Improved Spectrum Sensing Technique in Cognitive Radio for 5G Massive System

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Abstract— Error free transmission and increase in multimedia applications is one of the main aims of wireless communication. MIMO-OFDM is the system to improve the reliability of the WiMAX system. The fundamental tasks that are used in the Cognitive Radio (CR) networks are spectrum shaping capability and multi carrier systems. In these structures activation of fundamental (primary) users will generate a defined number of sub carriers in the secondary users. In this paper, the design of Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing (MIMO-OFDM) system using compressive Sensing Cognitive Radio Network is presented. A compressive is a spectrum-sensing method that detects the free portions of the primary user's spectrum and allocates it to secondary users. It derives from cross-correlating an unknown signal with known ones to detect the unknown signal's presence based on the basis of its Signal to Noise Ratio (SNR).
Accordingly, an efficient scheme is developed here that is having better SNR vs Bit Error Rate (BER) against a different MIMO-OFDM system.

Keywords- BER, Cognitive Radio, Compressive Sensing, MIMO-OFDM.

I. INTRODUCTION

A cognitive radio has allowed the complete operation of the underutilized certified spectrum by opportunistically transmitting with no destructive intrusion to certified users. Through improvement of cognitive radios, there are several safety menaces has been elevated. As per safety risks concern as cognitive radio network (CRN) is a kind of wireless network, it had all typical risks present in the conservative wireless networks. Aside from that had a major threat called prepositioning of Material Configured in Unit Sets (PUEA) in spectrum sensing method. To defeat Spectrum shortage and unused frequency band, new spectrum allocation policy called Dynamic spectrum sharing (DSS) came into use [1]. This original rule could permit vacant certified spectrum known as white gaps to be utilized by uncertified user referred to as SUs. Thus achievement of the rule depends at the precision of the spectrum sensing used by the SUs to reveal the band hole. Thus CR generation act, because the allowing era for the Dynamic spectrum Access (DSA) allocation. CR facilitated DSA systems are intended to recognize and inventorially exploit the idle spectrum bands [2, 3]. Electromagnetic spectrum is turning into scanter owing to the growth in utilization of wireless networks. It is an intuitive useful reserve ,it is able to be neither formed or damaged. So, numerous methods are recommended for the powerful utilization of electro-magnetic spectrum.

One of the superior expertise brought is CRN. CR (or smart) systems are ingenious technique to wireless in which radios are planned with an extraordinary stage of intellect and dexterity. This superior expertise allows radio devices to exploit the spectrum (i.e., RF radio frequencies) in completely novel and abundant methods. CR has the capability to supervise spectrum sense and identify the situations in their functioning circumstances, and with dynamism reorganizes their own traits to meet the situations. The major extent of effort is to investigate the energy detector based cooperative spectrum in various fading channel and development of the PUEA detection [4].

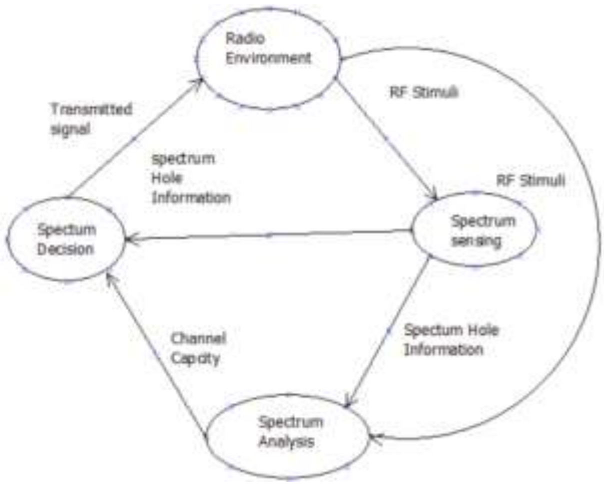

Figure 1: Cognition cycle

DSA is required to assign the accessible bandwidth in a effectual way. The legacy strategies of allocating several fixed bandwidth to distinct device did not offer the overall gain of having DSA. It assists to reduce vacant white bands or spectral bands via Marcus. Cognitive radio has massive property of not inflicting interference with licensed band. When the PU desires to start communication, the CR allowed the device to lose the band and transfer to some other free band. This method of accessing to vacant bands actively for appropriate usage is called DSA. In CR expertise, primary unit (PU) be the customers who are having superior precedence to use a selected spectrum and SU are customers who are having lesser precedence, it utilizes the spectrum without inflicting intrusion to PU [5].

