A Sensor Networking Architecture for ENTROPY - Energy-Aware Information and Communication Technologies Infrastructure Enabling Smart Building Solutions

Aristotelis Agianniotis, Vincent Schülé, Antonio Jara, Mariam Barque, Dominique Genoud
Institute of Information Systems
HES-SO VS
Sierre, Switzerland
a.agianniotis.in@gmail.com

***Abstract*—The ENTROPY project aspires to significantly contribute to (1) the reduction of energy consumption, and (2) the reduction of micro-generated energy losses, in buildings. As part of this ongoing project, we have created a sensor networking infrastructure for the interconnection of heterogeneous smart sensors and devices, and the aggregation and fusion of data from multiple sources. The developed architecture provides the relevant and necessary data for the further development of energy-efficiency solutions for buildings with the aim to reduce the energy consumption and reduce the micro-generated energy losses. The sensor deployment is presented in this article for the two use cases of the HES-SO pilot. Ongoing work envisages to utilize the deployed infrastructure in conjunction with gamification techniques and serious gaming applications to record, and analyze the energy behavior of residents, and train them in order to adopt more energy efficient behaviors.**

Keywords-Wireless sensor networking; Data aggregation and fusion; Smart building; FIWARE platform; Information and communication technologies.

I. INTRODUCTION

The ENTROPY project [1] aims to significantly reduce the energy consumption and the micro-generated energy losses, in buildings. For this to be possible, we have to develop a suitable Information and Communication Technologies infrastructure for the HES-SO Technopole site which will provide the necessary energy-related and behavior-related data. In this article, we present the sensor networking architecture created for the ENTROPY project, and which architecture can be scaled, adapted, and applied to other industrial or residential applications. The deployed infrastructure will serve as a testbed for the ENTROPY project.

II. METHODS AND RESULTS

In order to facilitate the efficient aggregation of data management of smart sensors, we focus on the end-to-end interconnection of heterogeneous set of sensor networking devices, combined with existing monitoring systems and embedded devices, the design and application of efficient routing schemes and the efficient metering and storage of the collected information. We further take into account of Internet of Things (IoT) [2] networking principles for the interconnection of the network nodes. We define the whole functional and technical model of the smart metering process, together with the algorithmic and pilot part. Furthermore, we design and implement mechanisms that support efficient data aggregation and data fusion of the available data from the set of the sensor nodes in the networking infrastructure. We design techniques for information acquisition, learning and managing the associated knowledge to support the aforementioned functionalities, interlinking of collected data with other data sources available in the Linked Open Data cloud [3], and analyze the best data fusion techniques according to the requirements of the project and taking into account Complex Event Processing [4] solutions to correlate data coming from different data streams in different formats. In ENTROPY project, we take advantage of and leverage the tools for different functionalities of the FIWARE platform [5].

Sensor deployment in selected use cases of the HES-SO Technopole site is presented in Fig. 1 for the Institute of Information Systems (IIG) and in Fig. 2 for the restaurant MIKADO, respectively. The figures show the layouts of the two use cases and the specific positions of the installed sensors. Concretely, Fig. 1 shows the layout of the IIG and the position of installed sensors in the different rooms of the IIG (SAP, DUDE, YANN-OFFICE, POLARIS, Cyberlearn). Fig. 2 shows the layout of MIKADO with its different areas (main and secondary dining room, and kitchen) and the sensors currently installed there.

The sensor networking infrastructure in the HES-SO pilot is shown in Fig. 3. The ENTROPY pilot subnetwork infrastructure is centralized in the Access Point Dude-lab. The internal sensors are connected via Ethernet, Wi-Fi and 863.3 MHz radio wave. These different technologies give us a better flexibility on the sensors' placement. The Access Point then routes the connection towards the context broker server. Sensors outside of the network reach, such as the sensors of MIKADO, connect directly to the context broker server. After the data are collected, information is transmitted to the ENTROPY main server outside of our pilot infrastructure.

