



ABCDE



## Scientific Report

First name / Family name

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Nationality

Pakistan

Name of the *Host Organisation*

Masaryk University, Faculty of Informatics, LaSArIS Lab, Brno, Czech Republic.

First Name / family name of the *Scientific Coordinator*

Assoc. Prof. Dr. Tomas Pitner

Period of the fellowship

01/01/2014 to 28/02/2015



## I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

### **Brief description**

I worked in LaSArlS lab with Assoc. Prof. Dr. Tomas Pitner, head of the team.

With colleagues in a team work, I designed a Middleware Ontological Model to integrate Building Management System (BMS), Building Information Model (BIM) and Computer Facility Management (CAFM) for the whole campus. The model provides information according to different SPARQL queries. The model not only covers the building information i.e. Location and Device Information but also information of various devices connected through BACnet address at each location. End user i.e. technical personals easily searches and identifies devices' location, connected with other devices and purpose of the device. This also supports to search historical data of a device.

### **Research Application Area**

The Middleware Ontology Model is used at Masaryk University, because the information related to the building is used by the technical staff working in Masaryk University. This model is used for searching required information by end users and could be extended for smart devices that provide solutions at hand. Masaryk University has in total of 200 buildings, 100 active devices and more then 100, 000 data points.

The Middleware Ontological Model informs the system about the critical information. The system forwards the information according to defined rules, which can be handled automatically or informs administrator or technical personal subsequently.

### **Scientific Activities**

#### **Introduction**

BMS, BIM and CAFM are the current systems used in Masaryk University. These systems provides intelligent building facility that covers multiple disciplines, which ensure functionality of built environment by integrating people, place, process and technology. Middleware Ontology Model is designed and integrated with BMS, BIM and CAFM for automatic intelligent decision making.

#### **Middleware Ontology Model**

Initially, Middleware Ontology Model is designed that integrates not only various type of information used in building automation system but also locates rooms and devices, where the devices are installed, with which index number and system, sub-system they are connected, and purpose of installed devices.

The required Information was collected according to the provided data used in systems. The current systems were analysed and relations between information was identified. This information is used for rooms allocations, allocations of installed devices, devices purpose and types of devices used in the various buildings. The model is also capable to inform the technical personal according to their queries. The Middleware Ontology Model also provides required information to the system which performs operations subsequently.

The Ontological model was constructed in different levels to connect similar room conventions used in different buildings and also at various floors, with index numbers assigned to various devices on the bases of installations in rooms. The different levels provides a unique URI for each of the concept (i.e. entity) in Ontology, this facilitate to achieve required results according to submitted queries. Therefore, we designed three levels of Ontology i.e. Abstract Level, Extended Level and Merge Level. The Abstract Level has the common concepts and relations extracted from provided data used at Masaryk University. The Abstract Level is also populated with BMS data because it is common for each of the



building in all campuses. The Extended Level is used for each of the building, because the BIM data is repeated in each building. To keep the uniqueness of BIM data for each of the building, the Extended Level of Ontology Model is used. The Merge Level is used for those devices that are shared between two buildings, for example central HVAC systems.

The Jena API is used to design a Web Application that connects the historical data of various sensors and other devices, available at CAFM. The Web Application connects the Ontology Model with currently running system at Masaryk University. In the whole scenario, I have connected BMS and BIM data through Ontology Model and CAFM is connected afterwards with Ontology Model through Jena API. The Abstract Level Ontology Model used in Middleware Ontology Model is shown in figure 1.

