BIM4EEB

BIM based fast toolkit for Efficient rEnovation in Buildings

www.bim4eeb-project.eu

Digital Twin for energy buildings' renovation based on new ontologies and linked data

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POLITECNICO
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This project has received funding from European Union's H2020 research and innovation programme under grant agreement N. 820660

BIM4EEB General objectives

An EU-funded project supporting the renovation industry in retrofitting existing residential buildings with a complete

BIM-based toolkit for Efficient rEnovation in Buildings, in order to :

- **make the flow of information efficient**
- **decrease intervention working time,**
- **improve building performances, quality and comfort for inhabitants.**

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The BIM4EEB specific objectives

O1. Maximise efficiency in building renovation:

- Renovation working time reduction (20%)
- Renovation costs reduction (15%)
- Building quality control with less than 10% performance gap
- Faster energy audits -50% of time
- Net primary energy use decrease (10%)

O2. Accelerate the market uptake across Europe towards a digital built environment:

- Uptake of BIM-based renovation by construction companies (50%)
- Uptake of BIM-based dynamic energy assessment plus 30%
- Connection of BIM and GIS environments
- Implementation of as-built data collection in logbooks

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The BIM4EEB objectives

O3. Speed-up data gathering and processing

- Fast mapping tools for acquiring data of existing buildings and creating BIM models (30% time reduction)
- Innovative tools for connecting BIM models and BACS
- Improved performance and environmental data monitoring/ analysis to support decision-making on renovation scenarios (30% time reduction)
- Occupant behaviour data monitoring to enhance comfort, performance and building operation
- Enhanced simulation (performance gap of max. 10%)

O4. Interoperability of different stakeholders and tools, harmonising data exchange formats

- Improve the utilisation of increasingly heterogeneous building data by making it more accessible and interconnected
- Central, accessible, reusable platform for storing information
- Harmonised standardisation for data exchange formats
- Standardise data exchange between BACS and BIM

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The project in a nutshell

CALL/Topic

- INDUSTRIAL SUSTAINABILITY - ENERGY-EFFICIENT BUILDINGS (EEB)
- LC-EEB-02-2018 Building information modelling adapted to efficient renovation (RIA)

ACTION ID

- BIM4EEB
- BIM based fast toolkit for Efficient rEnovation in Buildings
- GA No. 820660

Duration:

- 42 months - 1 January 2019 – 30 June 2022

Financial

- Costs 6’933’940 EUR
- EC Funding 100%

15 partners representing main stakeholders

- 3 Universities: PoliMi, UCC, TUD
- 2 Research Institutes: VTT, RISE,
- 2 Public administrations: Lombardy Region / ALER VCBM
- 4 SMEs/ Start-ups: SOLINTEL, SUITE5, OneTeam, VisualLynk
- 3 Large Enterprises: CAVERION, GCI Sverige, PROCHEM
- 1 Association ACE

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The BIM4EEB toolkit

Fast Mapping of Buildings

Mapping and AR

CGI RISE

BIMPlanner

Renovation works' management

VTT

BIM4Occupants

Occupants' Profiling Mechanism

Suite5

BIMMS BIM Management System

one team

Procurement Requirements Specification for BACS

Auteras

TECHNISCHE UNIVERSITÄT DRESDEN

BIMcpd

HVAC Performance Eval

UCC IERC

BIMeaser

Decision support tool for Energy Savings

VTT

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From BIM towards Digital Twin