In central design, a central organizer is accountable for sharing the bandwidth to proposed users. With the purpose of avoiding the crisis because of hidden node and to acquire entire data of idle spectrum hole sensing is measured to be dispersed in the figure 1. Under the Centralized Architecture, each secondary unit (SU) transceiver has a dedicated control channel and a second channel for Spectrum sensing. The Control Channel is used to forward the data of Spectrum hole to the master /Central organizer [6].

II. CR NETWORK ARCHITECTURE

The possible architecture of a CR network as defined is shown in Figure 2. The components of such CR network architecture can be classified into two groups as primary network and secondary network (i.e. cognitive radio network).

Primary network: A primary network is referred to an existing network infrastructure, where the nodes called primary users (PUs) have authorized license for exclusively accessing a certain frequency band. Examples of such networks include the cellular and the TV broadcast networks. Primary user (PU) activities are controlled through the primary base-stations in infrastructure based the primary network. Since the PUs have their priority in spectrum access, the operations of PUs should not be affected by any other unlicensed or secondary users.

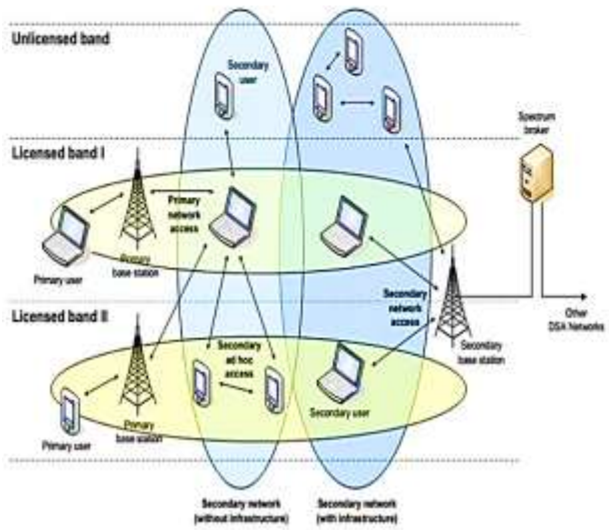

Figure 2: Cognitive Radio Network Architecture

Secondary network: A secondary or unlicensed network is referred to a network, with fixed infrastructure or based on ad hoc communication principle, without license to operate in a desired licensed band. Hence, to share the licensed spectrum band with primary networks, the additional functionalities are used by the nodes called CR users/secondary users (SUs). The infrastructure based secondary networks are equipped with a central entity called CR base station, which implements a single-hop connection to SUs. On the other hand, the secondary ad-hoc networks have no infrastructure backbone and a SU can communicate with other SUs through the ad-hoc connection on both licensed and unlicensed spectrum bands. Furthermore, secondary networks may include spectrum brokers, which can play a role in sharing spectrum resources among different secondary networks.

In the context of network architecture, the spectrum management functionalities are implemented by different entities. For instance, in infrastructure based architecture, the spectrum broker is responsible for coordinating the tasks of spectrum sensing, decision and management (sharing and mobility), while in ad-hoc architecture; CR nodes themselves are responsible for spectrum sensing, decision and management. The former requires a dedicated control channel whereas in infrastructure less architectures use of dedicated control channel is optional.

III. PROPOSED METHODOLOGY

When multiple CRs cooperate with each other in a network for the purpose of spectrum sensing, the process is called cooperative sensing. Fig. 4 illustrates a system model where CS is established for cooperative network. In a cooperative Cognitive Radio Network (CRN), there are more than one CR nodes, where each of them individually conducts CS to detect the existence of PU. According to the occupancy of spectrum by the PU, each of the CR nodes generates a local decision (binary or decision statistic). Among all the cognitive nodes, there are one CR node which acts as a common receiver called Decision Fusion Center or Cognitive Manager (CM). From Figure 3 each of the local decision is sent by the CR nodes to the Decision Fusion Center. Usually, the local decision is made by comparing the energy of the received spectrum with a predetermined threshold value. In order to minimize the control channel overhead, CRs only share their final 1-bit hard decisions (H0 or H1) rather than their decision statistics. It is the responsibility of the decision fusion center to gather the local sensing decisions from all the member nodes presenting in the CRN. For the final decision, the local decisions are combined by employing different hard decision fusion rules.

