BEMSERVER ONTOLOGY

ONTOLOGY FOR A BUILDING ENERGY MANAGEMENT PLATFORM

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NOBATEK/INEF4

BRIEF PRESENTATION

Private institute for the energy and environmental transition in the construction industry

Founded in 2004

4 offices :
Anglet - Bordeaux - Rennes - Paris

Main activities

Green construction

Energy Efficiency

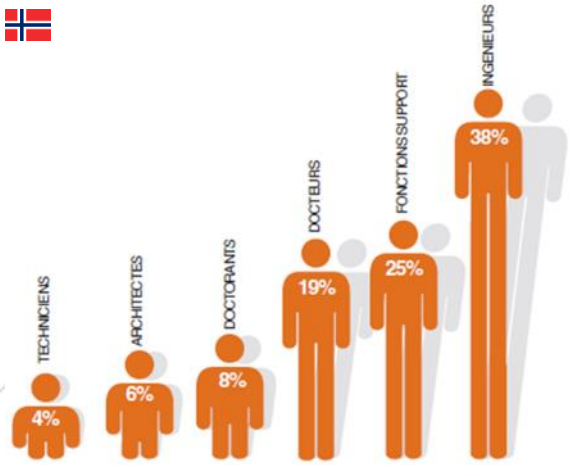
NOBATEK/INEF4

BRIEF PRESENTATION

60 employees

8 nationalities

10 spoken languages



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RESEARCH PROJECTS INVOLVING ONTOLOGIES

hit2gap

H2020 Project (2015 – 2019): http://www.hit2gap.eu/

Reduce energy Performance gap of the building

BEMOnt ontology

BIM4Ren

H2020 Project (2018 – 2022): http://bim4ren.eu/

BIM-based tools for fast and efficient renovation

B4R ontologies

MASSDOC

Thesis project (2015 – 2018)

Semantic Representation of a heterogeneous document corpus

LinkedMDR ontology

DATAVIEW

National research project (2019 – 2020)

Semantic Reasoning for urban and environmental assessments

DVO ontology

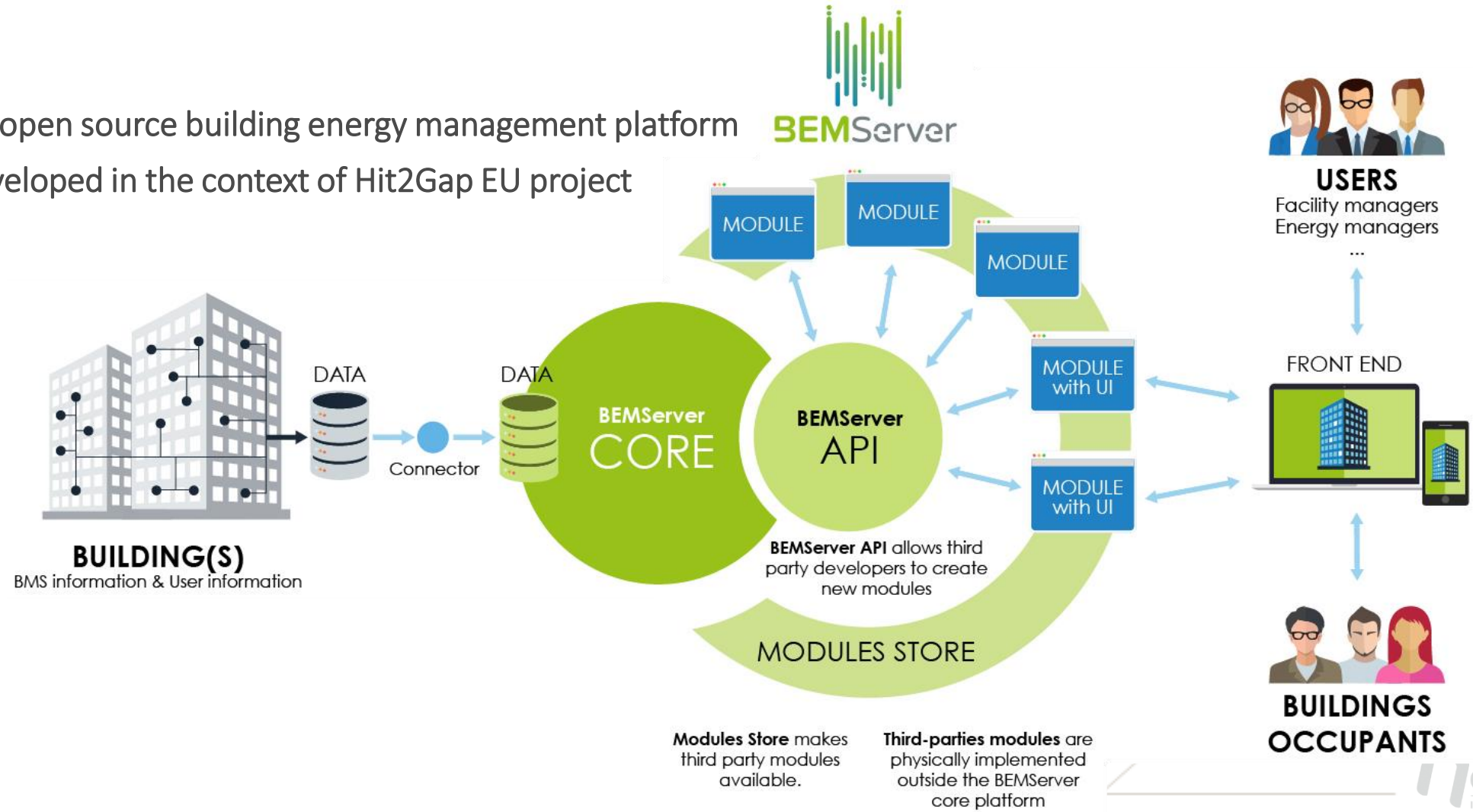
OUTLINE

- BEMSERVER
  - CONTEXT
  - BEMONT ONTOLOGY
  - MOTIVATIONS
- METHODOLOGY
  - COMPETENCY QUESTIONS
  - IDENTIFICATION OF THE DIFFERENT LAYERS/MODULES
  - REVIEW OF EXISTING ONTOLOGIES
- PROPOSED ONTOLOGY
  - OVERVIEW
  - PRESENTATION OF THE DIFFERENT LAYERS
  - ALIGNMENTS
- FUTURE WORK

