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## UPDATE OF THE STANDARD-BASED IR-ONTOLOGY NETWORK IN DIGITAL CONSTRUCTION PROJECTS

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Chair of Computing  
in Engineering

Bauhaus-Universität Weimar

Construction Engineering and Management

# Current Status & Motivation

Which information is needed for construction projects?

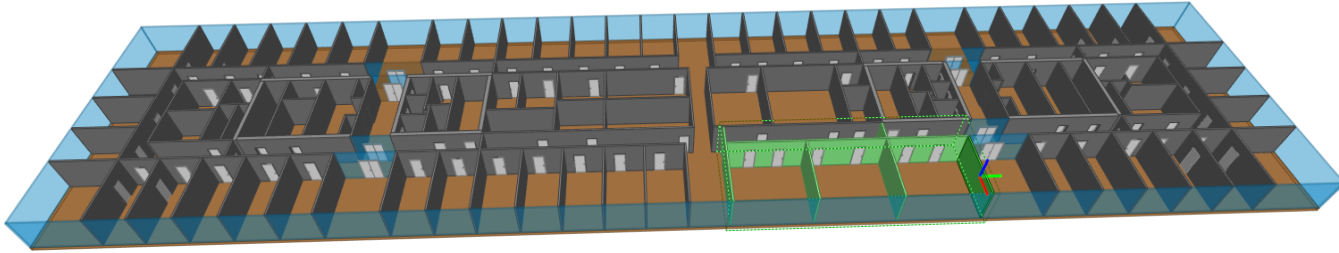
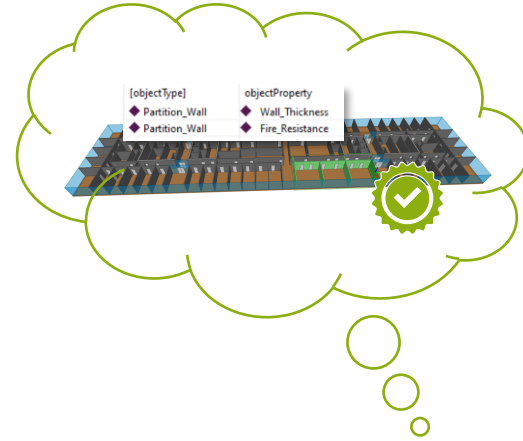


Illustration of a project deliverable



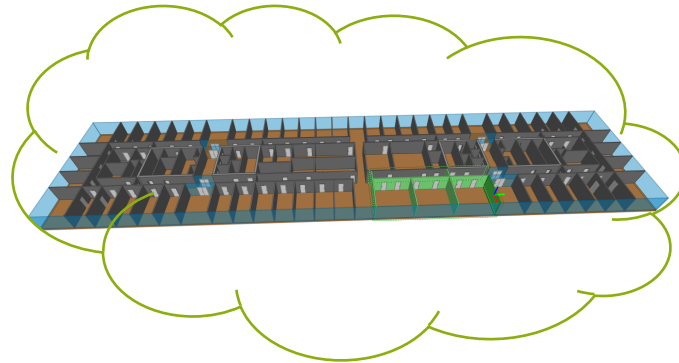
# Current Status & Motivation

## Definition of information requirements



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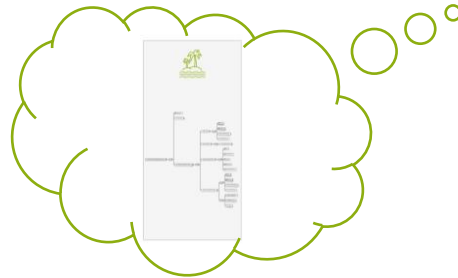


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## Definition of information requirements

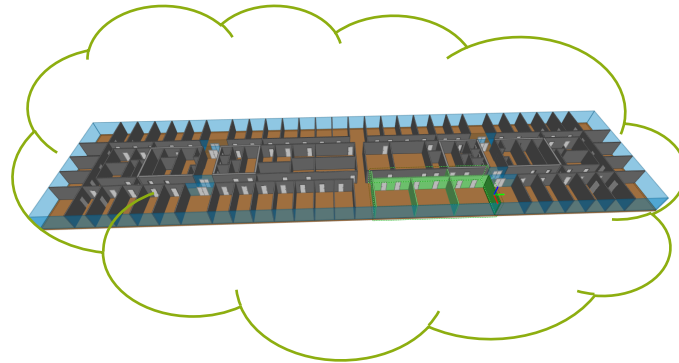
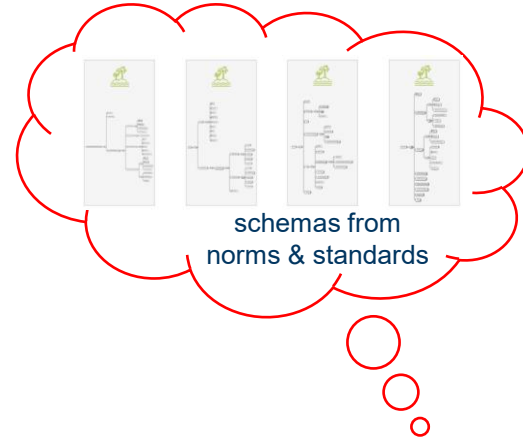


