Announcing the Final Examination of Enas Khairullah for the degree of Doctor of Philosophy

Time & Location: July 5, 2017 at 11:00 AM in HEC 450
Title: RESOURCE ALLOCATION AND PRICING IN SECONDARY DYNAMIC SPECTRUM ACCESS NETWORKS

The paradigm shift from static spectrum allocation to a more dynamic and flexible one has opened up many challenges that need to be addressed for the true vision of Dynamic Spectrum Access (DSA) to materialize. This dissertation proposes novel solutions to dynamic spectrum allocation, spectrum pricing, routing, and scheduling of packets among users in a DSA network.

We start by proposing an auction-based spectrum allocation scheme in a multi-channel DSA network where secondary users (SUs) bid to buy channels from primary users (PUs) based on the signal to interference and noise ratio (SINR). The allocation of channels is done such that i) the SUs get their preferred channels, ii) channels are re-used, and iii) a channel is not used by any interfering primary or secondary users. Then, we propose a double auction-based spectrum allocation by considering multiple bids from SUs and heterogeneity of channels that causes some channels to be preferred than others. In order to reuse the channels temporally and spatially, we use the concept of virtual grouping of conflict-free buyers that allow us to transform multi-unit bids to single-unit bids. We prove that the proposed double-auction satisfies the three economic properties of truthfulness, individual rationality, and ex-post budget balance.

As for routing, we propose a market-based model where the PUs determine the optimal price based on the demand for bandwidth by the SUs. Routes are determined through a series of price evaluations between message senders and forwarders. The process involves the forwarders bidding the price and the sender choosing the winner with the minimum bid. We consider both the cases where buyers can bid for only one channel or they could bid for a combination of non-substitutable channels. The proposed routing heuristic that takes $O(n \log n)$. For a centralized DSA network, we propose two scheduling algorithms-- the first one focuses on maximizing the throughput and the second one focuses on fair allocation. In order to enhance spectrum utilization, we allow multiple SUs to use the same channel simultaneously as long as there is no interference between them. We extend the scheduling algorithms to allow multiple channel allocation to users. Expected throughput for every channel is computed by considering: i) instantaneous channels conditions of receivers, ii) back-logged queue length of SUs, and iii) primary transmission activities. The state transitions are modeled using a discrete-time Markov chain process and their probabilities are calculated which occur at the frame/slot boundaries. All proposed algorithms are validated using simulation experiments with different network settings and their performance are studied in terms of throughput, fairness, number of slots allocated, delay and blocking probability.

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Approved for distribution by Mainak Chatterjee, Committee Chair, on June 19, 2017.

The public is welcome to attend.