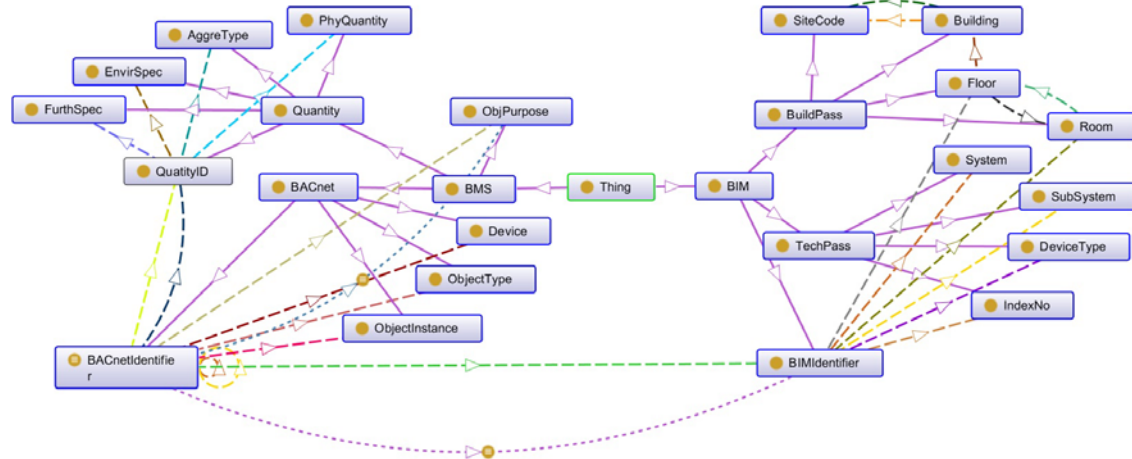


Figure 1: Abstract Level of Middleware Ontology Model

### Conclusion

The Middleware Ontology Model not only facilitates users in providing searching mechanism but also to analyse the various format of data/readings received from different sensors and entities. The model is capable to make accurate decision on the basis of defined rules that helps in fast and quick response to facility system for performing certain actions or to inform technical personal.

## II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. Smart Buildings: Semantic Web Technology for Building Information Model and Building Management System; ICoDSE, IEEE Publishers, Accepted paper, Conference from 26-28 Nov in Indonesia (2014).
2. Smart Buildings: Semantic Web Technology services for BIM (Location and Device Information); selected for Book Chapter in SCITEPRESS, 22. Nov, (2014).
3. Semantic Web Technology for Smart Buildings; Proceedings of 11th Summer School of Applied Informatics, Accepted Paper , Conference from 19-20 Sep in Bedrichov, Czech Republic, (2014).
4. Semantic Web Technology for Building Information Model; 9th ICSoft-EA, SCITEPRESS, ISBN 978-989-758-036-9, 109-116 (2014).

## III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. Attended and presented **Smart Buildings, Integration of various systems to facilitate**



- Facility Management.** Presentation organized by CTT & LaSArIS lab, Research and Development promo at LaSArIS, Promotion event for Business partners, Event; on 17th June 2014, at Hotel Continental, Kounicova, Brno, Czech Republic
2. Attended and presented paper at International Conference 9th ICSoft-EA, at Technische Universität Wien, Vienna, Austria.
  3. Attended and presented work at Summer School of Applied Informatics, at Bedrichov, Czech Republic.
  4. Performed duties as Program Committee Member for "International Conference on Data and Software Engineering 2014", <http://icodse.itb.ac.id/commite.html>
  5. Attended and presented paper at International Conference ICoDSE, at ITB, Bandung, Indonesia.
  6. Attended and presented current Project in 2 Days ERCIM ABCDE, Marie Curie, European Commission Workshop and 25 Years Anniversary, at CNR (Consiglio Nazionale delle Ricerche), Pisa, Italy.
  7. Attended a one day Workshop on "Smart Grid: Research Project by LaSArIS & Mycroft Minds", at Masaryk University, Brno, Czech Republic.

#### IV – RESEARCH EXCHANGE PROGRAMME (REP)

1. Artificial Intelligence Research Institute - CSIC, Catalonia, Barcelona, Spain
  - Worked with Prof. Dr. Marco Schorlemmer
  - One week stay at the Institute from 17th Nov to 21 Nov, 2014.
  - Presented my work at AIRI-CSIC.
  - **Semantic Alignment:**
    - Semantic Alignment is an Algorithmic alignment of somehow two similar Ontologies. The concept of Semantic Alignment is to design an Algorithm for those Ontologies, which are used for similar purpose and having somewhat similar relations and concepts. The Semantic Alignment algorithm is applied to use Ontologies at one platform, without disturbing the structure of Ontologies. The work is new for me, and I learnt a lot about algorithms that are used for various different Ontologies. The work is totally different form Ontology mapping, which is used in Semantic Web Technology. This expands my horizons of knowledge in working with Ontologies without disturbing actual structure of the model.
2. Secure Business Austria -SBA, Vienna, Austria
  - Worked with Dr. Peter Kieserberg and Dr. Stefan Fenz.
  - One week stay at the Institute from 15th Dec to 19 Dec, 2014.
  - Presented my work at SBA.
  - **SEMERGY:**
    - Middleware Ontology Model, designed at Masaryk University is of interest to the team leader of SEMERGY project. In Masaryk University we worked on BMS, BIM & CAFM, which is based on Location and Device Information. The one of main aim of SEMERGY is information optimization based on backhand calculations. This aims to integrate the optimization information (used at SEMERGY) with BIM & BMS information (used at Masaryk University). We have discussed the available information at Masaryk University at SBA and also discussed with LaSArIS lab team to design a project that optimise the available information. Looking forward for a new project.