Multiple Relay Selection Improves the Performance of Wireless Communication Systems using MIMO

P. Lakshmi Surekha[1], I. Krishna Rao[2]

[1]M.tech (14L31D7008) Department of ECE, Vignan's Institute of Information and Technology, Visakhapatnam-49
[2] Associate Professor, Department of ECE, Vignan's Institute of Information and Technology, Visakhapatnam-49

Abstract**—** *Cognitive radio is an eminent technology that has been deployed in multiple communication systems in recent times. As in case of any communication system, the performance can be analyzed purely on the basis of transmitter and receiver. But it can be further enhanced by introducing relay concepts into the system. In a primary network, the data transmission takes place through a licensed channel. But at times the spectrum is not properly utilized and at that instant the secondary network comes into the picture, which takes care such that the efficiency of the spectrum shouldn't be wasted. The secondary network consists of ST (Secondary Transmitter), SD (Secondary Destination) and Eavesdroppers. Here in the endeavor the main focus lies on the secondary network operations. The throughput of the network can be abruptly increased by introducing relays. To increase the overall system ability MIMO and OFDM techniques were implemented. The comparative analysis of the system with the single, multiple relays and the traditional direct transmission schemes has been done in order to analyze the system's performance.*

Keywords* — *Cognitive Radio, Eavesdropper, MIMO, OFDM, Relay Selection, Throughput.

I. INTRODUCTION

In any communication system, the client mainly concentrates on the security features. Because of the extremely attractive privacy settings, cognitive radio system has grabbed the attentions of the researchers. Even though an appreciable work has carried out regarding cognitive radio systems, due to its dynamic behavior the data is being accessed by the unauthorized users. The data loss occurs during the following phases: Spectrum sensing, Spectrum sharing, Spectrum mobility and Spectrum management. A lot of work involved in order to make sure that the CR environment is free from primary user emulation against denial of service and eavesdropper. The confidential transmission of data can be achieved by using traditional cryptographic methods at an expense of additional computational complexities. But still the existing cryptography methodology is not good enough to provide high accuracy and reliable security features to the system.

In the ISO-OSI layers, network layer is responsible for providing the security measures for the data to be transmitted. In addition to that, the security through the physical layer is inherited to provide excess security capabilities. Inculcation of security features in the physical layer is a sophisticated methodology which minimizes the data decryption by the eavesdroppers.

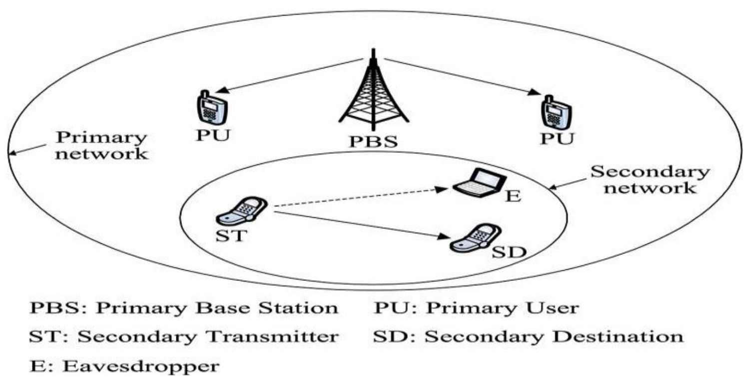

FIG.1: A PRIMARY NETWORK WITH SECONDARY CR NETWORK

MIMO OFDM has the ability to achieve throughput. The main objective of this paper is useful resource allocation on LTE (Long Term Evaluation). LTE advance type II relay selection is used to beautify the mobile communication. Water filling algorithm is applied for allocating the energy with a purpose to lower the channel ability for energy consumption. The objective of this paper is useful resource allocation on LTE (Long Term Evolution).

II. EXISTING METHODS

In order to improve the overall performances, it is preferable to use MIMO and OFDM systems for dynamic resource allocation through which the numbers of clients can be extended to a higher value. The efficiency of a system is inheritably dependent on the transmitting energy but it is a constraint. To enhance the system performance in the multi user OFDM environment, there are two issues:

- For maximizing the throughput at an expense of transmitting power.
- Reduction in the constraints of the transmit power, bit error rate will be considered.