Best case: standardized  
schemas for information  
requirements



# Current Status & Motivation

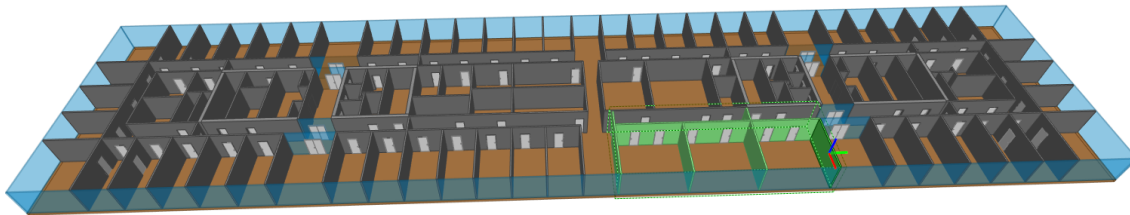
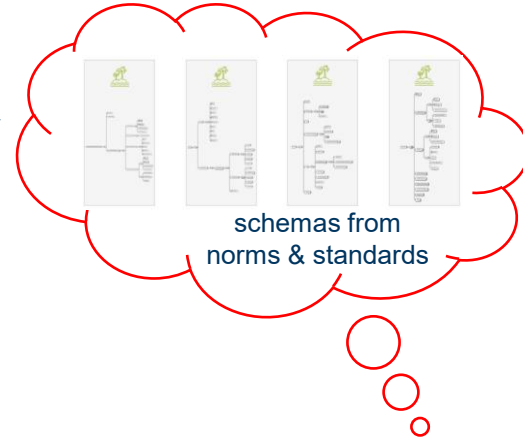
## Definition of information requirements



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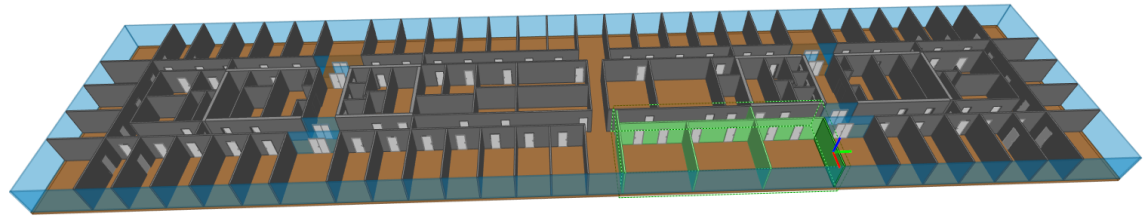
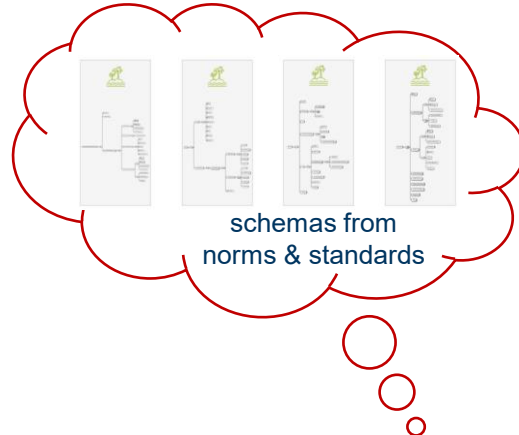
[objectType]	objectProperty
◆ Partition_Wall	◆ Wall_Thickness
◆ Partition_Wall	◆ Fire_Resistance



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## Definition of information requirements

