Residential Energy Gateway (REG) Reference Design

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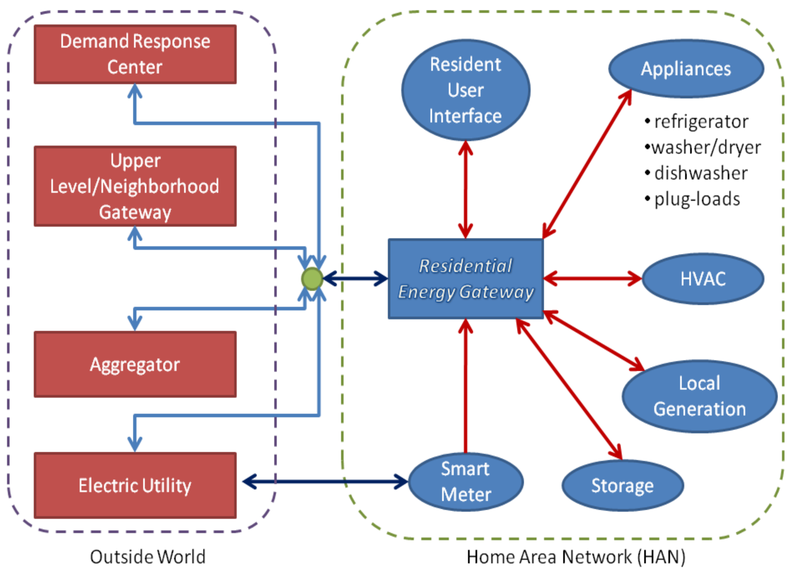
Overview

Since 2009 we have been developing a software suite to enable different HAN components to exchange energy-related information and participate in supervisory control events. The software uses the highly modular OSGi software framework for JAVA to enable interoperability between heterogeneous communications media in the residence. The software easily allows new applications to be integrated into the existing codebase.

Residential Energy Gateway



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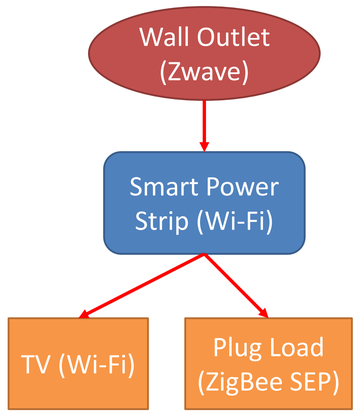
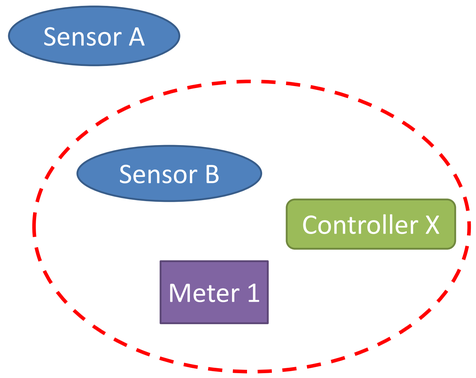
Major Innovations



Device Hierarchy: Removes ambiguity in measurement and control

Gateway Measurement/Control Resources



Virtual Associations: link different sources of information to form something meaningful to the resident

Milestones/Achievements

- Embedded web server
- Embedded database
- DHTMLX scheduler
- Integrated external demand response resource into REG (OpenADR)
- Smart Meter connection
- 5 conference publications
- 2011 DOW Sustainability Innovation Student Challenge Winner
- Project completion: December 2013

As a tool for control:

Operate plug loads for demand response

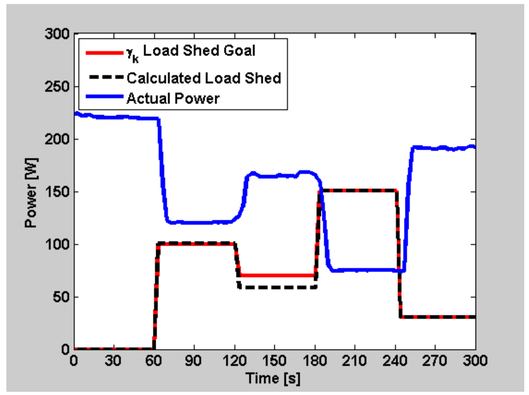
$$\min_{[x_1,x_2,\ldots,x_n]} \left| \gamma_k - \sum_{i=1}^{n} c_{i,k} x_i \right| + \beta_k \left(\sum_{i=1}^{n} p_{i,k} x_i \right)$$

$$s.t. \quad \sum_{i=1}^{n} p_{i,k} x_i \leq \sigma_k \, , \, x_i \in \{0,1\}$$

x_i	Actuation state of device (outlet): 0 = on, 1 = off	Solved for
γ_t	Load shed goal at time t [W] (shed from prior to event)	From CBC
$c_{i,t}$	Power use of device i at time t [W]	Device property
$p_{i,t}$	Incurred inconvenience from actuation of device i at time t	User defined
β_t	Weighting between meeting shed goal and inconvenience [W]	From CBC
σ_t	Maximum allowable inconvenience for time t	From CBC

CBC: Central Building Controller – sends control signals to Gateways in DR testing

Resulting Load Shed



Resident Inconvenience