A VIRTUAL TESTBED FOR SMART MICRO GRIDS

A. Sant'Anna[1], V. Gaspes[1], W. Taha[1], R. Bass[2]

1. Centre for Research on Embedded Systems, Halmstad University, SE-301 18 Halmstad, Sweden
2. Power Engineering Lab, Portland State University, 97207 Oregon, USA

This project is part of CERES+. The project addresses the cooperation between Portland State University (PSU) and Halmstad University (HU) and strengthens the group at HU working on modeling cyber physical systems. The project started on June 2012 and is concerned with the development of models and simulations that support the study and development of smart micro grids.

1. Background and Motivation

Electrical grids with the ability to automatically gather, monitor, and react to information are commonly referred to as "smart grids". Grids are becoming "smarter," in part, thanks to the proliferation of phasor measurement units (PMU), which enable synchronized real-time measurements of multiple remote points on the grid. The tendency for the future is to have more and more of these units deployed throughout the grid, making new ways of monitoring and managing power systems possible.

Power systems are composed of three main elements: generation, transmission and distribution. These can span thousands of kilometers and provide electricity to thousands of houses, offices and industries. In this project, however, we will consider small parts of the grid referred to as micro grids. An example of micro grid could be a neighborhood or a university campus.

In this context, smart buildings are important components of smart micro grids. They can monitor the use of electricity, optimize costs based on current electricity prices and even predict its occupant's needs.

2. Problem Statement

Micro grids can be decomposed into three layers:

- The *physical layer*, which includes appliances and equipment that consume electricity;
- The *sensor and communication networks*, which gather and transmit information about the grid;
- The *grid management*, which processes the acquired information and makes decisions about when and how to use electricity.

Normally, each layer is studied separately. However, smart grids are the combination of all three and can only be studied by considering all three layers together.

This project addresses the need for models and simulation tools that can consider all three layers concurrently.

3. Approach

This project will be organized as two interrelated studies. The activities of each of the studies are explained below.

A. Residential heating systems for demand response programs

This study will develop models of residential heating systems composed of an isolated water tank and forced convection. It is believed these heating systems may be used by electricity distribution companies to dynamically adjust voltage, frequency and load in the grid - known as demand response programs. Simulations will be used to investigate whether this is possible to achieve without compromising the thermal comfort of the home.

B. Modeling a smart home: development and validation

This study will develop models of home appliances and other residential loads, as well as models of sensors and management schemes that are feasible with the technology commercially available today. This incorporates all three layers described in Section 2. These models will represent a real home where data can be collected. The acquired data will be compared to the simulated data in order to validate the models.

PARTNERS AND STATUS

Funding: CERES+ (KK foundation)
Duration: 01 June 2012 – 01 June 2013
Project coordinator: Veronica Gaspes

This project includes two trips to Portland, Oregon, where Anita Sant'Anna can meet and interact with Robert Bass and his team, and a number of other actors in the field of smart grids. The first trip took place during October 2012.

The first study is being conducted jointly with Robert Bass at Portland State University. The respective publication will be written during January and February 2013.

The second study will enlist the help of Hans Erik Eldemark. Most models have been developed, but the data collection and the writing of the respective publication will take place during February, March, April and May 2013.

PUBLICATIONS

Two publications have been planned:

- A feasibility study of the use of residential heating systems for demand response programs based on simulations;
- Comparison of simulation results and real data collected from a smart home.