Selection of Relays and Clustering For Spectrum Sharing

Nijina A[1], Devi Radhakrishnan[2]

[1]M. Tech Student, Department of Electronics and Communication Engineering, Mount Zion College of Engineering, Kadammanitta, Pathanamthitta, Kerala, India

[2]M.Tech Student, Department of Electronics and Communication Engineering, Mount Zion College of Engineering, Kadammanitta, Pathanamthitta, Kerala, India

Abstract: ***A wireless communication system comprising of primary users and secondary users. The secondary users access the channel of primary users when the channel is free (spectrum sharing). There may be a chance of interference on primary system. In order to minimize this interference relays are used at secondary. Clustering schemes are used to improve the secondary rate. Here as the number of relays increases the interference on primary diminishes as well as secondary rate goes up. Alternate relay protocol is employed. It helps to reduce half duplex loss.***

Keywords: spectrum sharing, clustering, relaying, cognitive radio, ARP.

1. Introduction

A wireless communication system has wide applications in nowadays. In order to improve spectrum utilization consider cognitive radio concept. It consists of two type of users; primary and secondary users. The primary users have license to access the radio frequency spectrum. Cognitive radio networks are used to find out unused band and allocate it to the secondary users. It is necessary to understand cognitive radio network and radio frequency allocation. Here we mainly focus on interference reduction. The primary users have license to use radio frequency spectrum. The CR network allocates the unused band for secondary users. There may be a chance of interference on primary due to spectrum sharing. This will diminish the secondary rate. So that in order to enhance secondary rate, use clustering schemes. The primary interference can be minimized by the use of relays placed at secondary.

The system model has Np primary nodes that communicate through direct channel. The secondary system has M source antennas, n half duplex relays and M destination antennas.

2. Motivation and Related Works

The earlier works of cognitive radio system involves the study of cooperative channels by Y. Liang And V. V. Veeravalli [1].Here capacity regions are investigated for two Cooperative Relay Broadcast Channels; partially relay broadcast channels and fully relay broadcast channel. In partially relay broadcast channel, we consider two users. Here user1 acts as relay. User 1 transmits data to user2.In fully relay broadcast channel; two users can communicate with each other.

Yulong zou, and yu-dong yao[2] studies multiple radio cognitive radio channel. Here the network consists of primary and secondary users. At primary the communication is through the same channel. In the case of secondary system the relays are positioned at intermediate position of source and destination. The relays receive information from the source. Then it decodes received information and makes a decoding set. From the decoding set a best one will be send to the destination. Also the relay sends the data to destination through a direct link. At the destination all received information are combined with maximal ratio combining diversity scheme. Then estimates a good one by maximum likelihood estimation.

In [3] deqiang chen propose a system with single relay under slow fading environments. Under this method transmission rate at the secondary is poor. For [4] of Lie.l to calculate secondary rate greedy relay selection was used.

3. Existing System

The spectrum sharing network has primary and secondary users. The system model has primary nodes that communicate through direct channel. The secondary system has source antennas, relays, destination antennas. The secondary users access the channel of primary users. This will cause interference on primary system. In order to reduce interference on secondary due to spectrum sharing at secondary, use relays. Here the relays uses decode and forward algorithm. The received signal is decoded at relays and forwarded to the destination. This has certain limitations, such as it requires complex signal processing at relays. Here relays need to decode the received information. Also a lot of problems faced for interference reduction.

4. Proposed System

In the proposed system under radio frequency spectrum sharing concept, the system has primary and secondary users. The primary users have license to access the radio frequency spectrum. The secondary users share the frequency spectrum of primary users. So that the interference on the primary is higher. To minimize this interference, use relays at the secondary. Also to maximize the secondary rate we use clustering schemes. The secondary rate under this scheme is given by(M/2) logn. M denotes the number of antennas and n denotes the relays.

The system model for spectrum sharing network has Np number of primary nodes, n number of relays, M number of source and destination antennas and is shown in figure 1.Let H be the M×n channel co efficient matrix to relays from source, F and G be channel coefficient matrices to destination and primary nodes from relays.

