Abstract:

We consider the problem of a Load Serving Entity (LSE) trying to reduce its exposure to electricity market volatility by incentivizing demand response in a Smart Grid setting. We focus on the day-ahead electricity market, wherein the LSE has a good estimate of the statistics of the wholesale price of electricity at different hours in the next day, and wishes its customers to move a part of their power consumption to times of low mean and variance in price. Based on the time of usage, the LSE awards a differential number of “Energy Coupon” to each customer in proportion to the customer’s electricity usage at that time. A lottery is held periodically in which the coupons held by all the customers are used as lottery tickets.

Our study takes the form of a Mean Field Game, wherein each customer models the number of coupons that each of its opponents possesses via a distribution, and plays a best response pattern of electricity usage by trading off the utility of winning at the lottery versus the discomfort suffered by changing its usage pattern. The system is at a Mean Field Equilibrium (MFE) if the number of coupons that the customer receives is itself a sample drawn from the assumed distribution. We show the existence of an MFE, and characterize the mean field customer policy as having a multiple-threshold structure in which customers who have won too frequently or infrequently have low incentives to participate. We then numerically study the system with a candidate application of air conditioning during the summer months in the state of Texas. Besides verifying our analytical results, we show that the LSE can potentially attain quite substantial savings using our scheme. Our techniques can also be applied to resource sharing problems in other societal networks such as transportation or communication.
Biography of the speaker:
Jian Li is a Ph.D student in the department of Electrical and Computer Engineering at Texas A&M University. He received a B.E. in Electronic Engineering from Shanghai Jiao Tong University in June, 2012. His research interests include model and analysis of communication networks and social networks, network economics, game theory, queueing games, optimization and smart grids.

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