BEMSERVER

CONTEXT

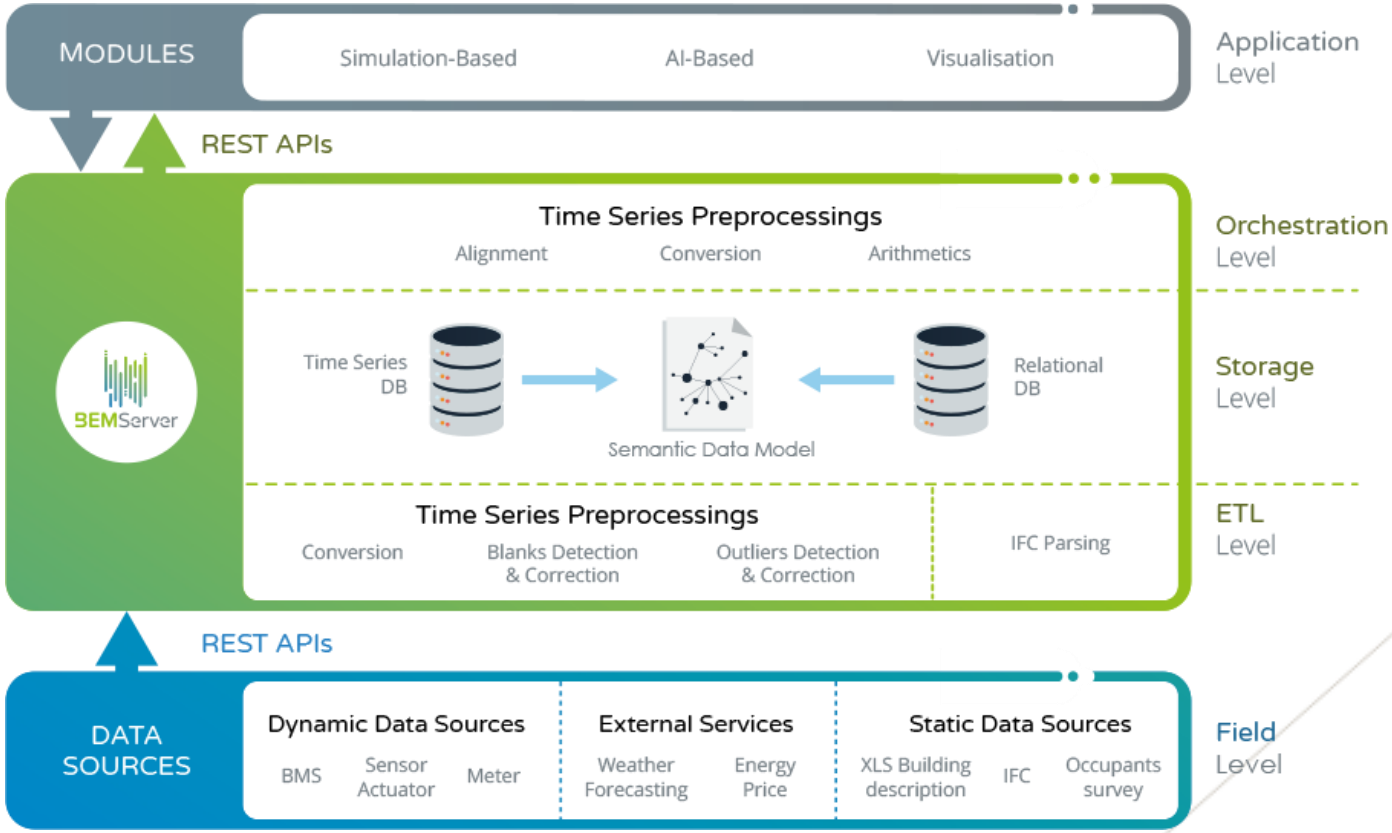
An open source building energy management platform developed in the context of Hit2Gap EU project



BEMSERVER

CONTEXT

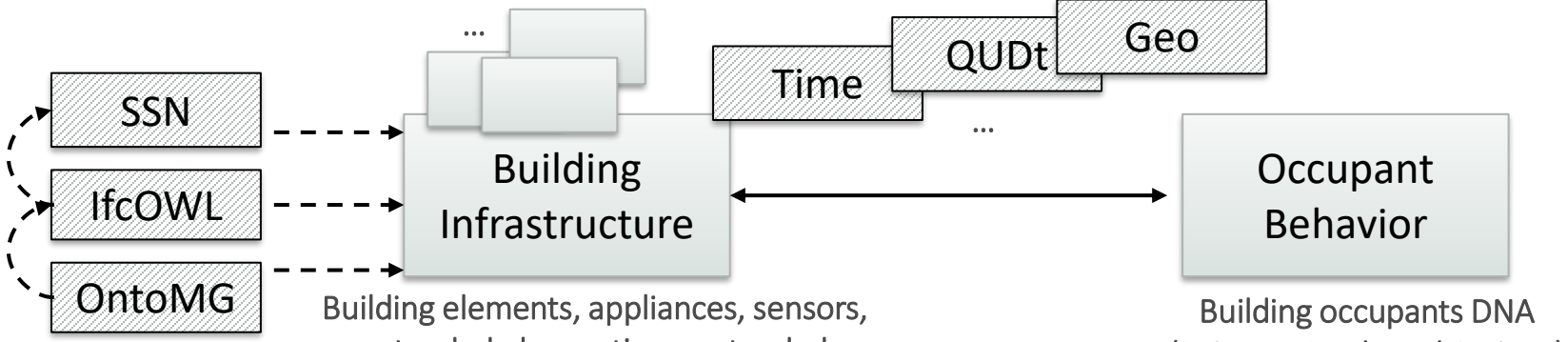
Architecture



BEMSERVER

BEMONT ONTOLOGY

BEMOnt*: the ontology behind BEMServer



- Complexity
- Extensibility
- Querying
- Overlaps with commonly used LBD ontologies

https://github.com/HIT2GAP-EU-PROJECT/BEMOnt

* Chbeir R. et al. (2019) OntoH2G: A Semantic Model to Represent Building Infrastructure and Occupant Interactions. In: Kaparaju P., Howlett R., Littlewood J., Ekanyake C., Vlacic L. (eds) Sustainability in Energy and Buildings 2018. KES-SEB 2018. Smart Innovation, Systems and Technologies, vol 131. Springer, Cham