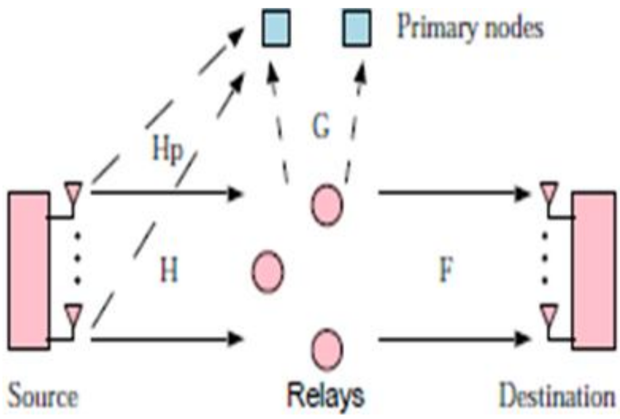

Figure 1: System Model

Here the relays positioned between secondary source and destination. There are no direct transmissions between source and destination. The transmissions are done by two steps. In the first step the source antennas transmit data packets to relays. The relays uses Amplify and Forward (AF) protocol. The signal received at the relay i is given by

$$r_i = \sqrt{\frac{P_s}{M}} h_i^t s + n_i \qquad (1)$$

Ps represents the source transmit power, s denotes the iid Gaussian signals.h_i^t represents the i^{it}column of H matrix.

The selection procedure for relays is based on their interference profile and is give by

$$T_i = \begin{cases} 1, \textit{the relay is eligible} \\ 0, \textit{otherwise} \end{cases} \qquad (2)$$

The received signal at the destination after forwarding packets from relays is given by

$$y = \sqrt{\frac{Ps}{M}}\, FDHs + FDn + w \qquad (3)$$

Dis given by diag(T1C1,…………TnCn). w is the additive noise. Here the interference can be minimized by the use of relays. There is no need for channel side information for interference management.

5. Selection of Relays

In spectrum sharing we need to minimize interference by the selection of relays. The relays selection has important role. It is achieved by considering their interference profile. Select the relays that have less interference The relays are selected based on their channel gain. The relay i is selected if it’s channel gain is smaller than pre specified threshold value and is given by

$$T_i = \begin{cases} 1, |g_{li}|^2 \le \alpha \text{ for } l = 1,2, \ldots\ldots\ldots. Np \\ 0, \textit{otherwise} \end{cases} \qquad (4)$$

Where $|gli|^2$ is the channel gain.

6. Clustering Methods

In order to maximize the secondary rate, clustering methods are used. There are two types of clustering scheme; fixed and gain clustering. Clustering can be defined as follows. If we are using M number of antennas, divide the total system into M groups. Each group consists of source antennas, destination antennas and corresponding relays for communications. There is no relationship between selection of relays and clustering.

For fixed clustering, each group has n/M relays. The grouping is based on a pre specified manner.

Let,

$$Gm = \left\{ i: \frac{(m-1)n}{M} + 1 \le i \le \frac{mn}{M}, 1 \le m \le M \right.$$

For gain clustering,

$$Gm = |h_{im}| > |h_{iq}|, q \ne m, 1 \le q \le M$$

In gain clustering, the clustering is based on their channel gain. A relay was selected to a group if it’s channel gain is higher than others gain. Here we get the secondary rate as (M/2)log n.

7. Alternate Relay Protocol (ARP)

In spectrum sharing, use half duplex relays. The relays don’t listen to the source while they are transmitting. This will lead so many problems. When a group of relays are activated for transmission of previously received information, the other relays sense the source. Thus the source can send continually and the half duplex loss can be eliminated. The ARP consists of L transmission frames, as shown in Figure 2.Here during each frame, the channel coefficient remains constant, but varies from frame to frame. The relays are divided into two groups

G1 = {1 ≤ i ≤ n/2 } and

G2 = {n/2 + 1 ≤ i ≤ n}.

During even-number of transmission frames a group of relays in G1sends to destination, the relays in G2 listen the source. For odd numbered transmission frames, a group of relays inG2 sends the data, G1 listen the source. . Thus half duplex loss can be eliminated.

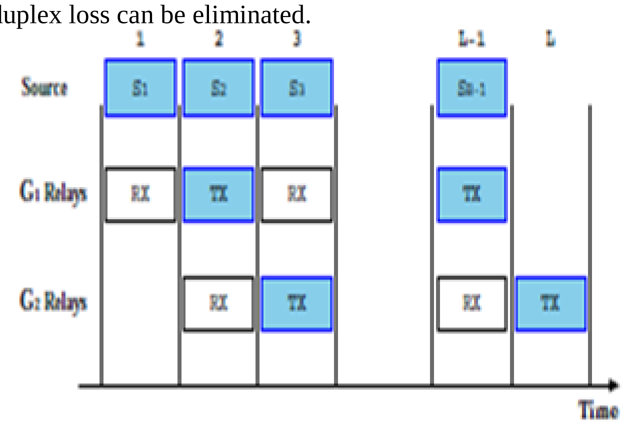

Figure 2: Transmission schedule in the alternating relay protocol (ARP)

8. Simulation Results

In this paper we are using multiple relays. The relays are used to improve the secondary rate as well as interference reduction. The interference $\gamma = o(n)^{-\delta}$,as n→ ∞, it will become zero. The simulation results are shown in figure2. It shows that as the number of relays increases the primary interference reduction occur. Also as the relays increases secondary rate increases.

