openDBL

A digital building log book

based on a

Plugable, ontology driven data model

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Klaus Linhard (iabi)
Michele Alori (e-metodi)
Jakob Martin (iabi)

Funded by the European Union

openDBL project objectives

openDBL project aims at facilitating the adoption of DBL in Europe: we are developing a system for the conception, creation, implementation and updating of the Digital Building Logbook

1. **To create a DBL with useful content and innovative functionalities,**

2. **To ensure a usable and simple openDBL and reducing the time of uploading, searching, and processing of the information and data**

1. **To ensure attractive economics, through value propositions and convenient pricing**

Project period: 36 months
Project consortium: 13 partners from 8 countries
Funded call: HORIZON-CL4-2022-TWIN-TRANSITION-01-09
Grant agreement no: 101092161

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1. Pluggable ontology driven data model

2. Retrieving IFC-Data

3. AI – Advanced Attribute Mapping of classification (bsDD)

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Type of action: IA
Project period: 36 months started in January 2023
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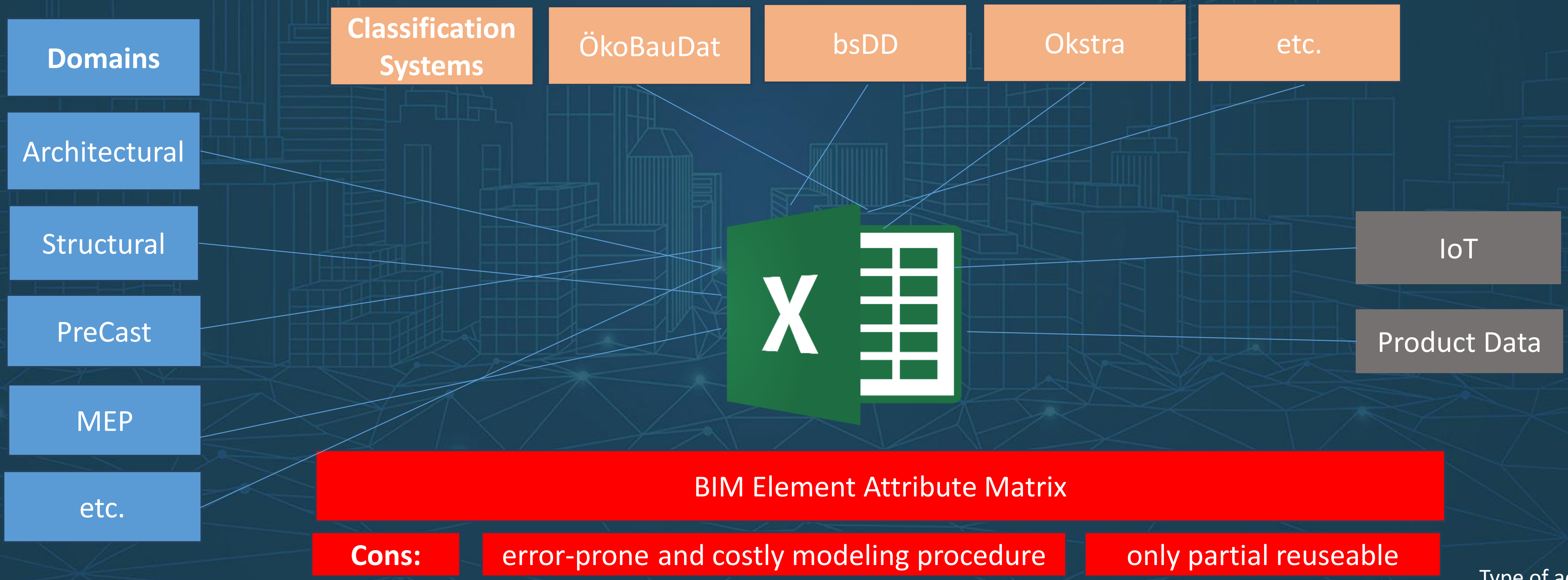
Current approach defining a BIM data model

The process of linking data within the BIM models plays a vital role in ensuring accurate representation and effective communication among project stakeholders



Domains

Architectural

Structural

PreCast

MEP

etc.

Classification Systems

ÖkoBauDat

bsDD

Okstra

etc.

IoT

Product Data

BIM Element Attribute Matrix

Cons: error-prone and costly modeling procedure | only partial reuseable

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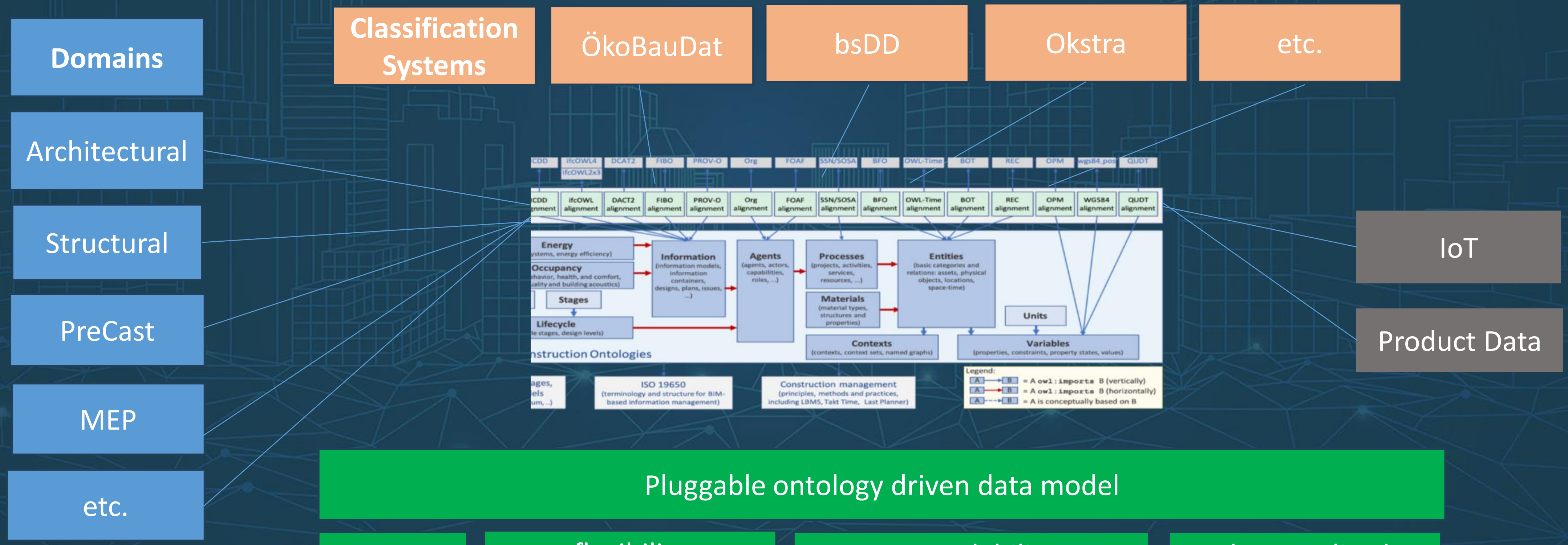
Pluggable Ontology driven dynamic data model