In wireless communication systems, the transmitting power is allocated to multiple users by the MIMO technique. All the receiving base stations in the system will have an equivalent traffic conditions.

2.1 Amplify and forward methodology for co-operative MIMO- OFDM communications.

Step1: The data from the transmitter will be transmitted to the relay and destination simultaneously.

Step2: The power received by the relay will get amplified and then it will be transmitted to destination.

Step3: The original signal will be obtained by combining the signal accumulated through the above two steps.

Non-regenerative relaying method is the other form for amplifying and forward methodology. This process is mainly used for analog signals. When AF method is compared with all the existing methods, it is evident AF is the easiest of all. Even though a weak signal is detecting at the destination node, it will ensure a full diversity gain and adaptive performance. Noise which is incorporated with the receiving signal at the relay will gets amplified. It is the major limitation in this methodology.

2.2 Delay and forward methodology for co-operative MIMO and OFDM communications.

Step1: The data from the transmitter will be transmitted to the relay and destination simultaneously.

Step2: Relay detects and decodes the signal received from the transmitter and retransmits it to the destination.

Step3: The original signal will be obtained by combining the signal accumulated through the above two steps.

DF is also known as regenerative relaying scheme. Processing of digital signals is the major area of application for this method. The error rate of this method is highly dependent on the transmitter ability to transmit the signal. To guarantee an original signal reception at the receiver node, techniques like cyclic redundancy check is included in the transmitter side. The characteristics of channel between the transmitter and relay play a vital role in determining the accuracy of the system.

III. PROPOSED METHOD

This work mainly focused on the multiple transmitters, multiple receivers and fixed relays. The approach towards this proposed methodology is as follows: Description of the block diagram, assumption of the system and representation of the downlink model.

3.1 MIMO System

It refers to a system environment which includes more than one input and output i.e. more than one antenna on either of the system (transmitting and receiving end). Good channel robustness and high channel throughput are the guaranteed parameters through the MIMO system. Proper coding techniques should be used to differentiate the data retrieved from various relays, but it includes additional processing. Irrespective of the additional processing, the results obtained are appreciably good.

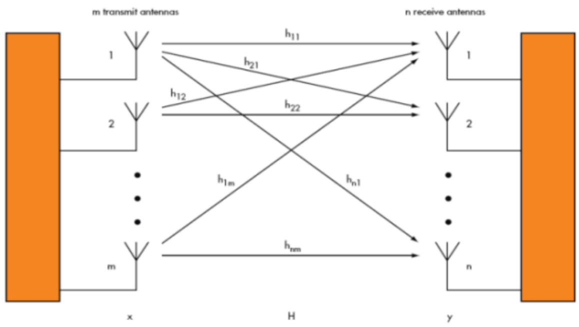

FIG.2 A MIMO SYSTEM

3.2 Power Allocation in MIMO using water filling algorithm:

In a multi user OFDM environment, prematurely it is considered as the base station can acquire a perfect CSI (channel state information) and minimal total transmit power without degrading the QoS (quality of service) rate for the clients. As the size of OFDM is fixed, the number of users is not well guaranteed. To provide the orthogonality among the clients in a group, one should derive the sum rates of the MIMO system using coding. Sum rate using dirty paper coding can be expressed as a function of pre-coding matrix 'F' and relay coding matrix 'R'. The above mentioned matrices must undergo processing to extend the value of sum rate, as in turn which includes number of computations. However, this approach optimizes large number of parameters and hence very high computational cost. In this optimization technique, uniqueness among the optimizers may alter. Thus finding a global optimal solution is a tedious job.