Common elements – 3D model viewer and IoT connection

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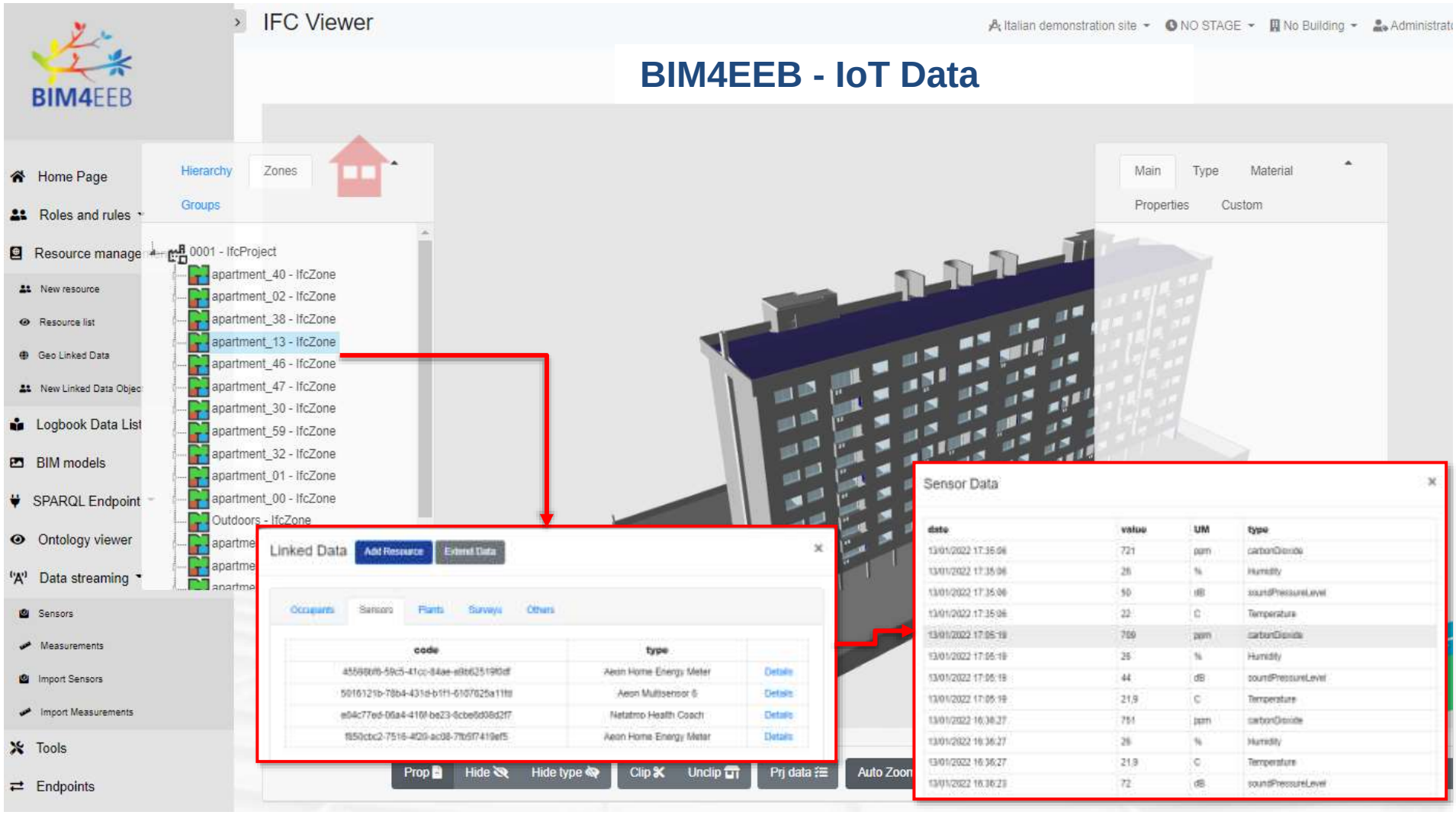
From BIM towards Digital Twin



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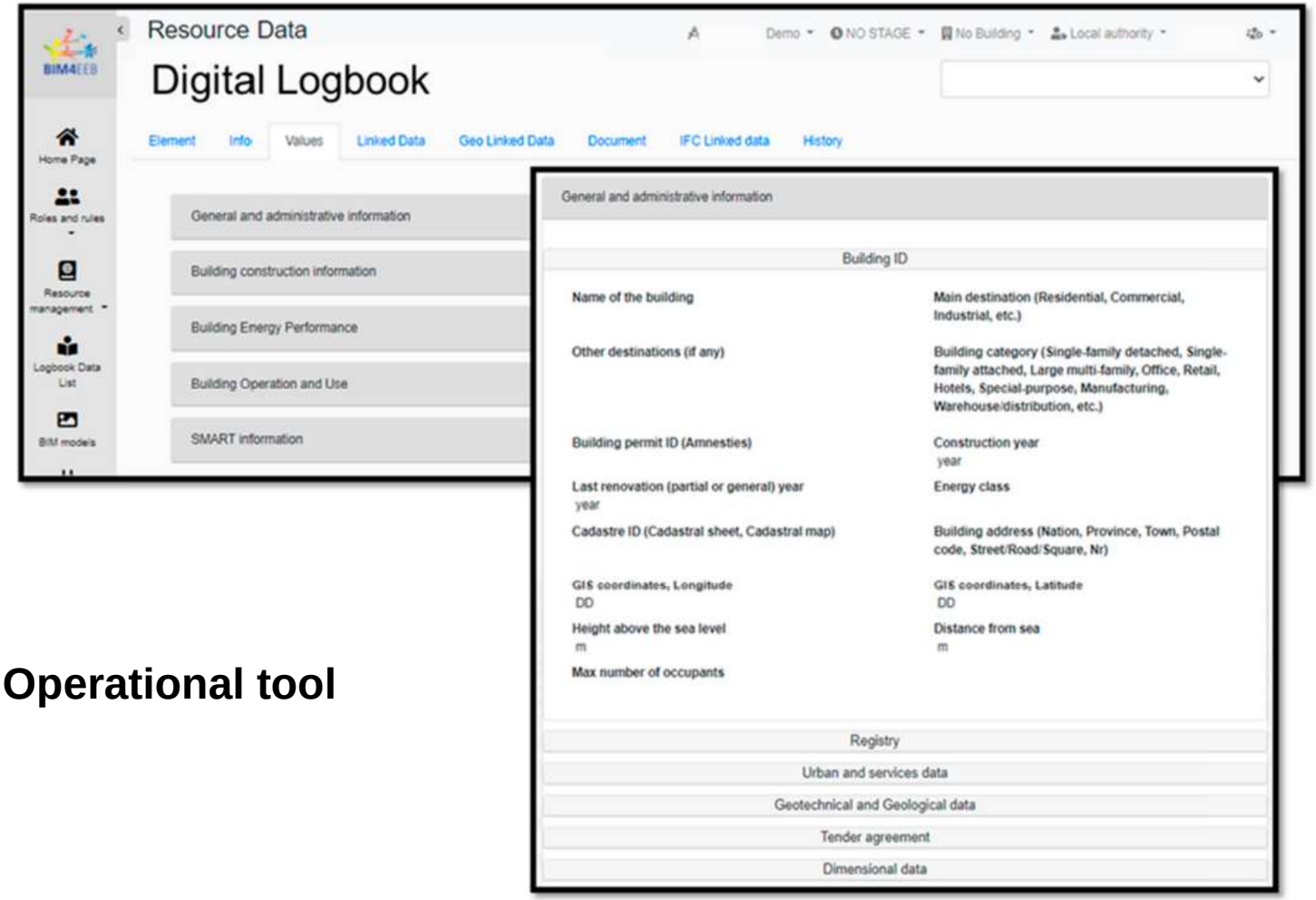
From BIM towards Digital Twin

