DISASTER RESPONSE NETWORK USING DEVICE TO DEVICE COMMUNICATION

Dr. K.D.Kulat [1] , Aitha Manaswini, M. Chandra Srikruthi, Toram Ganesh [2]

[1] Professor, Visvesvaraya National Institute of Technology, Electronics and Communications Department, Nagpur, India
kdkulat@ece.vnit.ac.in
[2] Visvesvaraya National Institute of Technology, Electronics and Communications Department, Nagpur, India
{aithamanaswini55, srikruthi2871, satyaganesh2468}@gmail.com

Abstract. Development of technology has increased human reliance on various devices like mobile phones for communication. These devices rely solely on base stations and satellites to establish a link between the users. In case of natural disasters like floods, hurricanes etc. if there is damage in base stations, it may cause error in link establishment. The key technologies which can be used to overcome this drawback is Device to Device Communication and Cognitive Radio network. In this paper, Relay Selection and Co-operative Beamforming methods are used for Device to Device Communication. A cluster-based topology with a multihop relay network is used to span large distances between the information source and the receiver. A system model is developed to showcase message transfer from the primary users to the secondary users which act as relay nodes and finally to the destination nodes. Graphical results display the effectiveness and competence of our approach.

Keywords: Device to Device Communication, Co-operative beamforming, Relay selection.

1 INTRODUCTION

The advancement of technology has increased the number of cellular users; thereby increasing the traffic volume. Providing services to the multiplying users within the available spectrum has become difficult. In this scenario, Device to Device communication can be used to resolve the capacity bottleneck problem.D2D communication enables communication between two user devices within close proximity with no involvement of the base station thus decreasing the distance signal has to travel thereby reducing the latency. A Cognitive Radio (CR) is a technique in which the network understands and analyses the current internal situations and makes decisions from the analysis. It is basically a spectrum sharing approach in which cognitive users change their transmission and reception criteria depending on the internal environment thereby reducing interference losses.

Cooperative beamforming technique and relay selection assist in establishing cooperation among the primary users and secondary users hence enabling spectrum sharing for CR network.CR network effectively utilizes the channel thus increasing the spectral efficiency. Moreover, D2D decreases the latency of the network and increases the spectral efficiency.

In this paper, D2D communication and CR network are employed together to establish communication in disaster affected areas with increased spectral efficiency. A cluster based mutli-hop topology is employed to establish connectivity between source and destination at larger distances in disaster affected areas. The cluster heads, which are termed as primary users (PUs) select the relay nodes among the secondary users within the cluster by considering certain parameters like lower latency, high power transfer etc.

The model is as follows:

1. A cluster based topology with multihop relay network has been deployed.
2. Multi-hop network helps to cover larger distances between transmitter and receiver.
3. Device to Device Communication is being employed to decrease latency thereby increasing spectral efficiency.
4. Cognitive Radio Network is being employed to establish connectivity within available spectrum by employing cooperation in the network.

2 RELATED WORK

Communication in the simulation model is done based on a multi-hop relay network. So, a reference cognitive radio dual hop network is seen in Fig.1 and this method is generalized for an n-hop network. It is assumed that all the nodes contain one antenna and that LOS (Line Of Sight) is not present between the Source (SO) and Receiver (RX) nodes. Two hops are required for the transmitted information to reach the destination node. During the first hop, the SO node transmits message to the user devices (UDs) in its range, these UDs behave as relay nodes. They decode the received symbol, and then re-encode it and transmit the symbol to the So-Rx by using a beamforming method. This was proposed in [2].This is the second hop. So, for one symbol to reach the destination, two hops are needed. This gives the value of degree of freedom to be 0.5.

In a real life disaster scenario, distance between the primary node and the destination node is quite high. This distance cannot be covered by two hops. The usual models generated are two hop networks. In our paper, a four hop system model is constructed. This model is based on the system model seen in [1].

In a normal cognitive radio (CR) network, SUS (secondary users) do not interact with the PUs (primary users) after receiving information. But co-operation between primary users and secondary users, i.e. relay nodes is necessary to improve the quality of service. This has been incorporated in our model. The two-hop cognitive radio topology is also seen in [3].