BEMSERVER

MOTIVATIONS

Need to refactor existing BEMOnt ontology

Modularity

Easy Querying

Extensibility

SAREF

SAREF4BLDG

SEAS

BOT

BuildingElements

…

DistributionElements

Use of standardized and commonly used ontologies

METHODOLOGY

COMPETENCY QUESTIONS

Almost 50 Competency Questions expressed by Nobatek experts in the field of building monitoring and energy performance

- What is the topology of the building (commercial, residential, etc.)?
- What does the given sensor measure?
- What are the observations that we have on a given element (ex., boiler, refrigerator, radiator, etc.)?
- What are the observations that we have on a given system (heating, cooling, lighting, etc.)?
- Is a given system controlled remotely? Through which actuators?
- What data is measured by a given sensor over a given period?
- What is the price of the energy used to heat a given building?
- Is there any data provided by external services? What are their characteristics?
- What is the number of occupants in a given building?
- …

METHODOLOGY

IDENTIFICATION OF THE DIFFERENT LAYERS/MODULES

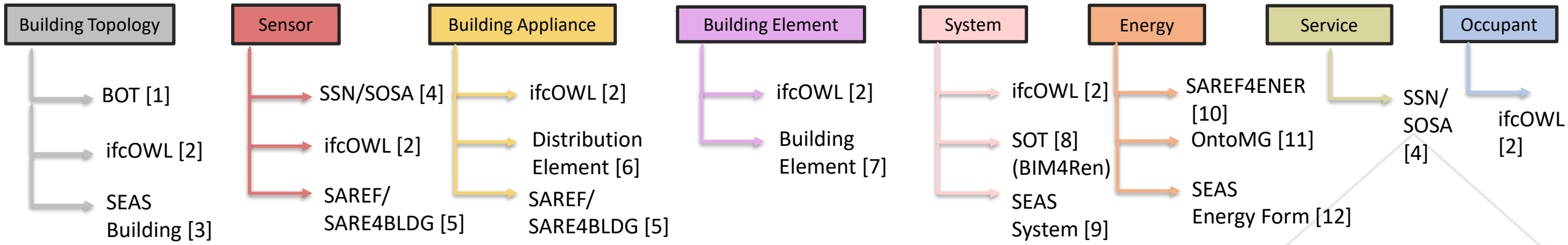
Target layers/modules

- What is the topology of the building (commercial, residential, etc.)? Building Topology
- What does the given sensor measure? Sensor
- What are the observations that we have on a given element (ex., boiler, refrigerator, zone, etc.)? Building Element / Building Appliance
- What are the observations that we have on a given system (heating, cooling, lighting, etc.)? Sensor System
- Is a given system controlled remotely? Through which actuators? System Building Appliance Sensor
- What data is measured by a given sensor over a given period? Sensor
- What is the price of the energy used to heat a given building? Energy Building Topology
- Is there any data provided by external services? What are their characteristics? Service
- What is the number of occupants in a given building? Occupant Building Topology
- …

METHODOLOGY

REVIEW OF EXISTING ONTOLOGIES

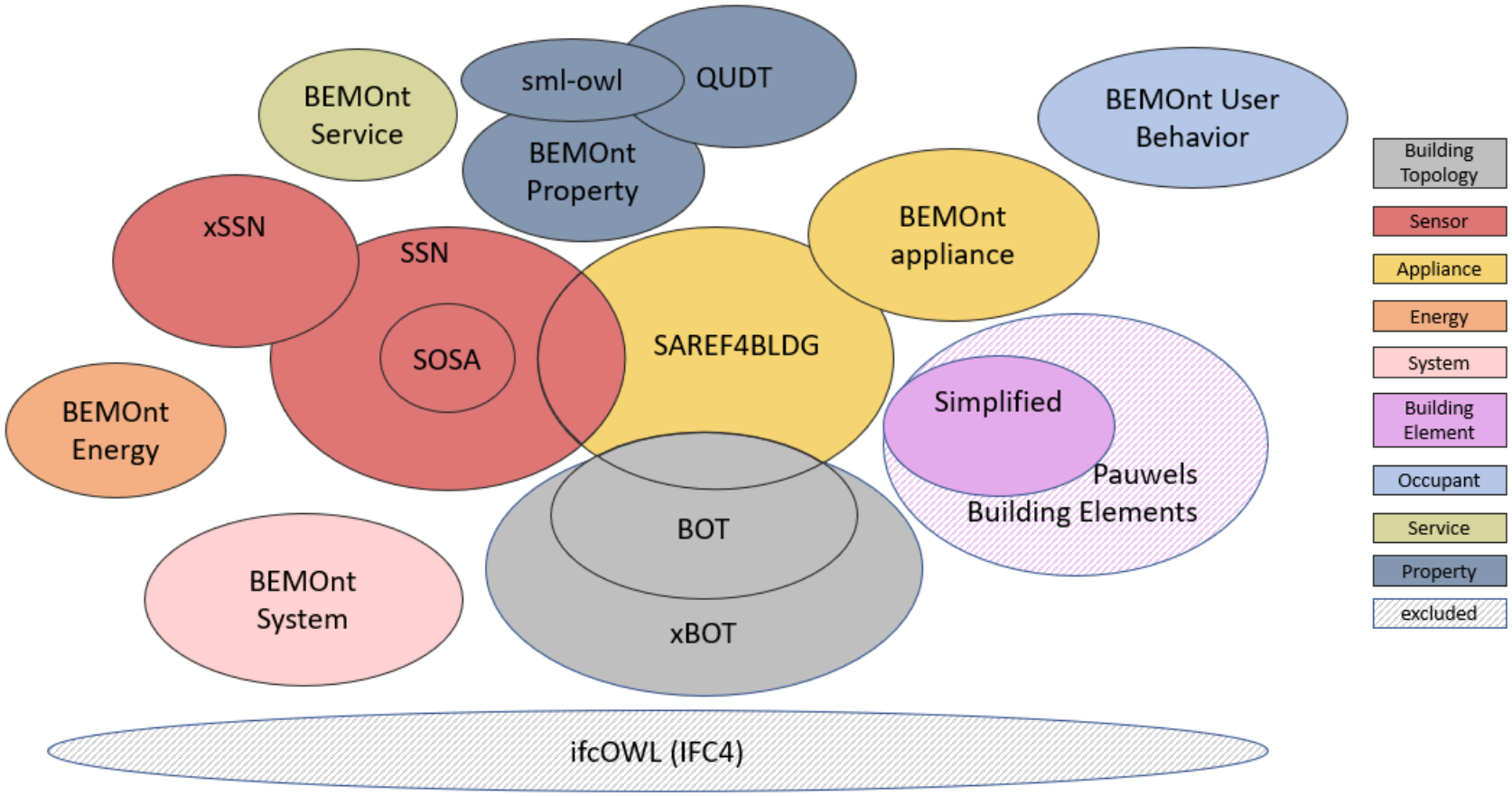
Relevant (or partially relevant) existing ontologies for each required layer/modules