The process of linking data within the BIM models plays a vital role in ensuring accurate representation and effective communication among project stakeholders



Domains

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IoT

Product Data

ICDD
ifcOWL4
ifcOWL2x3
DCAT2
FIBO
PROV-O
Org
FOAF
SSN/SOSA
BFO
OWL-Time
BOT
REC
OPM
wgs84_pos
QUDT
ICDD alignment
ifcOWL alignment
DACT2 alignment
FIBO alignment
PROV-O alignment
Org alignment
FOAF alignment
SSN/SOSA alignment
BFO alignment
OWL-Time alignment
BOT alignment
REC alignment
OPM alignment
WGS84 alignment
QUDT alignment
Energy
ystems, energy efficiency)
Occupancy
ehavior, health, and comfort, uality and building acoustics)
Stages
Lifecycle
le stages, design levels)
Information
(information models, information containers, designs, plans, issues, ...)
Agents
(agents, actors, capabilities, roles, ...)
Processes
(projects, activities, services, resources, ...)
Materials
(material types, structures and properties)
Entities
(basic categories and relations: assets, physical objects, locations, space-time)
Units
Contexts
(contexts, context sets, named graphs)
Variables
(properties, constraints, property states, values)
nstruction Ontologies
ages, els um, ..)
ISO 19650
(terminology and structure for BIM-based information management)
Construction management
(principles, methods and practices, including LBMS, Takt Time, Last Planner)
Legend:
A B = A owl:imports B (vertically)
A B = A owl:imports B (horizontally)
A B = A is conceptually based on B

Pluggable ontology driven data model

Pros: flexibility expandability decentralized

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Pluggable Ontology driven dynamic data model

- **Pluggable:** Ontologies can be dynamically integrated at any stage of the project, similar to puzzle part.

- **Ontology:** Ontologies provide the fundamental data schema and thus essentially supply the data specification. In this sense, they also define the query, i.e., the GraphQL.

- **Dynamic:** “Dynamic” means that we don't need to consider the data that's already present. We can add data at any time dynamically. Being dynamic simply implies that other use-cases remain unaffected.

- **Data model:** The data model applies to each domain. This represents decentralization. Every domain is in charge of its own data model, reflecting the specific expertise one possesses within that domain. This structure signifies a decentralized data model, allowing individual experts to expand and adapt it. Each domain holds responsibility for its respective data model.

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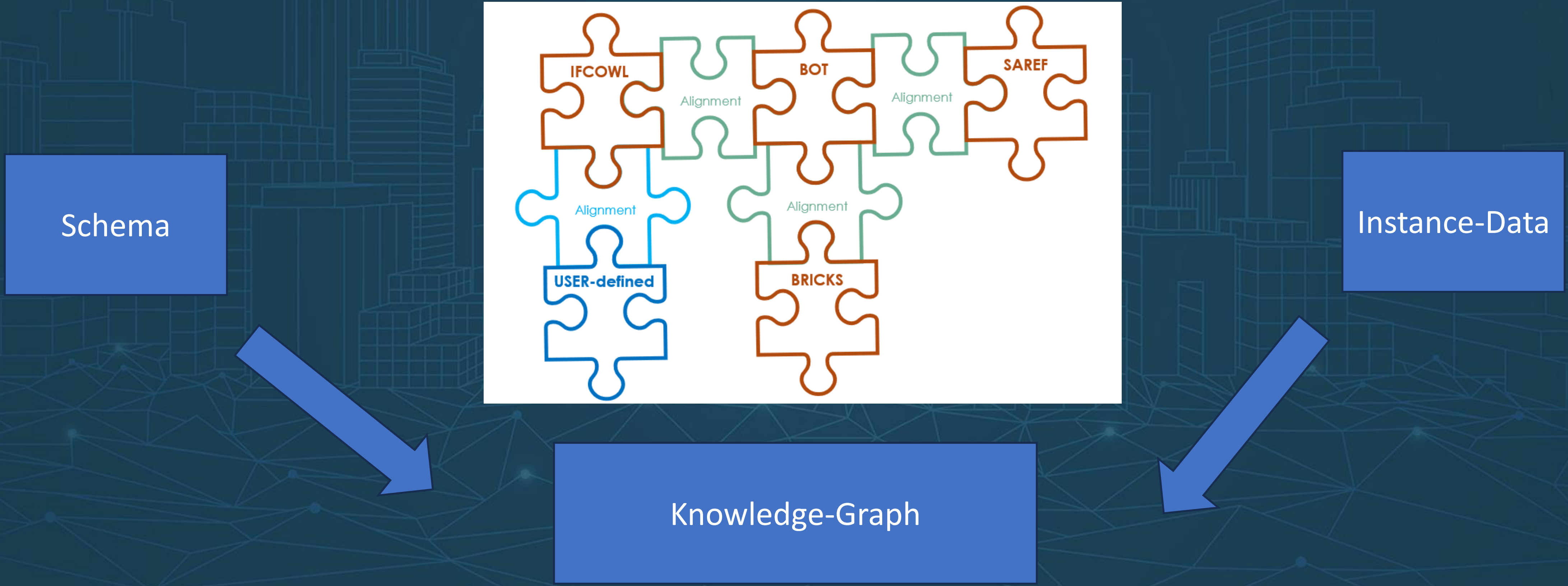
Alignment of ontologies

Ontology alignment identifies semantic links between classes in source and target ontologies, streamlining the mapping of related concepts for stakeholders.



