CHAPTER VI

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

Different mechanisms that aim to offer quality of service (QoS) to the transmissions of secondary devices in cognitive radio networks are proposed in this work. The first mechanism is focussed on reducing the blocking probability of high priority transmissions at the cost of low priority transmissions. Multiple levels of priorities are considered for its implementation, from SU1 to SU4, from highest to lowest priority in the allocation of channels. Further modification of this method is carried out by adding queue-shifting mechanism to this prioritised allocation. Queue shifting resolves the competition and the devices compete for channels based on their transmission time deadlines. Initially, all the secondary devices will compete in their respective priority classes along with other devices of that priority class. If they don't find transmission opportunities until their time deadlines approach the threshold value of that priority level, then they shift to next priority class to compete along with their next higher level priority devices. Due to this, the devices that have higher values of time deadlines will not compete with the transmissions of lower values of time deadlines, until their time deadlines approach. Results are compared with two-level RT-NRT priority method. An improvement in the form of reduced blocking probability in the range of 18% to 31% is observed. The percentage of improvement varies depending on the influencing parameters like number of channels, number of secondary users competing for them, channel occupancy rate of primary users and demand from the secondary users.

Range-Bound Bidding is the second mechanism proposed in the thesis. With this mechanism, Maximum value of the bid price is decided in advance, and the users are considered to quote their bid prices as per their priority needs. The highest priority devices quote at maximum bid price and the other users quote at sub-multiples of it depending on their priority needs. Final allocation would be done from highest priority to least priority, and applying uniform allocation price to all the allottes at the least price quoted by the user that was allotted with the channel. The main advantages with this mechanism are the removal of uncertainty in the bidding and linking the QoS to channel

cost. Results are compared with existing GSP auction method. It is observed that the proposed method takes demand and supply into consideration for finalizing the channel cost. In addition to this, it is found that the revenue to primary owner is also comparable with GSP method.

ANFIS based channel prediction is incorporated as a third mechanism that helps in planning and scheduling of secondary user transmissions, based on the expected vacant times of the channel. This has resulted in better utilization of bandwidth. Frequency reuse of channels with coexistence option among secondary users based on non-interfering power levels of the devices is explored as the fourth mechanism. Acceptable mutual interference values measured in terms of BER are identified. Performance improvements are obtained in terms of blocking probability, call completion rate and channel utilization. In all the proposed mechanisms, varying levels of improvements are observed for different configurations like the number of PUs, channel occupancy of PUs, number of SUs, etc. Hence it suggests that optimizations achieved through the proposed methods can best be realized for the matching configurations and conditions.

6.2. Future Scope

Even though cognitive radio concept is found to be one of the promising solutions to spectrum scarcity problem, there are several challenges that need to be addressed, for its further evolvement, to become a more practical solution. Spectrum sensing by individual devices is gradually losing its importance, because of the inaccuracies involved in it. In the present implementation of TV white spaces based systems also, it is the database-driven information that facilitates the channel identification at the geographic location of the user. Spectrum database services from Google, Microsoft and others are facilitating it, after appropriate registration of the users and applying the measures needed to ensure the user's conformance to the regulatory norms laid for using the white space frequencies. In this regard, to offer QoS to these transmissions, some mechanisms like the one proposed in this work can be used. Not having provision for QoS enabled services, is also one of the reasons for the TVWS usage not reaching the expected levels. Other reasons are uncertainties about the availability of these channels in future, and widely varying quantities of channel availabilities from location to location.

The latest efforts towards shared spectrum concept are the Licensed Shared Access (LSA) of Europe and Spectrum Access System (SAS) of USA. LSA was proposed to be implemented in 2.3 – 2.4 GHz band and SAS was proposed to use 3.55 - 3.7 GHz band. These frequencies were already allotted to military, navy or satellite communication applications, by the concerned regulators. Now, they proposed to offer them to secondary users, through opportunistic spectrum access methods. In LSA, 2-tier model is proposed, where the first tier belongs to original allottees, and the second tier to opportunistic users.

In SAS model of USA, 3-tier architecture was proposed. The first two tiers are same as those of LSA system. But the third tier users are those secondary users who do not enter into any agreement with primary users, but use those frequencies in opportunistic manner, if the frequencies are not in use by tier-1 or tier-2 users. This band is known as Citizens Broadband Radio Service (CBRS). With further additions like the ones proposed in this work that help in offering QoS supporting services by cognitive radio networks, it can be expected to improve further. Most of the times it is not a single secondary device that enters into spectrum competition but multiple such devices under the umbrella of a secondary network. In that context, the improvements can be adopted at the secondary user network levels.