A roadmap toward a unified ontology for building service systems in the AECO Industry: TSO and FSO

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Challenge: Complexity management

Can these competency questions be answered?

- Which building service systems are in the project?
- How is the hierarchical subdivision of the service systems?
- How are these systems interconnected?
- How is the flow of matter, energy and data through these systems?
- etc.
State of the Art

- Several ontologies have been developed to improve interoperability within the AECO industry.

- Ontologies related to building service systems are among others:
  - ifcOWL
  - REC
  - BRICK
  - SAREF
  - SEAS
  - FSO
  - TSO

- All of them consist of hierarchical, structural and functional concepts
A tso:System is a model of a whole which is isolated from the world or a supersystem, which may consists of interconnected components or sub-systems and has attributes such as inputs, outputs and states.
A fso:System is defined as a collection of components that can have attributes such as design properties attached to it.

fso:Components are tangible components that participate in the flow of energy or matter.
Application example

See figures 3-5

Conference Room

Office

Pump
Active chilled beam
Heat Exchanger
6-way valve

Cooling Supply
Heating Supply
Ventilation Supply

Cooling Return
Heating Return
Ventilation Return
Hierarchical concept – Terminology

- tso:hasSubSystem
- tso:subSystemOf
- rdfs:subPropertyOf
- tso:hasIntegratedSystem
- tso:hasFunctionalSystem
- tso:hasTechnicalSystem
- tso:hasComponent

fso:hasSubSystem

fso:hasComponent
Topological concept – Terminology

- tso:connects
- tso:connectsAt
- tso:connectsThrough
- tso:connectsSystemAt
- tso:connectsSystemThrough
- rdfs:subClassOf

- tso:System
  - tso:connects
  - tso:connectsAt
  - tso:connectsThrough
  - tso:connectsSystem
  - tso:connectsSystemAt
  - tso:connectsSystemThrough

- tso:ConnectionPoint
- tso:Connection
- tso:InnerConnection
- tso:OuterConnection

- fso:System
- fso:Component
- fso:connectedWith
Topological concept – Application Example
Functional concept – Terminology
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BS-Visualizer (https://bs-visualizer.web.app)
Alignment

- Alignment between FSO v0.1.0 and TSO v0.3.0

<table>
<thead>
<tr>
<th>FSO</th>
<th>TSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>fso:System</td>
<td>rdfs:subClassOf</td>
</tr>
<tr>
<td>fso:DistributionSystem</td>
<td>owl:equivalentClass</td>
</tr>
<tr>
<td>fso:SupplySystem</td>
<td>owl:equivalentClass</td>
</tr>
<tr>
<td>fso:ReturnSystem</td>
<td>owl:equivalentClass</td>
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<tr>
<td>fso:Component</td>
<td>owl:equivalentClass</td>
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<tr>
<td>fso:isSubSystemOf</td>
<td>rdfs:subPropertyOf</td>
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<tr>
<td>fso:isComponentOf</td>
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<td>fso:hasComponent</td>
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<td>fso:connectedWith</td>
<td>owl:equivalentProperty</td>
</tr>
</tbody>
</table>
Roadmap toward a unified ontology

- Expressiveness vs. Simplicity/Useability
- Proposal of a modular structure
- Lightweight core module contains top level hierarchical, topological, and functional aspects, which are valid for all disciplines
- Further hierarchical, topological, and functional aspects which are valid for all disciplines be defined in a hierarchical, topological and functional ontology pattern
- Classifications of systems and concepts which are necessary to describe specific aspects of disciplines are defined in separate domain ontologies
- Building Service Systems Ontology – BOS
Roadmap toward a unified ontology

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Conclusion & Future Work

- The structured comparison of the two ontologies highlighting their respective strengths and weaknesses

- TSO (https://w3id.org/tso#) has a strong scientific background and a high expressiveness

- FSO (https://w3id.org/fso#) has a strong practical background and a high simplicity

- TSO and FSO as starting points for the unified „shared“ conceptualization BOS

- Discuss concepts in the W3C LBDCG and with stakeholders from ontologies such as SEAS, SAREF, BRICK, REC and ifcOWL
Q&A