Electrical and Computer Engineering

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Title:
"Decentralized coordination of on/off consumer loads to provide energy storage service to the power grid"
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Abstract

As we move away from fossil fuels and toward intermittent renewable energy sources such as solar and wind, inexpensive energy storage technologies are required. An alternative to batteries – which are quite expensive – is “smart loads”, such as air conditioners equipped with computation and communication capability. With appropriate software, the power consumption of air conditioners -- and many other loads -- can be varied around a baseline. This variation is analogous to the charging and discharging of a large battery. Loads equipped with such intelligence have the potential to provide a vast and inexpensive source of energy storage. Two principal challenges in creating a reliable “virtual battery” from millions of consumer loads include (1) coordinating the actions of many loads to track a grid-supplied reference signal while maintaining every consumers’ Quality of Service (QoS) within strict bounds, and (2) determining capacity of a collection of such loads that can be used for planning, e.g., answering questions such as “how many MW/MWh is a collection of 100,000 air conditioners equivalent to?”. The on/off nature of residential loads is a key challenge, since a direct approach leads to an intractable mixed integer optimization problem.

This talk describes a novel approach that addresses these challenges by using randomized control architecture and a Markovian aggregate model of the collection. A key advantages of our approach – compared to prior work – are that (i) it allows determining capacity with all QoS constraints: temperature, lock-out time, and energy cost of the consumer while prior work only considers temperature, (ii) it yields a decentralized coordination scheme that is scalable to millions of loads with minimal communication, and (iii) it provides computationally tractable methods for real-time scheduling and off-line planning that are useful to the grid operator.

Biography

Prabir Barooah is a Professor of Mechanical and Aerospace Engineering at the University of Florida, where he has been since 2007, and is currently a University Term Professor. He received the Ph.D. degree in Electrical and Computer Engineering in 2007 from the University of California, Santa Barbara. From 1999 to 2002 he was a research engineer at United Technologies Research Center, East Hartford, CT. He received the M. S. degree in Mechanical Engineering from the University of Delaware in 1999 and the B. Tech. degree in Mechanical Engineering from the Indian Institute of Technology, Kanpur, in 1996. Dr. Barooah is the winner of the ASEE-SE (American Society of Engineering Education, South-East Section) outstanding researcher award (2012), NSF CAREER award (2010), General Chairs' Recognition Award for Interactive papers at the 48th IEEE Conference on Decision and Control (2009), best paper award at the 2nd Int. Conf. on Intelligent Sensing and Information Processing (2005), and NASA group achievement award (2003).