[1] https://w3c-lbd-cg.github.io/bot/
[2] https://standards.buildingsmart.org/IFC/DEV/IFC4_1/OWL/ontology.ttl
[3] https://w3id.org/seas/BuildingOntology
[4] https://www.w3.org/TR/vocab-ssn/
[5] https://labs.etsi.org/rep/saref/saref4bldg
[6] https://pi.pauwel.be/voc/distributionelement
[7] https://pi.pauwel.be/voc/buildingelement
[8] https://models.bim4ren.eu/sot/0.1
[9] https://w3id.org/seas/SystemOntology
[10] https://saref.etsi.org/sources/saref4ener/
[11] Salameh, K., Chbeir, R., Camblong, H., Tekli, G. and Vechiu, I., 2015, September. A generic ontology-based information model for better management of microgrids. In IFIP International Conference on Artificial Intelligence Applications and Innovations (pp. 451-466). Springer, Cham.
[12] https://w3id.org/seas/EnergyFormOntology

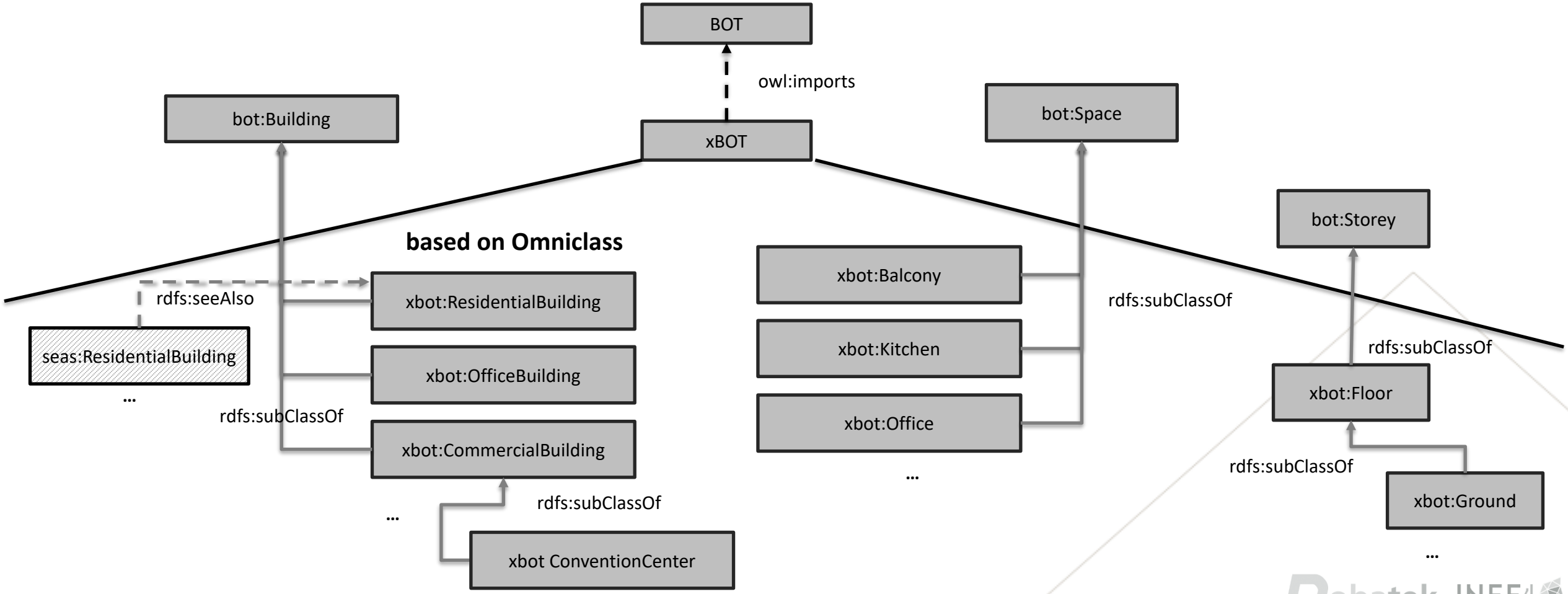
PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