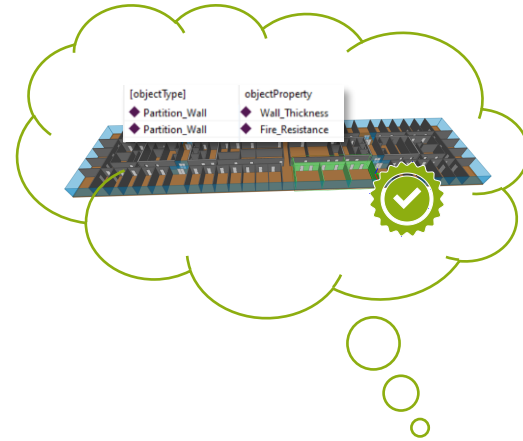
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# Currents Status & Motivation

## Information Requirement (IR)-Ontology Network

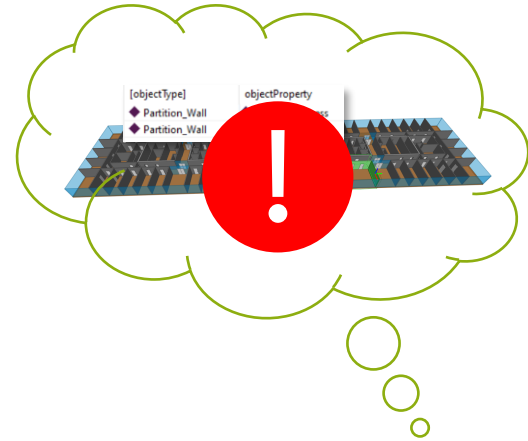
- Harmonizes the three most relevant standards in the information delivery Process
  - LOIN (ISO 7817-3)
  - DT (Data Template) (ISO 23387-3)
  - ISOProps (ISO 23386)
- Modular, extendable, and reusable ontology network



# Currents Status & Motivation

## Revision and updating of the ontology network

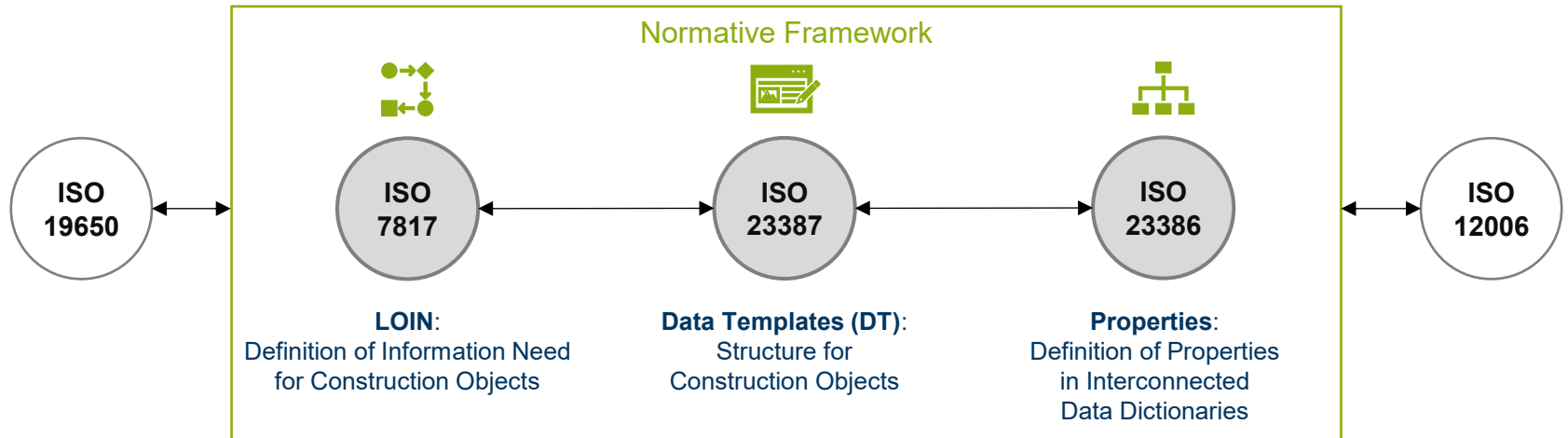
- Two relevant data formats have been updated
  - ISO 7817-3 (LOIN)
  - ISO 23387-3 (Data Template)
- Current ontology network no longer compliant with underlying standards
- A revision of the ontology network is required to
  - Review and adapt the ontologies
  - Regain compliance with standardization



