Performance Evaluation of some basic cooperative communication protocol for wireless networks

Prashant chouksey[1*],Dr. Neelesh Mehra[2*]
[1]M. Tech. Scholar, Department of Electronics and Communication Engineering, Samrat Ashok Technological Institute,Vidisha,M.P. India, Email Id: prashantchouksey31@gmail.com
[2]Assistant Professor, Department of Electronics and Communication Engineering, Samrat Ashok Technological Institute,Vidisha,M.P. India, Email Id : neeleshmehra@gmail.com

***Abstract* - In the frequency-limited cellular networks, the underlaying Device-to-Device (D2D) communications is an efficient way to enhance the user access probability and network capacity performance. To satisfy the communication requirements for users in different network sizes, a cooperative transmission strategy based on multi-relay D2D communications is proposed. Specifically, to increase the serving users simultaneously and meanwhile maintain the QoS of them, a joint admission control and cooperative nodes selection scheme is proposed, and then the power control and resource allocation scheme is provided correspondingly. Simulation results show that the proposed strategy can enhance the user access probability efficiently in frequency-limited cellular networks.**

There are several relaying strategies to implement cooperative diversity, and some of the basic strategies are Amplify-and- Forward, Decode-and-Forward and Compress- and Forward. Each of them have their own advantage and they can provide different performance results with different environment. Variation of probability of error can be seen with the change in signal combining strategy.

Keywords—Cooperative Communication, Diversity, Channel Capacitance.

I. INTRODUCTION

In a wireless network, signal from source to the destination propagates through line of sight as well as various indirect paths. This effect is referred to as multipath propagation. Because of the multipath propagation, signal degradation occurs. This signal degradation is called fading and it is a severe form of interference that can be encountered through the use of diversity. Cooperative communication is a technique in which redundant signals are transmitted over essentially independent channel and suitable receiver combines these redundant signals to average the channel effects which led to fading. [1]

Contrary to the more usual forms of space diversity with physical arrays [2], [3], [4], this work builds upon the classical relay channel model [5] and examines the problem of creating and exploiting space diversity using a collection of distributed antennas belonging to multiple terminals, each with its own information to transmit. This form of space diversity is known as cooperative diversity (cf., user cooperation diversity of [6]), this is because the terminals share not only their antennas but also other resources to create a "virtual array".

At the destination space diversity or multi-antenna diversity techniques are great as they can be readily combined with other forms of diversity, for e.g. time and frequency, and still offer great performance gains when other forms of diversity are unavailable.

Cooperative communication is a multi-hop transmission system, in which small single antenna mobile devices share their antennas in a multi-user environment. Thus the basic idea of the cooperative communications is that mobile devices in a wireless network can help each other to send signals to the destination cooperatively. Each user's data information is sent out to the destination not only by the user, but also by other users. Thus, it is becomes more reliable for the destination to detect the information transmitted by the user as the chance of all the channel links to the destination going down is rare.

Cooperative communication system therefore generates a virtual MIMO system, and in turn it achieves spatial diversity. Sharing resources of the cooperative system leads to saving of the network resources such as power and computations. [7] Various cooperative diversity algorithms have been developed for a pair of terminals based upon relays amplifying their received signals or fully decoding and repeating information. These algorithms are referred as amplify-and-forward and decode- and-forward, respectively. [8], [9]

The amplify-and-forward relay strategy is the simplest way that a relay node may cooperate. In this, the relay simply buffers the source node's transmission over some predefined time interval and retransmits an amplified copy of the signal during the following cooperation period. In the decode-and- forward relay strategy, the relay node fully decodes, re- encodes and retransmits the source node's message.

In spite of the numerous benefits offered by device-to device (D2D) communication, a number of concerns are involved with its implementation. When sharing the same resources, interference between the cellular users and D2D users needs to be controlled. For this, numerous interference management algorithms have been proposed in literature. Other concerns include peer discovery and mode selection, power control for the devices, radio resource allocation and security of the communication.