OVERVIEW



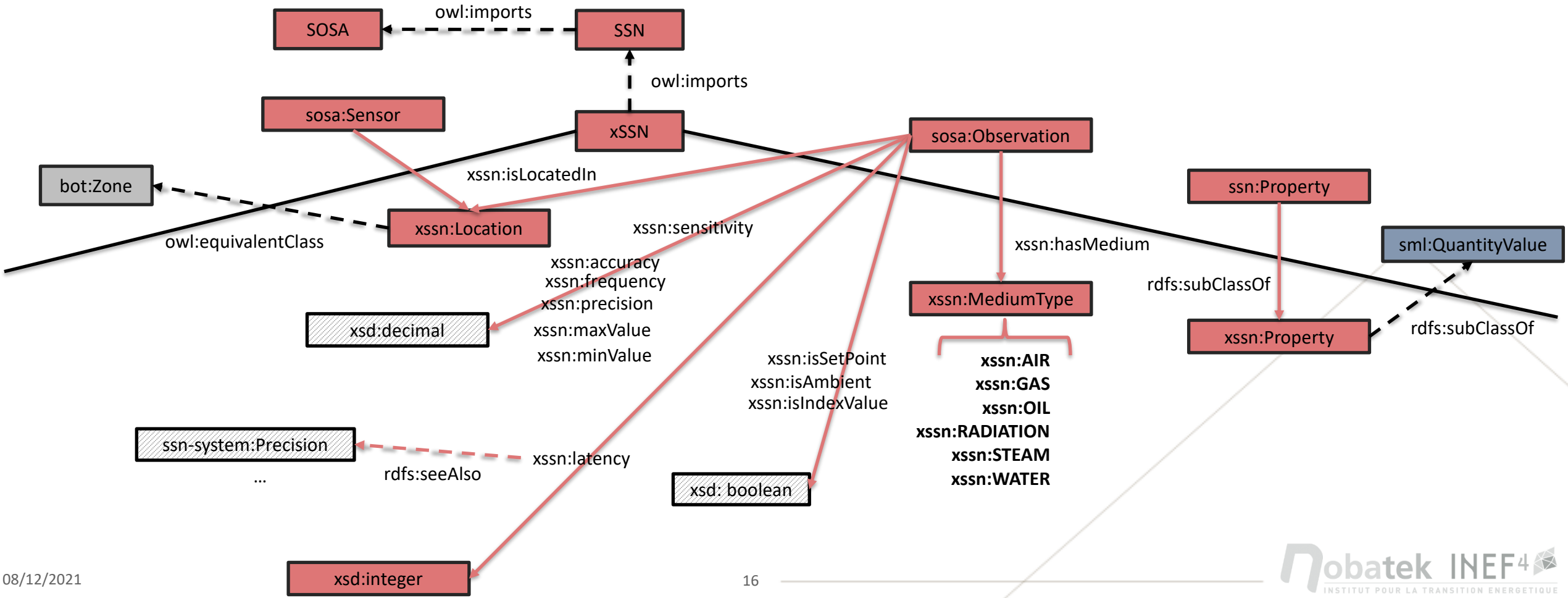
PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

BUILDING TOPOLOGY MODULE



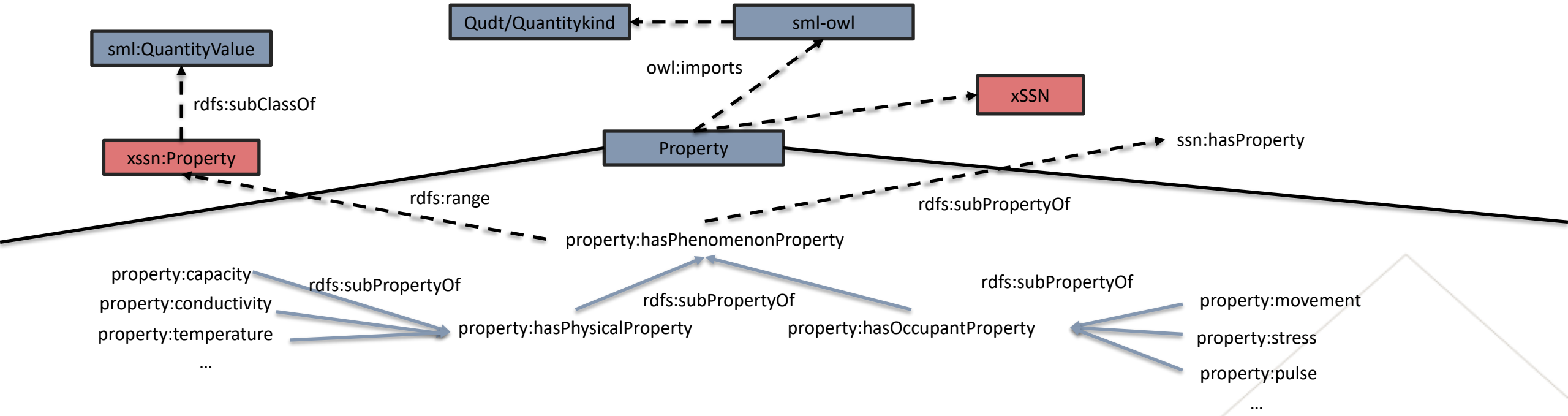
PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

SENSOR MODULE



PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

PROPERTY MODULE

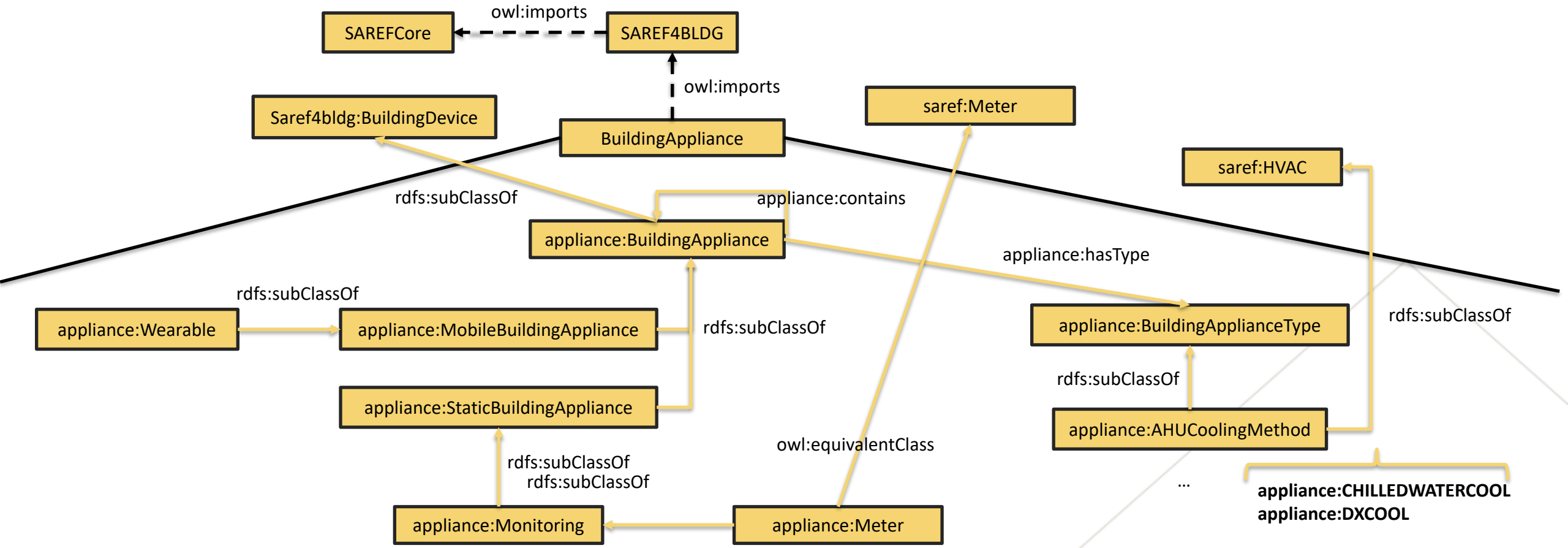



```
property:temperature rdf:type owl:ObjectProperty ;
                     rdfs:subPropertyOf :hasPhysicalProperty ;
                     rdfs:range xssn:Property
                     sml:quantityKind quantitykind:Temperature ;
```

```
bemserver:room1 a ssn:FeatureOfInterest;
                property:temperature [rdf:value "23.5"^^xsd:decimal ;
                                      sml: hasUnit unit:Celsius]
```

PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

BUILDING APPLIANCE MODULE



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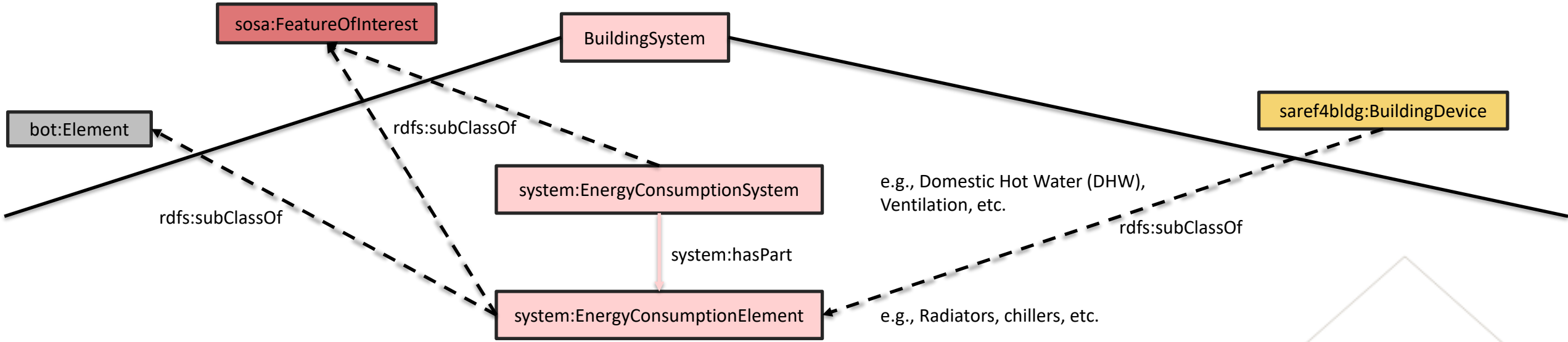
SYSTEM MODULE



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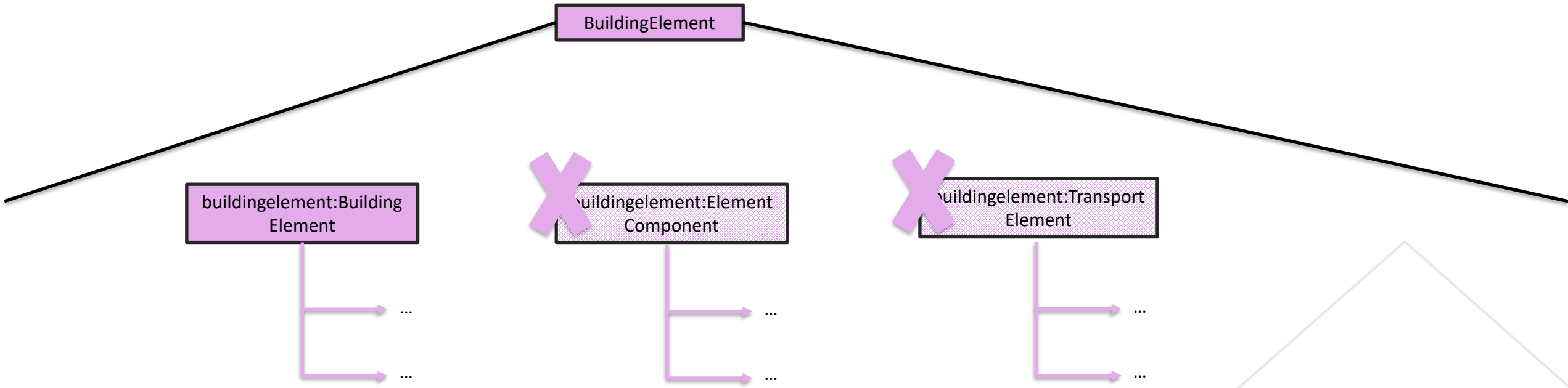
BUILDING ELEMENT MODULE



