SESAME: Semantic Smart Metering - Enablers for Energy Efficiency

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Abstract. The high-level societal goal of the project SESAME is to facilitate home owners and building managers in saving energy within their environments and in optimizing their energy costs, while actively controlling and maintaining their preferred quality of living. To achieve this goal, we design a technical solution that integrates smart metering and building automation in order to offer energy-optimization capability for both the energy consumer and provider.

1 Introduction and Problem Statement

Climate change due to rising CO_2 emissions is one of the biggest environmental challenges of the 21st Century. Achieving 20% savings of energy consumption by 2020 through energy efficiency is one of the key measures to keep the CO_2 emissions under control[i]. Intelligent solutions for home/building automation and management can offer significant contribution to energy conservation (currently potential savings are estimated to 35%) while providing for advanced security through leakage detection, fire detection and suppression, prevention of unlawful intrusions, pollution reduction and environment protection, thus helping to combat climate change.

To fully exploit the capabilities of building automation systems for the purposes of energy management, these systems need to integrate now smart metering solutions. Advanced metering[ii] is today an important enabler for a real-time optimization of energy supply and consumption. It is based on a system that interconnects advanced utility (energy) meters deployed at the customer premises to the information and control systems at the energy supplier's or distributor's side. The purpose of smart metering is to acquire a detailed knowledge of a temporal energy usage patterns at appropriate levels of aggregation, such as consumption per apartment, per building, per residential area, etc. At the energy supplier side this information facilitates supply planning through prediction of the demand, and can be used to devise adaptive energy pricing to stimulate changes of these patterns. Presented to the end-customer, the information about the detailed energy usage can encourage more responsible consumer behavior, leading to energy savings. By changing his behavior to take into account adaptive energy pricing information customer can achieve cost optimization.

The interaction between the customers and the suppliers, in which energy-related data (meter data and tariffs) are exchanged, can be significantly improved through ICT technology enabling new generation of energy-aware home automation systems.

2 Technical Approach

Figure 1 illustrates a scenario with the building automation and advanced metering solution. Currently these solutions exist in parallel but are not integrated. The project SESAME aims at integration of these systems and will design components and interfaces to realize their joint potential.

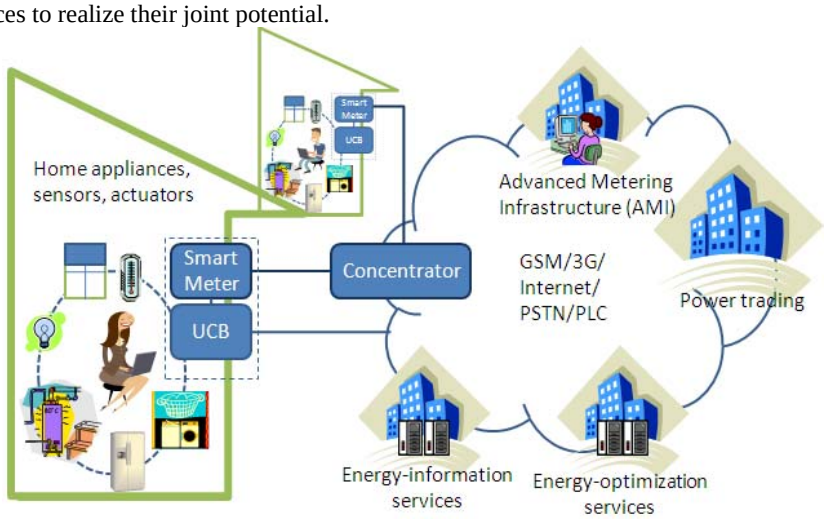

Figure 1: Towards Integration of Smart Metering and Building Automation

SESAME investigates two possible ways in which integration of a smart metering system and a building automation system can be accomplished.

The first approach is the one based on the current state-of-the-art and practices where advanced energy meters are exclusively controlled by an external operator, and hence the building automation system receives metering data only from remote sources. The second approach goes beyond this separation, and assumes that a central controller in a building automation system can establish local communication with the local smart metering device, or distributed energy meters embedded within the environment. For both settings ontology-based modeling, multi-objective policy-based reasoning methods and service-oriented architecture (SOA) design with appropriate security and privacy preserving mechanisms will be used.

Important research questions of the project SESAME are related to designing efficient semantic-enabled knowledge and service modeling approaches, as well as secure privacy-preserving communication techniques to improve interactions between the user and the home automation system, as well as, to facilitate direct automatic exchange of information between the energy suppliers and customers.

For the energy end-consumers the project designs a knowledge acquisition solution that supports creation and maintenance of policies describing preferences in energy use (e.g., green energy selection, reaction to dynamic tariff changes), as well as the rules describing how appliances within the environment will be operated - monitored, scheduled, regulated - based on the time, tariff data, real-life sensor data, real-time

energy consumption data, and appliances. The control and monitoring capability of devices will be realized through services which will be triggered and combined based on the policy-based reasoning[iii].

3 End-User Services - Evaluation

Targeting energy providers and grid operators, the project designs a foundation for a new type of services for interaction with the end customers – the so called energy services. Two technical feasibility and economic benefits of two types of services will be investigated: the energy information services and energy optimization services.

Energy Information Services automatically channel relevant energy information (e.g., pricing) over the Internet into the user policy framework for employment in the reasoning mechanisms. Today similar services are designed with a web browser interface presenting information to the user browsing through the information site. The aim of the project SESAME is to propose specific service definition that can be published and used for practical realization of service instances providing machine-optimized access to information of different providers. This approach can enable that changes in relevant information trigger events and automatic decision making at the user side.

Energy Optimization Services enable the users to co-control their environment together with the energy supplier. With such services in place, the control actions such as switching on/off of devices, configuring actuators, etc., can be on the one hand triggered from the supplier's control system with the goal to achieve higher level of energy optimization. On the other side these actions still need to be constrained by a special set of user-defined policies in order to guaranty that user expectations are met.

In the context of customer-provider interaction the issues related to the privacy and dependability of information, as well as accountability for committed changes and actions are of high importance. The project will address these issues in interaction with energy providers and end-consumers, and propose techniques to deal with potentially divergent requirements and constraints of different stakeholders in the energy market.

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[ii] European Smart Metering Industry Group (ESMIG), http://www.esmig.eu/smart-metering.

[iii] Zhdanova, A.V., Zeiss, J., Dantcheva, A., Gabner, R., Bessler, S. "A Semantic Policy Management Environment for End-Users and its Empirical Study". Networked Knowledge - Networked Media: Integrating Knowledge Management, New Media Technologies and Semantic Systems (Eds.: Schaffert, S., Tochtermann, K., Auer, S., Pellegrini, T.), Springer Verlag (2009).