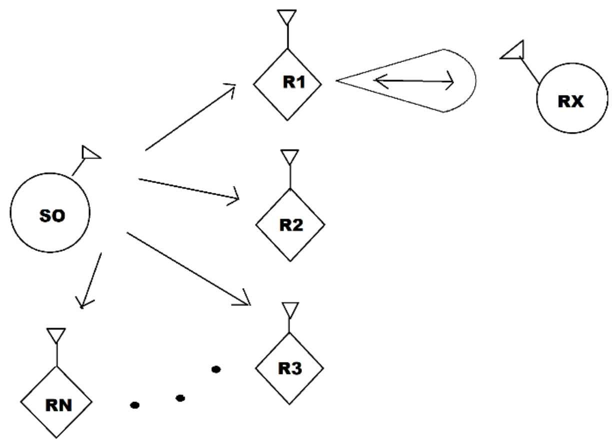

Fig.1. Two hop cognitive radio (CR) network

3 SCENARIO DESCRIPTION

A disaster response network is proposed to rescue the disaster affected area. The figure below depicts the affected area with an unaffected area in its vicinity. The user devices that require similar service form a cluster. The user with high computational power, battery life act as cluster head (CH). The cluster heads are the primary users of the licensed spectrum while the other cluster members become secondary users. The user devices in a cluster can communicate with the CH by device to device communication. The UEs communicate through relay selection and cooperative beamforming in case of severe disaster.

A hierarchical topology is proposed to transfer information from the source node in the unaffected area to the destination in the affected area. The more the number of levels, the more effectively the information is transferred. It is because the same information is transferred through different clusters. So if it is lost in any of the cluster it would be recovered from the other cluster.

Let a two-level hierarchical model be assumed. The primary user PU0 in the source cluster transfers the information to the PU2 in the second hierarchical level by first transferring information to the secondary users in its cluster through D2D technique. Let us consider an area which has been affected by a disaster. The antenna in the area is no longer in a condition to transfer information. The following scenario describes information transfer from a working source antenna to the user devices which are present in the affected area.

1. The first step depicts a working antenna in the surrounding area with free channels sending the necessary information to the user devices in its cluster. This is done via LTE method.
2. The SUs which behave as relay nodes in the source cluster are equal in number to the clusters in the first hierarchical level.

3. The relay nodes decode received information and transmit it after re-encoding by using beamforming technique. Cooperative beamforming helps to communicate in larger distances as total power can be concentrated in required direction.
4. The transmitted information by the relay nodes is received by the primary users of the second hierarchical level.
5. In the third step the primary users transmit the information received to relay nodes in their respective clusters.
6. In the final step the relay nodes again perform decoding and re-encoding and using beamforming technique transmit the information to their destination.
7. The power received is calculated using the formula

P=P0 * D^ (alpha * epsilon)

Here,
P0 – Power transmitted from SC
D– Distance between transmitting source and destination
alpha – number of relay nodes
epsilon – pathloss parameter

In the below figures the abbreviations expand to
PU-Primary User
RN-Relay Node
CH-Cluster Head
SC-Source Cluster
FHC-First Hierarchical Level Cluster
DC- Destination Cluster
BC- Broadcasting

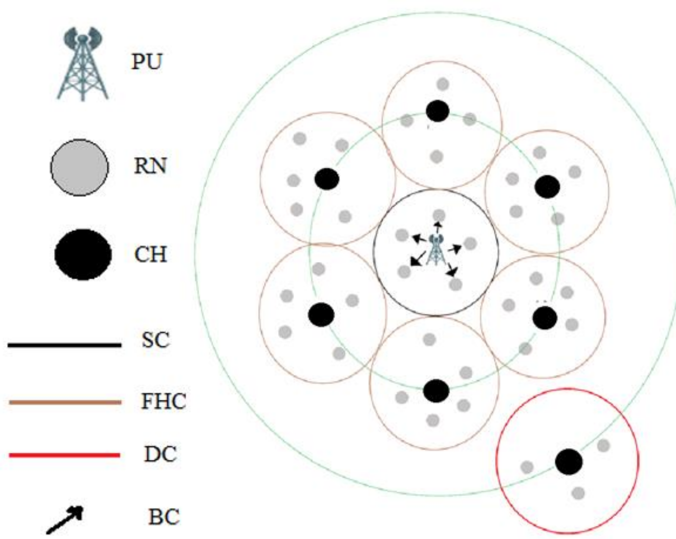

Fig.2. Time interval 1: Message transfer from PU0 to relay nodes R0.