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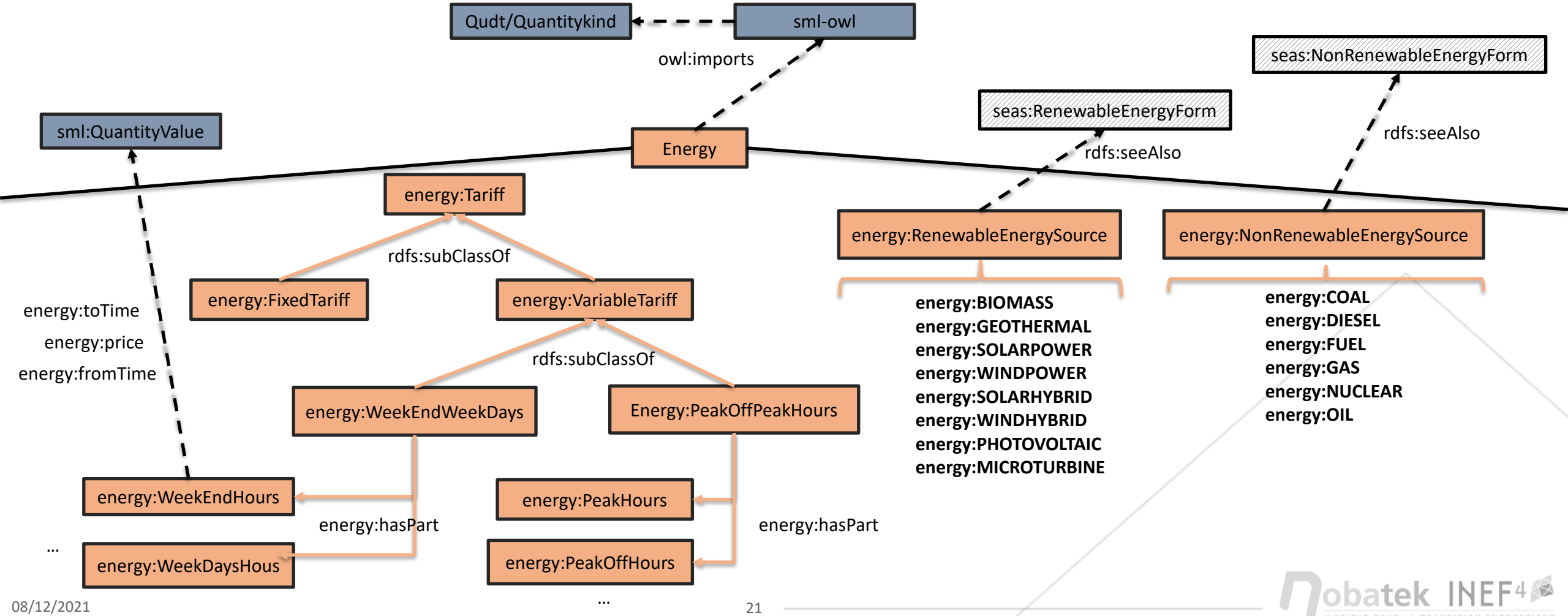
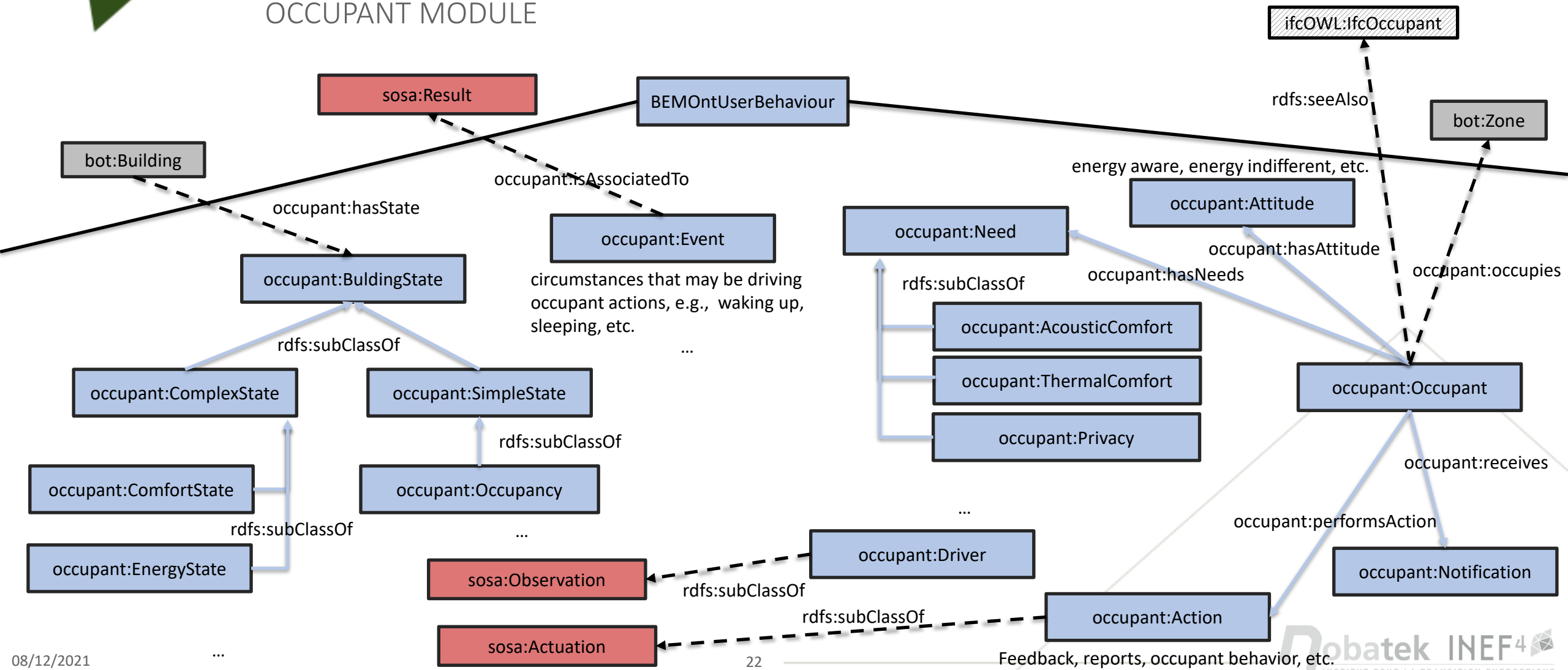
ENERGY MODULE



PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

OCCUPANT MODULE



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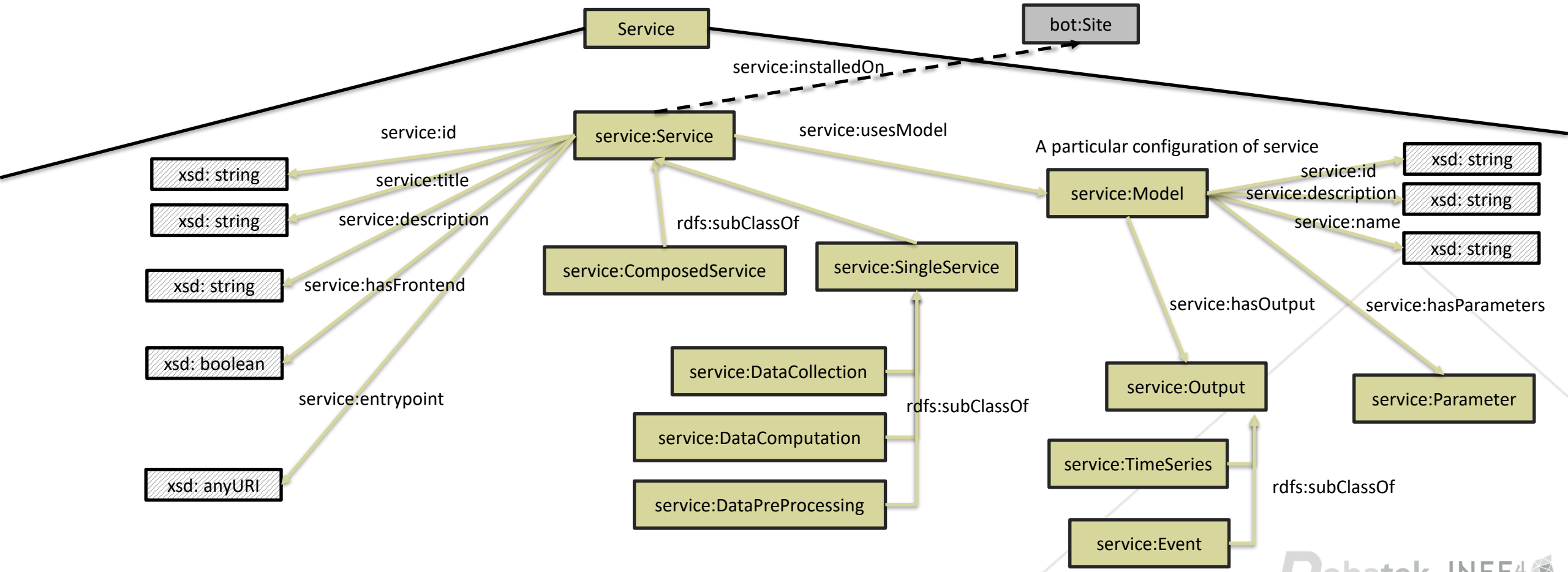
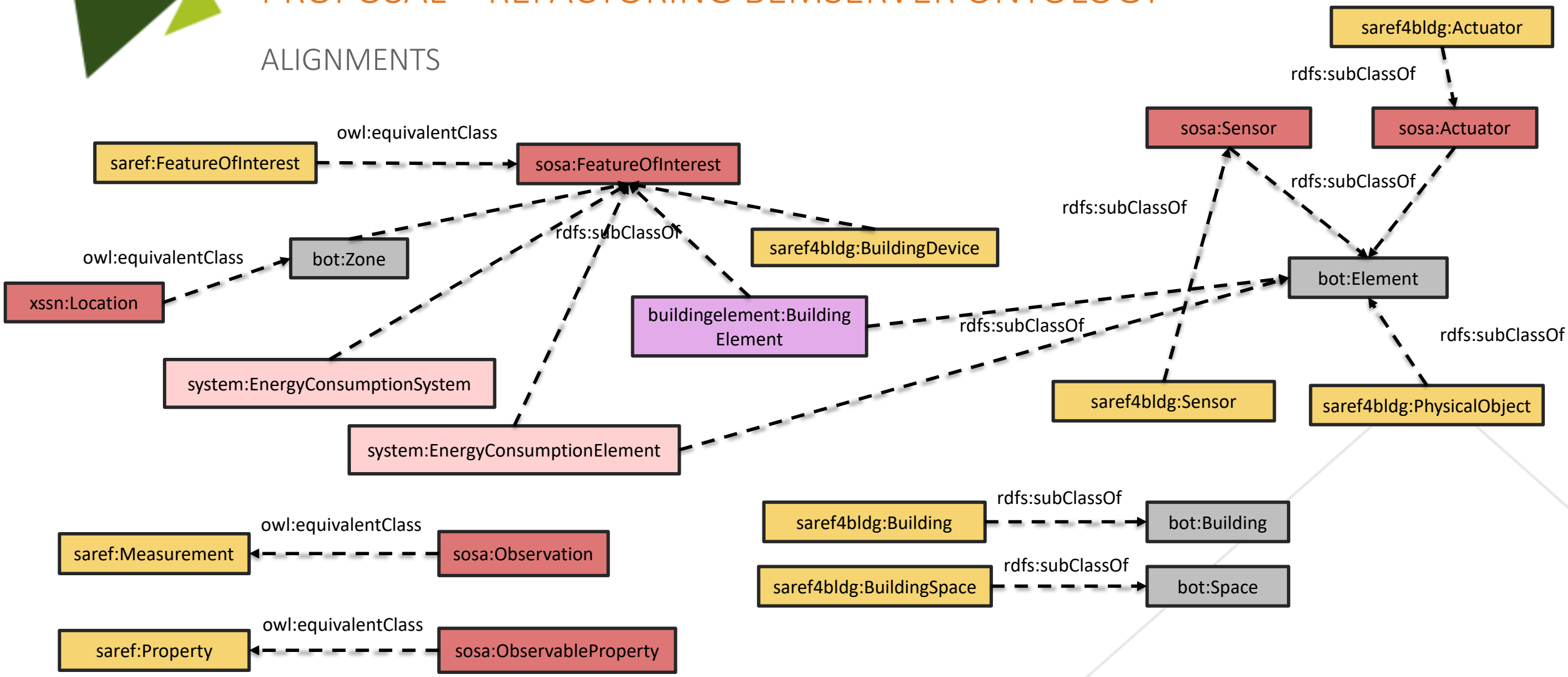
SERVICE MODULE



PROPOSAL – REFACTORING BEMSERVER ONTOLOGY

ALIGNMENTS



RECAP

REFACTORED BEMSERVER ONTOLOGY

New BEMOnt → refactored BEMServer ontology

- Uses modular ontologies, where each module (or group of modules) can be used separately
- So far, relies on : BOT, SOSA, SSN, SAREF4BLDG, BuildingElement, sml-owl, QUDT
- Refers to ifcOWL concepts (rdfs:seeAlso)
- Major extensions:
  - Modeling building typology (residential, non residential buildings, extended building spaces/storeys)
  - Modeling sensor and observation properties, physical medium, and location
  - Modeling specific building appliances and building appliance types
  - Linking sensors to energy consumption systems (heating, cooling, etc.) or energy consumption elements (radiators, etc.)
  - Modeling energy tariffs
  - Alignments between all modules

FUTURE WORK

PUBLICATION - DEPLOYMENT - MAINTENANCE

Publication

- Make it available online

Deployment

- Deploy it on BEMSERVER
- Create REST APIs on top of SPARQL endpoints
- Reuse it in other projects (INFINITE EU Project)

Maintenance

- Explore other relevant ontologies
- Keep up with other future LBD ontologies

Q & A

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