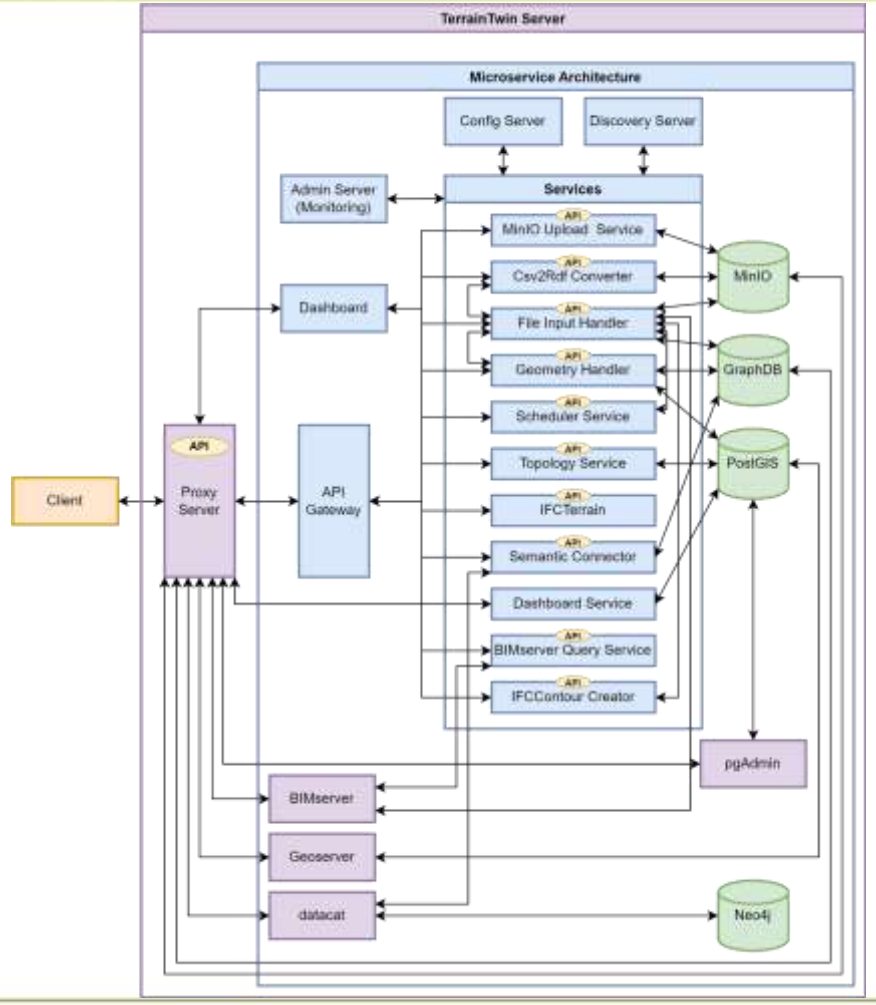
- prototype backend can **import**, **prepare**, **modify**, **integrate** and **provide** data from BIM and GIS domains



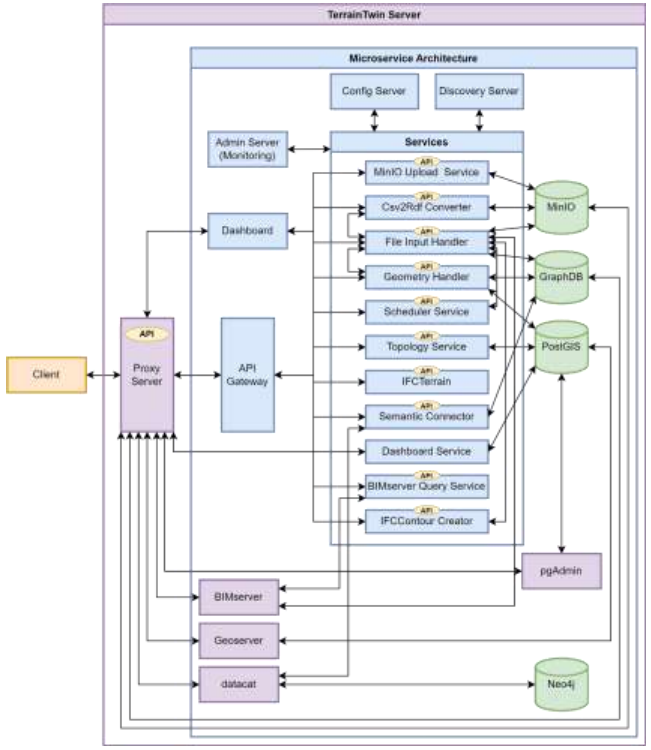
Resulting system architecture

- prototype backend can **import**, **prepare**, **modify**, **integrate** and **provide** data from BIM and GIS domains