Digital Logbook to manage the building and its renovation interventions



Operational tool

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DIGITAL TWIN definition

Data → Documents 3D model

Prediction Simulation

Digital Twin

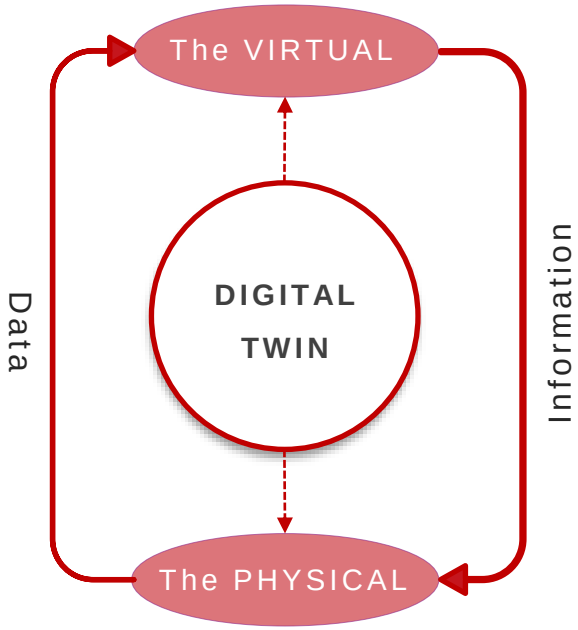
IoT

Data acquisition

AI

Data integration

Not a common definition



- "**a set of virtual information constructs** that fully describes a potential or actual physical manufactured product from **the micro atomic level to the macro geometrical level**" *Grieves & Vickers*
- "a **digital duplicate of the physical environment**, **states and processes**. While a BIM model contains as-is and historical data, a DT can be used to assess the current state, and to potentially forecast the future state" *Stojanovic et al.*
- "**a realistic digital representation of assets, processes, or systems** in the built or natural environment"*Bolton et al.*

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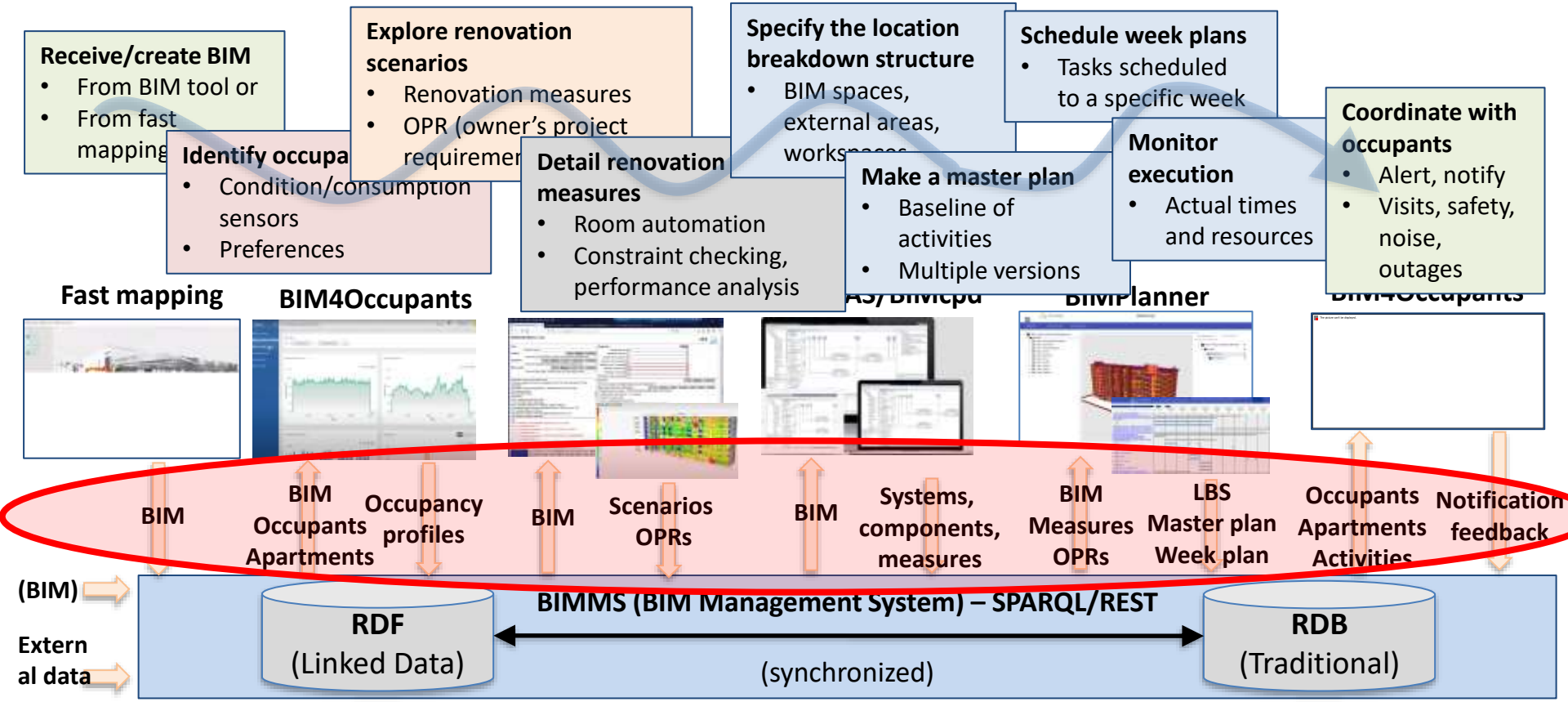
Role of ONTOLOGIES in the BIM4EEB toolkit