# Background

## Normative Framework

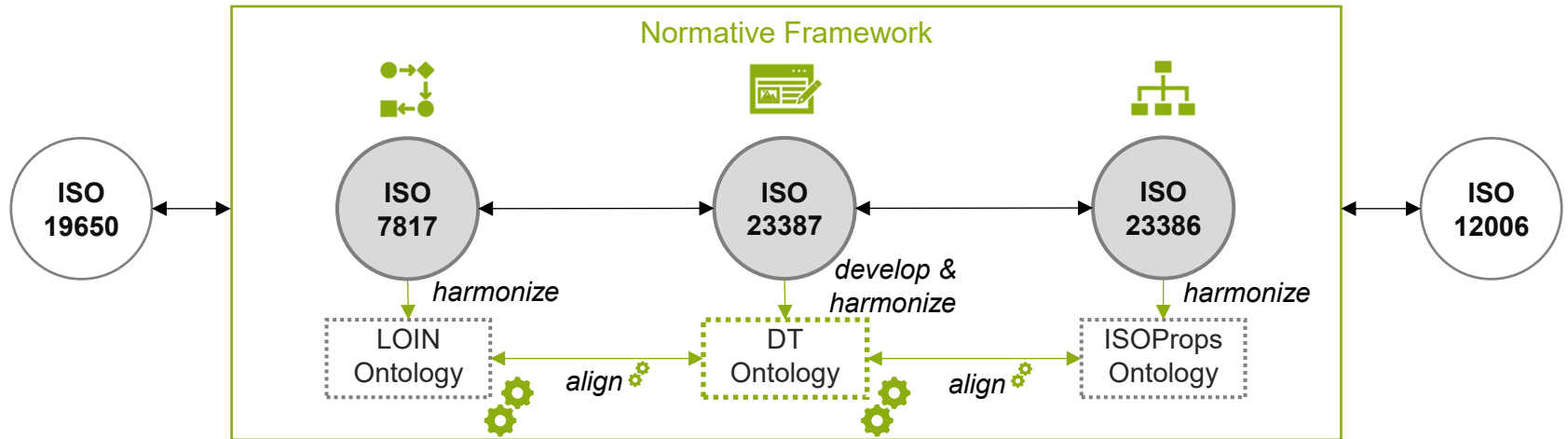
- Standards for the information delivery process
- Focusing on three ISO standards for information requirements definition



# Objective

## Based on the normative changes

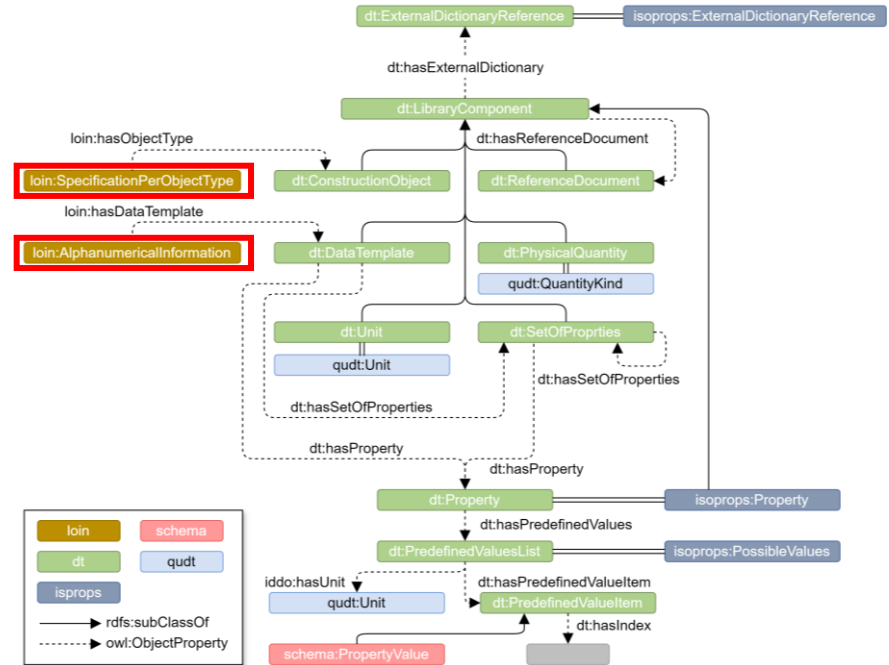
- Revision of the LOIN and the DT Ontology
- Adjustment of the existing alignment if necessary



# Tracking Changes in Standardization

## Key Changes in ISO 7817-3

- Naming and structural adjustments
- Major Changes made to
  - *Alphanumerical information*
  - *Specification per object type*
- Dual use of *object type* led to ambiguity
  - Clear reformulation of *alphanumerical information*
- Alignments to LOIN and DT ontologies must be updated