Schema

Instance-Data

Knowledge-Graph

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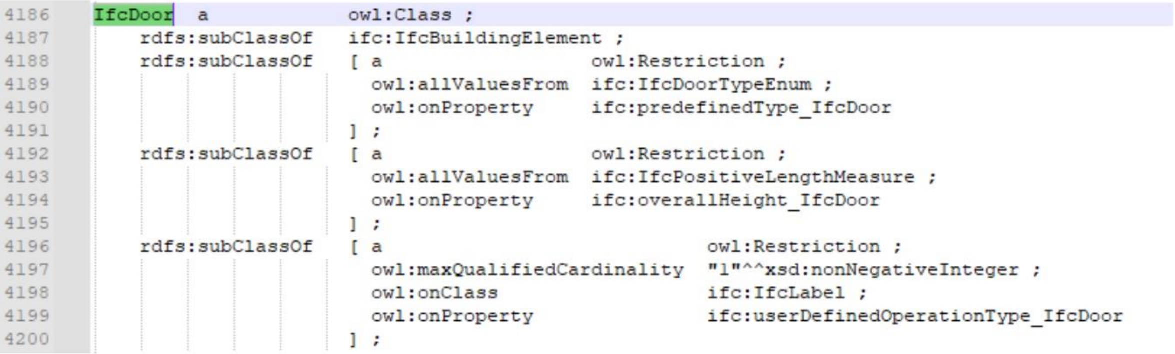
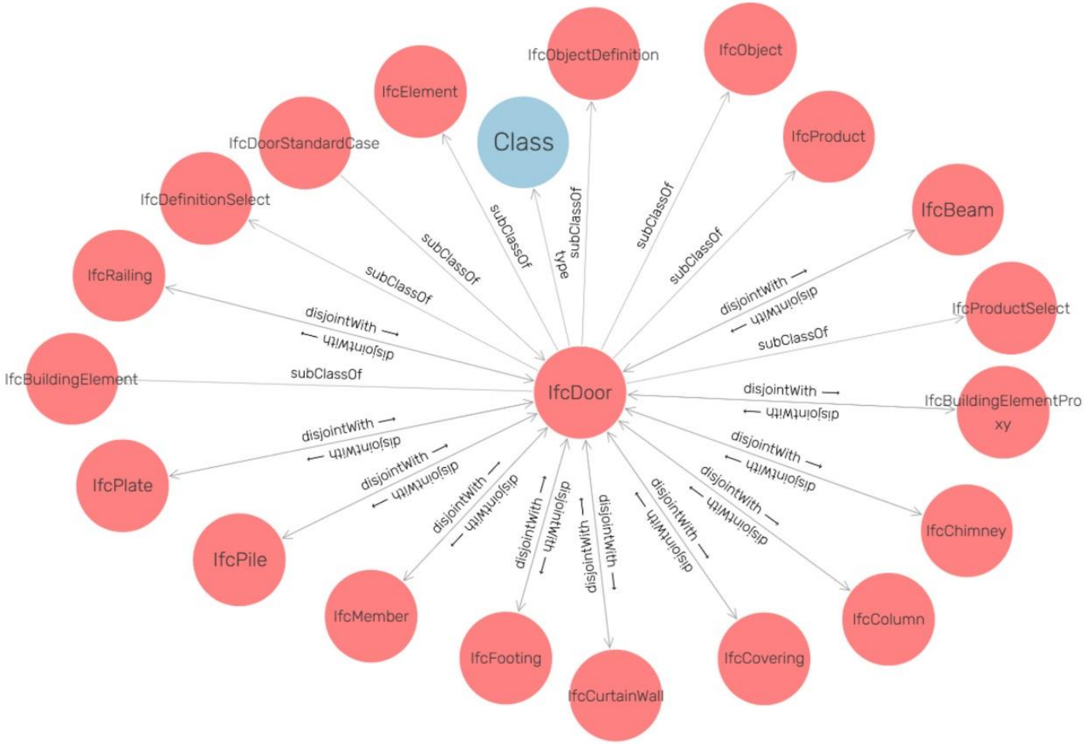
Alignment of ontologies

IFC4_ADD1



```
IfcDoor  a                owl:Class ;
    rdfs:subClassOf   ifc:IfcBuildingElement ;
    rdfs:subClassOf   [ a                    owl:Restriction ;
                        owl:allValuesFrom  ifc:IfcDoorTypeEnum ;
                        owl:onProperty     ifc:predefinedType_IfcDoor
                      ] ;
    rdfs:subClassOf   [ a                    owl:Restriction ;
                        owl:allValuesFrom  ifc:IfcPositiveLengthMeasure ;
                        owl:onProperty     ifc:overallHeight_IfcDoor
                      ] ;
    rdfs:subClassOf   [ a                              owl:Restriction ;
                        owl:maxQualifiedCardinality  "1"^^xsd:nonNegativeInteger ;
                        owl:onClass                  ifc:IfcLabel ;
                        owl:onProperty               ifc:userDefinedOperationType_IfcDoor
                      ] ;
```