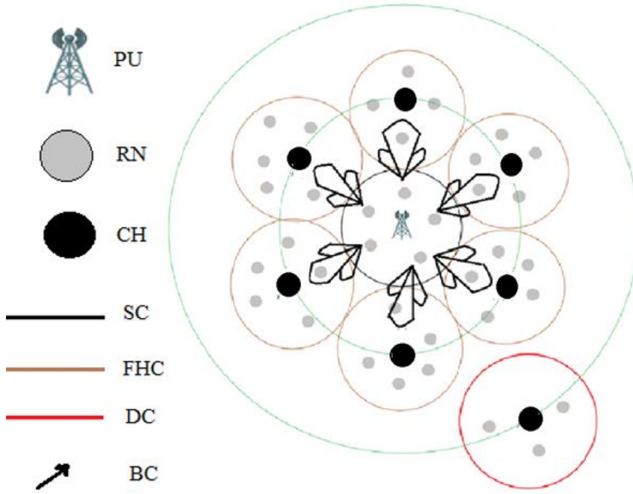

Fig.3. Time interval 2: Message transfer from relay nodes (R0) to PU1's of all the clusters in First Hierarchical Level.

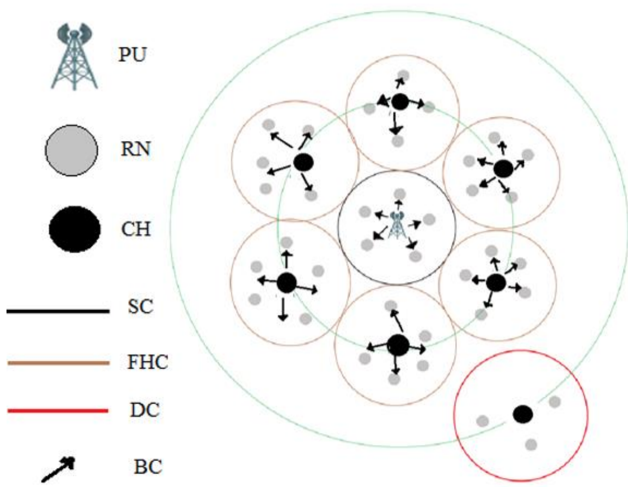

Fig.4. Time interval 3: Message transfer from all the PU1's to respective relay nodes.

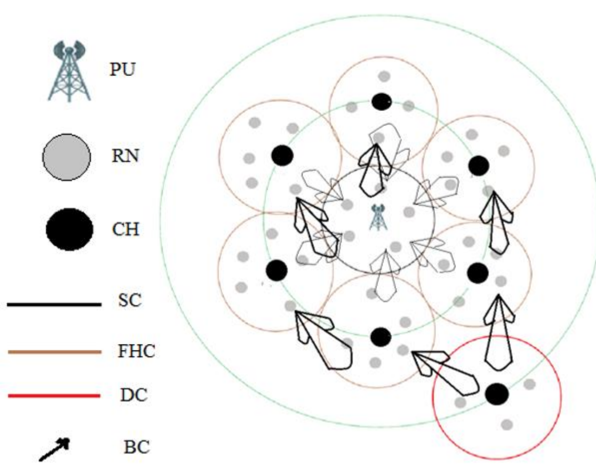

Fig.5. Time interval 4: Message transfer from relay nodes R1 to PU2.

4 RESULTS AND DISCUSSION

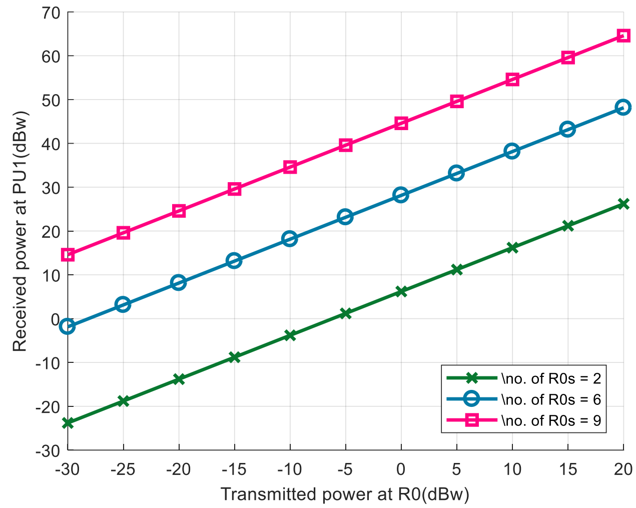

Fig.6.