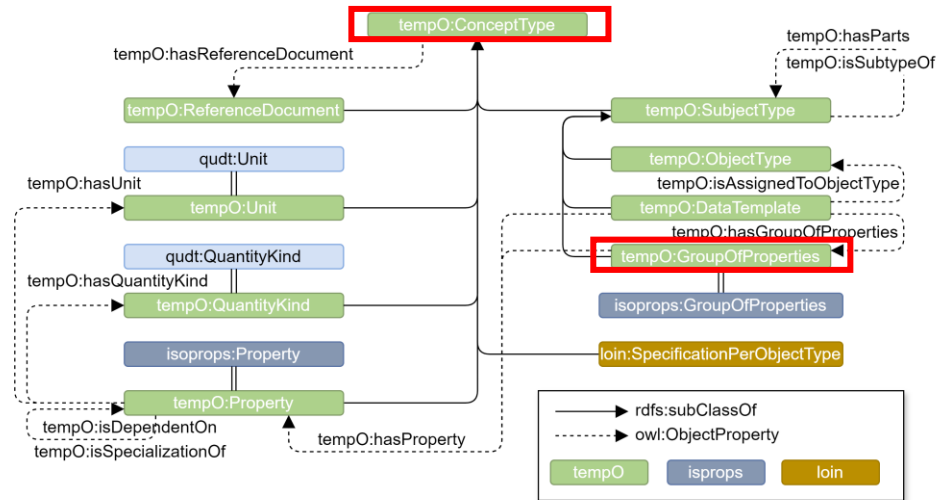




# Results

## Data Template Ontology (tempO):

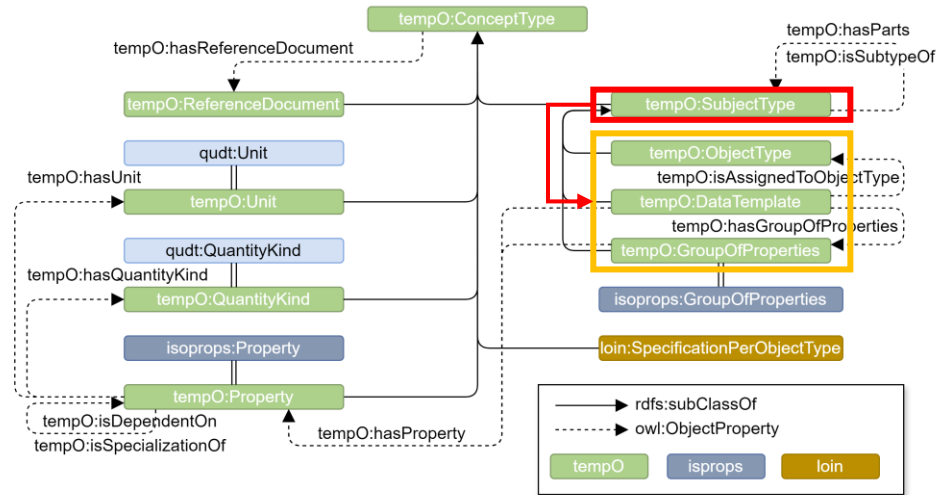
- Library component replaced by library (container role)
  - Linked to Data Catalog Vocabulary for improved interoperability
- New superclass *concept type* aligned with ISO 12006-3
- Abstracted class *group of properties* introduced



