

WattDepot: Enterprise-scale, sensor-based energy data collection and analysis

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Summary

Enterprise-scale energy data collection and analysis is becoming increasingly important with the advent of the “Smart” grid. We have developed and released an open source, sensor-based system called WattDepot for collecting, storing and analyzing energy data to fill this niche that is greater than individual households but less than entire utility grids. WattDepot is designed to allow data collection from a wide variety of energy production and consumption devices, and to support diverse visualizations and delivery of the data. We are using WattDepot to support a campus dormitory energy competition for Fall 2010. Since the process of selecting, purchasing, and installing the meters is ongoing, we have developed an end-to-end simulation of dorm energy to ensure that the WattDepot software sensors would work with any of the chosen meters. WattDepot’s sensor-based, service-oriented architecture makes it useful to a wide variety of energy application domains.

Motivation

Energy conservation has been proposed as one way to deal with the coming global energy crisis. Previous research has demonstrated that direct energy usage feedback of leads to reductions of 5-15% in energy use¹, which has been confirmed in dorm competitions². Our research examines the sustainability of energy behavior changes by monitoring energy usage before, during, and after behavioral interventions (such as competitions).

To support our research, we needed to collect energy data from meters on each floor of the dorms and visualize it in a variety of formats on a competition website. Systems exist for handling energy data on the individual home scale, such as the TED 5000, and on the utility scale, but we found no open system at a scale between those extremes.

Results

To support our needs for enterprise-scale energy data collection and analysis, we created WattDepot: a general-purpose system for dealing with energy data. WattDepot consists of software sensors that collect data from measurement devices, which is stored in a server repository, and queried by visualization clients as shown in Fig. 1. By using small software sensors to collect data from devices, WattDepot makes it easy to support diverse meters. By separating collection, storage, and presentation into separate services that communicate using a RESTful API, WattDepot is easily adaptable to different domains.

After researching power meters to use for the competition, we decided to focus on meters supporting the Modbus/TCP standard. Modbus/TCP is a low-level protocol where clients query registers on the remote meter over the Internet. Fig. 2 shows a diagram of the data flow in the simulated system. Modbus-supporting meters record data such as instantaneous power and energy used in registers, and the locations are different for each manufacturer. The meter simulations respond to queries from WattDepot sensors for the appropriate registers. An embedded simulation of a dormitory floor generates the data that the meter simulations send. Using simulated modules allows ‘what-if’ investigations into WattDepot’s architecture.

¹ S. Darby, “The effectiveness of feedback on energy consumption”, Technical report, Environmental Change Institute, University of Oxford, 2006.

² J. E. Petersen, V. Shunturov, K. Janda, G. Platt, and K. Weinberger, “Dormitory residents reduce electricity consumption when exposed to real-time visual feedback and incentives”, *International Journal of Sustainability in Higher Education*, 8(1):16–33, 2007.

Figures

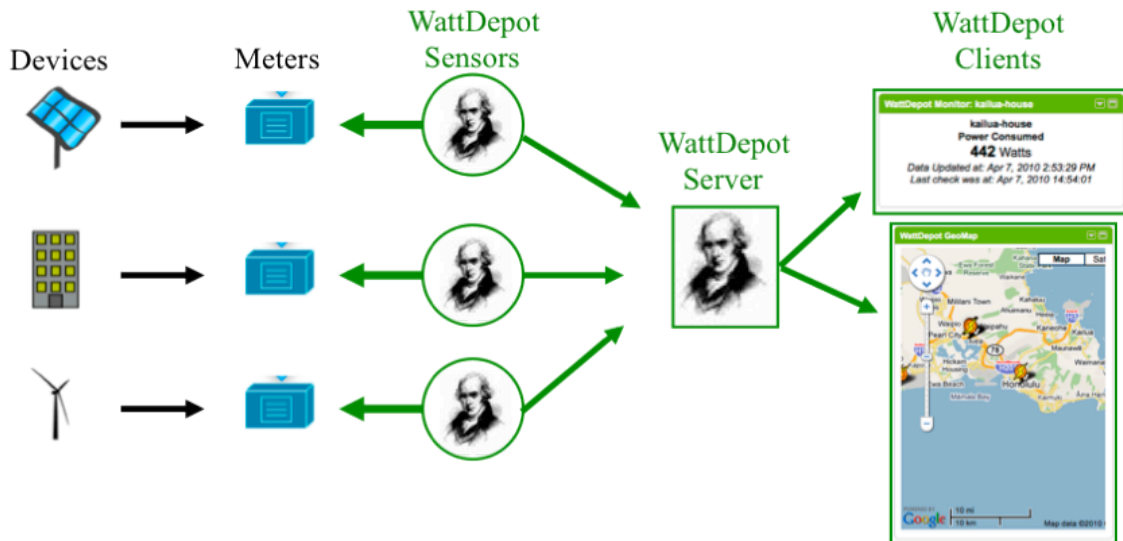


Fig. 1: The WattDepot architecture, showing sensors, server, and clients

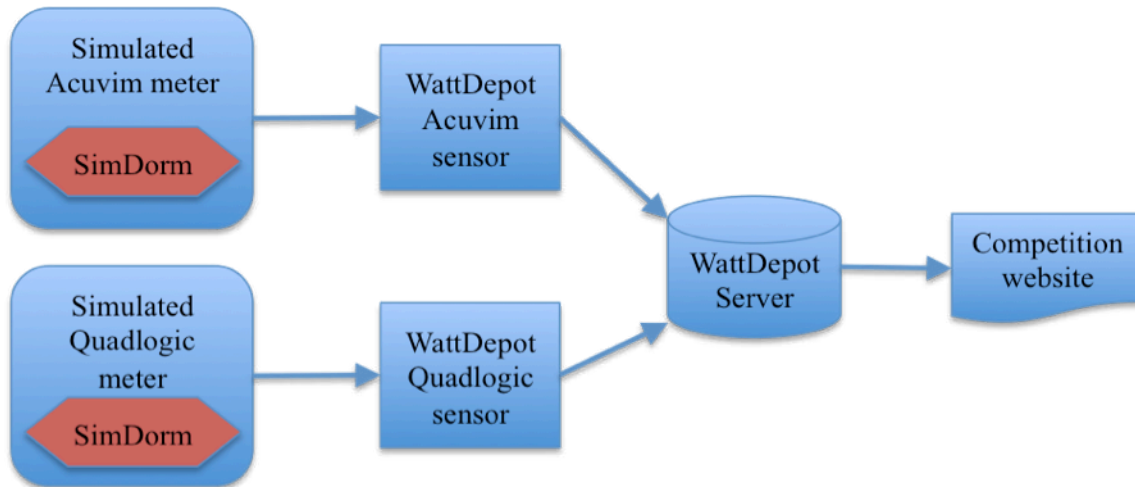


Fig. 2: End-to-end testing using simulated meters from two vendors generating simulated data