Consumer-centric and Service-oriented Architecture for the Envisioned Energy Internet

Søren Aagaard Mikkelsen and Rune Hylsberg Jacobsen
Department of Engineering, Aarhus University

Motivation & Overview

- Residential sector in EU: **26.6%** of the global energy consumption
- Internet-based companies sees an oppontunity in being Energy Service Companies (ESCOs)
- Energy-aware services can generate a profitable market for stakeholders
- **Problem:** Personal information can be extracted from the electric meter data
- **Contribution**: Service-oriented architecture that combines software agents and recent Internet-based technology with a privacy defense-in-depth approach

Assumptions & Adversary Model

- Home Energy Management System (HEMS) manufactures are benign
- Meter data obtained are legitimate and securely sent
- The authentication and authorisation service authorises only given the consumers' constent
- DSO and ESCOs are considered honest-but-curious adversaries
- DSO gives the "best" price to the consumer based on the avaliable information

Goals

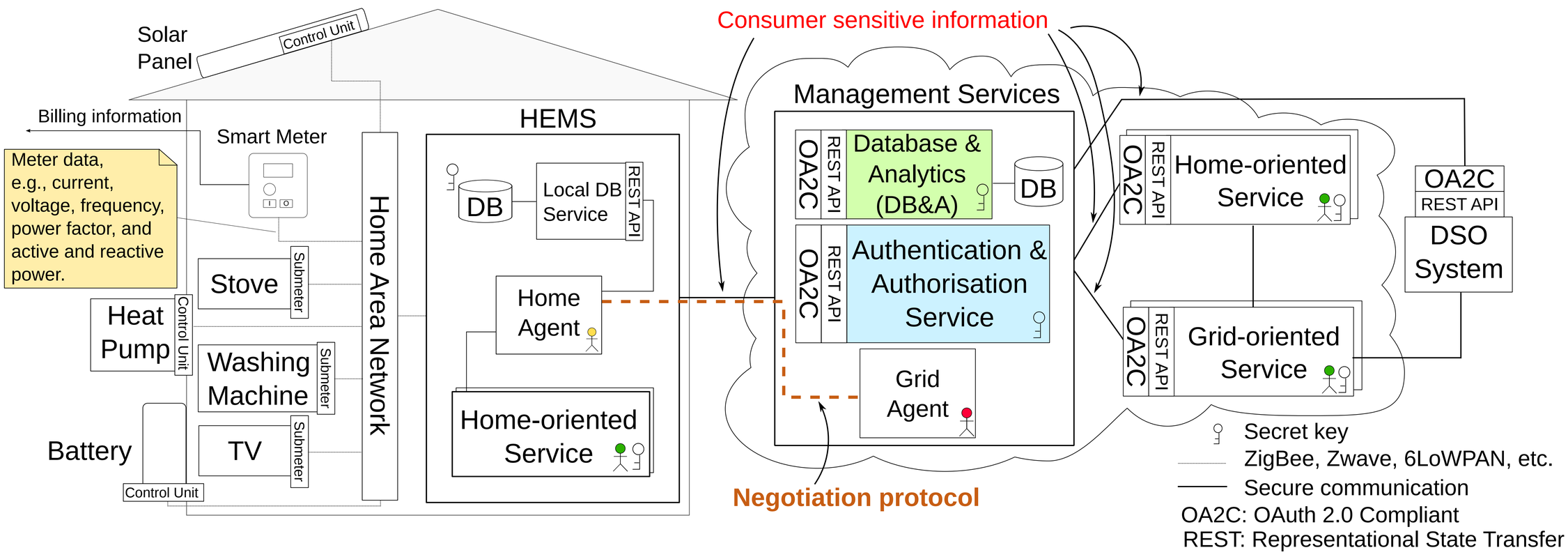
Overarching goals:

- Minimising energy usage and cost for the residential consumer
- Optimising operation of the grid for the Distribution System Operator (DSO)

Consumer centricity means:

- **Portability**: The liberty for the consumers to choose their energy service provider for handling data storage and processing
- **Privacy**: The decision to choose the desired level of privacy and the control of the physical location where their data are stored
- **Adaptability**: The possibility to participate voluntarily in adapting their energy usage to more preferable times
- **Opt-out**: An easy way for opting out of the contract to the DSO and ESCO, if they do not want to participate
- **Autonomy**: A system that requires minimal of effort for participating

