CERIES Tohoku University Electro-Related Departments Global COE Program
Center of Education and Research for Information Electronics Systems

International Workshop on Advanced Wireless Technologies

23th, February 2011,

Room No. 100, 1F, Research Building No. 2, Electrical, Information and Physics Engineering,
Tohoku University, Sendai, Japan

1:00PM – 2:40PM

Time synchronization and localization in multiple hop wireless networks

Assoc. Prof. Cheng Li, Memorial University, Canada

Abstract: In the first part, a routing based time synchronization protocol for multi-hop wireless networks will be introduced. Time synchronization is critical in distributed wireless networks to achieve and maintain coordination among distributed network nodes. In this paper, we propose a routing based time synchronization protocol (RBTSP) for multi-hop wireless networks. Different from many existing time synchronization protocols, our objective aims at minimizing the number of timing packet exchange and reducing the non-deterministic delay. We conduct mathematical analysis and simulation experiments to demonstrate the working of the proposed time synchronization method. The results manifest that our scheme can achieve better performance on synchronization accuracy and power efficiency. In the second part, an improved localization method using error probability distribution for underwater sensor networks will be introduced. An accurate localization scheme is essential to many underwater sensor applications. However, due to the persistent existence of uncertainties and measurement errors, an accurate localization is very difficult to achieve. To mitigate this problem, multi-iteration measurement and least squares scheme are often adopted in terrestrial applications to find a good estimate. But, in underwater applications the multi-iteration scheme is not practical due to high communication cost. Meanwhile, it has been observed that the errors in distance measurement often follow a certain pattern, which can be utilized to further improve on localization accuracy. In the paper, we analyze and utilize the measurement error distributions to better improve localization accuracy. An analytical model is developed for performance evaluation, along with extensive simulations. Both uniform error distribution and normal error distribution are considered in our research. Our results indicate that our proposed probabilistic localization method can significantly improve the localization accuracy over the commonly adopted least squares estimate scheme.

2:40PM – 3:20PM

Cooperative relay transmission with relay's private information

Dr. Koichi Adachi, Institute for Inforcomm research (I2R), Singapore

Abstract: A two-phase cooperative relay transmission setup with relay's private information (CRT-RPI) is considered. Different from the conventional setup in relay transmission, a half-duplex decode-and-forward (DF) relay not only helps the source-to-destination transmission, but also transmits its own private information to the destination node. Distributed space-time coding is employed across the source and the relay to obtain cooperative diversity gain for the source message, and superposition coding between the source and relay messages is used at the relay to transmit relay's private information. We derive the achievable rate region of CRT-RPI and design i) optimal time sharing factor between two phases and ii) the power allocation factors for the two messages, based on the rate region. Numerical results are also provided to verify the effectiveness of our proposed optimization schemes.

3:20PM-4:00PM

Optimal Cooperative Sensing Scheduling for Energy-Efficient Cognitive Radio Networks

Prof. Danny Hin-Kwok Tsang, Hong Kong University of Science and Technology

Abstract: Due to the problem of spectrum scarcity and large energy consumption in wireless communications, designing energy-efficient Cognitive Radio Networks (CRNs) becomes important and necessary. In this paper, we consider the problem of optimal Cooperative Sensing Scheduling (CSS) and parameter design to achieve energy efficiency in CRNs using the framework of Partially Observable Markov Decision Process (POMDP). In particular, we consider the CSS problem for a CRN with M Secondary Users (SUs) and N primary channels to determine how many SUs should be assigned to sense each channel in order to maximize the objective function that is related to energy efficiency. By assigning more SUs to sense one channel, higher sensing accuracy can be gained; however, by spreading out the SUs to sense more channels, spectrum opportunities can be better exploited. The CSS problem is formulated as a combinatorial optimization problem. While such problem is generally hard and can only be solved by numerical methods with high computation complexity, in this paper we provide a detailed analysis and the analytical results provide useful and interesting insights. The optimality of the myopic CSS is proved for the case of two channels, and it is also conjectured for the general case. We also study the tradeoff between the sensing and transmission durations. In addition, the structure of the optimal sensing time that maximizes the energy efficiency objective is also analyzed, the condition for the optimality of the myopic sensing time is obtained, and the performance upper bound of the myopic policy is derived. Based on the numerical results, we show that by carefully tuning a punishment parameter, better energy efficiency can be achieved.

4:00PM-4:40PM

Cooperative Communications - A Cross-Layer Protocol Design Perspective

Prof. Weihua Zhuang, University of Waterloo, Canada

Abstract: Cooperative communication has been proposed recently as an effective way to mitigate channel impairments in wireless networks. With cooperation, single-antenna mobile terminals in a multi-user environment share antennas from other mobiles to generate a virtual multiple antenna system that achieves more reliable communication with a diversity gain. In this talk, we discuss two fundamental issues of cooperative communications in distributed wireless networks, namely when to cooperate and whom to cooperate with. We focus on medium access control (MAC) protocol design with beneficial node cooperation. With a practical constraint that only a limited number of transmission rates can be supported by the physical layer, we explore a concept of cooperation region in order to identify beneficial cooperative transmissions. To increase long-term network throughput, we propose an optimal grouping strategy for efficient helper node selection and investigate optimal helper placement. Analytical and simulation results will be presented to demonstrate the performance of the proposed MAC protocol and the effectiveness of optimal helper placement. Some insights of the tradeoff between multi-user diversity gain at the physical layer and the helper contention overhead at the MAC layer will also be presented.