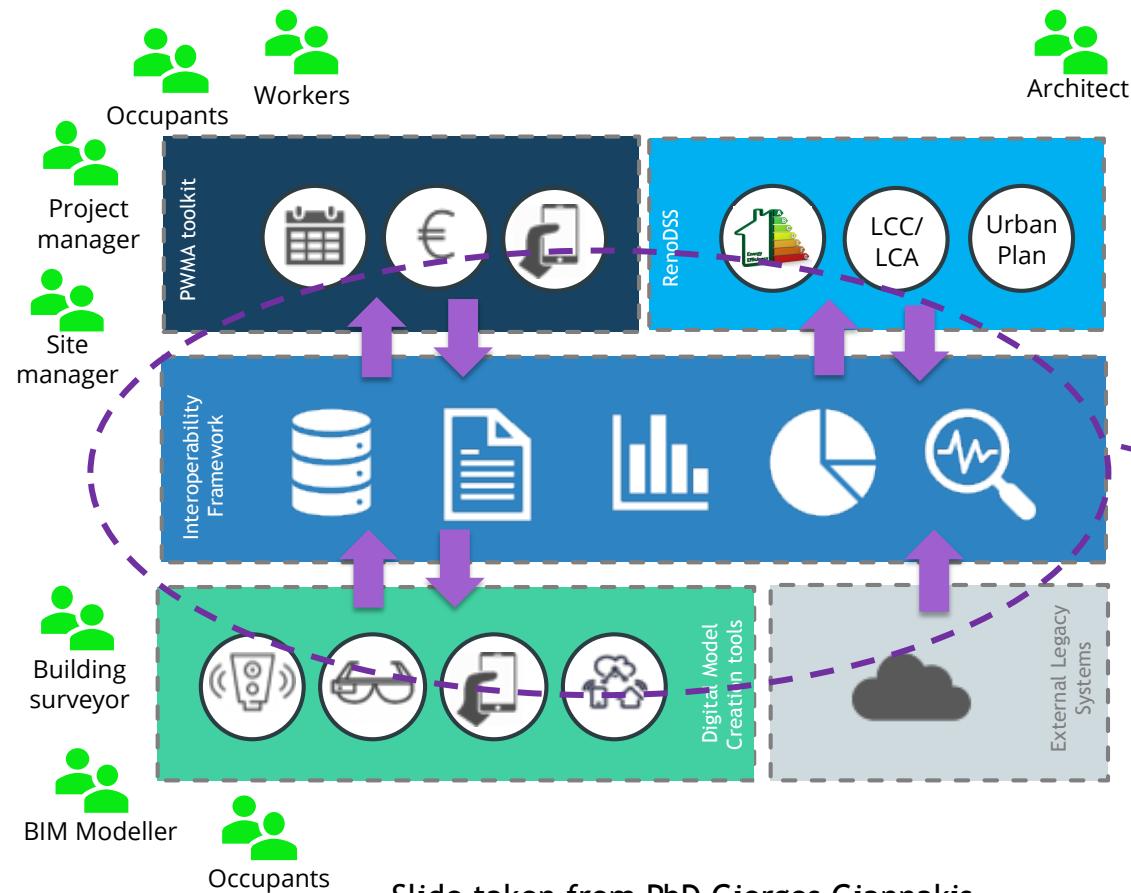


# BIMERR ontology network

**María Poveda Villalón, Serge Chávez Feria, Salvador González Gerpe**  
**Ontology Engineering Group**  
**Universidad Politécnica de Madrid, Spain**

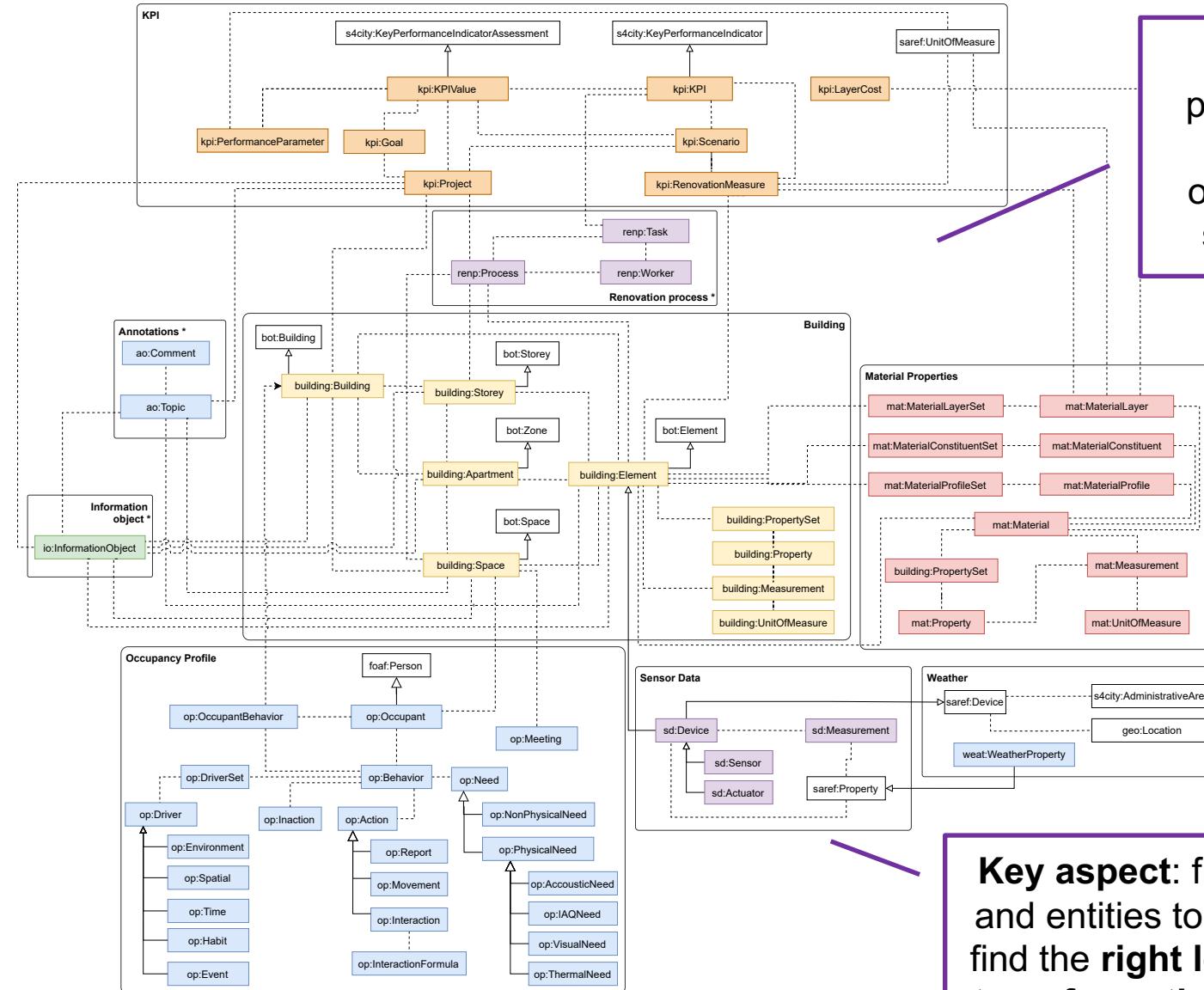


Slide taken from PhD Giorgos Giannakis

Need for interoperability  
between heterogeneous  
data formats, sources,  
schemas, etc. for data  
exchange.

