the ENERGY lab

PROJECT FACTS

Advanced Research

Distributed Sensor Coordination for Advanced Energy Systems

Background

As advanced energy systems grow in size, they require an increasing number of pressure, temperature, and composition sensors for optimal control and operation. In many cases, communication of individual sensors with a central controller is inefficient. Distributed systems consisting of groups of sensors communicating with an assigned controller have been around for a long time, but coordinating their efforts to optimize efficiency and operational parameters remains a challenge. The U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL) sponsors several research projects to address this technology need. In this project, Oregon State University researchers will develop control algorithms to manage a network of sensors that can collect and process data and provide key control decisions. The project will focus on developing a sensor algorithm that will lead to a good network-wide solution, while allowing individual sensors to function independently.

Objectives

The project will derive, implement, and test agent-objective functions that promote coordinated behavior in large sensor networks. The long-term objective of the project is to provide a comprehensive solution to a scalable and reliable sensor coordination problem leading to safe and robust operation of advanced energy systems.

Description

Project work will be focused in two areas including (1) deriving criteria for assessing the impact of sensor locations and objectives; and (2) demonstrating the effectiveness and reconfigurability of sensors in response to a change in performance criteria.

Achieving these objectives requires quantifying the effectiveness of various sensor configurations. The project will directly evaluate the impact of information quantity on the effectiveness of the sensor configurations and will quantify the amount of global information necessary for different sensor configurations to effectively

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PERIOD OF PERFORMANCE

11/01/2009 to 10/31/2012

COST

Total Project Value
$887,606

DOE/Non-DOE Share
$709,217 / $178,389

assess the state of the system. Approximately five tests may be conducted with 100 sensors where access to global information will increase from 0 to 100 percent in intervals of 25 percent.

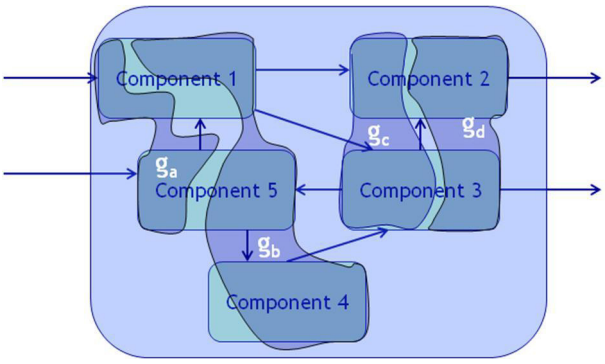

Figure 1. Algorithms automatically group sensors into subsystems. Each group may contain sensors from several different components of the energy system. The groups are selected so that optimizing each group individually will lead to the best overall system performance.

Project researchers will test sensor objective functions (instructions) under increasingly challenging conditions. The tests will devolve from *ideal network conditions*, to *noisy conditions*, where some information will be corrupted, and then to *faulty conditions*, where varying numbers of sensors will fail or deliver spurious readings. Following successful completion of these tests, the reconfigurability of the sensors in response to a change in performance criteria will be evaluated, first through computer simulation, and then in an actual hardware test bed.

Benefits

A successful demonstration of this technology will lead to reliable, robust, scalable, and reconfigurable sensor networks, which will enhance the efficiency of advanced power systems through more precise control. In an advanced energy system, sensor networks will allow information to be collected more efficiently, more quickly respond to sudden developments, and allow for autonomous system reconfiguration. Smart sensor networks provide other benefits to the DOE and the U.S. government through their use in a smart power grid, coordinated search and rescue, and self-organizing nano/micro devices. Inside smart homes, smart highways, and smart airports, sensor networks can facilitate real-time coordinated control of multiple assets in order to increase efficient use of energy.

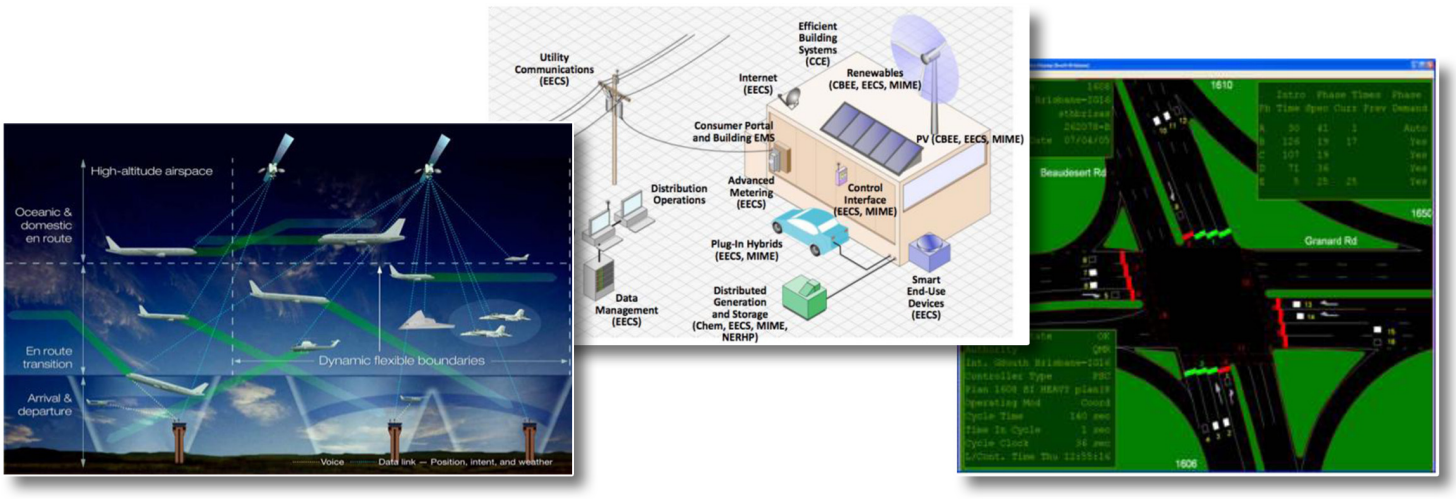

Figure 2: Sensor coordination in power plants will allow more efficient operation of the plants. Sensor networks can be applied to smart homes, smart airports, and smart highways to allow real-time, responsive distribution of power and management of traffic flow.