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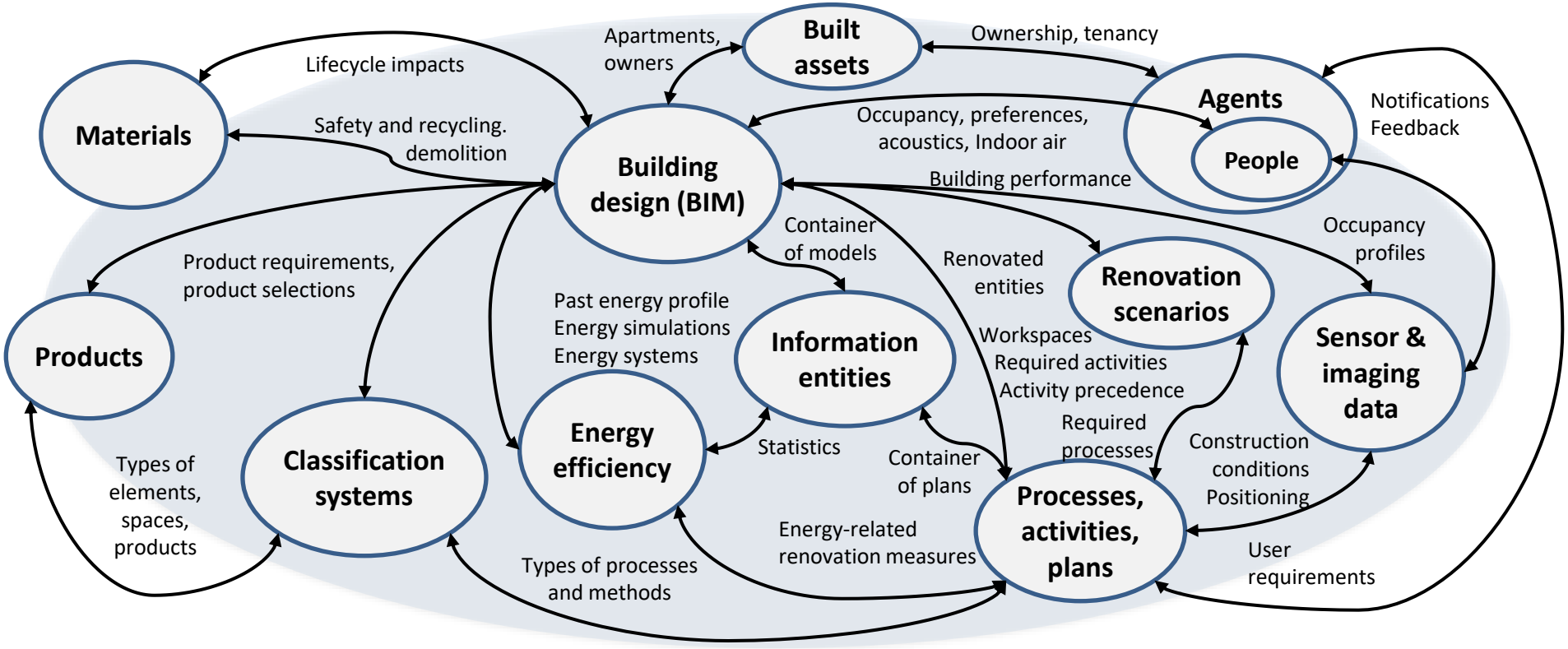
Areas of the renovation terminology