# Results

## Data Template Ontology (tempO):

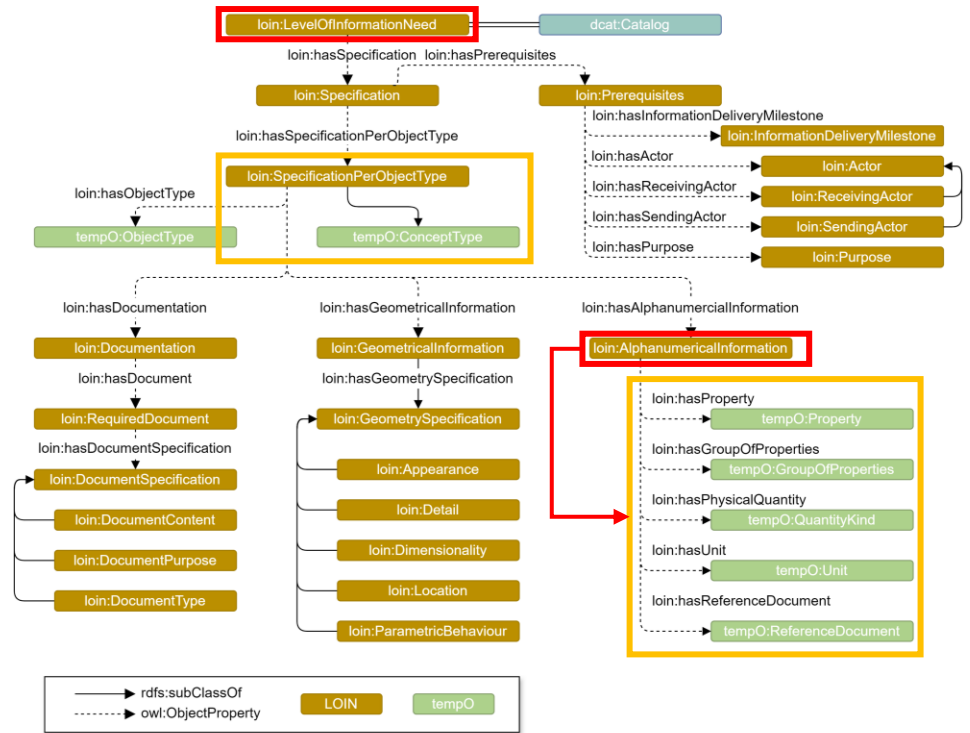
- New superclass *subject type* added
- *Subject type* governs: *object type*, *data template*, *group of properties*
- Supports object relations: *hasParts*, *isSubtypeOf*
- Property now uses: *isDependentOn*, *isSpecializationOf*
- Value types grouped in new *data type* class



# Results

## LOIN Ontology

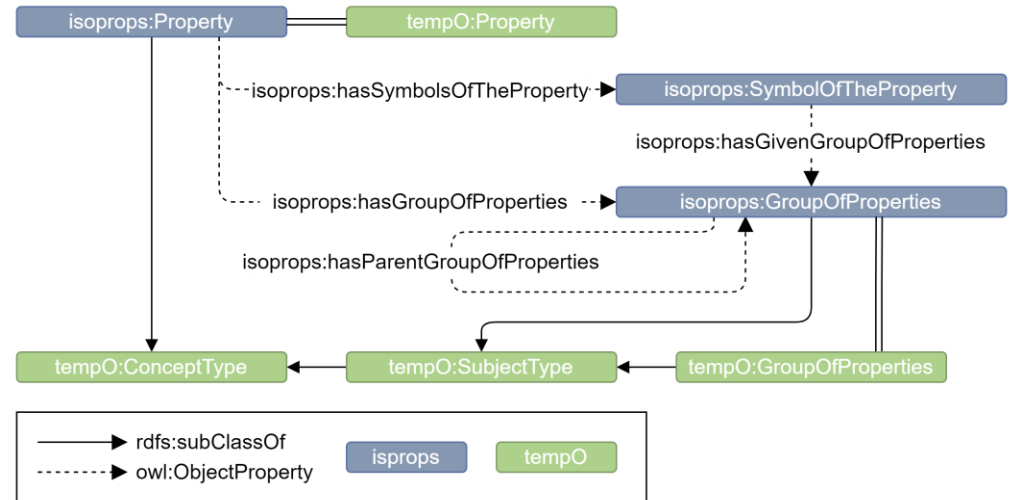
- New top-level class *Level Of Information Need*
  - Linked to Data Catalog Vocabulary
- *Alphanumerical Information* revised:
  - Reuses elements from tempO
  - Removes ambiguity of dual *object types*
- *Specification per object type* subordinated to *concept type*



# Results

## ISOProps Ontology

- Aligned with tempO structure
  - *Property* subclass of *concept type*
- *Group of properties* realigned
  - Equivalent to *group of properties* of tempO
  - Now a subclass of *subject type*



# Demonstration

## Global Warming Potential (GWP) in building design

- GWP defined in ISO 14040, measured in kg CO<sub>2</sub>e/m<sup>2</sup>/year
- Focus on concrete due to high CO<sub>2</sub> impact