II. SYSTEM MODEL

To see the effects of cooperative communication on a pre existing system with one Source Node and one Destination Node, one extra node is added, this node is called the Relay node. The simplest description of the system considering a source node (SN), a destination node (DN) and one relay node (RN) is as given in Fig 1.

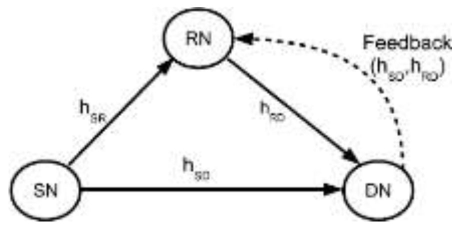


Fig.. 1. System model for Cooperative communication

In the Fig 1, h_{SR}, h_{SD} and h_{RD} represents channel state between source and relay, source and destination and relay and destination respectively. The distances between various nodes are represented as follows:

Nodes	Distance
Source to Destination	$d_{s,d}$
Source to Relay	$d_{s,r}$
Relay to Destination	$d_{r,d}$

The channel coefficients are assumed to follow block Rayleigh fading. The information transfer is divided into two phases. In phase 1, information is sent from SN to RN and from SN to DN. In phase 2, information is sent from RN to DN. At the destination both the signals are processed to give the output. The distance between each of the node is considered to be 1 unit. Therefore all the nodes are equidistant. Hence any change in the performance or change in probability of error will be because of the protocol used to transmit data.

The basic blocks used to simulate the transfer of data between nodes is given below in Fig 2.

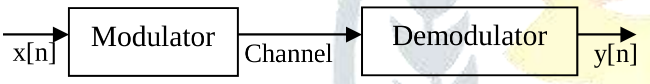


Fig 2. Basic Model for data transfer from one node to another

To avoid in change of results because of different modulation schemes, only QPSK (*Quadrature Phase Shift Keying)* modulation is used.

III. PROTOCOLS

The Cooperative communication protocol that is used in the relay station is Amplify and Forward protocol. This protocol will describe how the data that is received by the relay node is going to be processed before it can be sent to the destination. In Amplify and Forward protocol the signal that is received by relay simply is amplified before it is sent again. By doing so the noise is also amplified and this leads to bad performance by this protocol. Amplify and Forward protocol is mostly used when the relay has only limited amount of computing time available all the time delay caused by the relay to decode and encode the message has to be minimized and when the transmitted signal is either analogue or digital.

At the destination Enhanced Signal to Noise Combining (ESNRC) is used, this method ignores an incoming signal when the data from the other incoming channels have a much better quality. If the channels have more or less the same channel quality the incoming signals are rationed equally. This combining type has the best probability of error versus signal to error ratio response.

Multipath fading introduces errors and distortions and the methods employed for compensation fall into three general categories: forward error correction, adaptive equalization, and diversity techniques. Typically, techniques from all three categories are combined to combat the error rates encountered in a mobile wireless environment

the energy efficient routing schemes, cooperative nodes are randomly paired based on the locations in accordance with each other and the channel conditions. The single source node may utilize different cooperative partners at different times. As shown in Figure 1, the deterministic policy, with a pre-defined allocation, node 1 is be used as the cooperative node and if fixed over time. Here, node 2 has no impact on the system, but at times sometimes node 2 may be a better relay than node 1, whereas in the random scheme, relay nodes are randomly determined based on their location in the network and the channel conditions. Both node 1 and node 2 have certain probabilities to serve as the relay in the system. So, the system performance is jointly related to node 1 and node 2.

The source nodes forward the data to the relay node ‘x’ within its cluster which is located nearby to the next cluster in its path to reach the destination. This short range communication will utilize only the minimal energy from the nodes