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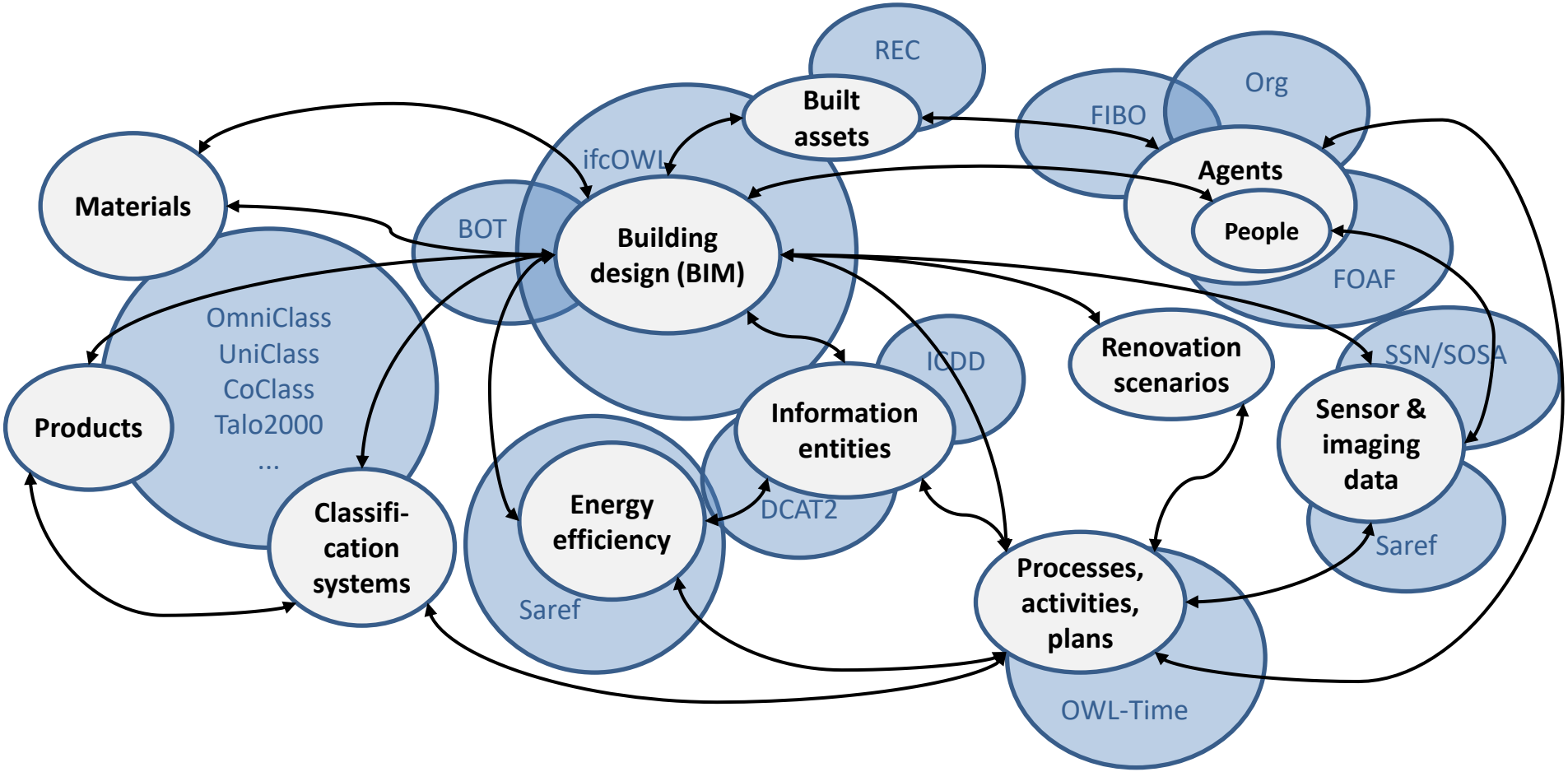
Existing ontologies or terminologies