**Solution:** \*/\$%&!

# BIMERR ontology network

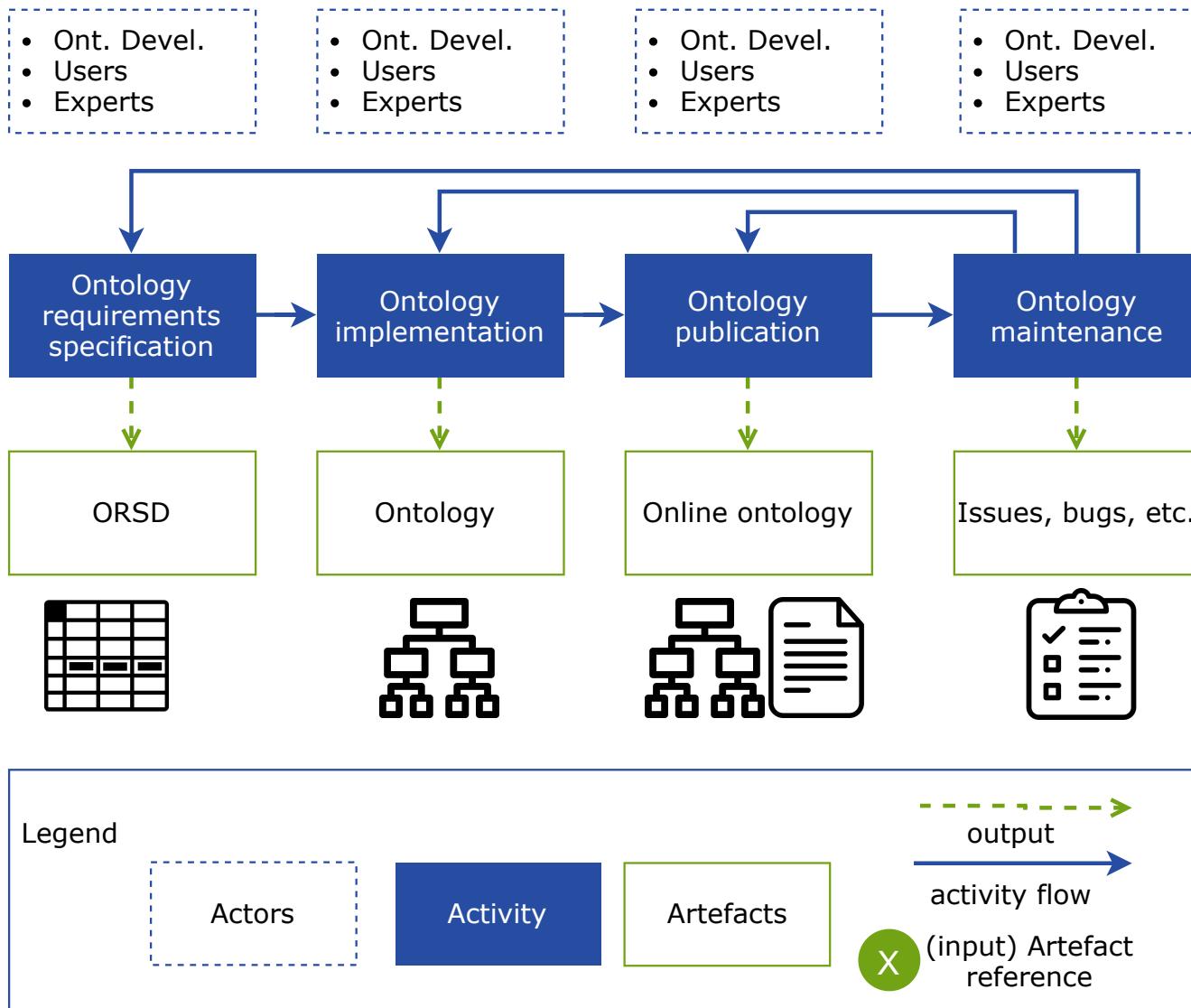


**Modular solution:** KPI, project, building, materials, annotations, information objects, occupancy profile, sensor data and weather

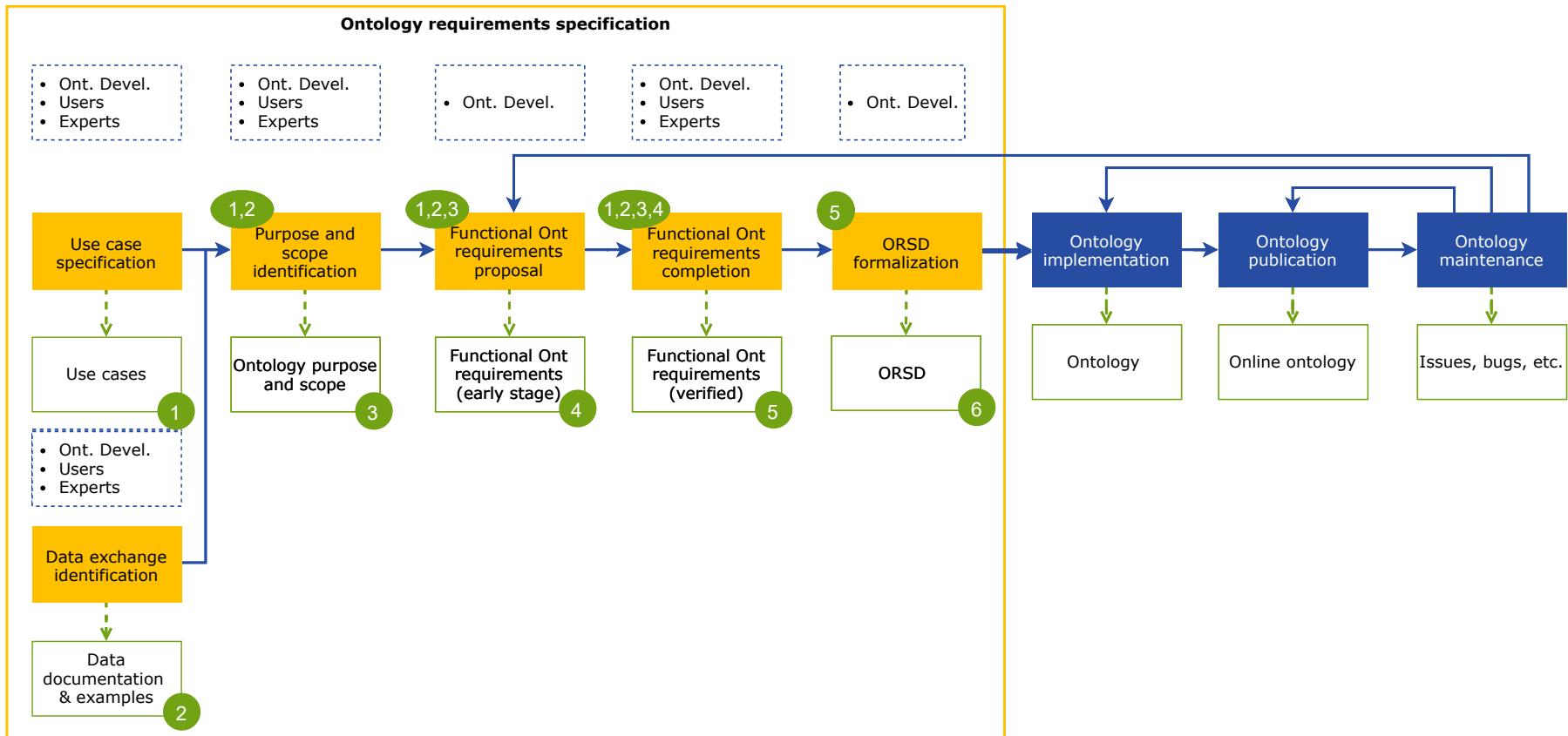
**Key aspect:** find common identifiers and entities to **link** different data and find the **right level of details** for data transformation in combination with original file storage