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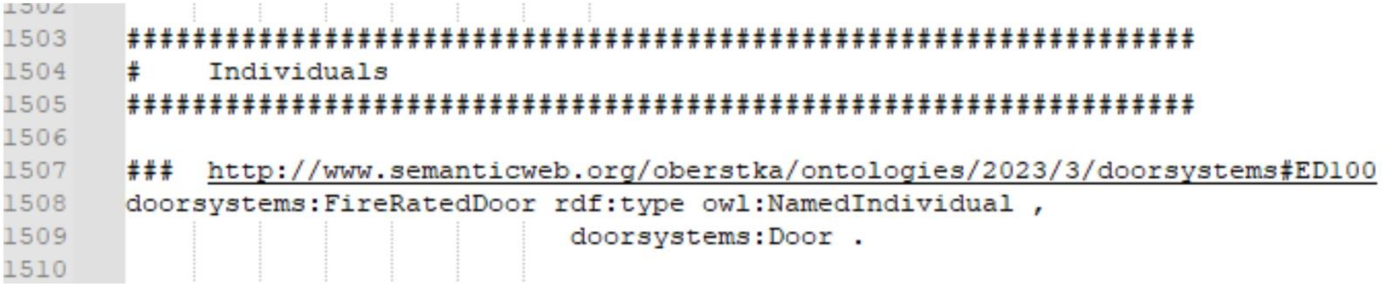
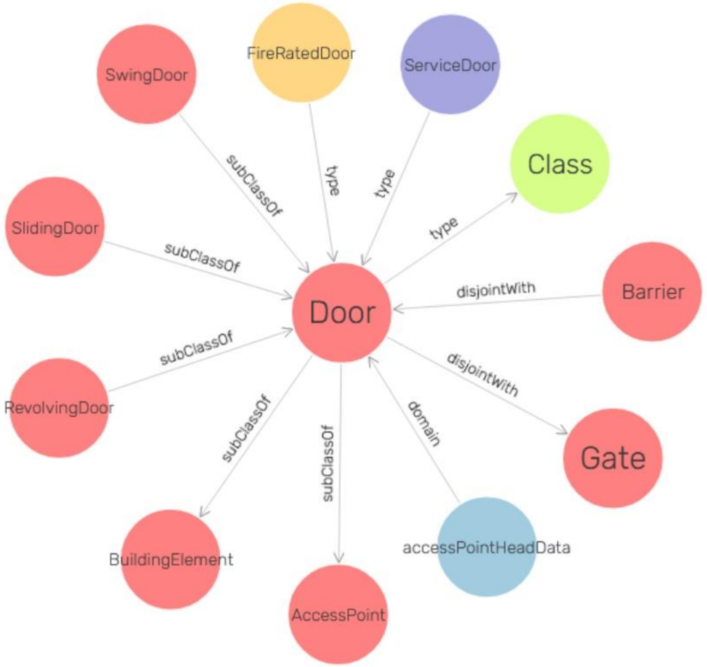
Alignment of ontologies

Doorsystems door



```
#################################################################
#    Individuals
#################################################################

###  http://www.semanticweb.org/oberstka/ontologies/2023/3/doorsystems#ED100
doorsystems:FireRatedDoor rdf:type owl:NamedIndividual ,
                                   doorsystems:Door .
```



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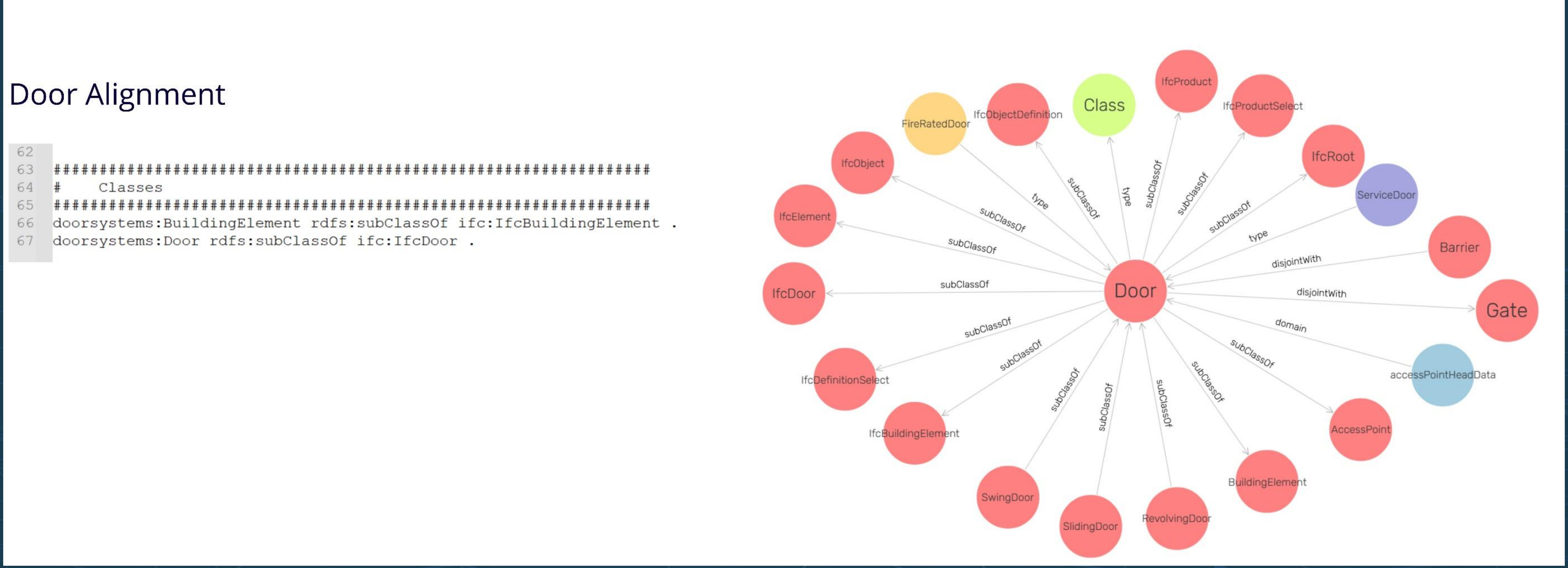
Alignment of ontologies



Door Alignment

```
####################################################################
#    Classes
####################################################################
doorsystems:BuildingElement rdfs:subClassOf ifc:IfcBuildingElement .
doorsystems:Door rdfs:subClassOf ifc:IfcDoor .
```