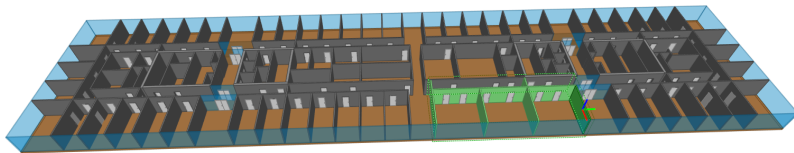
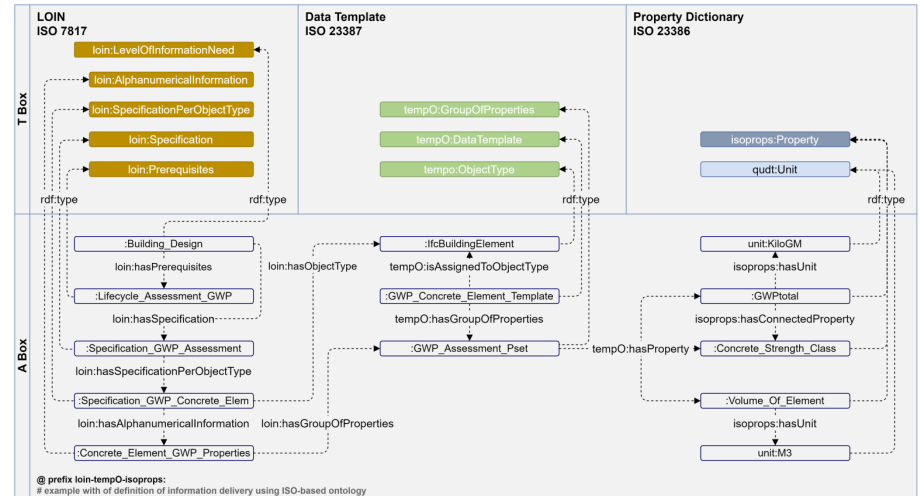
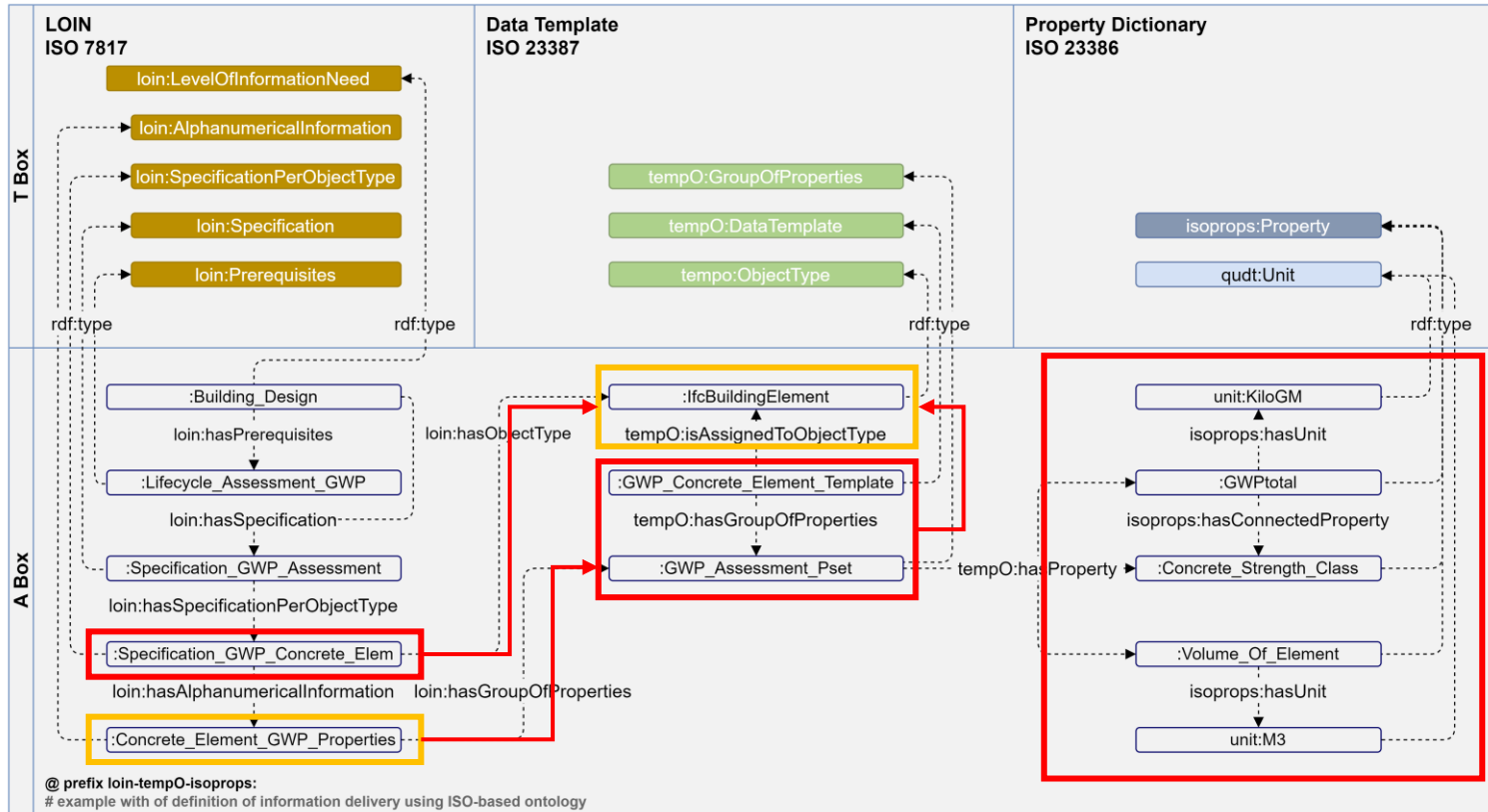