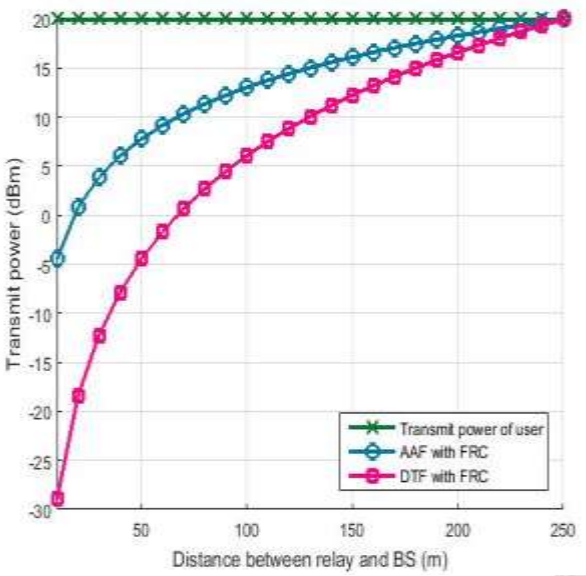
The relay node ‘x’ now tries to relay the data to the node in the next cluster which is in its path to reach the destination. The next node in the path will be the node from the next cluster. This node could be the destination node, if not it will act as the relay node ‘y’ to provide a path to reach the destination node. This relay node ‘y’ is chosen randomly based on its location and channel conditions. This enhances the short range communication, performance and, thus saving the systems lifetime. A single relay node can help ‘n’ number of source nodes in the system. This process is repeated until the destination node is reached. The acknowledgment to the source node is given using the same path but in the reverse direction.

An error correcting code is implemented at the relay station which performs the function of checking every decoded symbol in the DAF protocol. This allows the symbols to be re- encoded and sent if and only if they were correctly detected. One way of implementing an error correcting mechanism is using an interleaver in the communication model at the sender. There are efficient forward error correcting mechanisms like Low Density Parity Check (LDPC) which involve channel coding but these are not very efficient when employed with the DAF protocol as they need very high processing power and bandwidth. In this thesis a pseudo-error correcting mechanism that checks every signal symbol by symbol rather than a block-wise error correction is used

IV. RESULTS

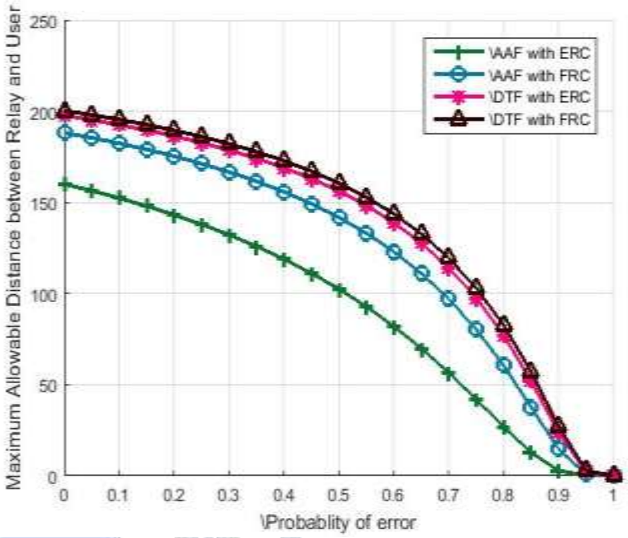
Designing the reliable cooperative communication protocol is principle working area in wireless cooperative networks. The implementation of the relay nodes with intelligence to perform some parametric operations (such as compress, demodulate, amplify etc.) on the incoming signals and brings out the advantageous manipulations for effective communication is key idea behind. The detect-and forward is superior to the amplify and forward protocol, so it issue in this comparative study. In these experiments binary phase shift keying (BPSK) modulation is used with coherent detection at the receiver.

In this chapter the simulation results obtained are demonstrated which further compares the different cooperative communication protocols along with different combining techniques and discuss their performance under different transmission condition by changing pathloss exponent. The proposed work is established by using Binary Phase Shift Keying modulation technique and transmission channel is taken as a non-selective (flat) fading channel in which all frequency components are affected by the same fading coefficients [25]. The proposed work has been implemented using MATLAB software.



Combining techniques are methods used to combine the multiple received signals of a diversity reception device into a single improved signal since there are usually more than one received transmission with the same burst of data. The simulations studies the performance of two protocol with two distinct combining technique Equal ratio combining (ERC) and Fixed ratio Combining (FRC). The comparison of AAF and DTF protocol with different combining techniques in terms of probability of error and distance between relay and base station. It is found that performance of DTF along with FRC is better than the other scheme illustrates the different combining techniques. It is found that as the probability of error increases the maximum allowable distance between relay and BS is also decreases The results indicate poor performance for the combining methods that don't require the exact channel . conditions. The reason behind is that in AAF everything, including errors and noise, is also amplified along with signal however, in DTF an error correcting mechanism is used.