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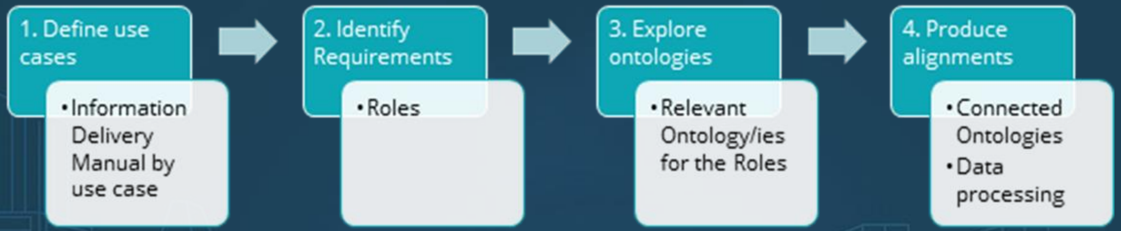
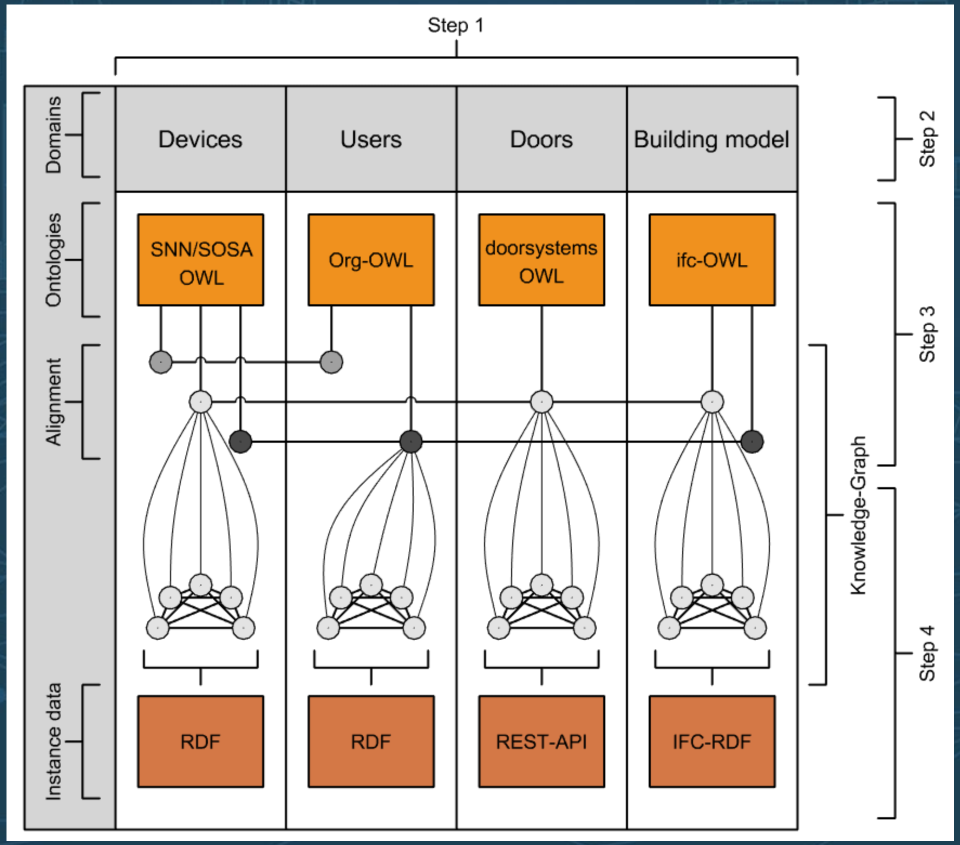
Configuration steps



1. Define use cases
   - Information Delivery Manual by use case
2. Identify Requirements
   - Roles
3. Explore ontologies
   - Relevant Ontology/ies for the Roles
4. Produce alignments
   - Connected Ontologies
   - Data processing



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Graph database - Ontotext

	Ontotext (Pros)	Ontotext (Cons)	Neo4j (Pros)	Neo4j (Cons)
Underlying Model	Supports RDF and is suitable for semantic web applications	RDF might be less intuitive to some users compared to property graphs	Uses property graph model, encompassing both nodes and relationships	Doesn‘t have the same standards focus as RDF
Use Cases	Particularly suitable of semantic web application and linked data	Might be less ideal for general graph applications in some use-cases	Versatile for a wide range of applications e.g. social network	Inference and semantic reasoning is limited
User-Interface	Easy to use, especially when it comes to Data import- and export			User-Interface and data exchange is complicated

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Ontotext usage with AI

- Rich Semantic Data Models
- Inferencing Capabilities
- Standardized Querying with SPARQL
- Interoperability
- Schema Flexibility
- Linked Data Integration
- Knowledge Graphs