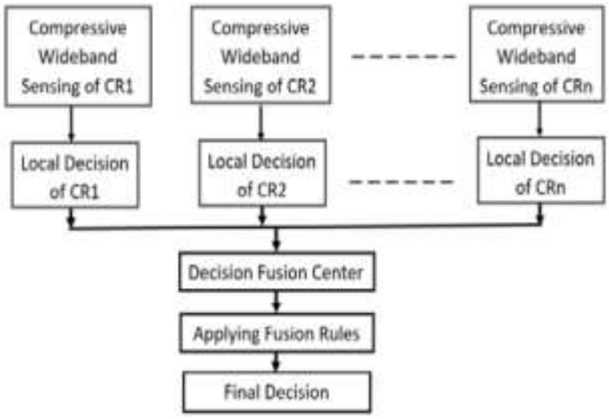

Figure 3: Design of MIMO-OFDM System using Compressive Sensing Cognitive Radio Network

This signal is then passed through an Additive White Gaussian Noise (AWGN) channel. At the receiver end, the CP is removed and the signal is converted from serial to parallel to get the original, with FFT applied to each symbol for analysis in the frequency domain. After demodulation, the signal is cross correlated with that of a time-shifted local oscillator.

We implemented our circuit (Figure 4) in MATLAB software, with the main parameters described below. We generated a random binary signal in a serial manner. To analyses a signal in the time domain, we apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel to serial OFDM signal to add a cyclic prefix (CP), which helps avoid interference between OFDM symbols. We then feed this signal through an Additive White Gaussian Noise (AWGN) channel. At the receiver end, the CP is removed and the signal converted from serial to parallel to get the original, with FFT applied to each symbol for analysis in the frequency domain. After demodulation, the signal is cross correlated with that of a time-shifted local oscillator.

The implementation of the system model in MATLAB software, with the main block described below. A random binary signal is generated in a serial manner. To analyze a signal in the time domain, apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel-to-serial OFDM signal. The OFDM signal is added the Cyclic Prefix (CP) because of the remove interference between OFDM symbols. This signal is then feed through an Additive White Gaussian Noise (AWGN) channel. At the receiver site, the OFDM signal is CP removed and the signal is converted from serial-to- parallel then applied FFT (Fast Fourier Transform). Then Received the output of FFT signal, and then signal converted from parallel-to-serial converter to each symbol for analysis in the frequency domain is received. After demodulation, the signal is cross-correlated with that a time-shifted in demodulation signal.

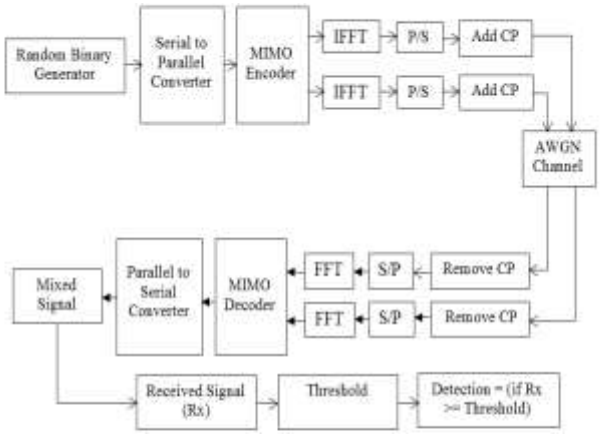

Figure 4: Design of MIMO-OFDM System using Compressive Sensing Cognitive Radio Network

SNR to determine whether the signal is absent or present; if the received signal is greater than the threshold value, there will be a detection, otherwise not:

$$H_0: y(t) = n(t) \qquad \text{PU is absent}$$

H_1: y(t) = h*s(t) + n(t) PU is present

IV. SIMULATION RESULT

In Massive MIMO-OFDM system, a bit error rate (BER) and spectrum efficiency estimator is a cognitive radio network which minimizes the BER and increase the spectrum efficiency.
The bit error rate of massive MIMO system are defined by the following equations

$$BER = \frac{1}{2}\left(1 - \sqrt{\frac{E_b/N_0}{E_b/N_0 + 2}}\right) \quad (1)$$

E_b/N_o is the relation between symbol energy and the bit energy of the signal.