Probability of Detection also known as probability of false alarm used to indicate the false detection of signal during spectrum sensing required before cooperative communication. Since this include mixed signal there will be probability for wrong estimation of transmitted signal. POD is better in DTF as comparison to AAF since signal is also further processed at the relay and sent onwards to the destination. In the case of the AAF protocol, both the noise and the signal are amplified at the relay which is quite advantageous as the signal with little noise gets amplified. This amplified signal is able to withstand the channel impairments that might be encountered as it is transmitted from the relay to the destination. In the case of the combining methods which require rough or complete estimation of the channel conditions, it is useful to know the channel qualities beforehand with the probable position of the relay. In varying the position of the relay irrespective of the layout geometry, continually low performances were recorded as the relay moved closer to the destination. Performance, however, increased as the relay was moved closer to the signal source.



REFERENCES

[1] N. Chandrasekaran, "*Diversity Techniques in Wireless Communication Systems*", Rutgers University, pp. 1-8, 2005.

[2] D. W. Bliss, K. W. Forsythe and A. M. Chan, "MIMO Wireless Communication*", Lincoln Lab. J.*, vol. 15, no. 1, pp. 97-126, 2005.

[3] S. M. Alamouti, "A simple transmit diversity technique for wireless communications," *IEEE J. Select. Areas Commun*., vol. 16, no. 8, Oct. 1998, pp. 1451-1458.

[4] D.K. Borah, G. Moreno-Crespo and S. Nammi, "Distributed Alamouti Transmit Diversity Technique for Co-Operative Communications," in *Proce 65th. IEEE conf. Veh. Technol.,* Dublin, April 2007, pp. 2210-2214.

[5] A. Nosratinia, T.E. Hunter and A. Hedayat, "Cooperative communication in wireless networks," *IEEE Commun. Mag.*, vol. 42, no. 10, pp. 74- 80, Oct. 2004.

[6] J. N. Laneman, G. W. Wornell and D.N.C. Tse, "An Efficient Protocol for Realizing Cooperative Diversity in Wireless Networks," in *Proc. IEEE ISIT*, Washington, DC, June 2001, p. 294.

[7] D.B. Da Costa and S. Aissa, "Performance of Cooperative Diversity Networks: Analysis of Amplify-and-Forward Relaying under Equal-Gain and Maximal-Ratio Combining," *IEEE Int. Conf. on Commun.*, Dresden, June 2009, pp. 1-5.

[8] M. Yuksel and E. Erkip, "Diversity in Relaying Protocols with Amplify and Forward", in *Proc. IEEE GLOBECOM Commun. Theory Symp.*, San Francisco, Dec. 2003, pp. 2025- 2029.

[9] P. A. Anghel and M. Kaveh, "Exact Symbol Error Probability of a Cooperative Network in a Rayleigh-Fading Environment", *IEEE trans. wireless commun.*, vol. 3, no. 5, pp. 1416-1421, Sept. 2004.

[10] S. Haykin and M. Moher, "*Modern Wireless Communication Systems*", Upper Saddle River, NJ: Prentice-Hall, 2004.

[11] W. Stallings, *Wireless Communications and Networks*, 2nd ed., Upper Saddle River, NJ: Prentice-Hall, 2005.

[12] K. J. R. Liu et al., *Cooperative Communication and Networking*, New York: Cambridge University Press, 2009.

[13] Kumar Mishra M., Trivedi A., Mehra N. (2021) mmWave-Based 5G and Beyond Cellular Networks. In: Mandloi M., Gurjar D., Pattanayak P., Nguyen H. (eds) 5G

[14] Beyond Wireless Systems. Springer Series in Wireless Technology.Springer,Singapore. https://doi.org/10.1007/978-981-15-6390-4_7