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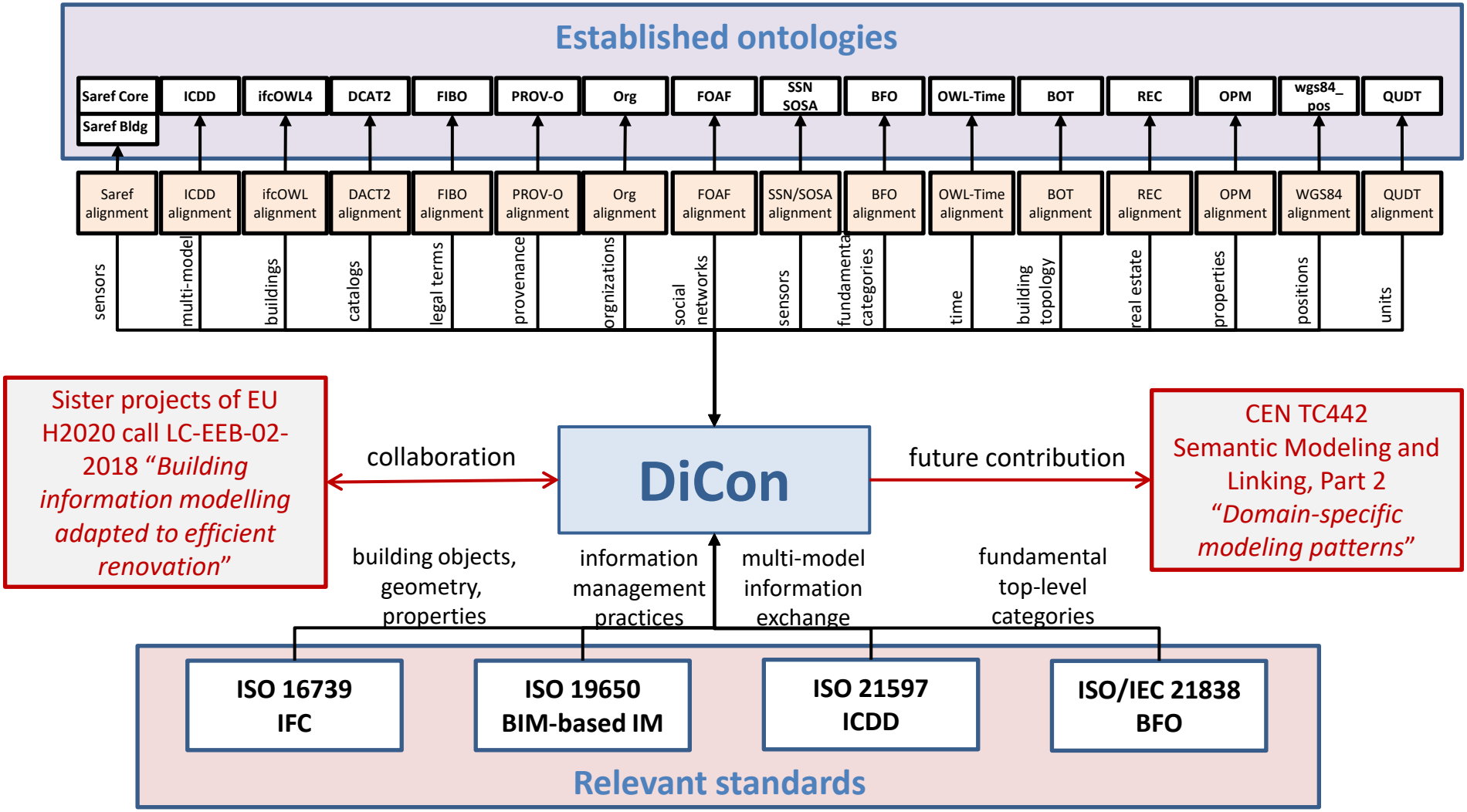
DiCon relations



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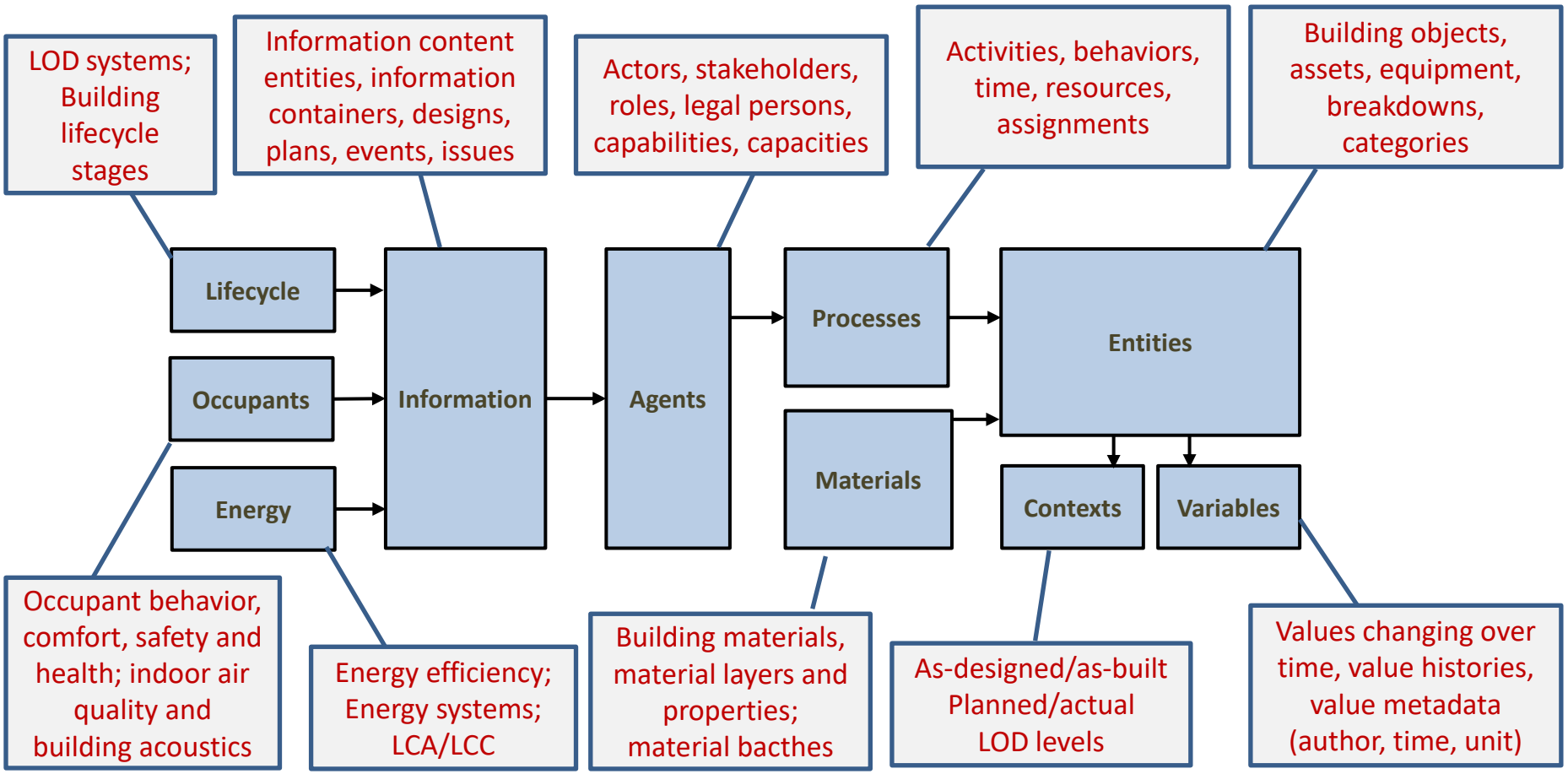
Modules of DiCon