Ontologies available at <https://bimerr.iot.linkeddata.es/>

# Linked Open Terms Methodology



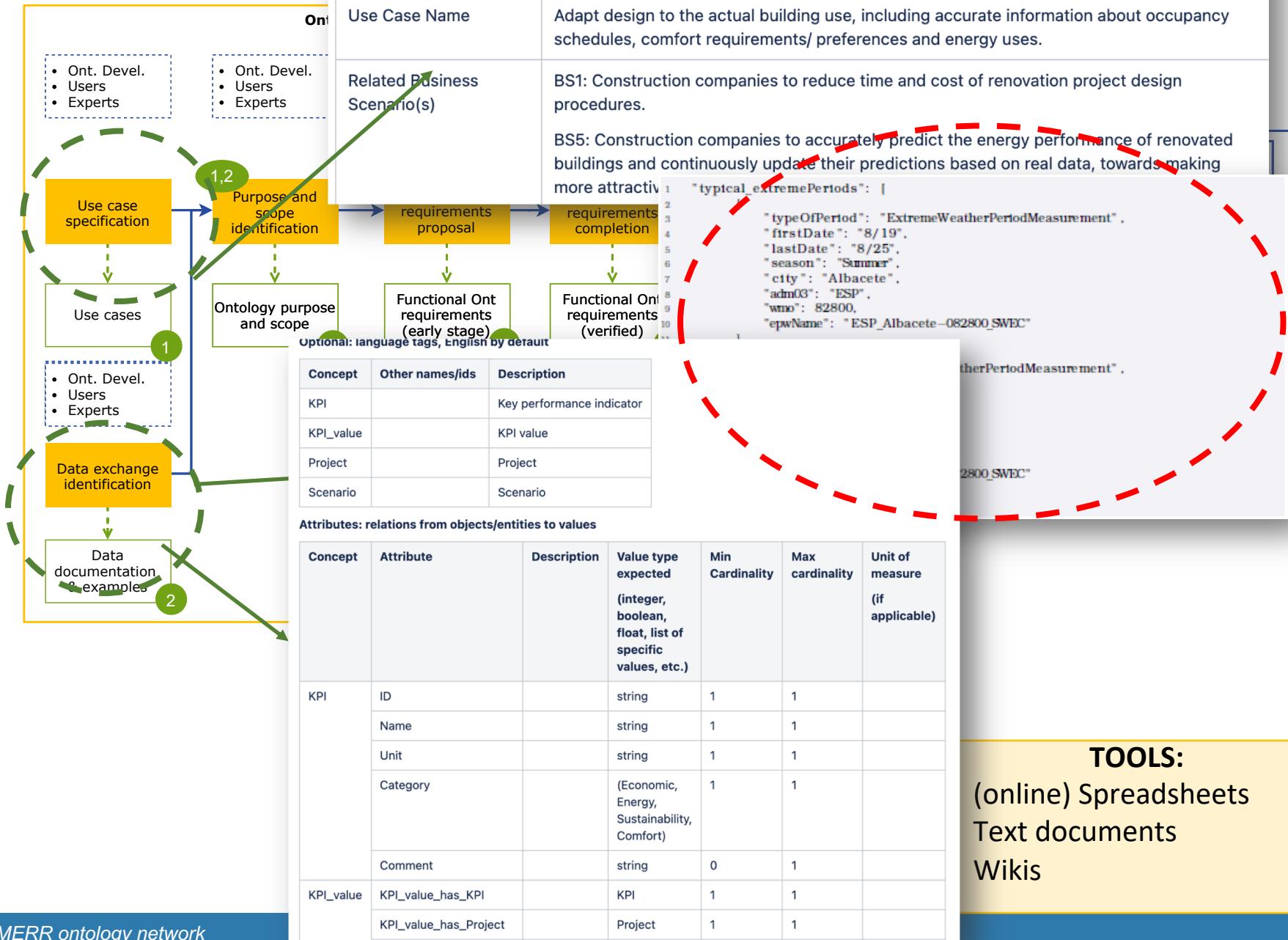
# Requirements specification



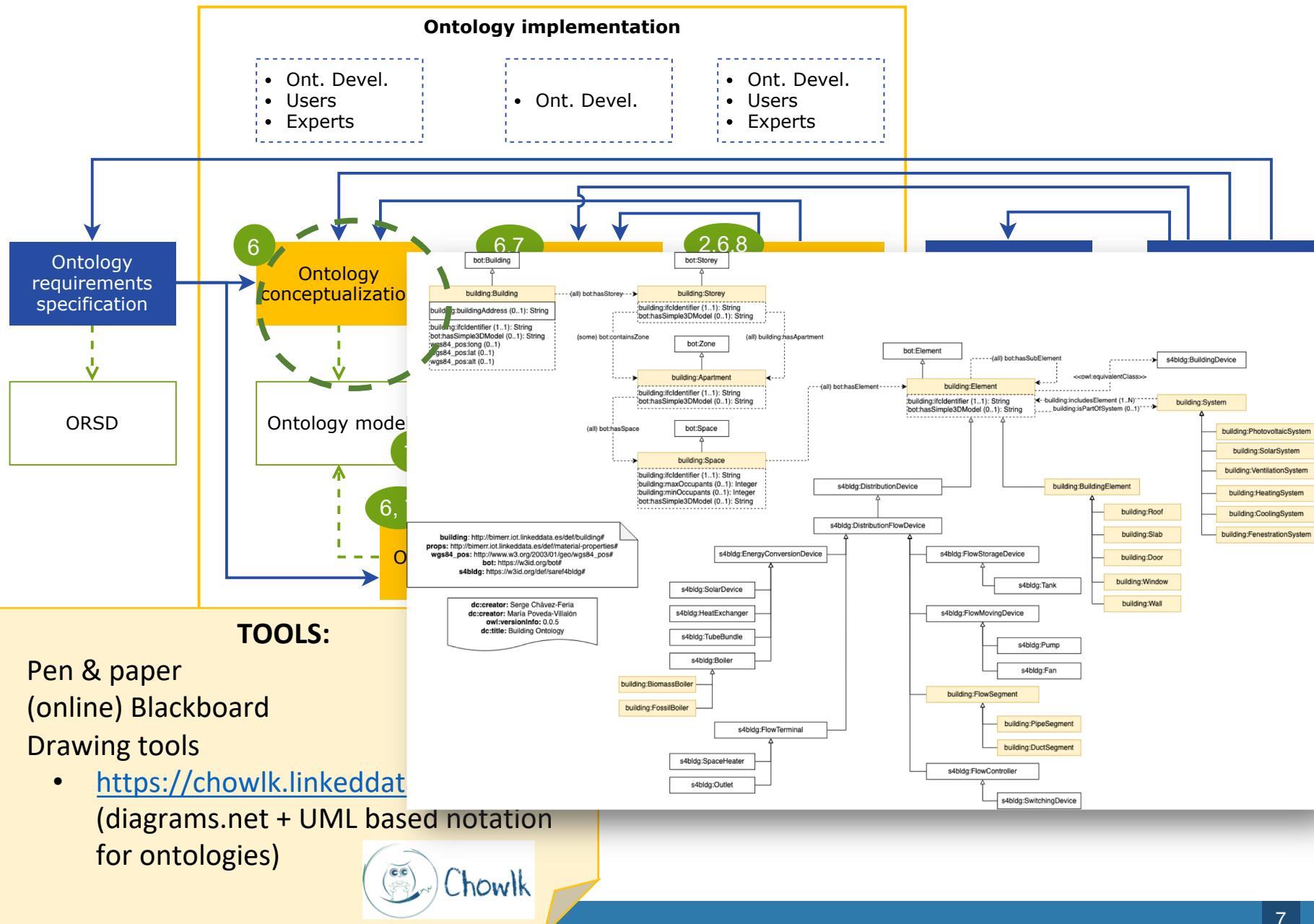
## TOOLS:

- (online) Spreadsheets
- Text documents
- Wikis

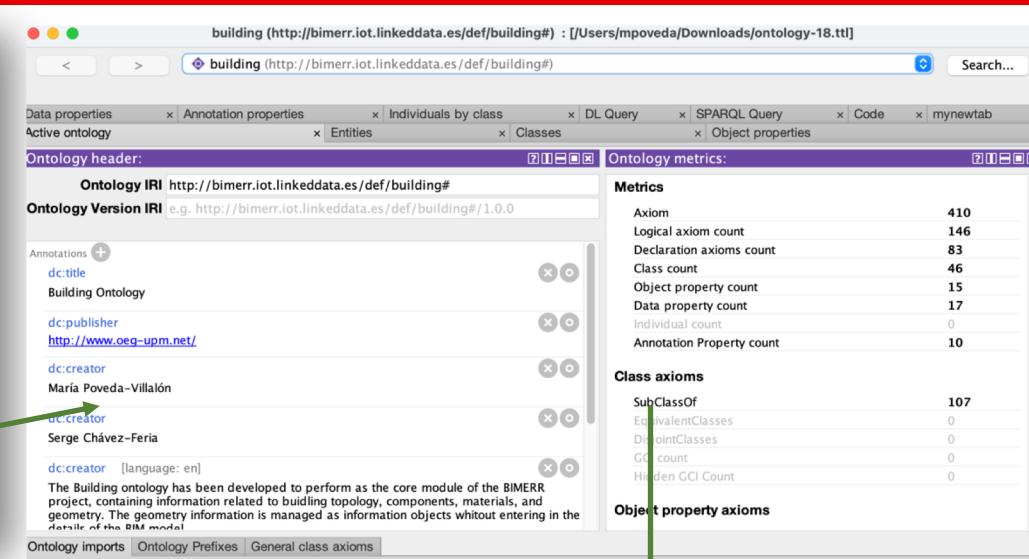
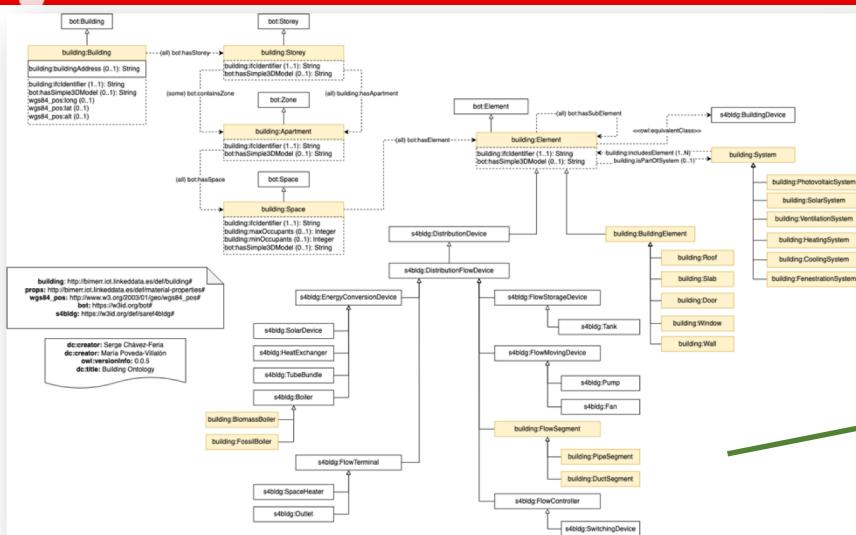
### BIMERR Use Case 3



# Implementation - Conceptualization



# Implementation - Encoding

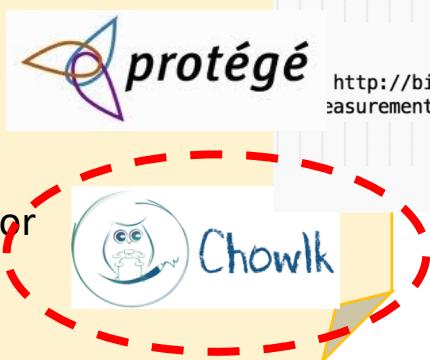


```
#####
# Object Properties
#####
### http://bimerr.iot.linkeddata.es/def/building#hasApartment
:hasApartment rdf:type owl:ObjectProperty ;
    rdfs:domain :Storey ;
    rdfs:range :Apartment ;
    rdfs:comment "Relation between a storey and the apartments it is composed of."@en ;
    rdfs:label "has apartment" .
```

```
http://bimerr.iot.linkeddata.es/def/building#isMeasurementOfElement
:measurementOfElement rdf:type owl:ObjectProperty ;
    rdfs:comment "Relates a measurement with an element of the building."@en ;
    rdfs:label "is measurement of element"@en .
```

## TOOLS:

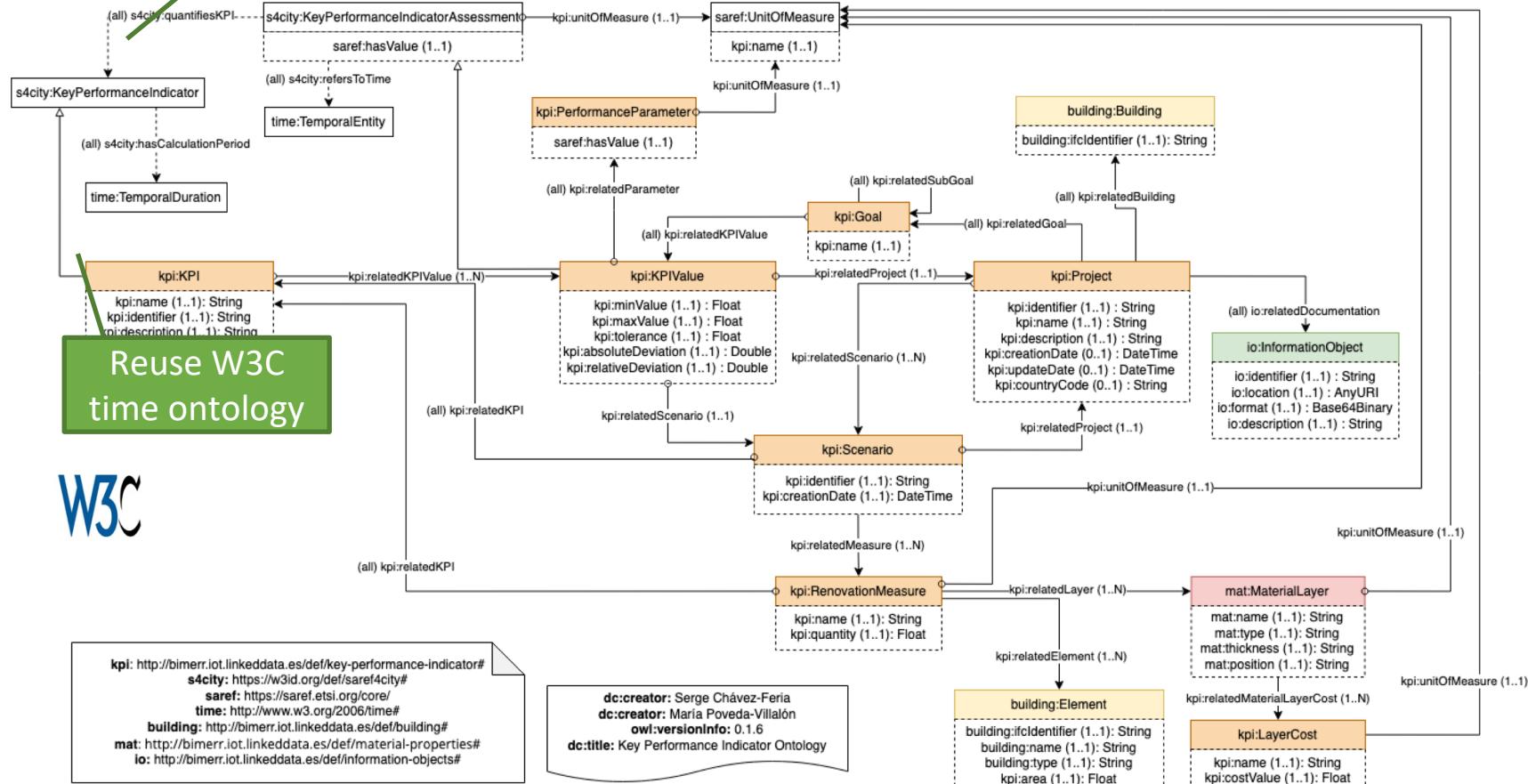
- Protégé
- Top Braid Composer
- Ad-hoc coding
- OpenRefine
- Chowlk + ontology editor
- Support: Git



