Illinois Center for Wireless Systems

ICWS Seminar Series

ECONOMICS OF SPECTRUM ALLOCATION IN COGNITIVE RADIO NETWORKS

Professor Saswati Sarkar
Electrical and Systems Engineering Department
University of Pennsylvania

Monday, November 7, 2011
141 Coordinated Science Lab, 4:00 p.m.

Abstract: Limited availability of spectrum has been deterring the proliferation of wireless services, until measurements revealed that large swaths of spectrum are in fact under-utilized. Cognitive radio networks have provided the flexibility to users to access licensed parts of spectrum. But, economic incentives must be in place to incentivize the license holders (primaries) to use the spectrum they have licensed in an intelligent manner, and thereby facilitate access by the rest (secondaries). More specifically, license-holders should be allowed to sell their white spaces in an open spectrum market. We study price competition among primaries in a Cognitive Radio Network (CRN) with multiple primaries and secondaries located in a large region. In every slot, each primary has unused bandwidth with some probability, which may be different for different primaries. Also, there may be a random number of secondaries. A primary can lease out its unused bandwidth to a secondary in exchange for a fee. Each primary tries to attract secondaries by setting a lower price for its bandwidth than the other primaries. Radio spectrum has the distinctive feature that transmissions at neighboring locations on the same channel interfere with each other, whereas the same channel can be used at far-off locations without mutual interference. So in the above price competition scenario, each primary must jointly select a set of mutually non-interfering locations within the region (which corresponds to an independent set in the conflict graph representing the region) at which to offer bandwidth and the price at each location. We analyze this price competition scenario as a game and seek a Nash Equilibrium (NE). For the game at a single location, we explicitly compute a NE and prove its uniqueness. Also, for the game at multiple locations, we identify a class of conflict graphs, which we refer to as mean valid graphs, such that the conflict graphs of a large number of topologies that commonly arise in practice are mean valid. We explicitly compute a NE in mean valid graphs and show that it is unique in the class of NE with symmetric independent set selection strategies of the primaries. Finally, we show that price competition in spectrum markets shares several key properties with energy trade and in fact the analysis of the Nash equilibrium in the first context reveals key insights about such equilibria in the latter context.

Biography: Saswati Sarkar received Master of Engineering from the Electrical Communication Engineering Department at the Indian Institute of Science, Bangalore in 1996 and PhD from the Electrical and Computer Engineering Department at the University of Maryland, College Park, in 2000. She joined the Electrical and Systems Engineering Department at the University of Pennsylvania, Philadelphia as an Assistant Professor in 2000 where she is currently an Associate Professor. She received the Motorola gold medal for the best masters student in the division of electrical sciences at the Indian Institute of Science and a National Science Foundation (NSF) Faculty Early Career Development Award in 2003. She was an associate editor of IEEE Transaction on Wireless Communications from 2001 to 2006, and is currently an associate editor of IEEE/ACM Transactions on Networks. Her research interests are in stochastic control, optimal control, security, resource allocation, dynamic games and economics of networks and sustainable development.

ICWS Seminar series is supported by a grant from Rockwell Collins