ABSTRACT

The explosive demand of multimedia services over heterogeneous mobile devices has placed a huge spectrum requirement from Mobile Network Operators (MNOs) to cater to the growing demands of the customer. Advancement of technology in the communication field makes very high speed data of the order of 100s of Mbps possible per user over wireless communication which however requires wide Band Width (BW) of the order of 100 MHz and the same is not available to the MNOs. The present situation thus demands shared spectrum access among the MNOs, which is a disruption compared to the current licensed scenario, where each MNO operates in dedicated licensed band exclusively in the region without any interference and radio resource coordination. The drawback is however reduced channel utilization efficiency or trunking efficiency and hence the data rates. In heterogeneous network scenario, spectrum scarcity does not allow allocation of huge BW to several operators operating in the same geographical area. Hence new approaches for spectrum sharing and coordination among users/operators are required. With this objective, the research work in this thesis is presented in four parts.

Cognitive radio systems are helpful to access the unused spectrum in heterogeneous networks by incorporating spectrum sensing techniques. In order to improve wireless channel utilization, there is a need to implement efficient spectrum sensing techniques to detect the spectrum white spaces. In this research work, a novel intelligent fuzzy system based cooperative spectrum sensing incorporating Selection Combining (SC) and Maximum Ratio Combining (MRC) concepts has been developed for improved detection
accuracy. Cooperative spectrum sensing takes advantage of the spatial diversity in multiple cognitive radio users to improve the sensing accuracy; however the conventional implementation proposed in the literature requires the knowledge of noise variances and exchange of channel state information leading to increased transmission overheads. To overcome these drawbacks, an intelligent fuzzy fusion algorithm is developed in the first part of this thesis. The improved performance of the proposed scheme over the conventional schemes in terms of sensing accuracy is validated using simulations.

Cognitive radio networks are popular for their scope for providing wide wireless bandwidth and support quality driven wireless multimedia services. The satisfaction of the end user is normally assessed by the Quality of Experience (QoE) which is difficult to achieve under resource constraints. An efficient channel allocation scheme for SUs in CRNs is analysed by simulation in the second part of the thesis work, wherein, two algorithms namely greedy algorithm and distributed algorithm are used to efficiently allocate the PCs to SUs.

Cognitive Radio Network (CRN) has many practical applications. One such application in a multi network scenario is the implementation of CRN for Hospital Management System. Wireless transmission of medical data of the patients over heterogeneous networks has become a focus area in recent research works. With the objective of improving the spectrum utilization in an energy efficient manner suitable for a heterogeneous communication environment and to utilize medical devices efficiently among the patients, in the third part of this research work, a CRN hardware called “Bio Cog” is designed for healthcare services application, interoperable in a heterogeneous network scenario with different wireless technologies such as XBee, Wi-Fi and Bluetooth.
In order to utilise the spectrum efficiently, the multiple mobile technologies can be implemented and integrated using Software Defined Radio (SDR) architecture using common hardware and different software modules. The SDR implements most of the radio parameters through reconfigurable software modules using digital signal processors or Field Programmable Gate Arrays. In order to achieve this, the incoming radio signal has to be brought down to the Intermediate Frequency or the baseband spectrum at the earliest in the RF front end and this can be achieved using band pass sampling. An efficient algorithm for band pass sampling is developed in the fourth part of the research work for a heterogeneous network scenario considering three frequency bands of very high RF signals. This algorithm helps in estimating the valid sampling frequency ranges for down converting RF signals of different frequencies and bandwidths as needed in an SDR. Further, software based receiver for WLAN standards is designed and the parameters from the band pass sampling algorithm are implemented in this receiver design. Using the algorithm developed in this work, valid sampling frequency ranges are calculated for down converting RF signals of different Wireless Local Area Network (WLAN) standards. The same has been further extended to Bluetooth, Wireless Fidelity (Wi-Fi) and Zigbee technologies.