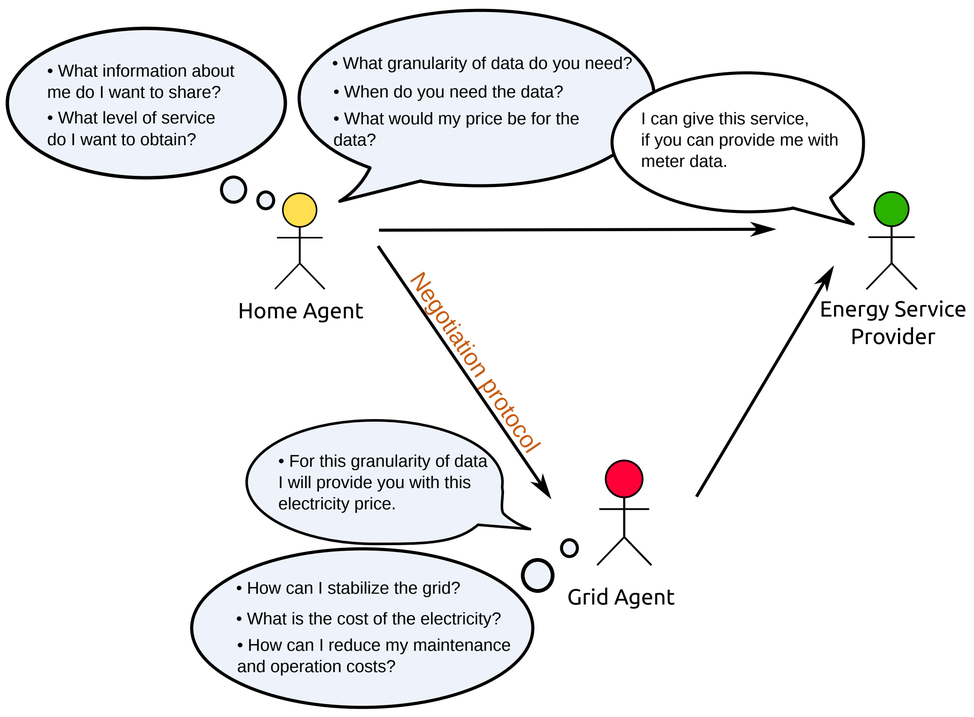
System Model



Negotiation Protocol

Purpose

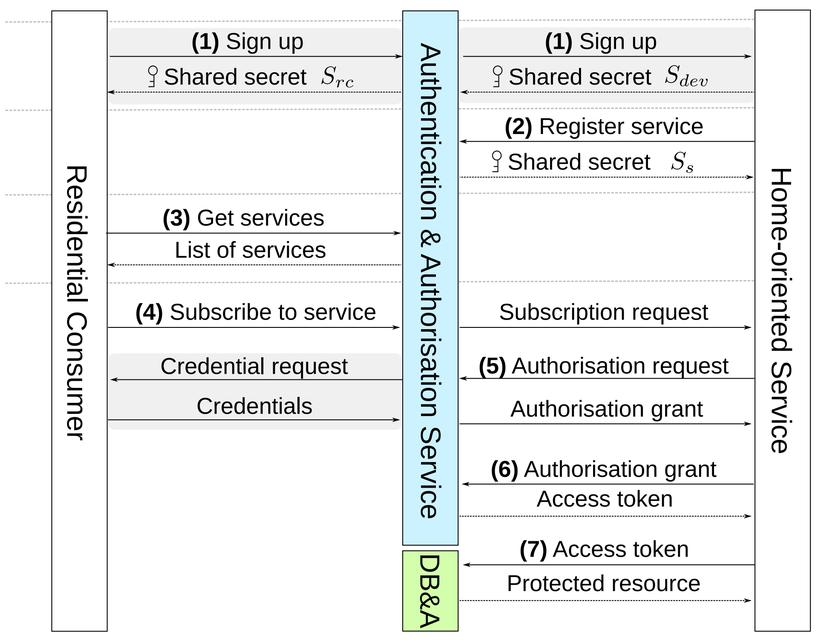
- To exchange near real-time data from electric meters installed at the consumer's premise through a negotiation protocol that protects the residential consumer's privacy



Authentication & Authorisation

Overview

- An extension to the OAuth 2.0 protocol that allows residential consumers, ESCOs and DSOs to authorise specific access to each other's data through web tokens



A successful authentication and authorisation cycle between the residential consumer and a home-oriented service. Protocol phases are indicated by (·)

Conclusion and Future Work

Conclusion:

- Service-oriented architecture constructed in compliance to challenges and assumptions
- Meter data are stored in the HEMS at the residential consumer's premise
- Data authorisation to ESCOs are controlled in the cloud using an extended version of the OAuth 2.0 protocol

Future Work:

- Design and implementation of algorithm in HEMS for extracting user behavior from meter data to present to the residential consumer
- Implementation and evaluation of negotiation protocol between the home agent and grid agent
- Implementation of authentication and authorisation service to comply to the smart grid ecosystem

Acknowledgement

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 317761