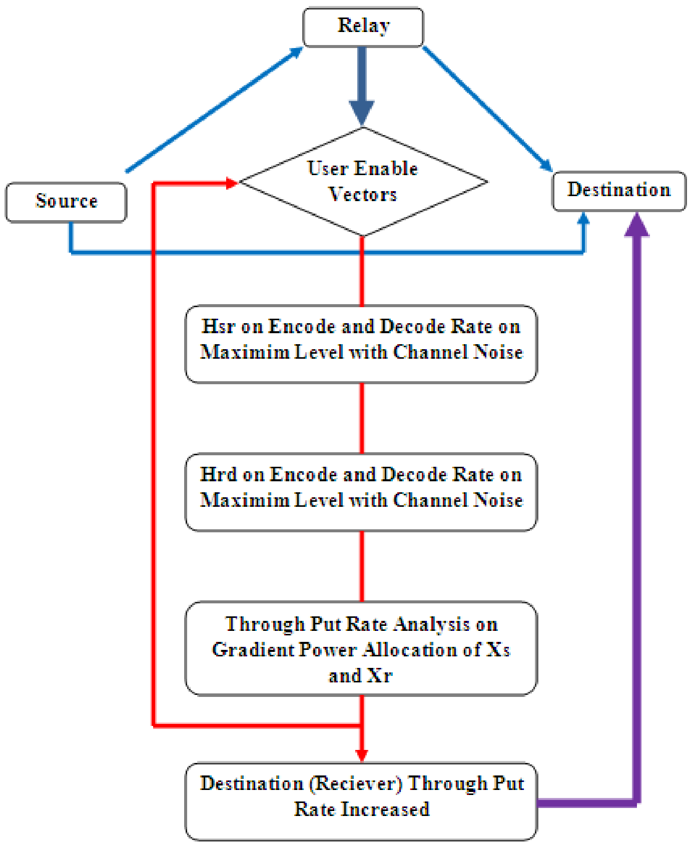

FIG.3 FLOW CHART OF WATER FILLING ALGORITHM

$$R^{(k,l)} = \frac{\rho^{(k,l)}}{n} \log\left(1 + H^{(k,l)} P^{(k,l)}\right) \tag{1}$$

While the ideal solution is of a theoretical interest it has certain drawbacks in real time applications. Here the users are handled in a round robin fashion and the best free resource is tentatively allocated to the current user. Since the test resource is pinched the first the SNR reduces for each additional resource.

The functionality of this process aborts, when the SNR drops below a manual threshold value. The number of resources for any user can be limited to improve the performance of cell edge users at the expense of the channel input.

In order to overcome these issues, we consider an algorithm that takes the power budget analysis of each client as a parameter i.e. water filling algorithm.

3.3 Relay Communication:

3.3.1 Non- co-operative Communication:

Here in this type of communication, it consists of a single input and single output. This transmission operates with single antenna on the transmitter end and another single antenna on the receiver end. There is no requirement for the diversity and other additional processing. Signal strength is quiet low and the measures taken for rise in the signal strength leads to the cost inefficient.

3.3.2 Equal Power Allocation:

We derive bounds on the achievable sum rates of the MIMO fixed relay system using coding. The sum rate using dirty paper coding can be expressed as a function of pre-coding matrix 'F' and relay coding 'R'. This approach involves large number of parameters.

3.3.3 Synchronous Communication:

This is the most common communication model. Here, the data traverses through the combinational inputs and relay paths and the receiver registers the samples and passes it to the output. In order to provide the synchronization among the system functions, relay events acts as a clock signal. There is no acknowledgement upon finishing the transmission. The shortest relay path will be selected among number of paths between the multiple input and output paths, in doing so the system can achieve a higher performance.

3.3.4 Asynchronous Communication:

This also a most common form of serial communication. The status of the data transmission between the source to destination will be provided by the acknowledgement. This mode of communication has extended its wings in the field of classic dial up modem system. Internally generated event function takes care of the ordering of system functions.

IV. RESULTS AND ANALYSIS

The above proposed model is simulated using MATLAB tools and the observations are as follows:

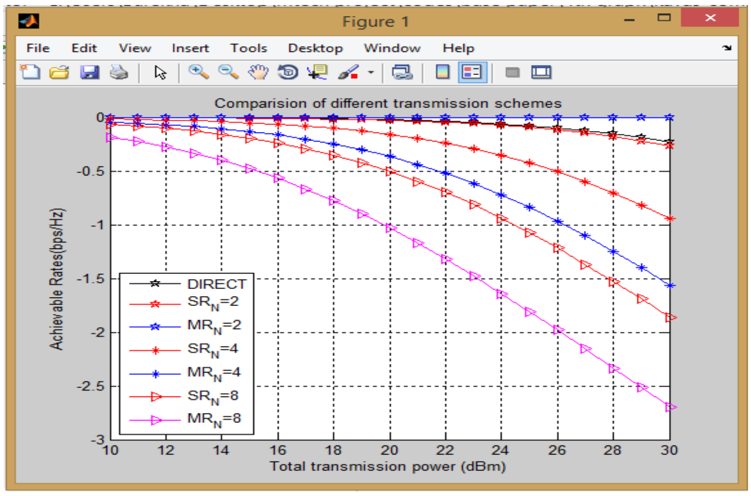

FIG.4 COMPARISION OF DIFFERENT TRANSMISSION SCHEMES

Fig 1 shows the comparison of different transmission schemes i.e., direct transmission as well as SRS and MRS schemes for N= 2, 4 and 8. It is observed that SRS and MRS schemes are generally better than that of direct transmission. Moreover, for the number of single relays increase from N = 2 to 8 the achievable rates significantly improves demonstrating the benefits of security and reliability using multiple single relays for assisting secondary transmissions.

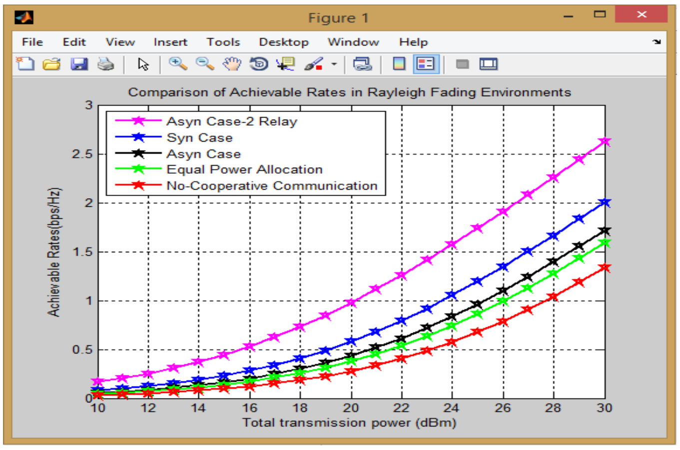

FIG.5 COMPARISION OF ACHIEVABLE RATES IN RAYLEIGH FADING ENVIRONMENTS

Figure shows achievable rates of synchronous relay and asynchronous relay as well as co-operative and non- co-operative communication. Achievable rate is high in asynchronous case II relay compared to SRS and MRS in Rayleigh fading environments.

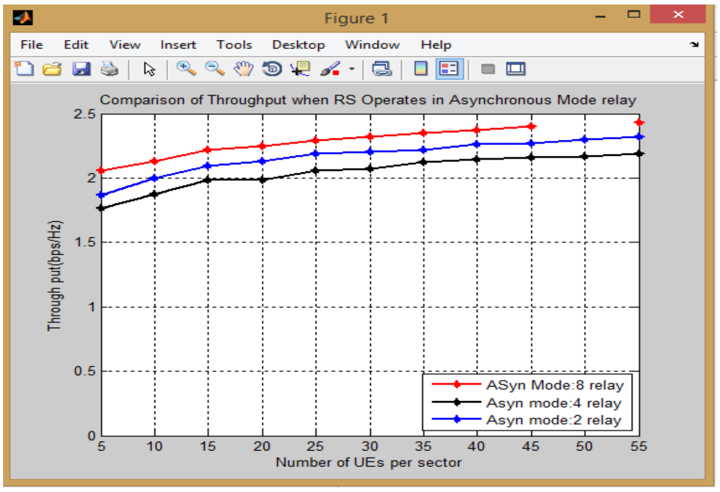

FIG.6 COMPARISION OF THROUGHPUT WHEN RS OPERATES IN ASYNCHRONOUS MODE

Figure shows throughput in synchronous and asynchronous mode relay. Asynchronous mode relays increases from 2 to 8. Asynchronous mode 8 relay gives better throughput compared to asynchronous 2, 4 mode relays.