- more than 20 software modules **work together** as microservices

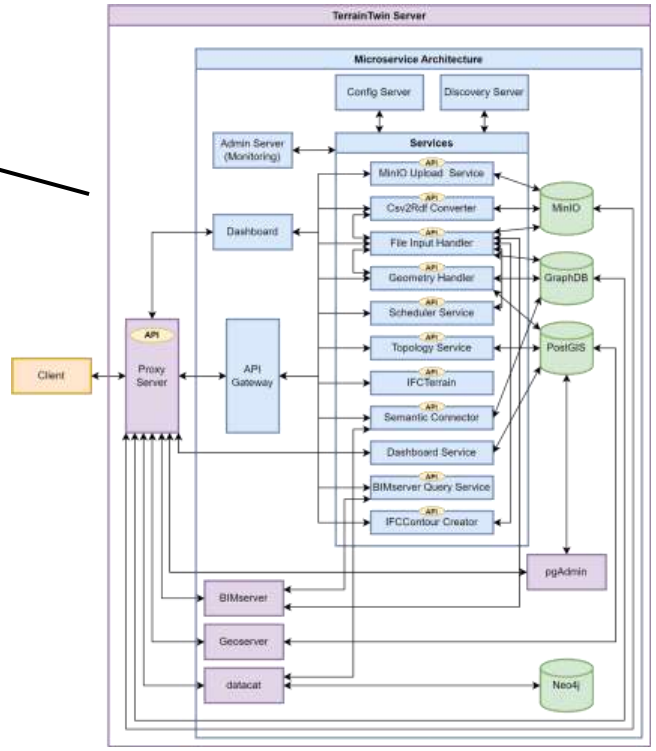


System functionalities



System functionalities

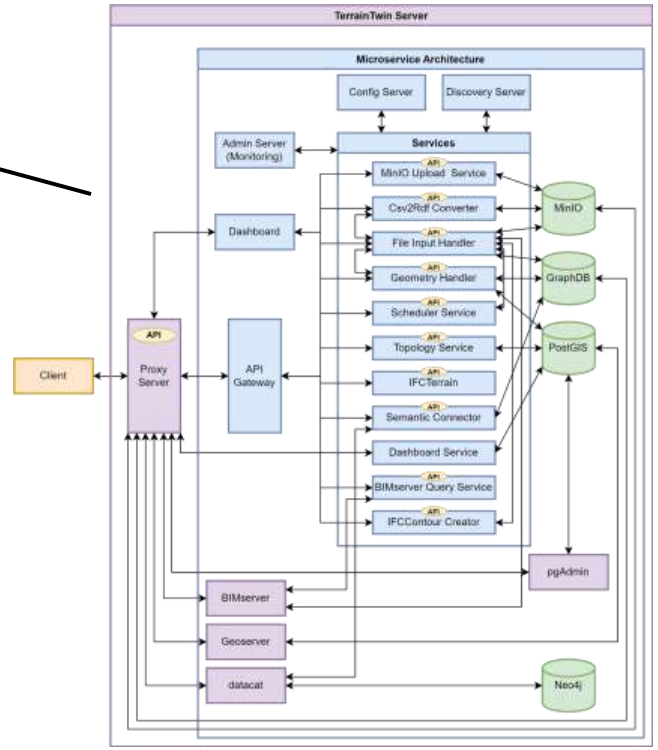
link



System functionalities

link

query

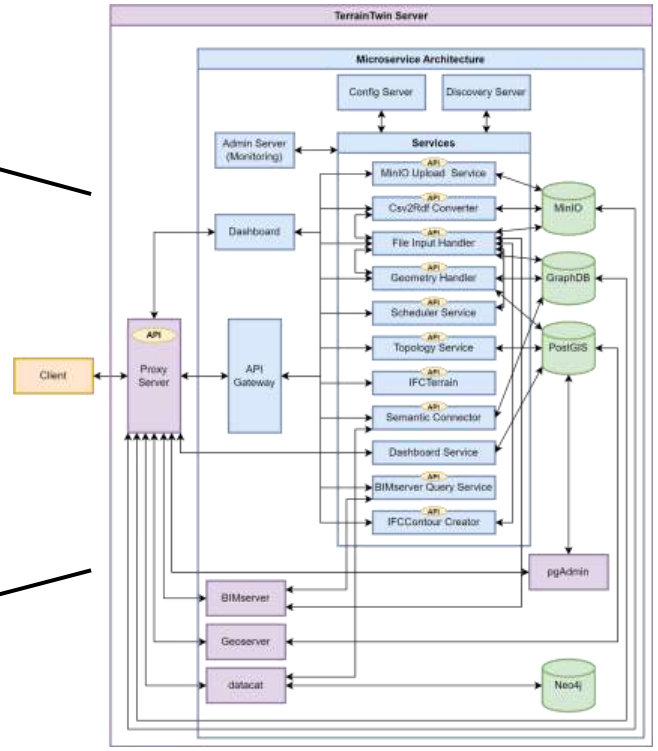


System functionalities

link

query

convert



System functionalities

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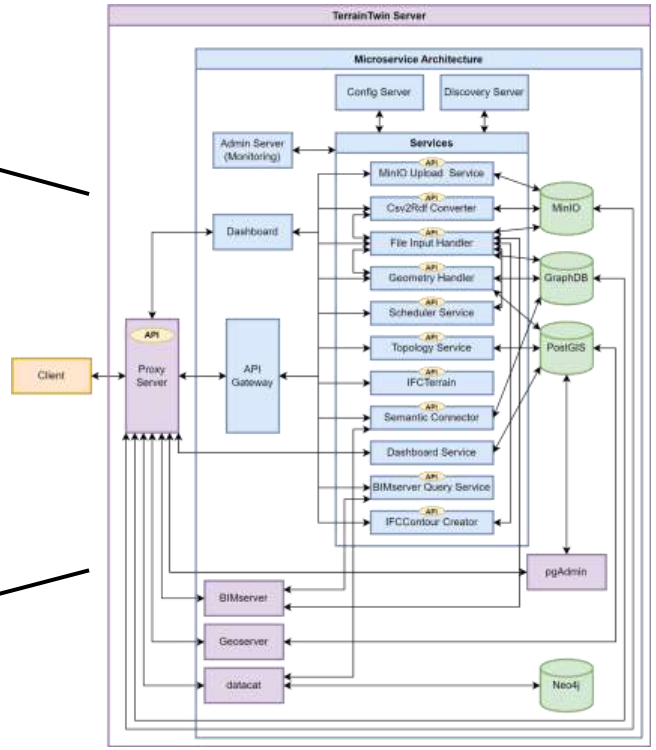


