Two-day Seminar Series
By Ekram Hossain
University of Manitoba, Winnipeg, Canada
12-13 August, 2013

Time: Monday 12 August 9:00 am - 1:00 pm, 2:00pm - 4:00 pm, and
Tuesday 13 August 9:00 am - 12:00 pm.

Venue: TS 128

ECTS: TBD

COURSE DESCRIPTION

Day 1, Lectures #1, 2, 3: Modeling, Analysis, and Design of Multi-tier and Cognitive Cellular Wireless Networks

Abstract: Multi-tier architecture with small cells such as femtocells, picocells, macrocells, and metrocells, overlaid with traditional macrocells is considered as a promising option to improve the network coverage and capacity of the next generation cellular wireless networks. Also, in such multi-tier networks, cognitive radio concepts will likely to be used by these small cells to improve the radio spectrum utilization. In this context, modeling, analysis, and design of multi-tier and cognitive cellular networks is increasingly attracting the attention of the research community. Recently, stochastic geometry models have been shown to provide tractable yet accurate performance bounds for multi-tier and cognitive cellular wireless networks. Given the need for interference characterization in multi-tier cellular networks, stochastic geometry models provide high potential to simplify their modeling and provide insights into their design. In this lecture series, I will present a comprehensive review of the stochastic geometry models for single-tier as well as multi-tier and cognitive cellular wireless networks. I will also present a taxonomy based on the target network model, the point process used, and the performance evaluation technique. To this end, I will discuss the open research challenges and future research directions.

Day 1, Lecture # 4: Interference Modeling in Random Carrier-Sense Multiple Access Wireless Networks

In random networks, point processes are used to statistically describe the spatial distribution of the network nodes. A common and analytically tractable assumption is that the nodes are distributed in the space according to a homogeneous Poisson point process (PPP). Then the aggregate interference is obtained using the shot noise theory. However, a PPP cannot be directly used to model the spatial distribution of interference sources when modeling aggregate interference in random networks using carrier-sense multiple access (CSMA). This is because, using PPP does not forbid any two points of the process to coexist within a distance less than a certain value. This distance reflects the sensing range of the CSMA protocol and defines an exclusion region around a receiver. Hard core point process (HCPP) is one form of the point processes that has been used to model the spatial

distribution of interferers in CSMA networks. However, HCPP suffers from two major drawbacks. First, it highly underestimates the number of the interferers existing in the network, hence, underestimates the resultant aggregate interference. Second, since HCPP is no longer a PPP, the well-known formulas available in the literature for the PPP do not apply to it.

In this lecture, I will present a modified HCPP model to eliminate the underestimation problem and obtain the intensity of the modified HCPP (MHCPP). Subsequently, closed-form approximate expressions for the moment generating function, mean and variance of the associated aggregate interference will be obtained. The accuracy of the MHCPP modeling and the aggregate interference approximation will be validated. Extension of the model for the generalized fading environments will be also discussed.

Day 2, Lectures # 5, 6: Dynamic Spectrum Access in Cognitive Radio Networks

Abstract: Dynamic spectrum sharing through cognitive radios can significantly enhance the spectrum utilization in a wireless network. Simultaneous sharing of the frequency bands among primary and secondary users (i.e., cognitive radios) is possible by restricting the transmission power of the secondary users so as not to cause any harmful interference to the active primary users. This talk presents a framework for resource allocation (i.e., transmission power and rate allocation and admission control) for cognitive radios for dynamic spectrum sharing using this interference control paradigm. A code-division-multiple-access (CDMA)-based wireless access scenario is considered where the cellular users are considered as the primary users. The cognitive radios, which communicate in an ad hoc mode using single-hop transmission, are able to dynamically measure/estimate the interference from primary users at their receiving ends. The resource allocation problem for cognitive radios is solved subject to their minimum signal-to-noise-plus-interference ratio (SINR) and transmission rate constraints and interference constraints for primary users. Since tracking channel gains instantaneously for dynamic spectrum allocation may be very difficult in practice, a case is considered where only mean channel gains averaged over short-term fading are available. Due to the usage of mean channel gains (i.e., perturbation in the channel state information) this results in sub-optimal resource allocation for cognitive radios. To this end, for an ad hoc/distributed dynamic spectrum access scenario, using some results from the stability analysis of optimization problems, perturbation in allocated power and transmission rate to cognitive radios is analyzed as a function of the number of secondary users.

BIO

Ekram Hossain (http://www.ee.umanitoba.ca/~ekram) is a Professor in the Department of Electrical and Computer Engineering at University of Manitoba, Winnipeg, Canada. He received his Ph.D. in Electrical Engineering from University of Victoria, Canada, in 2001. Dr. Hossain's current research interests include radio resource management in small cell networks, cognitive radio systems, and network economics. He has authored/edited several books in these areas. Dr. Hossain currently serves as the Editor-in-Chief for the IEEE Communications Surveys and Tutorials, an Editor for the IEEE Journal on Selected Areas in Communications - Cognitive Radio Series and IEEE Wireless Communications. Also, he serves on the IEEE Press Editorial Board. Previously, he served as the Area Editor for the IEEE Transactions on Wireless Communications in the area of ``Resource Management and Multiple Access'' from 2009-2011 and an Editor for the IEEE Transactions on Mobile Computing from 2007-2012. Dr. Hossain has won several research awards including the University of Manitoba Merit Award in 2010 (for Research and Scholarly Activities), the 2011 IEEE Communications Society Fred Ellersick Prize Paper Award, and the IEEE Wireless Communications and Networking Conference 2012 (WCNC'12) Best Paper Award. He is a Distinguished Lecturer of the IEEE Communications Society. Dr. Hossain is a registered Professional Engineer in the province of Manitoba, Canada.