Name: Hisham Almasaeid
Degree: Ph.D. – Electrical Engineering

Spectrum Allocation Algorithms for Cognitive Radio Mesh Networks

Abstract:
Empowered by the cognitive radio technology, and motivated by the sporadic channel utilization, both spatially and temporally, dynamic spectrum access networks (also referred to as cognitive radio networks and next generation wireless networks) have emerged as a solution to improve spectrum utilization and provide more flexibility to wireless communication. A cognitive radio network is composed of wireless users, referred to as secondary users, which are allowed to use licensed spectrum bands as long as their are no primary, licensed, users occupying the channel in their vicinity. This restricted spectrum access strategy leads to heterogeneity in channel availability among secondary users. This heterogeneity forms a significant source of performance degradation for cognitive radio networks, and poses a great challenge on protocol design. In this dissertation, we propose spectrum allocation algorithms that take into consideration the heterogeneity property and its effect on the network performance.

The spectrum allocation solutions proposed in this dissertation address three major objectives in cognitive radio mesh networks. The first objective is maximizing the network coverage, in terms of the total number of served clients, and at the same time simplifying the communication coordination function. To address this objective, we proposed a received based channel allocation strategy that alleviates the need for a common control channel, thus simplifying the coordination function, and at the same time maximizes the number of clients served with link reliability guarantees. We show the superiority of the proposed allocation strategy over other existing strategies.

The second objective is improving the multicast throughput to compensate for the performance degradation caused by channel heterogeneity. We proposed a scheduling algorithm that schedules multicast transmissions over both time and frequency and integrates that with the use of network coding. This algorithm achieves a significant gain, measured as the reduction in the total multicast time, as the simulation results prove. We also proposed a failure recovery algorithm that can adaptively adjust the schedule in response to temporary changes in channel availability.

The last objective is minimizing the effect of channel switching on the end-to-end delay and network throughput. Channel switching can be a significant source of delay and bandwidth wastage, especially if the secondary users are utilizing a wide spectrum band. To address this issue, we proposed an on-demand multicast routing algorithm for cognitive radio mesh networks based on dynamic programming. The algorithm finds the best available route in terms of end-to-end delay, taking into consideration the switching latency at individual nodes and the transmission time on different channels. We also presented the extensibility of the proposed algorithm to different routing metric. Furthermore, a route recovery algorithm that takes into consideration the overhead of rerouting and the route cost was also proposed. The gain of these algorithms was proved by simulation.