A minimum of 47 heterogeneous smart sensors and devices are interconnected. The devices and sensors consist of person counters, air thermometers, electric counters, energy meters, luminosity sensors, control valves, windows and door switches, CO2 detectors. Further, local weather

 ISBN: 978-1-61208-572-2

information and weather forecast is integrated into the system. The data aggregation and fusion takes place in almost real-time (adequate for the needs of the project). A frequency of one minute is adopted for all the data sources, with the exception of the weather forecast which occurs on an hourly basis. The data are stored in a MongoDB database and are available and can be queried at any time. A web portal [6] is also developed on which the HES-SO Technopole site manager is able to connect for assigning sensors to rooms, monitoring and visualizing data streams acquired, making queries and exporting data.

III. DISCUSSION

We have created a sensor networking infrastructure for the interconnection of heterogeneous smart sensors and devices, and the aggregation and fusion of data from multiple sources. The collected data include energy-related and behavior-related data. The developed architecture will provide the relevant and necessary data for the further development of energy-efficiency solutions for buildings with the aim to reduce the energy consumption and reduce the micro-generated energy losses. The developed architecture is developed for the HES-SO Technopole site and can be scaled and adapted to other industrial or residential applications. In order to achieve the aim of the ENTROPY project, on-going work envisages to utilize the deployed infrastructure which provides the data in conjunction with gamification techniques and serious gaming applications to record, and analyze the energy behavior of residents, and train them in order to adopt more energy efficient behaviors. To that end, the HES-SO pilot and other pilots are involved within the ENTROPY project and are working closely with academic and industrial partners.

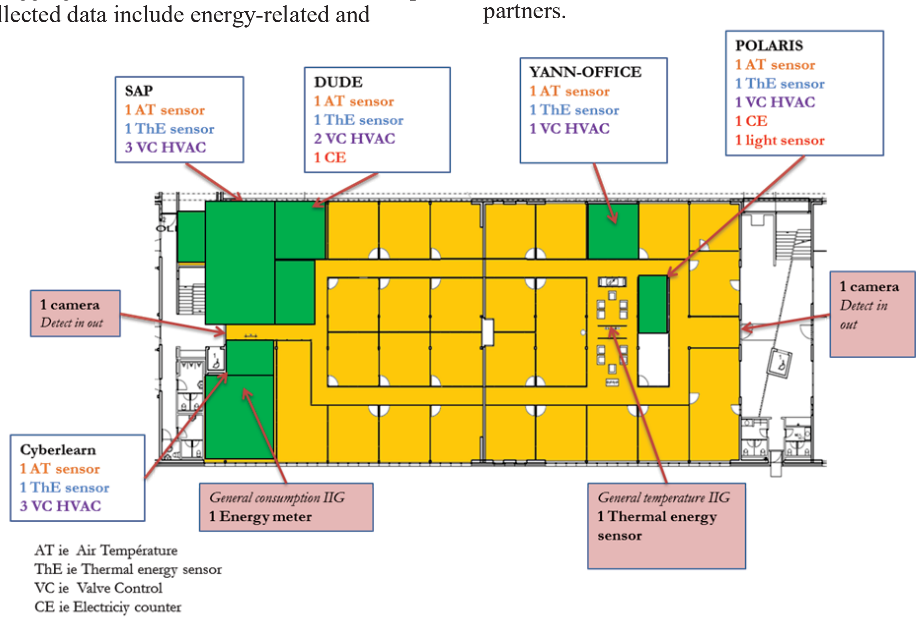

Figure 1. Sensor installation in the use case of the Institute of Information Systems (IIG).