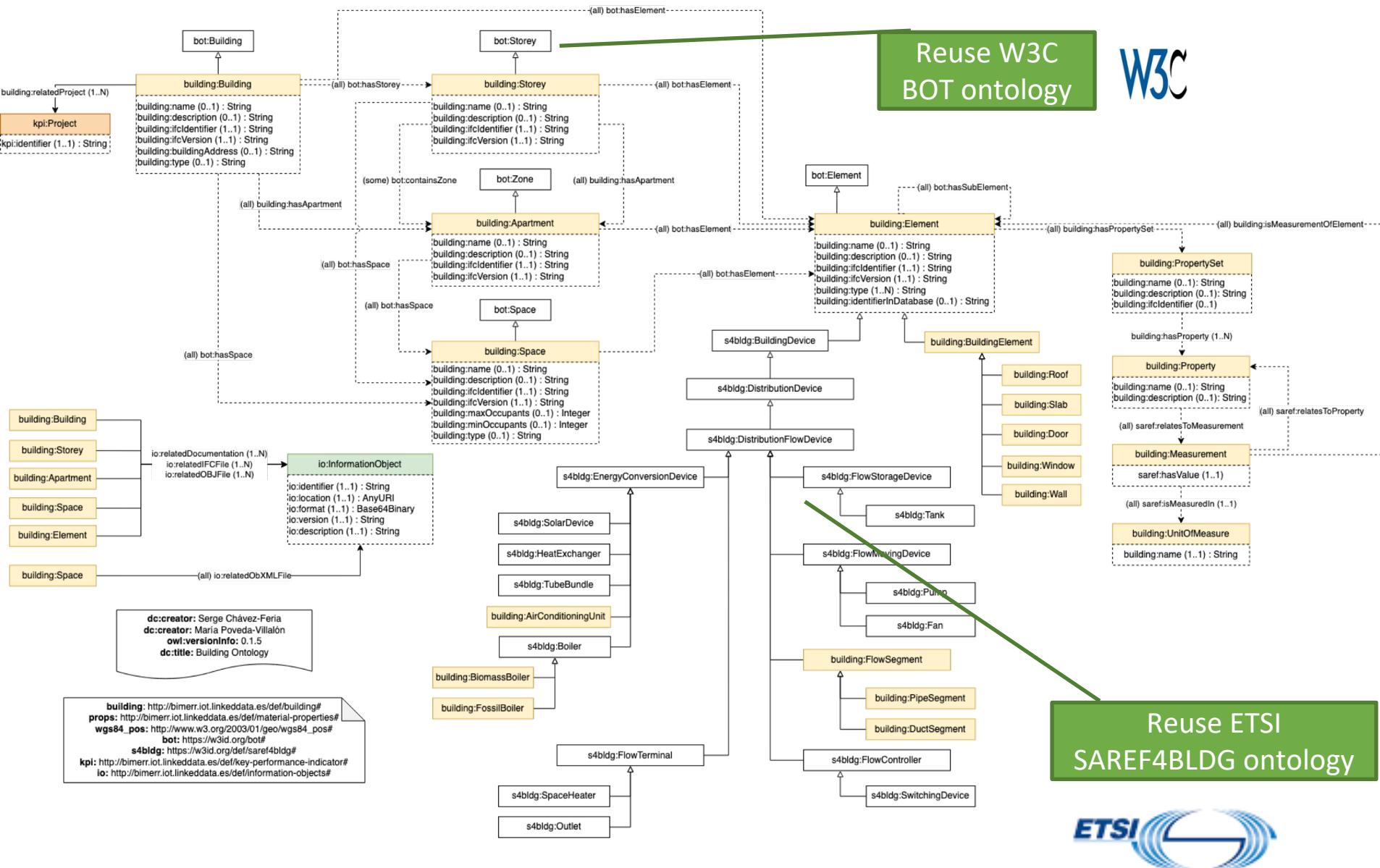
# Reuse existing ontologies



## Reuse ETSI SAREEF & SAREF4CITY ontology



# Reuse existing ontologies



# Transform existing standards

<!--  
An obXML case study based on 12 zones and 16 occupants

**Version History:**

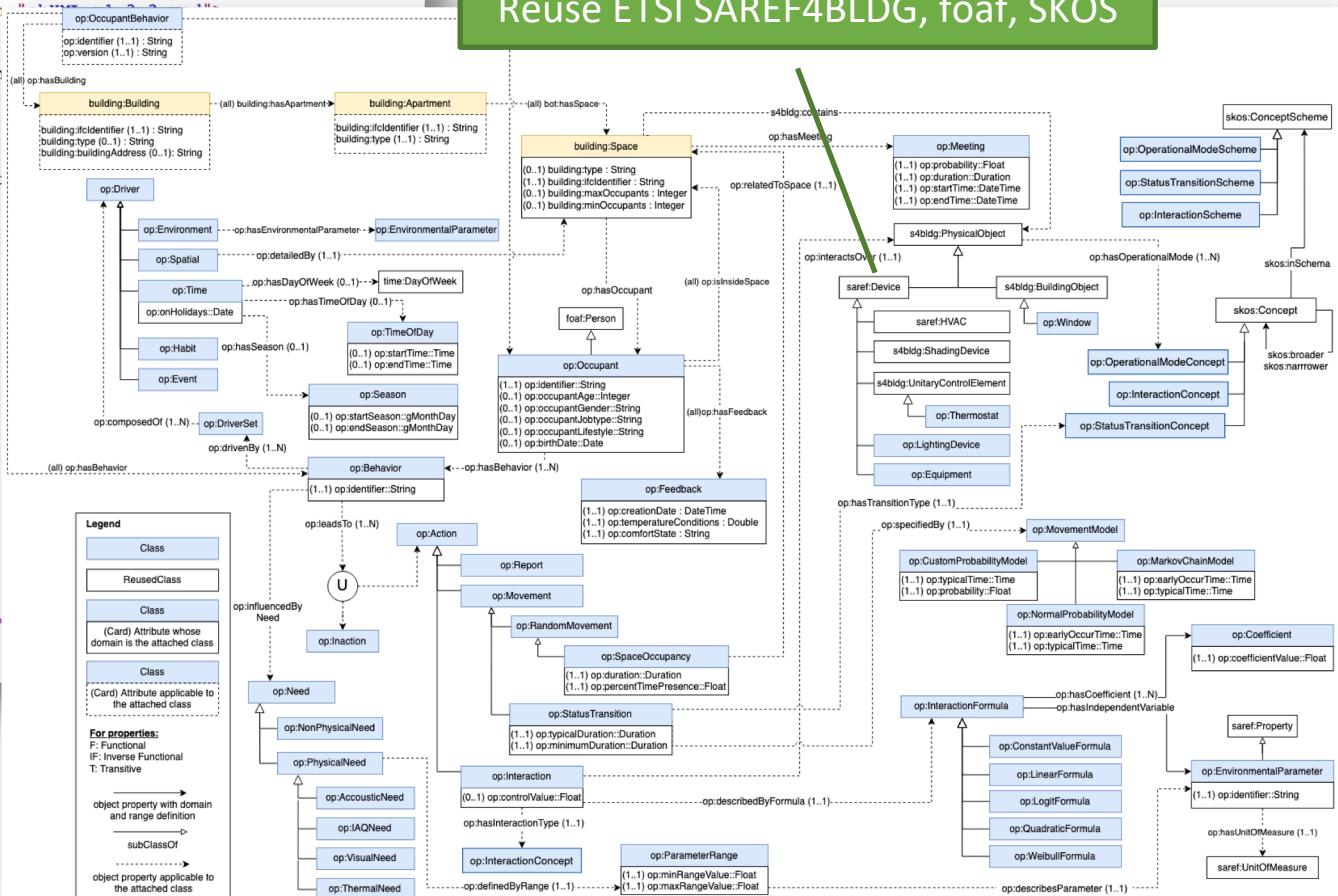
- 2016-07-28: Update to obXML version 1.2.1 for Occupancy Simulator paper
  - Update the space ID to match the layout diagram
  - Update the occupant ID to be readable
- 2016-09-07: Update to obXML version 1.3.2 for new obFMU
  - Update the meeting event element
  - Update the movement behavior element
- 2016-10-17: Update to obXML version 1.3.3 for special behaviors

**TODO:** Update the behaviors to use more real behaviors  
-->

```

<OccupantBehavior xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" ID="obXML"
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      <Address>Athens</Address>
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          <Description>Outdoor space</Description>
          <Type>Outdoor</Type>
        </Space>
        <Space ID="S1">
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        <Systems>
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          </HVAC>
          <Light ID="Light1">
            <Type>OnOff</Type>
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          <PlugLoad ID="PlugLoad1">
            <Type>ContinuousControl</Type>
          </PlugLoad>
          <Thermostat ID="Thermostat1">
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          <ShadeAndBlind ID="ShadeAndBlind1">
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    </op:Feedback>
  </OpBehavior>

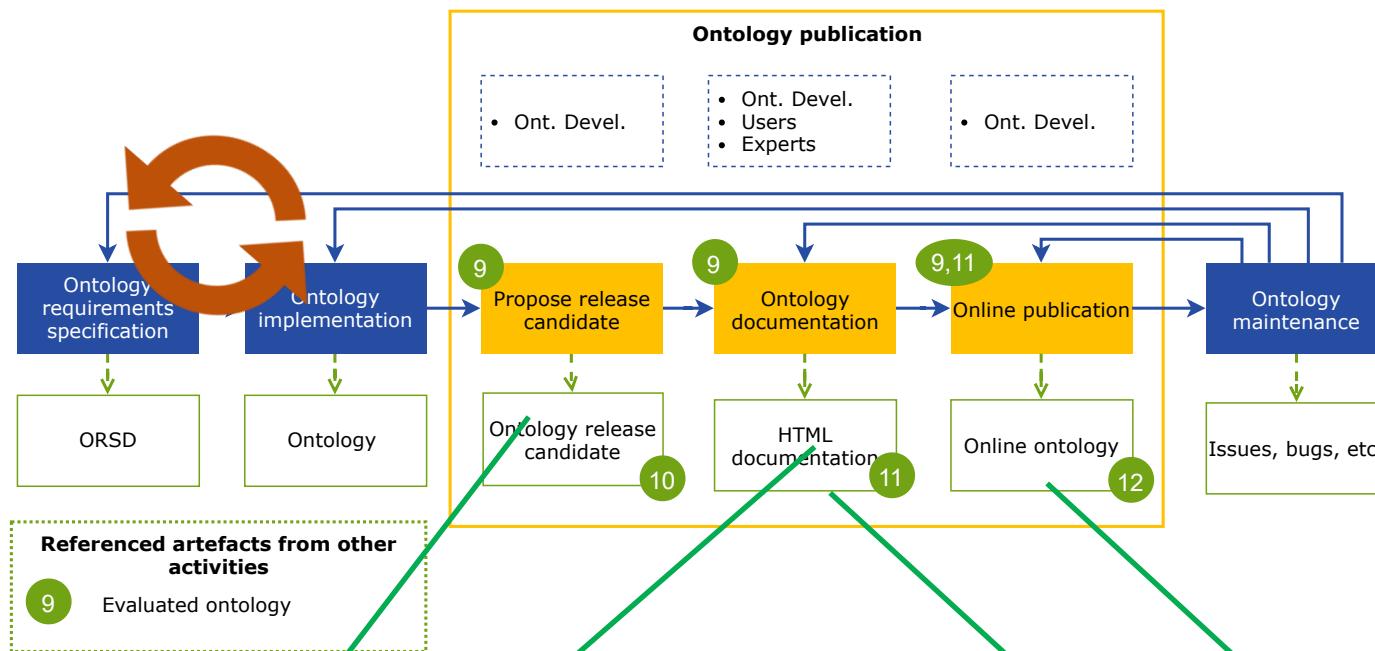
```



LDAC2020

<http://ceur-ws.org/Vol-2636/01paper.pdf>

# Ontology publication



+ Diagrams and examples (Some ideas:  
<https://arxiv.org/abs/2003.13084>)



<http://ontology.linkeddata.es/>



<https://lov.linkeddata.es>

<https://bimerr.iot.linkeddata.es/def/building>

