ABSTRACT

The rapid proliferation of Information and Communication Technology (ICT) has led to an exponential increase in the demand for radio spectrum.

The spectrum scarcity and under-utilization problem must be addressed via innovative technology, and standard telecommunication regulatory bodies, which need to obtain significant improvements in spectrum efficiency, and thereby increasing the dynamic performance of wireless devices compared to conventional spectrum management methods. Spectrum scarcity remains one of the major issues in the era of wireless communication systems and much of this need to be attributed to inefficient spectrum usage amongst licensed users. The Federal Communication Commission (FCC) has been examining various new standard techniques to manage the scarce Radio Frequency (RF) spectrum resources and to minimize overcrowding.

Cognitive Radio (CR) networks are an innovative technology that focuses on the radical shift in both radio and networking technologies that ensemble with the potential to provide major performance gains in optimizing the efficiency of any spectrum. As cognitive radio domains have started to progress significantly, new research work is required to address some prevailing technical challenges like Dynamic Spectrum Allocation (DSA) methods, spectrum sensing, cooperative communications, cognitive network architecture protocol design, cognitive network security challenges and dynamic adaptation algorithms for cognitive system and the evolving behavior of systems in general.

This thesis highlights the need for an efficient Handover Decision (HD) mechanism to perform switches from one network to another, to provide unified and continuous mobile services that include seamless

connectivity and ubiquitous service access. The HD involves efficiently combining handover initiation and Network Selection process. The network selection decision is a challenging task and it is a central component to making HD for any mobile user in a heterogeneous environment that involves a number of static and dynamic parameters.

CR is proposed as a robust solution to the problem of inefficient spectrum usage and handover decision making. As CR can coexist with existing licensed primary users, efficient protocols are required to perform spectrum sensing and unused spectrum allocation among secondary users. The Cooperative Spectrum Sensing (CSS) methodology of CR is implemented and will efficaciously overcome handover challenges such as energy efficiency, spectrum management, and data communication problems.

The main contributions of the thesis include proposing the cooperative transmission protocol scheme for improving the uplink data transmission and increase the sensing accuracy of mobile terminals in terms of both communication reliability and battery sustainability. This satisfies following requirements such as: (i) Minimizing interference by increasing SNR rate (ii) increasing sensing speed and energy reduction rate through periodic sensing and (iii) Dynamic handover at any BS during Inactive state (both Deep sleep and Micro sleep).

The proposed work is extended to focus on quantitative analysis of the two major spectrum sensing techniques – Energy Detection Spectrum Sensing and Random Noise Sensing. The evaluation of spectrum noise is based on the probability detection and false alarm probability during varied levels of Signal-to-Noise Ratio (SNR) levels based on Additive White Gaussian Noise signal (AWGN).

The proposed spectrum sensing algorithm called Cooperative CUSUM performs better than optimal rule based techniques through a single observed spectrum sensing techniques under cooperative networks. Cognitive wireless networks are trained for the dynamic processing of spectrum handovers via artificial intelligence and machine learning algorithms. They are much more capable to assist humans in making expert decisions by penetrating into the complexity of handovers. This work mainly focuses on the learning and reasoning quality of CR by analyzing Primary User (PU) and Secondary User (SU) communication of data through Home Location Register (HLR) and Visitor Location Register (VLR) databases, respectively.

For optimizing handovers, the SpecPSO is proposed which uses a bio inspired supervised learning technique called Particle Swarm Optimization (PSO) to perform handover to make smart decisions by dynamically adapting to the environment. A novel dynamic spectrum sharing method called Social Cognitive Radio Network (SCRN) based on social language, is inspired by natural communities (like Swarm) has been anticipated to – a) Predict efficient utilization of spectrum and b) Increase the data rate for social applications like Facebook and LinkedIn. This also combines networks based on social and mobile data communication by stimulating a wide range of data delivery services among mobile users pertaining to social relationships to overcome prevailing spectrum under-utilization and scarcity.

The research work is proposed to (i) increase the ability and efficiency of the cooperative spectrum sensing and (ii) optimize handover performance to enhance the adaptive nature of SU in CR networks for the efficient communication and reliable data transmissions under dynamic spectrum observations.