ABSTRACT

Exponential growth in the number of wireless devices may lead us to an inevitable spectrum gridlock situation. It has been observed that the fixed spectrum allocation technique may not be efficient as it increases spectrum inefficiency. Spectrum sharing has been proposed as a possible solution, which may help in supporting the ever-increasing demand while efficiently using the available spectrum. In recent years, we find tremendous efforts within research community as well as industry to make the spectrum sharing concept both technologically and economically viable. Cognitive radio is considered as a major technology which helps in implementing spectrum sharing concept. In cognitive radio networks, unlicensed users (a.k.a. secondary users (SUs)) share licensed users' (a.k.a. primary users (PUs)) spectrum

There are three different modes for spectrum sharing, i.e., underlay, overlay, and opportunistic/interweave. We use terms opportunistic and interweave interchangeably in this thesis. Irrespective of any spectrum sharing mode, SUs are required to maintain quality-of-service (QoS) of PUs. For both underlay and overlay modes, SUs and PUs coexist with each other. Whereas, for interweave mode, SUs perform spectrum sensing to detect PUs' activities. SUs access licensed spectrum only when PUs are detected to be idle. Therefore, SUs' performance strongly depends on the sensing outcome for interweave mode based cognitive radio networks. Cooperative spectrum sensing has gained widespread attention due to its robustness against wireless channel impairments like fading and shadowing. Multiple SUs participate in cooperative spectrum sensing, which send their sensing information to a central entity (a.k.a. fusion centre (FC)). The FC decides whether the licensed spectrum is free or occupied.

Sensing performance for interweave mode based cognitive radio networks depends on several factors like received signal to noise ratio (SNR), number of sensing samples, etc. More number of sensing samples may improve sensing performance at the cost of reduced transmission time for SUs. On the other hand, poor sensing performance increases the chance of harmful interference on PUs from SUs, which is not acceptable. Hence, a clear tradeoff is observed between sensing and performance metrics for interweave mode based cognitive radio networks. Sensing thresholds at SUs and the FC should be appropriately designed targeting interweave mode based cognitive radio networks' performance

metrics. In this thesis, we aim to explore tradeoff in throughput maximization and resource allocation problems for interweave mode based cognitive radio networks.

In chapter-3 of this thesis, we consider a throughput optimization problem for a sequential sensing based cognitive radio network. The FC performs sequential probability ratio test (SPRT) collecting SUs' sensing information. SUs send their sensing information over bandwidth limited control channel, which we consider in the optimization problem. We design both of the FC's and SUs' sensing thresholds jointly from the optimization problem. We observe that the optimization problem is non-convex; however, we develop an optimal and efficient algorithm to solve the optimization problem. In simulation results, we show the efficacy of our proposed algorithm. Please note that we assume full buffer at SUs in chapter-3.

In chapter-4 and 5 of this thesis, we relax the full buffer assumption and consider two different resource allocation problems, where we design economy based utility functions for different nodes. The FC plays a dual role, i.e., as global decision-maker and resource allocator. During resource allocation, the FC uses prior knowledge of SUs' buffers. In both chapters, we design sensing thresholds of participating nodes of cognitive radio networks while maximizing economic utility functions. We observe that resource allocation problems may not be feasible all the time. Hence, we find out set of SUs in chapter-4 to make the resource allocation problem feasible. In chapter-5, we find possible regions of different parameters to make the resource allocation problem feasible.

Keywords: Cognitive radio, sequential sensing, throughput maximization, resource allocation, user selection.