Building ontology

Ontology URI: http://bimerr.iot.linkeddata.es/ontology/building

Version: 0.1.5

Author: Daniel Chávez Fernández (Ostegy Engineering Group, Universidad Politécnica de Madrid)

Publisher: Daniel Chávez Fernández (Ostegy Engineering Group, Universidad Politécnica de Madrid)

Documentation: http://bimerr.iot.linkeddata.es/def/building

Licenses: CC-BY-SA 4.0

Cite as: Chávez Fernández, Daniel. Building Ontology. v0.1.5. Povratiso, F. 2019.

Abstract

The Building ontology has been developed to perform as the core module of the BIMERR Ontology Network, containing information related to building topology and components. The model is constructed as an extension of the IOT ontology that provides the vocabulary to describe the topology of a building as well as the relationships between their main components such as rooms, spaces, and building elements. The taxonomy of building components is based on the proposed by the IFC 4.1 standard.

Table of contents

1. Introduction
2. Building Ontology: Overview
3. Building Ontology: Classes, properties and datatypes
4. Cross reference for Building Ontology classes, properties and dataproperties
5. References
6. Acknowledgments

1. Introduction

The purpose of the Building Ontology is to represent the main topological relationships that exists between entities in the building domain. Furthermore, the model aims to provide the most common semantics and properties directly involved in energy and the objects of buildings. This model works as the core module within the [BIMERR Ontology Network](#), where all other modules extend or reuse this one. This ontology is composed of three parts: a) Topological classes, b) General properties and c) Specific properties. The general properties are shared with the [SAINT-Building Ontology](#) to represent the main components and systems that directly impact the energy consumption of buildings and are susceptible to change in a future version of this ontology.