Spectral efficiency usually is expressed as "bits per second per hertz," or bits/s/Hz. In other words, it can be defined as the net data rate in bits per second (bps) divided by the bandwidth in hertz.

$$SpectrumEfficiency = Bits/\sec/Hz \quad (2)$$

Figure 5 shows the simulation results using four transmit antenna and four receive antennas which provide the matched filter detection spectrum sensing MIMO system. It is observed that transmit diversity has a 3 dB disadvantage when compared to MRC receive diversity. From the analysis of MIMO system, the 32x32 antenna combination gives a minimum bit error rate.

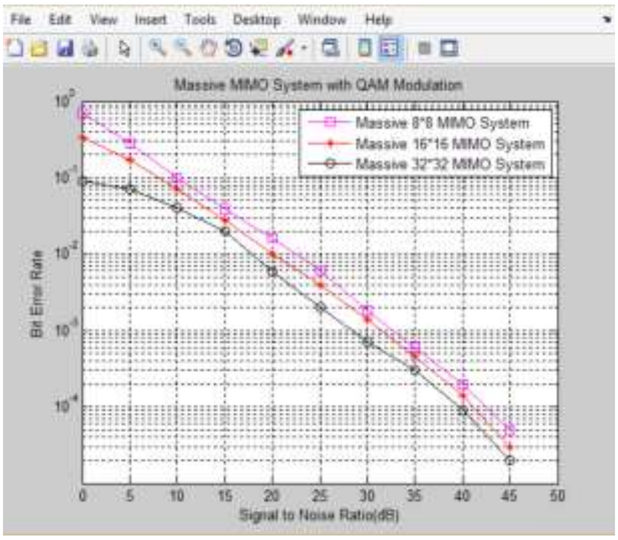

Figure 5: BER vs SNR for Compressive Spectrum Sensing Different System

As shown in figure 6 and figure 7 the spectrum efficiency result are obtained for the implemented 16×4 single and five user compressive spectrum sensing algorithm and previous algorithm**.** From the analysis of the results, it is found that the proposed compressive spectrum sensing algorithm gives a superior performance as compared with previous algorithm.

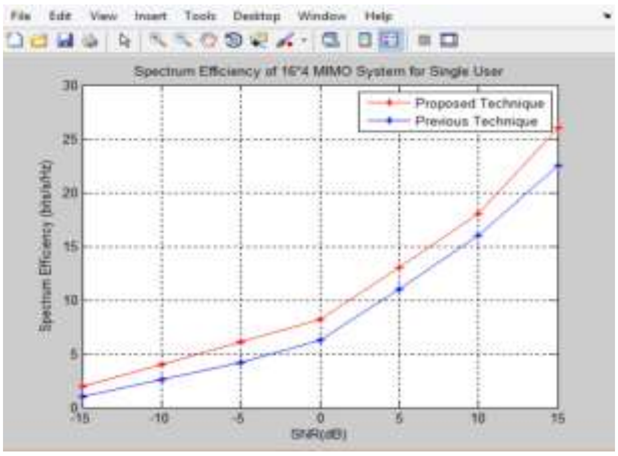

Figure 6: Comparison Result for Previous and Proposed Sensing Technique of 16×4 MIMO System with Single User