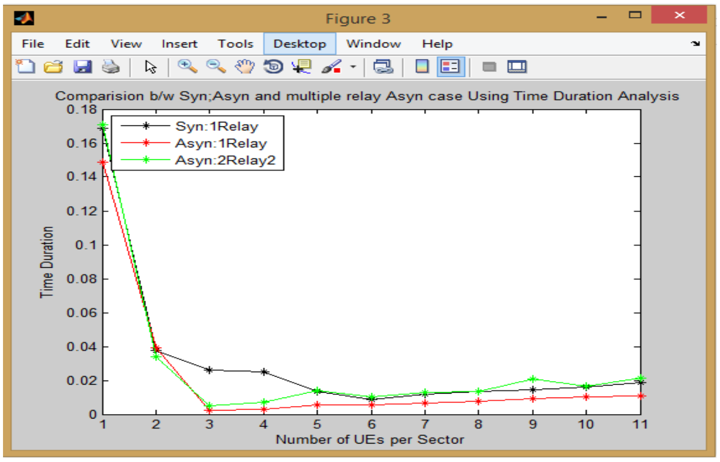

FIG.7 TIME DURATION ANALYSIS OF SYNCHRONOUS AND ASYNCHRONOUS CASE

Figure shows time duration analysis of synchronous mode 1 relay and asynchronous mode 1 and 2 relay. In asynchronous 2 relay mode the reception of signal is relatively fast without time delay.

V. CONCLUSION

In this paper, we propose relay selection schemes for a cognitive radio network consisting of ST (secondary transmitter), SD (secondary destination), and multiple SR (secondary relays) communicating in the presence of eaves dropper. We have examined the performance of the SRS (Single Relay Selection) and MRS (Multiple Relay Selection) assisted secondary transmission along with traditional direct transmission.

To improve the transmission efficiency in cellular system where relays are installed, instead of simply amplifying and forwarding the received signal, relays are expected to have more coding capabilities to achieve higher data rates. We also observed that with the help of multiple relays in asynchronous case compared to synchronous single relay case we are getting more throughput rate with the decode and forward (DF) relays where the source and relay transmit in the same channel. This works show that the proposed SRS and MRS schemes out-perform the conventional direct transmission. With the increase in the number of SR's, the performance of the system improves significantly.

REFERENCES

[1] H. Ekstrom, A. Furuskar, J. Karlsson, M. Meyer, S. Parkvall, J. Torsner, and M. Wahlqvist, "Technical solutions for the 3G long-term evolution," IEEE Commun. Mag., vol. 44, no. 3, pp. 38–45, 2006.

[2] A. Ghosh, R. Ratasuk, B. Mondal, N. Mangalvedhe, and T. Thomas, "LTE-Advanced: next-generation wireless broadband technology," IEEETrans. Wireless Commun., vol. 17, no. 3, pp. 10–22, 2010.

[3] S. Peters, A. Panah, K. Truong, and R. Heath, "Relay architectures for 3GPP LTE-Advanced," EURASIP J. Wireless Commun. Netw., vol. 2009, 2009.

[4] A. Lo and P. Guan, "Performance of in-band full-duplex amplify-andforward and decode-and-forward relays with spatial diversity for nextgeneration wireless broadband," in Proc. 2011 IEEE ICOIN, pp. 290– 294.

[5] X. Deng and A. Haimovich, "Power allocation for cooperative relaying in wireless networks," IEEE Commun. Lett., vol. 9, no. 11, pp. 994–996, Oct. 2005.

[6] A. Host-Madsen and J. Zhang, "Capacity bounds and power allocation for wireless relay channels," IEEE Trans. Inf. Theory, vol. 51, no. 6, pp. 2020–2040, May 2005.

[7] T. C.-Y. Ng and W. Yu, "Joint optimization of relay strategies and resource allocations in cooperative cellular networks," IEEE J. Sel. AreasCommun., vol. 25, no. 2, pp. 328–339, 2007.

[8] W. Rhee and J. Cioffi, "Increase in capacity of multiuser OFDM system using dynamic subchannel allocation," in Proc. 2000 IEEE VTC, vol. 2, pp. 1085–1089.

[9] X. Zhang, Z. Zheng, J. Liu, X. Shen, and L.-L. Xie, "Optimal power allocation and AP deployment in green wireless cooperative communications," in Proc. 2012 IEEE Globecom.

[10] Y. Liang, V. Veeravalli, and H. Poor, "Resource allocation for wireless fading relay channels: max-min solution," IEEE Trans. Inf. Theory, vol. 53, no. 10, pp. 3432–3453, 2007.