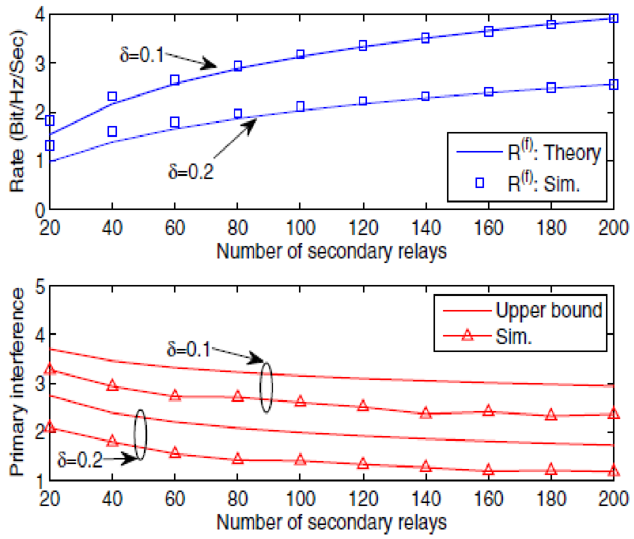

Figure 3: Secondary rate and primary interference as a function of number of relays

9. Conclusion

In this paper we proposed a novel method for interference reduction and for maximization of the secondary rate. The use of relays at the secondary and clustering achieved this goal. The relays use AF protocol. The secondary rate increases logarithmically as the number of relays increases. We can achieve secondary rate growth as log n without cross channel information. The relay does not require complicated decoding and encoding. And Improve spectrum utilization. The future work involves studying under dynamic environments where the topology and channel changes with time. A further study from coding and networking allows another scope in this area.

10. Acknowledgement

We would like to express our gratitude to the following people for their support and guidance for the success of this paper. We express our deep sense of gratitude to Mrs. Ann Susan Vargheese, Assistant Professor, ECE, MZC Kadammanitta, PTA, Kerala India. We deeply indebted to Dr. Rajaram N, Principal, MZC, PTA, Kerala.

References

[1] Yang Li, Student Member, IEEE, and Aria Nosratinia, Fellow, IEEE ''Spectrum Sharing with Distributed Relay Selection and Clustering ''IEEE *Trans. Inform. Theory*
[2] D. Chen, K. Azarian, and J. Laneman, "A case for amplify-forward relaying in the block-fading multiple-access channel," *IEEE Trans. Inform. Theory*, vol. 54, no. 8, pp. 3728 –3733, Aug. 2008.
[3] Y. Liang and V. V. Veeravalli, "Cooperative relay broadcast channels," *IEEE Trans. Inform. Theory*, vol. 53, no. 3, pp. 900 –928, Mar. 2007.
[4] A. ¨Ozg¨ur, O. L´evˆeque, and D. Tse, "Hierarchical cooperation achieves optimal capacity scaling in ad hoc networks," *IEEE Trans. Inform. Theory*, vol. 53, no. 10, pp. 3549 –3572, Oct. 2007.
[5] D. Chen, K. Azarian, and J. Laneman, "A case for amplify-forward relaying in the block-fading multiple-access channel," *IEEE Trans. Inform. Theory*, vol. 54, no. 8, pp. 3728 –3733, Aug. 2008.
[6] O. S¸ ahin, O. Simeone, and E. Erkip, "Interference channel with an outof- band relay," *IEEE Trans. Inform. Theory*, vol. 57, no. 5, pp. 2746–2764, May 2011.
[7] G. Zhao, J. Ma, G. Li, T. Wu, Y. Kwon, A. Soong, and C. Yang, "Spatial spectrum holes for cognitive radio with relay-assisted directional transmission," *IEEE Trans. Wireless Commun.*, vol. 8, no. 10, pp. 5270–5279, Oct. 2009.

Author Profile

Nijina A received the B.Tech degrees in Electronics and Communication Engineering from kerala University at SHM College of Engineering in 2013. And now she is pursuing her M.Tech degree in Communication Engineering under the M.G University in Mount Zion College of Engineering.

Devi Radhakrishnan received the B.Tech degrees in Electronics and Communication Engineering from M.G University, Kerala at Mount Zion College of Engineering in 2012. And now she is pursuing her M.Tech degree in Communication Engineering under the same university in Mount Zion College of Engineering.