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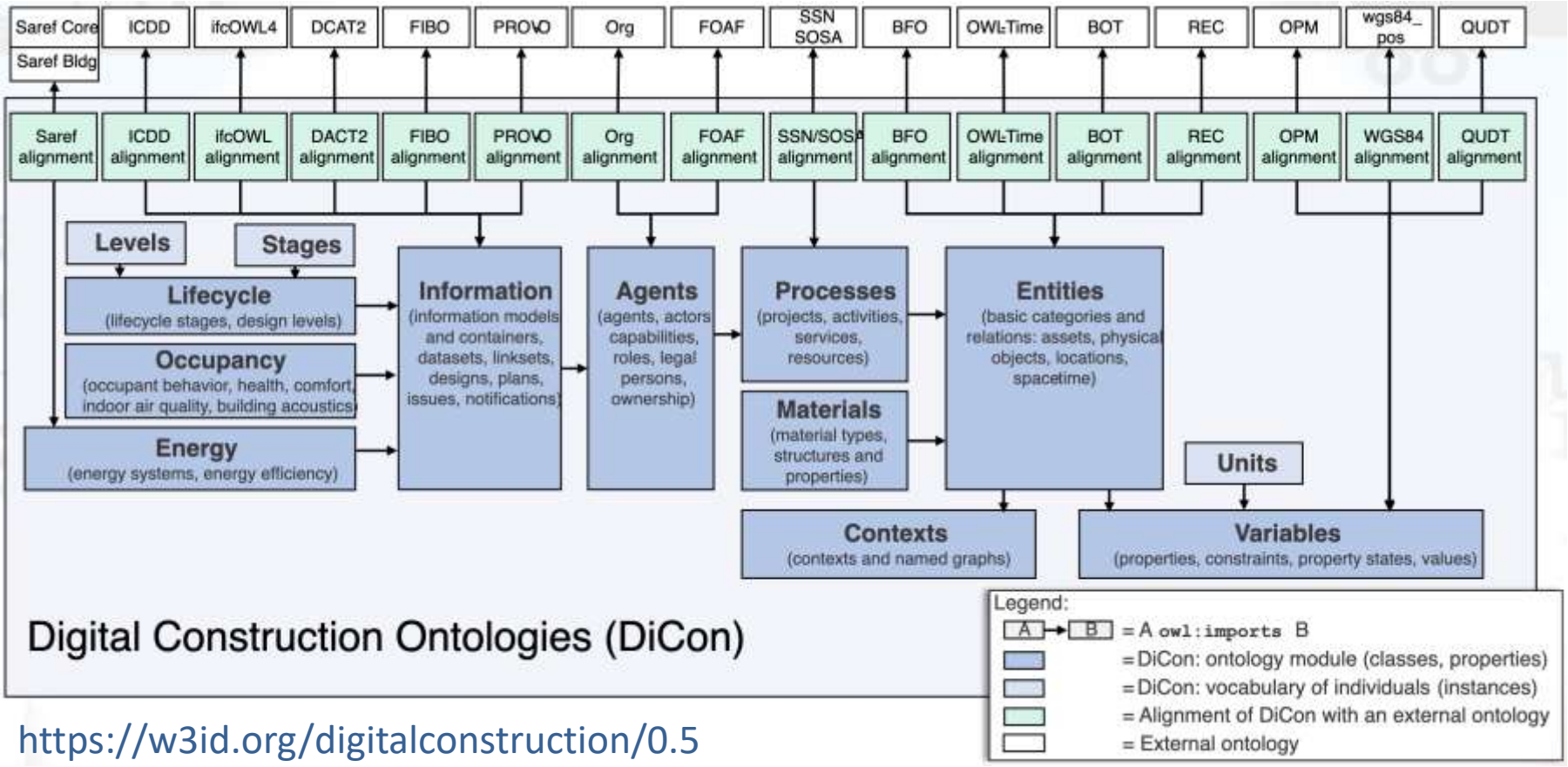
Digital Construction Ontologies (DiCon)