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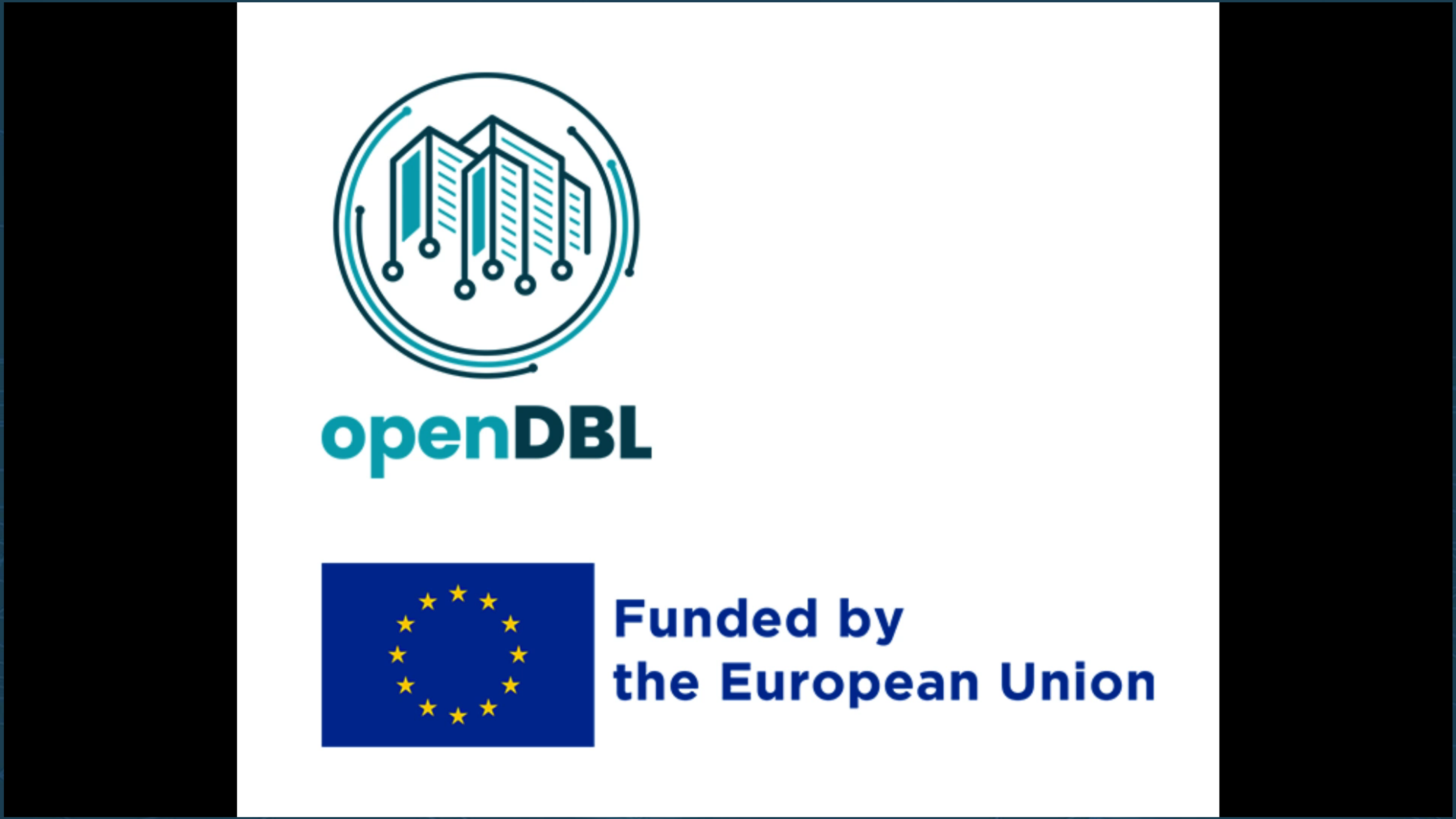
Retrieving IFC Data



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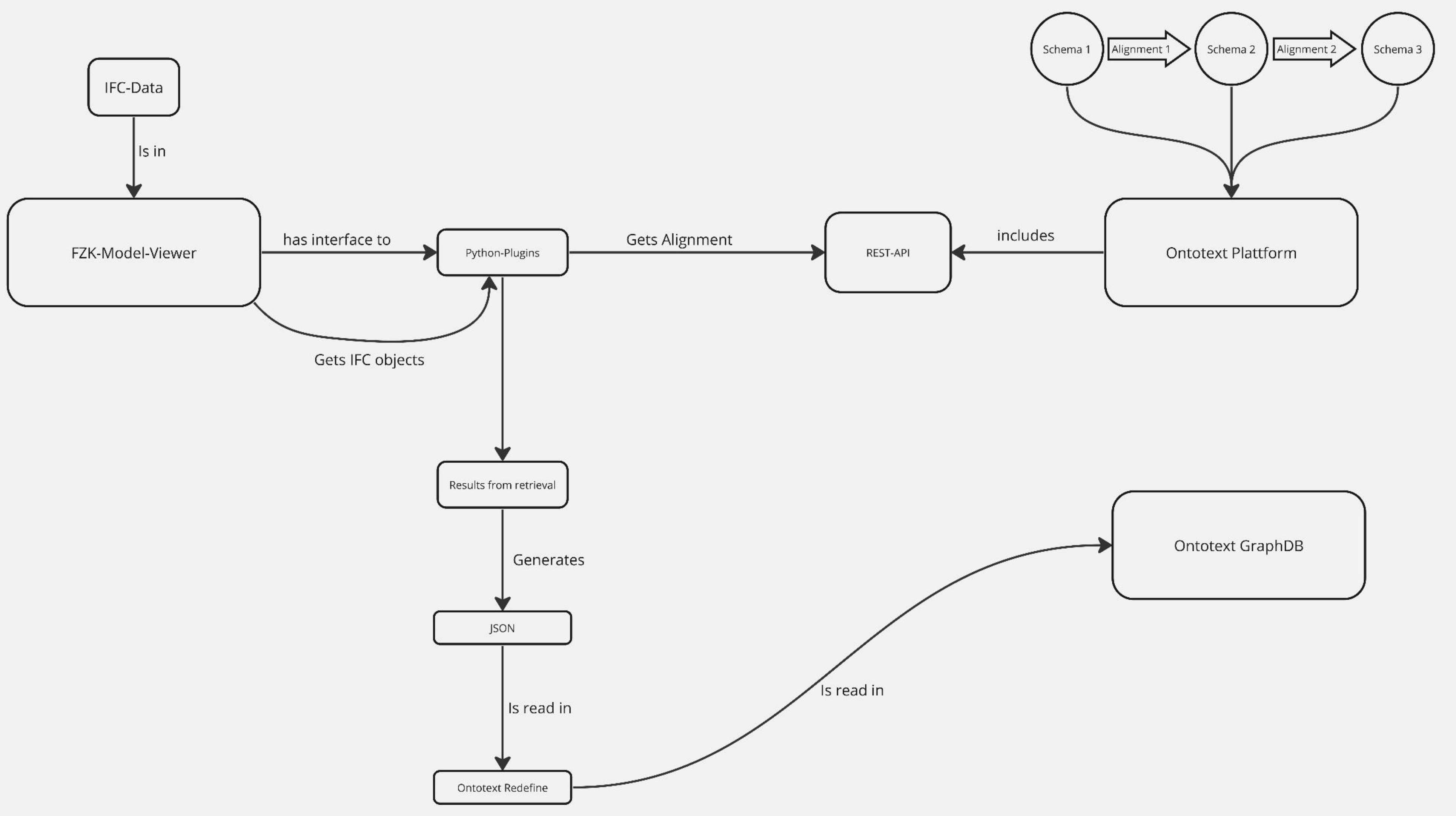
Retrieving IFC Data