Illustration of a project deliverable



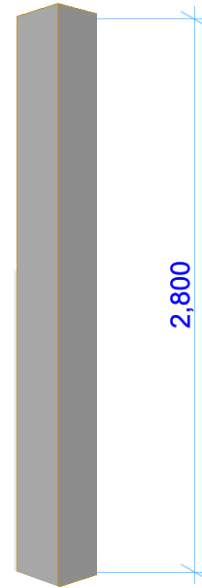
A Box graph of the illustrative example



# Demonstration

## Global Warming Potential calculation

- Column: 30x30 cm base, 2.8 m height, 0.252 m<sup>3</sup> volume
- GWP value: 175.2 kg CO<sub>2</sub>e
- IFC model created and converted to Linked Building Data
- Query targets *beo:Column* instances
- Retrieves: *GWPTotal* and *volume* values
- Enables direct calculation of GWP in LBD model



3D view of the illustrative example

# Demonstration

## Global Warming Potential calculation

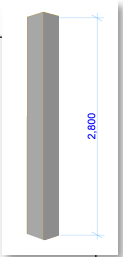
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- Enables direct calculation of GWP in LBD model

```
SELECT ?column ?gwpTotalValue ?volumeValue ?GWP
WHERE {
  ?column rdf:type beo:Column.

  # Retrieval of the GWptotal value
  ?column isoprops:hasProperty :GWptotal.
  :GWptotal opm:hasPropertyState ?stateGWP.
  ?stateGWP schema:value ?gwpTotalValue.

  # Retrieving the Volume_of_Element value
  ?column isoprops:hasProperty :Volume_of_Element.
  :Volume_of_Element opm:hasPropertyState ?stateVolume.
  ?stateVolume schema:value ?volumeValue.

  # Calculation of the GWP value
  BIND(?volumeValue * ?gwpTotalValue AS ?GWP)
}
```

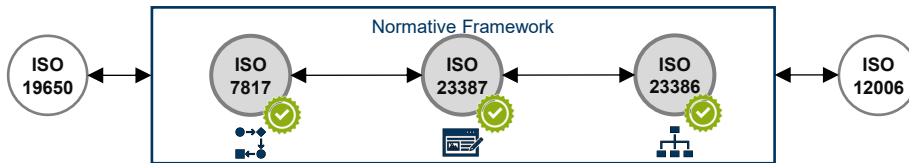
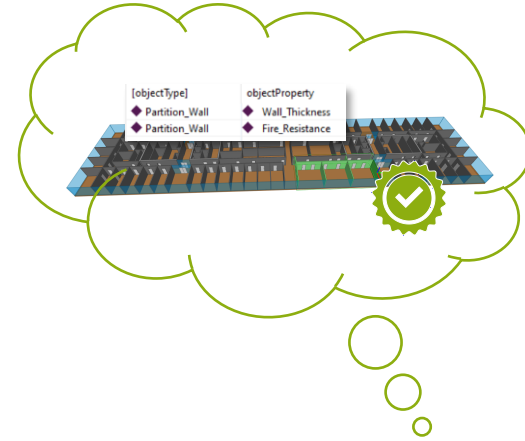


Query of the illustrative example

# Conclusion

## IR-Ontology Network

- Updated ontology network comply with current ISO standards
- Integrated LOIN, tempO, and ISOProps into a unified concept (ISO 12006-3)
- Alignment ensures consistency and standard-compliant information delivery
- Demonstrated through practical GWP case study



# Critical Reflection

- Ontology updates were conducted manually
- Process lacks automation and scalability
- Need for SMART standards to improve efficiency
- SMART standards enable machine-readability and ontological use



# Limitations and Outlook

## Limitations

- Scalability issues for large-scale projects
- Approach for requirement specification and delivery not yet validated across multiple domains



## Outlook

- Develop automated update processes for ontologies
- Enable dynamic alignment using machine-readable standards
- Validate in diverse domains and larger-scale projects
- Improve interoperability through standardized interfaces

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