https://w3id.org/digitalconstruction/0.5

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Comparison with sister Ontologies

Ontology	Description	Reused ontologies
BIM-SPEED		**No direct reuse**
Reno-Inst	Installation of windows, ETICS panels, and radiators in renovation projects.	_
LCA-C	LCA/LCC assessments, the assessed building, and the products/materials	_
BEM-Reno	A renovation ontology based on the structure of BOT, albeit not reusing it	Copy, adapt and extend BOT
BIMERR		**Reuse by reference**
Occupancy Profile	Occupants behavior inside buildings for the BIMERR project	Saref, Saref4Building, OWL-Time, SKOS, FOAF
Sensor Data	Sensors located inside buildings for the BIMERR project	Saref
KPI	Key performance indicators related to building renovation works	Saref, Saref4City, OWL-Time
Weather	Weather data for the BIMERR project	Geo, Saref, SSN, SOSA, Saref4City
Building	Building data for the BIMERR project	BOT
Material Properties	Properties to describe building elements in BIMERR	Saref
Annotations Objects	Annotations and extra information of building elements	–
Information Objects	Tthe files and documents attached to building elements	–
Renovation Process	The construction processes in a building renovation	Saref
Metadata	Annotations for ontology to data model transformation	–
BIM4REN		**No direct reuse**
buildings	Elements related to a basic description of a building, inspired by BOT	Copy, adapt and extend BOT
buildingcomponents	Components of the building that as walls, windows, ...	–
buildingsystems	HVAC, domestic hot water, lighting and appliances.	–
occupancy	Occupants and their activities within the building	–
energy	Energy modeling of the building.	–
BIM4EEB		**Reuse by alignment**
Contexts	Multi-contexts data: planned/actual, as-designed/as-built	ifcOWL
Variables	Objectified properties for time varying values, constraints, value metadata	QUDT, Geo, OPM, ifcOWL, PROV-O, SSN/SOSA, Saref
Entities	Basic categories with identifiers, classifications, breakdowns, and groupings	BFO, Geo, ifcOWL, OWL-Time, FOAF, Org, BOT, REC, SSN/SOSA, S4Bldg
Processes	Activities and resources, resource assignments, and objects of activities	ifcOWL, FOAF, PROV-O, REC, Saref
Agents	Actors, stakeholders, roles, legal persons, capabilities, capacities	ifcOWL, Org, FOAF, FIBO, ICDD, REC
Information	Information content entities, containers, designs, plans, events, issues	ifcOWL, PROV-O, FIBO, DCAT2, ICDD, REC
Materials	Material structures, properties and material batches	ifcOWL, BOT
Occupancy	Occupant behavior, comfort, safety, health; air quality; building acoustics	ifcOWL, BOT, SOSA, REC, Saref
Energy	Energy efficiency including energy systems	ifcOWL, Saref
Lifecycle	Information over LOD levels and construction lifecycle	ifcOWL, Org

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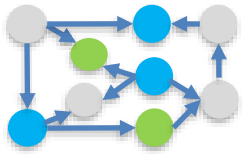
BIM4EEB Conclusion1: toolkit validated and available for further developments

Phase 1

Construction & service companies

HVAC designers

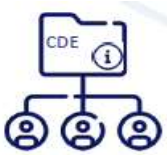
owners & inhabitants



linked data & ontologies

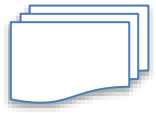
Requirements, linked data &ontologies

Phase 2



common data environment

AR for fast mapping & survey



Logbook for fast planning & tracking

BIM-BACS data exchange

Tools development

Phase 3

Monza demo site (IT)

Chorzow demo site (PL)

Tampere demo site (FI)

Demonstration in relevant environment

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Conclusion2: Digital Twin for energy buildings' renovation based on new ontologies and linked data

- BIM4EEB toolkit and ontologies are available for sharing, standardization further developments
- Digital Twin developments is ongoing: need for an agreed definition and finalization
- Dynamic Digital Logbook is one priority for existing building
- Need for an International and European Coordination Action to share Sister Projects results and to finalize them for:
  - Standardization (ex. CEN TC 442)
  - Buildingsmart, W3C
  - Building Digital Twin Association
  - DIGIPLACE

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Thank you for your attention!....

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VTT UCC one team ALER

Solintel iERC TECHNISCHE UNIVERSITÄT DRESDEN PROCHEM

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