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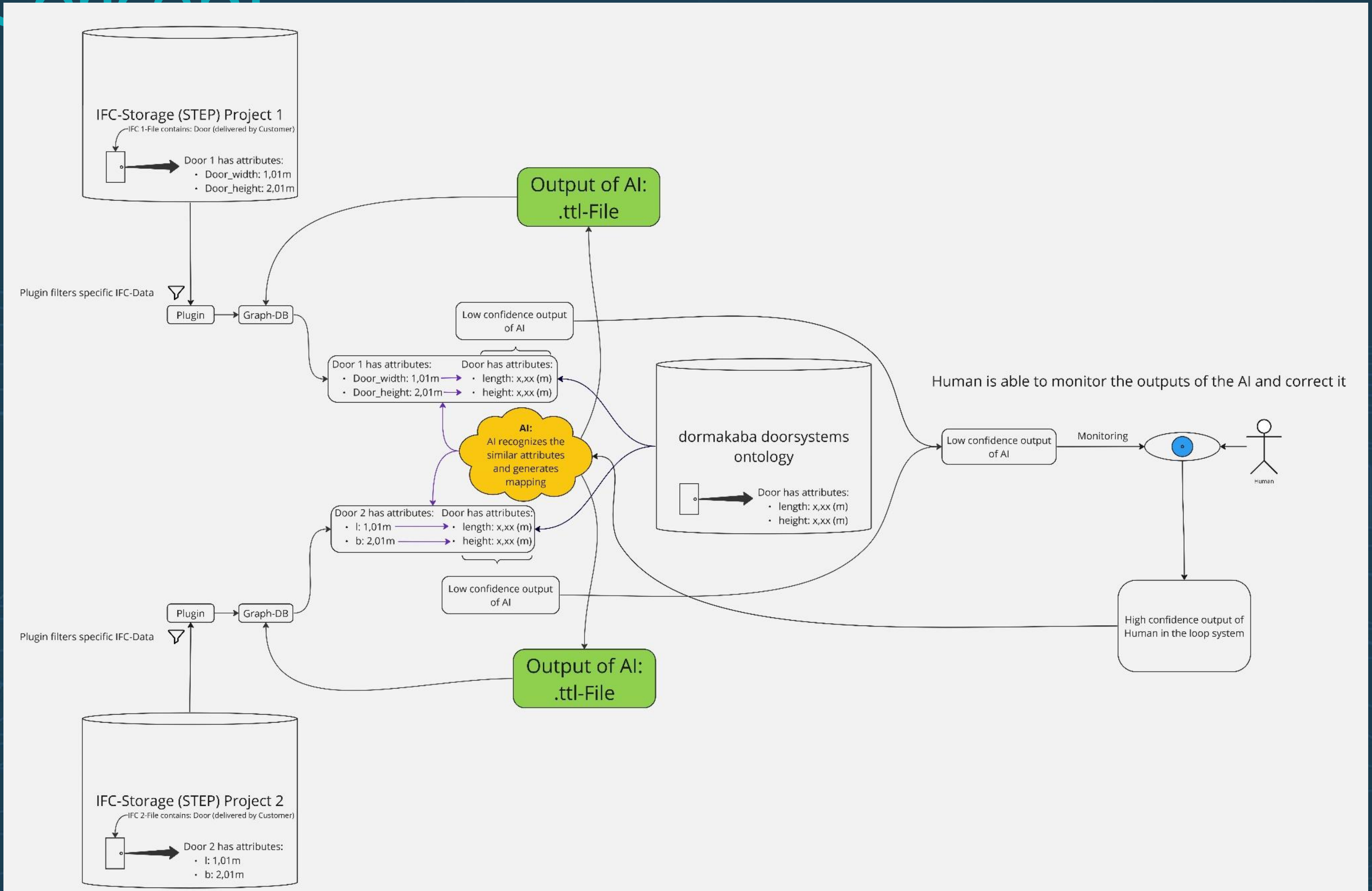
AI Concept


IFC-Storage (STEP) Project 1
IFC 1-File contains: Door (delivered by Customer)
Door 1 has attributes:
• Door_width: 1,01m
• Door_height: 2,01m
Output of AI:
.ttl-File
Plugin filters specific IFC-Data
Plugin
Graph-DB
Low confidence output of AI
Door 1 has attributes:
• Door_width: 1,01m
• Door_height: 2,01m
Door has attributes:
• length: x,xx (m)
• height: x,xx (m)
Human is able to monitor the outputs of the AI and correct it
AI:
AI recognizes the similar attributes and generates mapping
dormakaba doorsystems ontology
Door has attributes:
• length: x,xx (m)
• height: x,xx (m)
Low confidence output of AI
Monitoring
Human
Door 2 has attributes:
• l: 1,01m
• b: 2,01m
Door has attributes:
• length: x,xx (m)
• height: x,xx (m)
Low confidence output of AI
Plugin
Graph-DB
Plugin filters specific IFC-Data
High confidence output of Human in the loop system
Output of AI:
.ttl-File
IFC-Storage (STEP) Project 2
IFC 2-File contains: Door (delivered by Customer)
Door 2 has attributes:
• l: 1,01m
• b: 2,01m