The graph in Fig.6. depicts plot between transmitted power at R0 and received power at PU1 by varying the number of R0's.It is observed that as the number of relay nodes increases
the received power at PU1 increases. This is because of increase in beam width of radiation pattern of relays with increase in number of relay nodes.

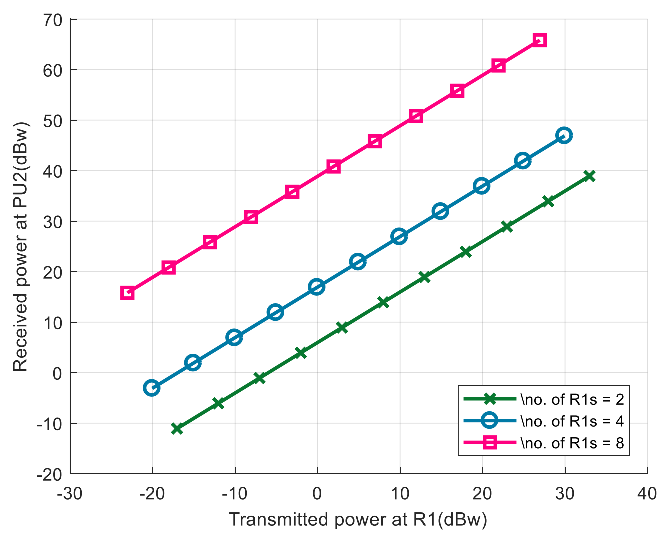

Fig.7.

The Fig.7. graph is plot between transmitted power at R1 and received power at PU2 by varying the number of R1's.As the number of R1's increases received power at PU2 increases. This is due to increase in relay radiation pattern.

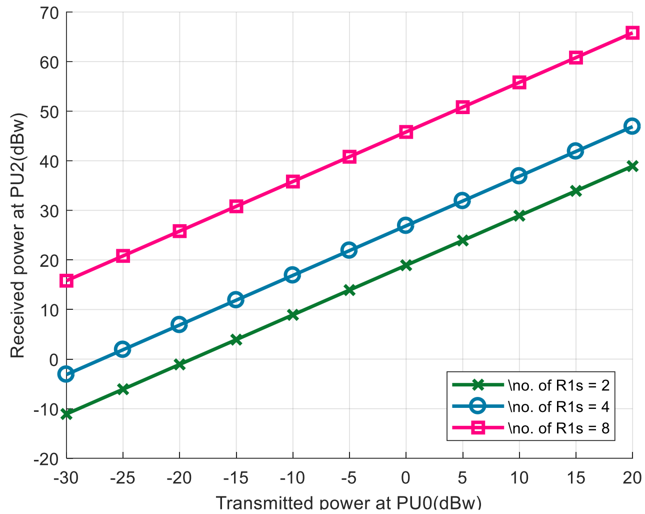

Fig.8.

The Fig.8. graph is plot between transmitted power at PU0 and received power at PU2 by varying the number of R1's.As R1's increases, received power at PU2 increases due to increase in relay radiation beam width.

5 CONCLUSION

During and after a disaster, effective communication is an important component of response and recovery. It connects affected people, families and communities with first responders, support systems and other family members. In our paper, cluster based topology using a multihop D2D network is demonstrated using a simulation model. Transmission distance can be selected to cover the full range of the base station. A joint cooperative beamforming and relay selection method is applied in each stage. This provides an advantage over other conventional schemes. A relay node is chosen by its contribution to the power received at next level and also the amount of leakage power observed at that node. Due to cooperative beamforming in multiple levels, received power at the destination is higher. This is observed from the included relevant graphical results.

6 REFERENCES

1.Javad Zeraatkar Moghaddam, Muhammad Usman , and Fabrizio Granelli, Senior Member, IEEE,"Disaster Management Using D2D Communication with Power Transfer and Clustering Techniques",June.2018.

2.J. Liu, W. Chen, Z. Cao, and Y. J. Zhang, "A distributed beamforming approach for enhanced opportunistic spectrum access in cognitive radios," in Proc. IEEE Glob. Telecommun. Conf. (GLOBECOM), Nov 2009, pp. 1-6.

3.H. Mu and J. K. Tugnait, "Secure degrees of freedom in cooperative MIMO cognitive radio systems," IEEE Trans. Commun., vol. 63, no. 11, pp. 4377–4389, Nov. 2015.