

## **W3C LBD Community Group**

### **Minutes - Call 16/11/2022**

#### **Attendees:**

- Mathias Bonduel (KU Leuven and Neanex Technologies)
- Katja Breitenfelder (Fraunhofer IBP / acatech)
- Elisabeth Eckstädt (Fraunhofer IIS)
- Vladimir Vukovic (Teesside University, UK)
- Rahel Kebede (Jönköping University, Sweden)
- Alex Donkers (Eindhoven University of Technology)
- Gonçal Costa Jutglar (La Salle BCN, Ramon Llull University)
- James Allan
- Edlira Vakaj (Birmingham City University, UK)
- Dimitris Mavrokapnidis (University College London)
- Francisco Regateiro (Lisbon University)
- Nabih Mousharbash (UNIVPM)
- Ali Küçükavci
- Gabriel Fierro
- Mads Holten Rasmussen (MHRA)

#### **Presentation slides**

- Github

#### **Date and time**

- 16/11/2022, Wednesday, 15:00-16:30@UTC/ 16:00-17:30@CET/ 07:00-08:30@PST/ 09:00-10:30@CST

#### **Moderators**

1. Mathias Bonduel

#### **Agenda**

1. Introduction of new members
2. Presentation: Elisabeth Eckstädt "Representing Modelica models as knowledge graphs using the MoOnt ontology"
3. Questions
4. Further topics

#### **Minutes**

1. **Introduction of new members**
  - a. Mousharbash Nabih Issam Michael: working on real time emergency simulation, Revit plugin.

- b. Gabe Fierro: Colorado, has been in the group earlier, working on BRICK.
- c. Dimitris Mavrokapnidis, PhD student at UCL.
- d. Ali Kükükcavci, PhD student Denmark, closely working with Mads, HVAC data in the design phase to build applications.
- e. James Allan, CH, attended Lissabon LDAC 2019.
- f. Vladimir Vucovic, researcher UK, interest in Modelica and BIM, integration of SAREF and BIM.

## 2. Presentation: Elisabeth Eckstädt “Representing Modelica models as knowledge graphs using the MoOnt ontology”

- a. Background:
  - i. HVAC design engineer, PhD researcher at TU Dresden, working at Fraunhofer Institute for Integrated Circuits IIS
  - ii. Expert in BIM and HVAC, less in information technologies. Open for suggestions
- b. Motivation
  - i. Energy simulation tools > modelica: very well suited for HVAC simulation in buildings. Impact on other stakeholders in planning. Planning and control system.
  - ii. Assumption: Modelica models as part of the Digital Twin (based on knowledge graphs / W3C standards).
  - iii. Specific focus on linking Modelica models with IFC > will not be discussed during the presentation.
- c. Previous works
  - i. Already from 2004 > semantic representation as ontology > no publication followed for a long time.
  - ii. 2017 > only storing simulation results in semantic KG.
  - iii. Wolfram modelica ontology > used as starting point for the research.
  - iv. Zeb 2017 > concluded that RDF is not a suitable approach.
  - v. Roxin 2021 > domain knowledge as relevant addition.
  - vi. Nachawati 2022 > framework for systems engineering for model catalog. Parser and ontology (ModelicaXXX - OML Ontology Modeling Language instead of OWL). Framework is not available.
- d. Knowledge engineering methodology
  - i. The five step approach > iterative procedure for ontology engineering.
  - ii. Specification > set of competency questions (CQ).
    - 1. Last CQ5 cannot be answered with the current knowledge graph > taking it into account for next work.
  - iii. Conceptualisation - formalization - implementation.
    - 1. Introduction to modelica > basics.
      - a. Modelica association
      - b. Object oriented modeling language > “text layer”

- c. Uses Daemola tool to apply the Modelica model > diagram, component list, library list.
      - i. Components and connectors.
      - ii. Connections are usually undirected.
      - iii. Components are instances of library elements.
      - iv. Components can have a text (code?) description, but not all.
    - d. Library stack in Modelica.
      - i. Basic = standard library by Modelica association (also take care of language spec).
      - ii. Other shared libraries such as IBPSA (four libraries share the same core). Not maintained anymore. Aixlib and MBL (Modelica Building Library) are mostly used in the research.
      - iii. User defined lib.
      - iv. Instance layer.
    - e. Mirrored the library stack with a stack of KGs
      - i. MoOnt representing the language.
  - 2. Term ontology > whole KG an ontology VS only Tbox an ontology.
    - a. AixLib is an instance and thus ABox <> AixLib is ontology from perspective of an instance layer.
    - b. Only MoOnt is called an ontology in the research.
  - 3. V3.5 of Modelica language => ontology (worked in Protégé).
    - a. Class hierarchy.
    - b. Relations.
    - c. Data type properties (no individuals).
  - 4. Simplified diagram from Wolfram system modeler ontology > already represents Modelica in ontology but has not been maintained since 2014.
    - a. Copied it and developed it further.
    - b. Main concepts remain the same.
      - i. Abstract super class > same as Modelica language spec.
      - ii. Model and Package are most used.
      - iii. Component > added ConnectorComponent and ParameterComponent.
      - iv. Added some relations.
      - v. Added small extra adjustments.
    - c. Resulting in a TTL file available on Github > has no license yet. Need to verify with colleagues.
  - iv. Maintenance and evaluation.
    - 1. Populating the KG: Modelica transcriptor tool (MoTTL).