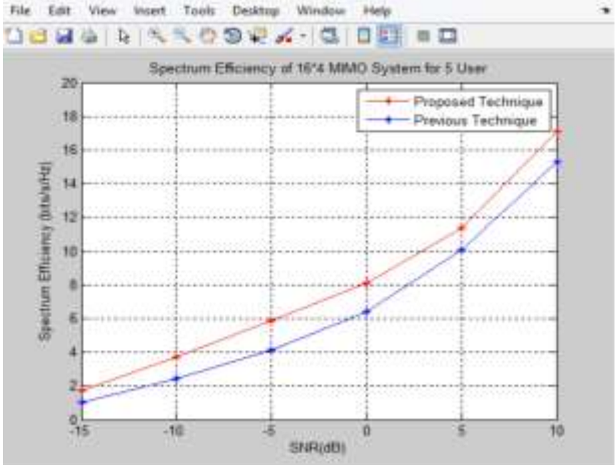

Figure 7: Comparison Result for Previous and Proposed Sensing Technique of 16×4 MIMO System with Five User

As shown in figure 8 and figure 9 the spectrum efficiency result are obtained for the implemented 64×16 single and five user compressive spectrum sensing algorithm and previous algorithm**.**

The effectiveness of network is enhanced due to interfacing of routing and allotment of channel is predominant extent of the work. The benefit is to determine the discrepancy among the cost to meet a demand and the sales got from request met. To enhance the effectiveness, the price of the scheme to calculate the path and determination for spectrum allocation must be decreased.

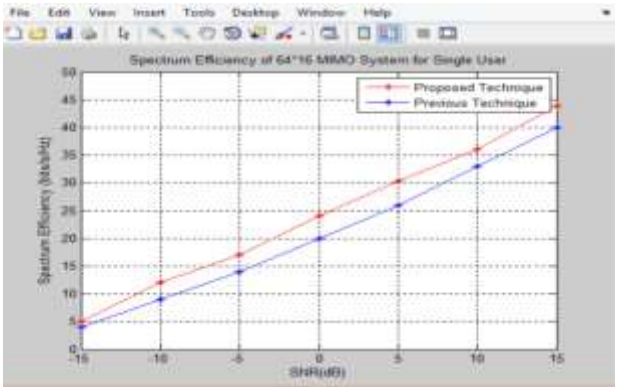

Figure 8: Comparison Result for Previous and Proposed Sensing Technique of 64×16 MIMO System with Single User

From the analysis of the results, it is found that the proposed compressive spectrum sensing algorithm gives a superior performance as compared with previous algorithm.

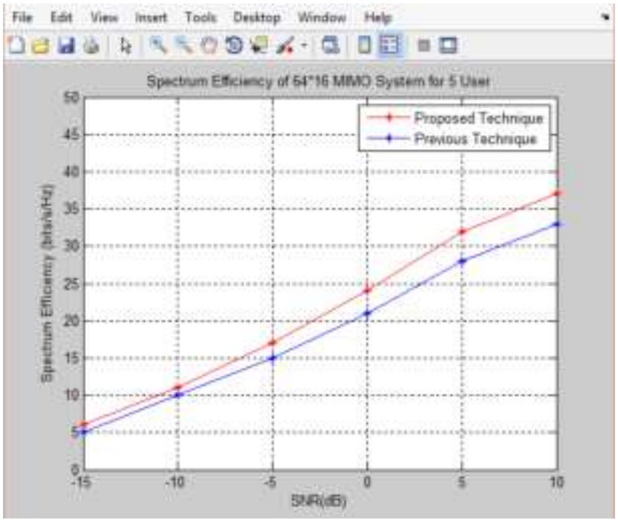

Figure 9: Comparison Result for Previous and Proposed Sensing Technique of 64×16 MIMO System with Five User

V. CONCLUSION

The channel distribution is primarily based upon spectrum benefit that is the discrepancy among the recompense to meet the demand and the corporal price. The dissimilarity is considered as fee to allocate the channel. If the fee is advantageous, the channel may be allocated else no longer. After allocating the channel if the primary user enters into the channel once more the fee is evaluated and channel allocation could be revised. If the spectrum is burdened, affiliation with secondary user might be disconnected and transported to another direction if reachable. This will enhance spectrum utility.

Convolution does essentially with two functions that it places one function over another function and outputs a single value suggesting a level of similarity, and then it moves the first function an infinitesimally small distance and finds another value. The end result comes in the form of a graph which peaks at the point where the two images are most similar. The matched filter is the optimal linear filter for maximizing the Signal to Noise Ratio (SNR) in the presence of additive White Gaussian Noise. The performance of implemented method including wireless communication is better as compared to the previous technique algorithm.

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