Stanford University

TomKat Center for Sustainable Energy
Precourt Institute for Energy
Energy and Environment Affiliates Program
Civil and Environmental Engineering
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Stanford SmartGrid Seminar

Resilience and Risk in Networked Systems

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Abstract: We will present recent work on the resilience and risk of failure emerging in cyber-physical infrastructures such as smart transportation systems and the smart grid. We will present results on the volatility and risk of failure associated with real-time response in the future smart grid. Real-time demand response has been postulated as the solution to the intermittency problem created by renewable generation. The proposed market architecture is simple, namely, consumers react directly to spot market prices in order to fulfill their demands. This mechanism creates a closed loop system between price and demand that has implications on efficiency, demand and price volatility, and risk of demand spikes. In this talk, we first present an analysis of this closed loop system for homogeneous consumers and highlight the tradeoffs between market efficiency and demand and price volatility. Then, we present an abstracted framework to analyze the tradeoffs between efficiency and risk for heterogeneous consumers in the presence of shiftable demands. In this context, we expand the market mechanism to study the impact of coordination on such a tradeoff. We show that although the non-cooperative load-shifting scheme leads to an efficiency loss (otherwise known as the price of anarchy), the scheme has a smaller tail probability of the aggregate unshiftable demand distribution than cooperative schemes. This tail distribution is important as it corresponds to rare and undesirable demand spikes. Such instances highlight the role of the market mechanisms in striking a balance between efficiency and risk in real-time markets.

Bio: Munther A. Dahleh} received the B.S. degree from Texas A \& M university, College Station, Texas in 1983, and his Ph.D. degree from Rice University, Houston, TX, in 1987, all in Electrical Engineering. Since then, he has been with the Department of Electrical Engineering and Computer Science, MIT, Cambridge, MA, where he is now the Associate Department Head. Previously, he was the acting director of the Laboratory for Information and Decision Systems. He has been a visiting Professor at the Department of Electrical Engineering, California Institute of Technology, Pasadena, CA, for the Spring of 1993. He has held consulting positions with several companies in the US and abroad.

He is the co-author (with Ignacio Diaz-Bobillo) of the book *Control of Uncertain Systems: A Linear Programming Approach*}, published by Prentice-Hall, and the co-author (with Nicola Elia) of the book *Computational Methods for Controller Design* published by Springer.