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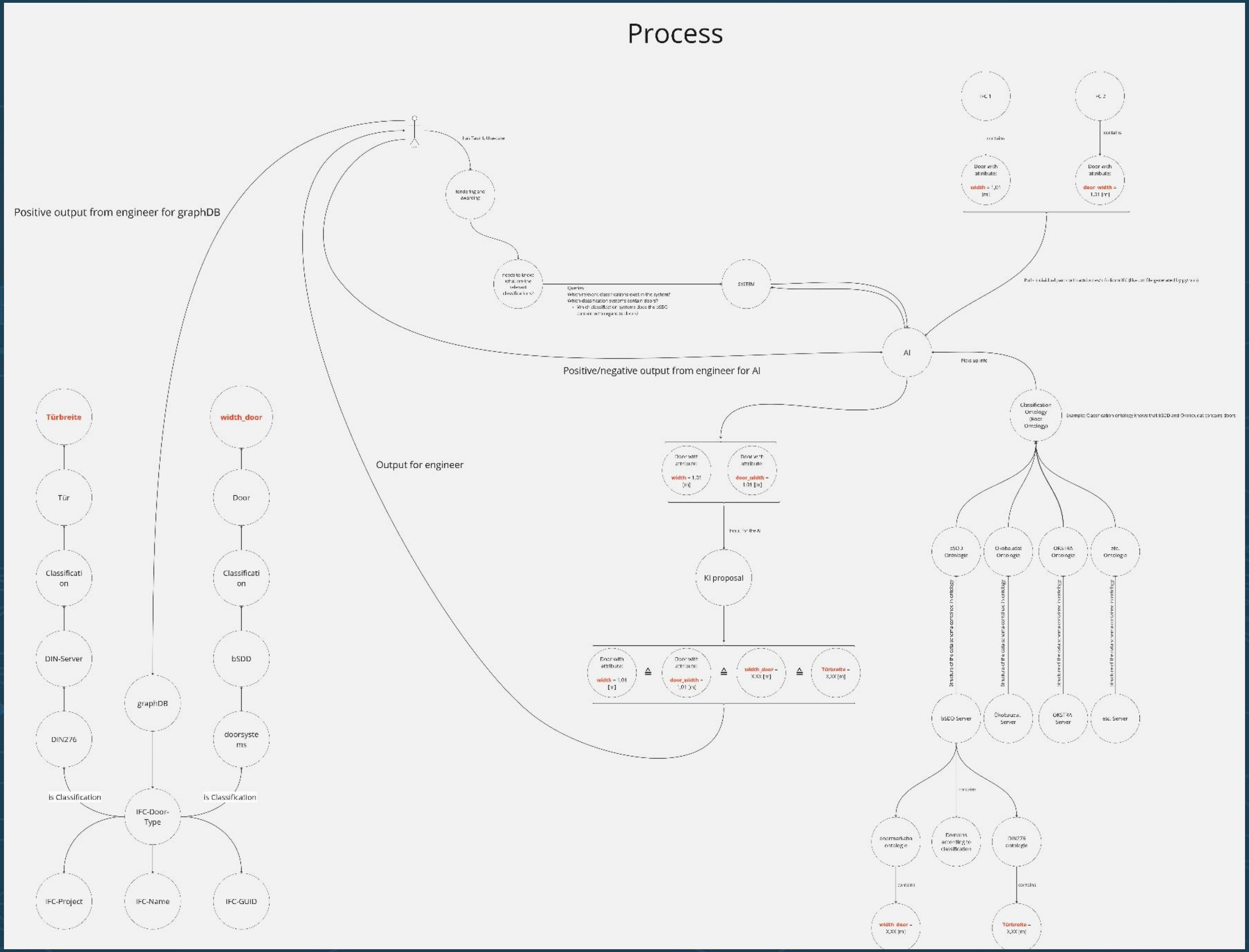
AI Concept


Process
Positive output from engineer for graphDB
Output for engineer
Positive/negative output from engineer for AI
Fin Task & Usecase
tendering and awarding
needs to know: what are the relevant classifications?
SYSTEM
AI
IFC 1
IFC 2
contains
contains
Door with attribute: width = 1,01 [m]
Door with attribute: door_width = 1,01 [m]
Pulls individual parts with attributes/info from IFC (like .txt file generated by python)
Picks up info
Classification Ontology (Root Ontology)
Door with attribute: width = 1,01 [m]
Door with attribute: door_width = 1,01 [m]
Input for the AI
KI proposal
Door with attribute: width = 1,01 [m]
≙
Door with attribute: door_width = 1,01 [m]
≙
width_door = X,XX [m]
≙
Türbreite = X,XX [m]
bSDD Ontologie
Ökobaudat Ontologie
OKSTRA Ontologie
etc. Ontologie
Structure of the data schema contained in ontology
Structure of the data schema contained in ontology
Structure of the data schema contained in ontology
Structure of the data schema contained in ontology
bSDD Server
Ökobaudat Server
OKSTRA Server
etc. Server
contains
doormarkaba ontologie
Domains according to classification
DIN276 ontologie
contains
contains
width_door = X,XX [m]
Türbreite = X,XX [m]
Türbreite
Tür
Classification
DIN-Server
DIN276
Is Classification
width_door
Door
Classification
bSDD
doorsystems
Is Classification
graphDB
IFC-Door-Type
IFC-Project
IFC-Name
IFC-GUID

Queries:
Which relevant classifications exist in the system?
Which classification systems contain doors?
- Which classification systems does the bSDD contain with regard to doors?

Example: Classification ontology knows that bSDD and Ökobaudat contains doors

- bsDD:

- Semantic BSDD: natural language querying, where LLM is used to generate GraphQL queries. I've recorded a video, but the demo is not productized: copy & paste from ChatGPT to GraphiQL query editor

- Using LLM for NLP tasks related to regulations: we did early experiments with LLM (eg "parse this regulation according to the RASE methodology")

- Automated classification or normalization: AFAIK, Petr Hradil and Markku Kiviniemi are looking for ways to match free-text descriptions of materials to data dictionaries like BSDD

- Product Data Templates

- Low hanging fruits

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