- a. Difference from other research: can process large amounts of data when the library is updated.
  - b. In Java: uses Antlr > requires formal grammar language, e.g. from Modelica language spec -> basis for translator to create internal data model.
  - c. Most of the datatype properties are not (yet?) translated as they were not required for the CQs proposed.
- 2. Example
  - a. with AixLib from RWTH Aachen > 5000 modelica files with one or more modelica models.
    - i. Carnot\_y heat pump as example.
  - b. Instance level: setting up a heat pump in a building.
    - i. Grey parts are ignored (only needed for graphical representation of Modelica model).
    - ii. Some parts are currently converted to one large string literal > will be improved in the future.
- 3. Competency questions > showing benefits, testing with SPARQL queries.
  - a. CQ3 > parameters are not translated to the KG, it cannot be answered yet.
  - b. Queries executed in RDFLib (python).
    - i. First two CQ are answered on AixLib > loaded all lower levels for the test.
      - 1. CQ1: some types of components have partial interfaces with multi inheritance > difficult to foresee if you're not the original developer of the library > the KG helps.
      - 2. CQ2
      - 3. Query1 > takes a long time, scales badly.
      - 4. Query2 > timed out (4 levels)
      - 5. Queries are not very generalizable > looking for hints to optimize this.
    - ii. CQ3 and CQ4 also require the higher levels.
      - 1. CQ4: inputs/outputs are directed connectors > data points.
      - 2. Query 6: query the library part of the KG as well > also find the not connected ports.

### 3. Questions

- A. [Mousharbas] slide 10: which kind of notation? SysML?
  - a. UML diagram from x project. Wolfram system ontology that was reused.
  - b. Created a simpler diagram.

- B. [Gabriel Fierro] EPlus and Modelica are not mutually exclusive:  
<https://www.energy.gov/eere/buildings/articles/its-alive-after-five-years-lab-spawn-energyplus-finally-here> Promising approach
- C. [Vladimir Vukovic] is this part of some larger project? When do you see alignment with IFC happening?
  - a. Project finished last month.
  - b. Further development in PhD, perhaps part of a new research project.
  - c. [Vladimir] interested to join any projects.
- D. [Mathias] What are you trying to achieve with aligning modelica and IFC?
  - a. Vision: Jumping between modelica and IFC during the design phase is possible, using IFC to generate a simulation model/ and if there is a modelica simulation model first (e.g. in plant design) we would like to convert into ifc (without geometry) in order to extract specific information.
  - b. BRICK, BOT or CEN representation, perhaps IECowl representation could be used as bridging element .
- E. [Elisabeth] one of the PhD researcher working with Ana Roxin. What is the status of the work?
  - a. [Vladimir] Side project, waiting for funding.
- F. [Mathias] What are the main points for choosing the technologies?
  - a. Free available tools, standardized .
- G. [Elisabeth] What is the definition of an ontology?
  - a. (Mathias) Ontology as the conceptual layer distinguishing it from the data layer. The term is apparently used interchangeable with the term knowledge graph. Both are graphs and can be smashed together with, of course, makes it confusing.
  - b. (Alex Dónker) ontology as the t-box sharing concepts and relationships
  - c. (Mathias) a lot of things are standardized but this not applies to certain terms.
- H. [Mousharbash Nabih Issam Michael] works on real time emergency system (using Revit..). In the need of recommendations for publications etc.
  - a. (Mathias) best formalizing the questions and send it to the internal mailing list. Invitation to make an elevator pitch at the beginning of the upcoming LBD call in December (meeting invitation follows).

## Next Call

- Possible additional december call (meeting invitation follows after presenters will be found):  
 21/12/2022, 15:00-16:30@UTC/ 16:00-17:30@CET/ 07:00-08:30@PST/ 09:00-10:30@CST

We are interested in getting suggestions from the community about potential agenda items and **Elevator Pitches** for the following calls. Please send your suggestions to the chairs or to

internal-lbd@w3.org, whether you have a short presentation to bootstrap the discussion, and an approximate duration you think the discussion will last.

## **Previous minutes**

<https://www.w3.org/community/lbd/meeting-minutes/>