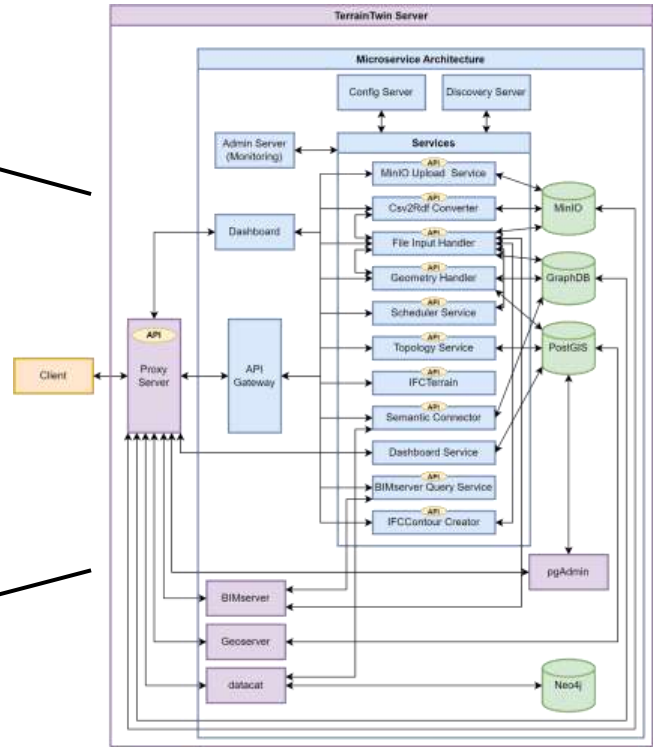
import

System functionalities

link

query

convert



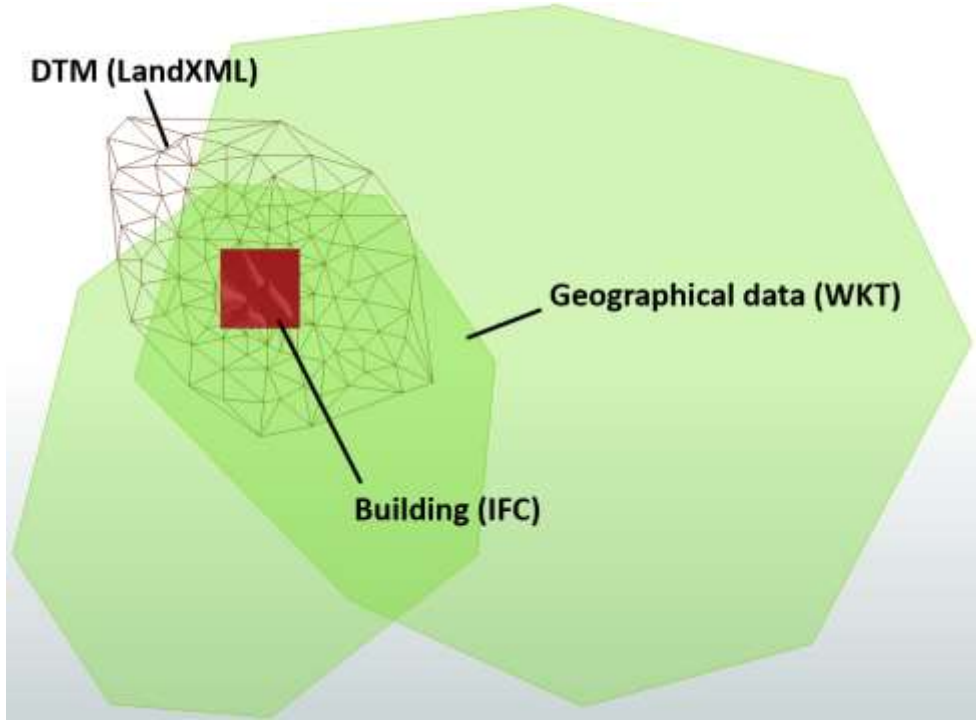
import

calculate

Example backend Requests

Question:
Which kinds of land use are affected by constructing the building? Give the geometry of these land uses.

Example backend Requests



Question:
Which kinds of land use are affected by constructing the building? Give the geometry of these land uses.

Example backend Requests

```
PREFIX geo: <http://www.opengis.net/ont/geosparql#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX tto: <https://terrain.dd-bim.org/terraintwin/ontology/>
PREFIX sd: <https://terrain.dd-bim.org/Sachdaten/>
select ?building ?url ?landUseType where {
    ?building tto:hasFootprint / geo:hasGeometry / geo:sfIntersects ?featureGeom .
    ?featureGeom ^geo:hasGeometry ?feature.
    ?featureGeom tto:url ?geomUrl .
    ?feature tto:hasSource / ^tto:hasSource ?landUse .
    ?landUse sd:id ?id .
    ?featureGeom tto:originId ?oId .
    ?landUse sd:LandUseType ?landUseType .
    Bind(str(?geomUrl) as ?url)
    Filter(?id = str(?oId))
}
```

Question:
Which kinds of land use are affected by constructing the building? Give the geometry of these land uses.

Example backend Requests

```
PREFIX geo: <http://www.opengis.net/ont/geosparql#>
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select ?building ?url ?landUseType where {
    ?building tto:hasFootprint / geo:hasGeometry / geo:sfIntersects ?featureGeom .
    ?featureGeom ^geo:hasGeometry ?feature.
    ?featureGeom tto:url ?geomUrl .
    ?feature tto:hasSource / ^tto:hasSource ?landUse .
    ?landUse sd:id ?id .
    ?featureGeom tto:originId ?oId .
    ?landUse sd:LandUseType ?landUseType .
    Bind(str(?geomUrl) as ?url)
    Filter(?id = str(?oId))
}
```

Question:
Which kinds of land use are affected by constructing the building? Give the geometry of these land uses.

	building	url	landUseType
1	bim:7181769e-ea89-4bbf-94c5-d089725b2079	"https://terrain.dd-bim.org/geometry/export/collections/polygon_2d/items/2143723d-c970-4524-a4d5-6792f857e842"	"Greenland"
2	bim:7181769e-ea89-4bbf-94c5-d089725b2079	"https://terrain.dd-bim.org/geometry/export/collections/polygon_2d/items/b78df06b-2814-4627-8750-858051a3f6a2"	"Forest"

Example backend Requests

- execution of link to geometry calls API method

https://terrain.dd-bim.org/geometry/export/collections/polygon_2d/items/2143723d-c970-4524-a4d5-6792f857e842


```
{
   "id": "2143723d-c970-4524-a4d5-6792f857e842",
   "geometry": "SRID=25832;POLYGON((685636.701199641 5646606.3536494,
                  685686.011941892 5646602 .44895838,685718.819502458 5646553.76775835,
                  685713.569069366 5646496.58646396,685652.508571504 5646448.69792641,
                  685605.234283641 5646452.58222739,685576.576094471 5646496.59665898,
                  685596.186207196 5646575.49078808,685636.479635002 5646606.11546631,
                  685636.701199641 5646606.3536494))"
}
```

XR frontend for landscape planning – use case “wind turbines”

Findings

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- **Semantic Web** and **microservices** are a **powerful team for data integration**, with demanding, heterogeneous information sources
- **complex, cross-domain queries** can be made by SPARQL requests on graph database and served to user via easy API's
- **linking original data** instead of converting data into formats of different domains can **minimize information loss**

Thank you for your attention!

Contact:

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christian.clemen@htw-dresden.de

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