1.1. Namespace declarations

Table 1: Namespaces used in the document
building : http://bimerr.iot.linkeddata.es/ontology/building# airconditng : http://bimerr.iot.linkeddata.es/ontology/airconditioning# owl : http://www.w3.org/2002/07/owl# rdf : http://www.w3.org/1999/02/22-rdf-syntax-ns# rdfs : http://www.w3.org/2000/01/rdf-schema# dc : http://purl.org/dc/terms/ wgb4_poc : http://www.w3.org/2005/10/greg/agent_poc#

2. Building Ontology: Overview

This ontology has the following classes and properties.

Classes

Air conditioning unit	Apartment	Biomass Boiler	Boulder	Building	Building Element	Building Element Type	Distribution Device	Distribution Flow Device	Door	Door Sensor Device	Floor	Floor Sensor Device	Flow Terminal	Generator	Light	Power Source	Radiator	Window
-----------------------	-----------	----------------	---------	----------	------------------	-----------------------	---------------------	--------------------------	------	--------------------	-------	---------------------	---------------	-----------	-------	--------------	----------	--------

Object Properties

can have additional documentation	can have element	can have property set	can have related process	can have space	can have sub-element	is measurement of
-----------------------------------	------------------	-----------------------	--------------------------	----------------	----------------------	-------------------

Data Properties

attribute	building address	describes	has format	has value	identifier	in database	is identifier	is version	label	location	language
-----------	------------------	-----------	------------	-----------	------------	-------------	---------------	------------	-------	----------	----------

3. Building ontology: Description

Figure 1 presents an overview of the classes and the properties included in the Building ontology. The hierarchical elements included in the model are Air Conditioning Unit, Apartment, Biomass Boiler, Boulder, Building, Building Element, Building Element Type, Distribution Device, Distribution Flow Device, Door, Door Sensor Device, Floor, Floor Sensor Device, Flow Terminal, Generator, Light, Power Source, Radiator, Window. These elements have at least one property, which is the has property set relationship. The model builds around the root concept `Building`. This class is the super-class for Apartment, Biomass Boiler, Boulder, Building Element, Building Element Type, Distribution Device, Distribution Flow Device, Door, Door Sensor Device, Floor, Floor Sensor Device, Flow Terminal, Generator, Light, Power Source, Radiator, Window. In addition, there are several subclasses of `Building`: `AirConditioningUnit`, `Apartment`, `BiomassBoiler`, `Boulder`, `BuildingElement`, `BuildingElementType`, `DistributionDevice`, `DistributionFlowDevice`, `Door`, `DoorSensorDevice`, `Floor`, `FloorSensorDevice`, `FlowTerminal`, `Generator`, `Light`, `PowerSource`, `Radiator`, `Window`. The `Building` class has several properties: `can have additional documentation`, `can have element`, `can have property set`, `can have related process`, `can have space`, `can have sub-element`, `is measurement of`. These properties are used to represent the relationships between the different elements in the ontology. For example, the `can have additional documentation` property is used to represent the fact that an apartment can have an additional documentation file. The `can have element` property is used to represent the fact that a building can have elements such as doors, windows, radiators, etc. The `can have property set` property is used to represent the fact that a building can have a set of properties associated with it. The `can have related process` property is used to represent the fact that a building can have related processes such as maintenance, cleaning, etc. The `can have space` property is used to represent the fact that a building can have spaces such as rooms, floors, etc. The `can have sub-element` property is used to represent the fact that a building can have sub-elements such as door sensor devices, floor sensor devices, flow terminals, etc. The `is measurement of` property is used to represent the fact that a building is a measurement of something. For example, a building can be a measurement of energy consumption, water usage, etc. In addition, there are several data properties: `attribute`, `building address`, `describes`, `has format`, `has value`, `identifier`, `in database`, `is identifier`, `is version`, `label`, `location`, `language`. These properties are used to represent the metadata of the ontology. For example, the `building address` property is used to represent the address of the building, the `describes` property is used to represent the description of the building, the `has format` property is used to represent the format of the data, the `has value` property is used to represent the value of the data, the `identifier` property is used to represent the identifier of the data, the `in database` property is used to represent the fact that the data is stored in a database, the `is identifier` property is used to represent the fact that the data is an identifier, the `is version` property is used to represent the fact that the data is a version, the `label` property is used to represent the label of the data, the `location` property is used to represent the location of the data, and the `language` property is used to represent the language of the data. Additionally, there are several annotations: `NOTE:` For more details about the visual notation used in this diagram, see [Check Visual Notation](#).

4. Cross reference for Building Ontology classes, properties and dataproperties

This section provides details for each class and property defined by Building Ontology.

4.1. Classes

Air conditioning unit	Apartment	Biomass Boiler	Boulder	Building	Building Element	Building Element Type	Distribution Device	Distribution Flow Device	Door	Door Sensor Device	Floor	Floor Sensor Device	Flow Terminal	Generator	Light	Power Source	Radiator	Window
-----------------------	-----------	----------------	---------	----------	------------------	-----------------------	---------------------	--------------------------	------	--------------------	-------	---------------------	---------------	-----------	-------	--------------	----------	--------

Air conditioning unit

NOTE: For more details about the visual notation used in this diagram, see [Check Visual Notation](#)

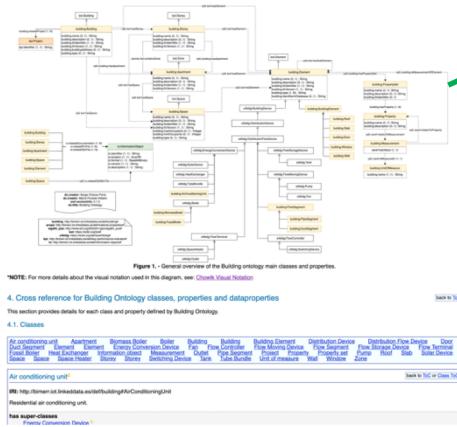
Metadata  
Different RDF serialization  
Content Negotiation

Abstract

Ontology concepts  
summary

Ontology description  
text & diagram

Concepts and relations  
details



# BIMERR Ontology network portal

Ontologies Enriched Ontologies Ontology testing



Here you can find the list of ontologies developed for BIMERR project  
If you want to contribute developing ontologies please follow the [guidelines](#) we provide