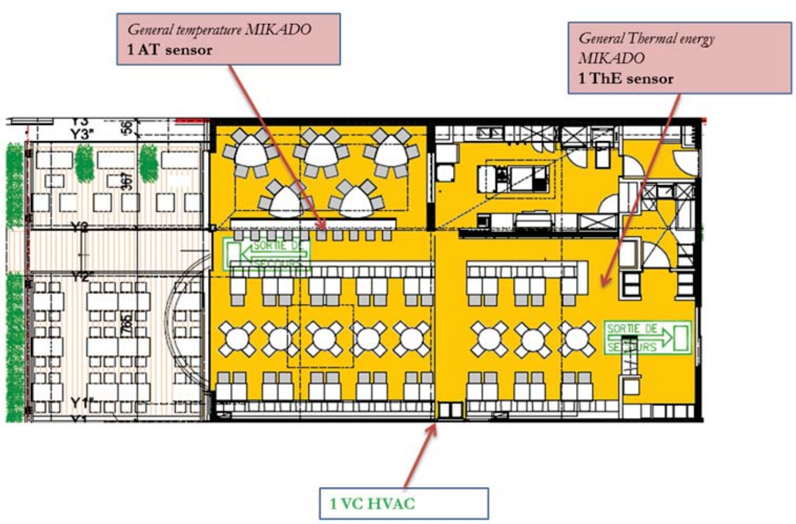

Figure 2. Sensor installation in the use case of the restaurant MIKADO.

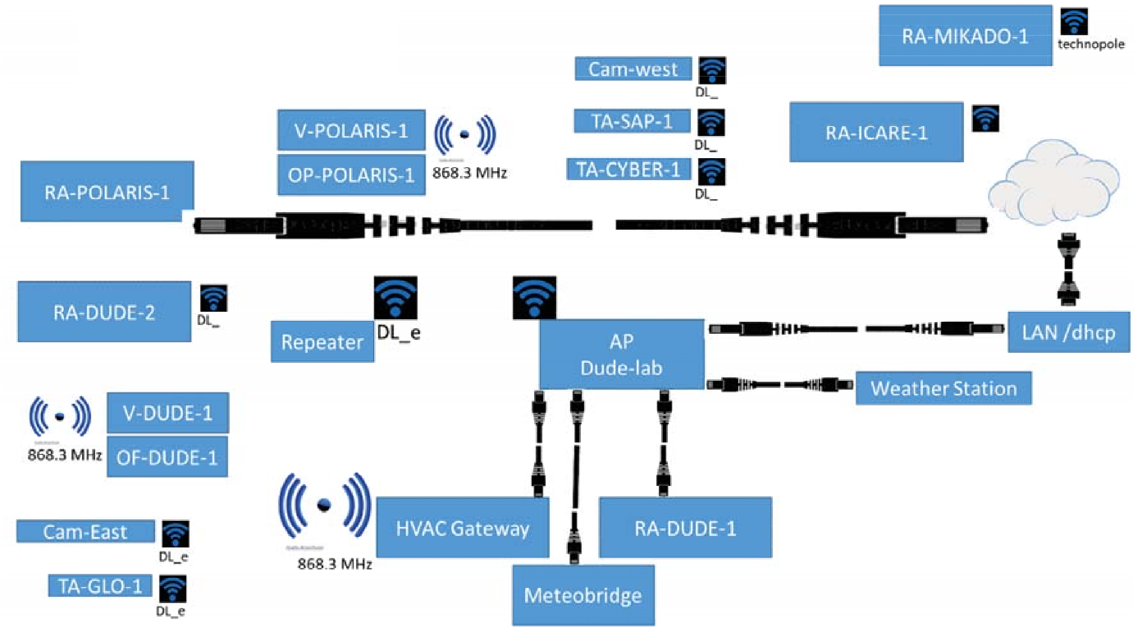

Figure 3. Sensor networking infrastructure in the HES-SO pilot.

REFERENCES

[1] Website of the ENTROPY project: http://entropy-project.eu/ 2017.05.16.

[2] C. Perera, A. Zaslavsky, P. Christen, and D. Georgakopoulos, "Sensing as a service model for smart cities supported by internet of things," Transactions on Emerging Telecommunications Technologies, pp. 81-93, 2014.

[3] V. C. Ostuni, T. Di Noia, R. Mirizzi, and E. Di Sciascio, "Top-N Recommendations from Implicit Feedback Leveraging Linked Open Data," IIR, pp. 20-27, 2014.

[4] D. C. Luckham, "Event Processing for Business: Organizing the Real-Time Enterprise,". Hoboken, New Jersey: John Wiley & Sons, Inc., 2012, ISBN 978-0-470-53485-4.

[5] Website of FIWARE: https://www.fiware.org/ 2017.05.16.

[6] Web portal of the ENTROPY project: http://entropy.euprojects.net/ 2017.05.16.