The Electrical and Computer Engineering Program presents

ECEN Seminar Series

Signal Processing in Smart-Grid Networks

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Thursday, 23 February 2012, 12 – 1 p.m.

Lecture Hall 144

Light lunch will be served

Future electrical grid networks will consist of many distributed sources. The very nature of many new distributed resources, including responsive demand, is stochastic, highly volatile and hard to predict. Moreover, the system may be prone to cyber-security threats. This challenges the fundamental assumptions underlying today's operations and planning which are by and large deterministic. In particular, a holistic stochastic formulation is needed to state the problem of sensing and communications as an integral part of supply/demand dispatch during normal conditions as well as during failures. They key is to bring probabilistic reasoning into supply and demand balancing because without such proactive tracking of the system state, the worst-case design approach to ensuring reliable services becomes unacceptably inefficient, and, at the same time, does not provide information about the likelihood of the worst-case service scenario. We propose an approach that brings together the probability estimates based on the sensed and communicated information.

In particular, in this talk we consider two basic problems in monitoring smart micro-grid networks. The first is the selection of sensor placements, and the second is the system tracking. The basic assumption is that the affordable number of sensors is much smaller than the total number of nodes in the system, and that the system tracking problem must be solved with such a small number of sensors. We propose several solutions to the posed sensor placement and state tracking problems. Interestingly, these solutions are related to well known signal processing algorithms in communication systems. First, we will show that the upper bound on the performance achieved by the best positions of sensor positions is related to the Rayleigh quotient. Second, we will show that the best known practical method for choosing the sensor locations relies on a version of the Viterbi algorithm, and finally, we will reveal how the well-known belief-propagation method can be used to track the system state in a smart micro-grid network. The talk develops the appropriate theoretical background, derives the algorithms and shows simulation results that demonstrate the performances of the derived signal processing methods for monitoring the electrical grid.

Aleksandar Kavcic received the Dipl. Ing. degree in Electrical Engineering from Ruhr-University, Bochum, Germany in 1993, and the Ph.D. degree in Electrical and Computer Engineering from Carnegie Mellon University, Pittsburgh, Pennsylvania in 1998. Since 2007 he has been with the University of Hawaii, Honolulu where he is presently Professor of Electrical Engineering. Prior to 2007, he was in the Division of Engineering and Applied Sciences at Harvard University, as Assistant Professor and Associate Professor of Electrical Engineering. He also served as Visiting Associate Professor at the City University of Hong Kong in the Fall of 2005 and as Visiting Scholar at the Chinese University of Hong Kong in the Spring of 2006. Prof. Kavcic received the IBM Partnership Award in 1999 and the NSF CAREER Award in 2000. He is a co-recipient, with X. Ma and N. Varnica, of the 2005 IEEE Best Paper Award in Signal Processing and Coding for Data Storage. He served on the Editorial Board of the IEEE Transactions on Information Theory as Associate Editor for Detection and Estimation from 2001 to 2004, as Guest Editor of the IEEE Signal Processing Magazine in 2003-2004, and as Guest Editor of the IEEE Journal on Selected Areas in Communications in 2008-2009. From 2005 until 2007, he was the Chair of the Data Storage Technical Committee of the IEEE Communications Society.

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