Ontology online documentation

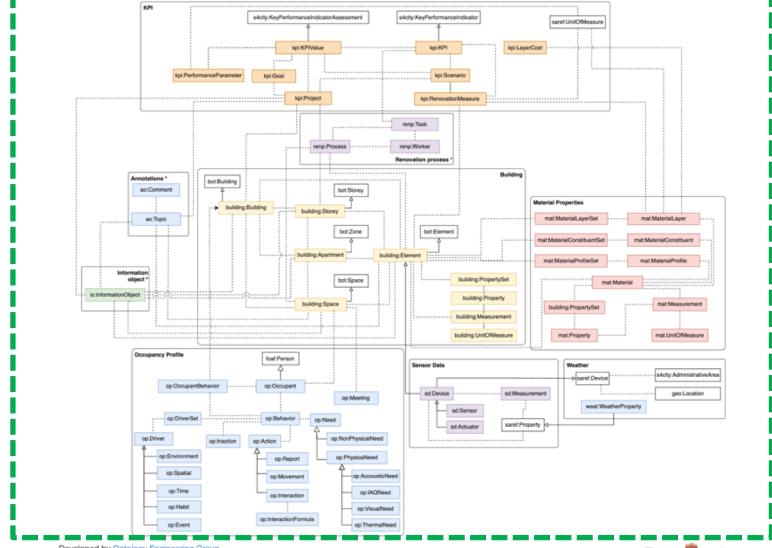
Ontology	Description	Repository	Issue tracker	Releases
Occupancy Profile Ontology	This ontology aims to model occupancy behavior inside buildings for the BIMERR project	occupancy profile ontology	occupancy profile issues	ontology releases
Sensor Data Ontology	This ontology aims to model data from sensors located inside buildings for the BIMERR project	sensor data ontology	sensor data issues	ontology releases
Key Performance Indicator Ontology	This ontology aims to model Key Performance Indicator information related to building innovation works for the BIMERR project	KPI ontology	KPI issues	ontology releases
Weather Ontology	This ontology aims to model weather data for the BIMERR project	weather ontology	weather issues	ontology releases
Building Ontology	This ontology aims to model building data for the BIMERR project	building ontology	building issues	ontology releases
Material Properties Ontology	This ontology aims to model the properties needed to describe building elements for the BIMERR project	material properties ontology	material properties issues	ontology releases
Annotation Objects Ontology	This ontology aims to model the annotations and extra information attached to building elements.	annotation objects ontology	annotation objects issues	ontology releases
Information Objects Ontology	This ontology aims to model the files and documents attached to building elements.	information objects ontology	information objects issues	ontology releases
Renovation Process Ontology	This ontology aims to model the construction processes in a building renovation project	renovation process ontology	renovation process issues	ontology releases
Metadata Ontology	This ontology defines annotation properties to support the ontology to data model transformation.	metadata ontology	metadata issues	ontology releases

GitHub Repository

Issue tracker

Releases

Network summary

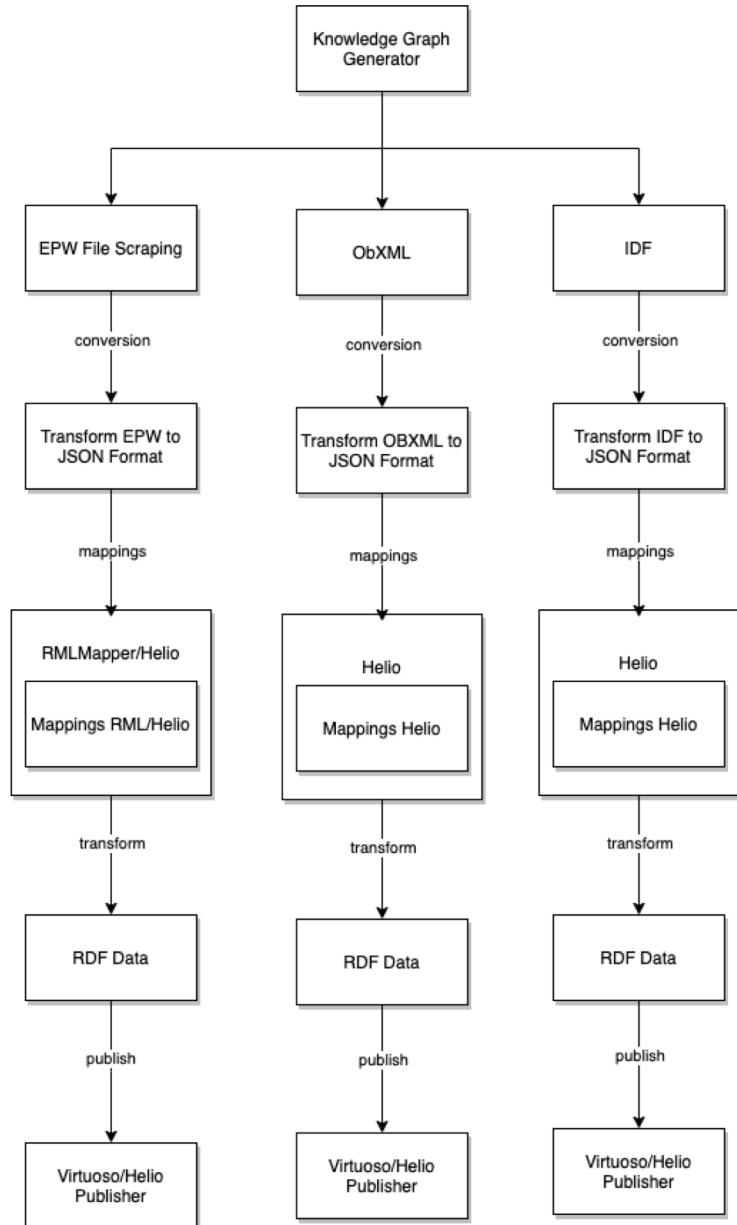


<https://bimerr.iot.linkeddata.es/>

Developed by Ontology Engineering Group  
Built with reasoning layer from Glypticons  
Latest revision July, 2020  
© Ontology Engineering Group



- Transformation to custom json model
  - But we also made an ontology for that ☺
- RML mappings for epw, IDF and obXML





- Ontology network **online** (portal + 9 modules)
  - W3C Best practices for publication
- **Open** approach on GitHub repositories
- **Reuse** of existing standard ontologies and formats
- **Chowlk**: ontology generator from conceptualizations
- RML mappings for epw, IDF and obXML
- Challenge: right level of detail?

- In data driven developments first set of requirements (from use cases/documents) are mostly illustrative
- Communication with data producers-consumers is key
- Agile reactions to change
- Identify your early adopters
- Needs better ways to communicate ontologies

Based on Annex 66 +  
obXML transformation  
to json + mappings



Here you can find the list of ontologies developed for BIMERR project

If you want to contribute developing ontologies please follow the [guidelines](#) we provide

Ontology	Description	Repository	Issue tracker	Releases
Occupancy Profile Ontology	This ontology aims to model occupants behavior inside buildings for the BIMERR project	<a href="#">occupancy profile ontology</a>	<a href="#">occupancy profile issues</a>	<a href="#">ontology releases</a>
Sensor Data Ontology	This ontology aims to model data from sensors located inside buildings for the BIMERR project	<a href="#">sensor data ontology</a>	<a href="#">sensor data issues</a>	<a href="#">ontology releases</a>
Key Performance Indicator Ontology	This ontology aims to model Key Performance Indicator information related to building renovation works for the BIMERR project	<a href="#">KPI ontology</a>	<a href="#">KPI issues</a>	<a href="#">ontology releases</a>
Weather Ontology	This ontology aims to model weather data for the BIMERR project	<a href="#">weather ontology</a>	<a href="#">weather issues</a>	<a href="#">ontology releases</a>
Building Ontology	This ontology aims to model building data for the BIMERR project	<a href="#">building ontology</a>	<a href="#">building issues</a>	<a href="#">ontology releases</a>
Material Properties Ontology	This ontology aims to model the properties needed to describe building elements for the BIMERR project	<a href="#">material properties ontology</a>	<a href="#">material properties issues</a>	<a href="#">ontology releases</a>
Annotation Objects Ontology	This ontology aims to model annotations and extra elements.			<a href="#">ontology releases</a>
Information Objects Ontology	This ontology aims to model documents and other objects.			<a href="#">ontology releases</a>
Renovation Process Ontology	This ontology aims to model renovation processes.			<a href="#">ontology releases</a>
Metadata Ontology	This ontology aims to support the ontology to data model transformation.			<a href="#">ontology releases</a>

Plan: to review  
SAREF4BLDG aligning  
with SSN/SOSA

IDF transformation to json + mappings

Would be a dataset useful for the community?

# Thanks for your attention!



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[mariapoveda](#)



[MariaPovedaVillalon](#)