iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VI **Month of publication:** June 2017

DOI:

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Cooperative Relay Based Communication Over Multi User Mobile Networks

F. Lalrinfeli[1,] Kavitha Balamurugan[2]
[1,2] Department of ECE, K.C.G College of Technology

Abstract:* The importance of energy efficiency is becoming more crucial in today's mobile communication systems. Cooperative Communication is a technique which aims to increase energy efficiency by the use of relay nodes. Basically, cooperative relaying is a technique for wireless communication which guarantees gains in throughput and energy efficiency. The basic idea is that when a device needs to transmit data to its destination, a third device overhears this signal and then relays the signal to the destination. The destination then combines these signals to improve decoding. This paper aims to prove that a cooperative communication system offers higher achievable rates than conventional communication systems. Then, the energy efficient transmission problem is focussed in a relay-based cooperative network which aims to prove that systems with relay nodes have higher transmission efficiency by comparing it with systems with the same number of source and destination nodes, but without relay nodes. This will help achieve high data transmission over the long distance communication. The disadvantage of the existing system is that it has base station to end user transmission which has low data transmission. This disadvantage can be overcome or improved by implementing cooperative relay based data transmission.
Keywords--- Cooperative relay, source node, relay node, destination node, Amplify and Forward

I. INTRODUCTION

In conventional communication systems, transmission of data is between the source nodes and the destination node, and there is no assistance provided to any of the user by another user. In a practical wireless communication network, there are many neighboring nodes, which are capable of great assistance. When data is transmitted by a single node, the signal is overheard by its neighboring nodes. The main aim of Cooperative Communication is to process and then forward this overheard information to the respective destination so as to create spatial diversity, by which performance of the system increases. In simple terminology, cooperative relaying can be defined as a technique for wireless communication that guarantees gains both in throughput and in energy efficiency. The main concept behind this is that when a device needs to transmit data to its destination, a third device overhears this signal or information. This third device then relays the signal to the destination device. The signals are then combined at the destination to improve decoding. Cooperative relaying concept gives rise to pure self-organizing networks without any need for base stations. It can be used for different applications of network embedded systems. Cooperative communication proves as a promising means to reduce the effects of small scale fading. The technique of cooperative relay is formed from the idea of cooperative diversity as alternative communication paths are being used in cooperative communication. This is done by getting assistance from other nodes surrounding the sender node and the receiver node of a currently affected communication link. These surrounding nodes then act as relays, which means that these relays are a dedicated or temporary wireless node which will help forward the information from the sender node to a receiver node. In this way, Cooperative relaying technique helps achieve significantly more efficient usage of resources thereby improving the quality of service. The Cooperative Relaying technique has been adopted by the 4th generation (4G) orthogonal frequency division multiple access (OFDMA) systems with LTE and LTE-Advanced standards. It is also the underlying technique for several potential features for 5G evolution. These networks typically have multiple communicating pairs along with available relays within the vicinity. To support simultaneous transmission, the efficient physical layer design of cooperative relaying is crucial[3]. The main differences of Cooperative transmission schemes from conventional non-cooperative transmission systems are mainly: 1) the resources of multiple users are used to transmit the data of a single source; and 2) there exists a good combination of signals from multiple cooperating users at the destination.

www.ijraset.com Volume 5 Issue VI, June 2017
IC Value: 45.98 ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Fig.1: System of Conventional Communication

Fig. 1 shows a conventional communication system. As seen from the figure, it is a direct communication between the source node and the destination node. This is our currently used system and it has many needs for improvement, specially in terms of long distance communication. Cooperative relaying scheme aims to solve some of its disadvantages.

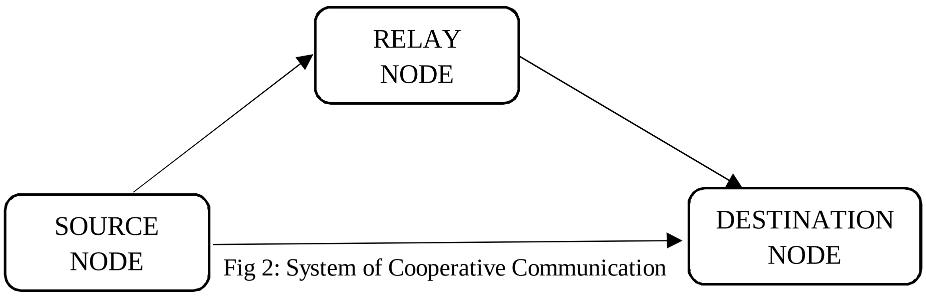


Fig 2: System of Cooperative Communication

From fig. 2, we can say that the source node is transmitting the data to the destination node; while the relay node (another mobile user) is also helping in the transmission. The relay station also processes and forward this message to the destination, where both of the received signals are combined. Since both of the signals are transmitted through independent paths, this results into spatial diversity. Hence, each wireless user is assumed to transmit its own data as well as act as a cooperative agent (relay) for the other user in cooperative communication [4].

II. CONCEPTS OF COOPERATIVE COMMUNICATION

The advantages of cooperation can be exploited in resource constrained networks, such as wireless sensor networks by optimally allocating the energy and bandwidth resources among users on the basis of the available channel state information (CSI) at each node. It exploits the spatial diversity inherent in multiuser systems by allowing users with diverse channel qualities to cooperate and relay each other's messages to the destination. Each transmitted message is passed through multiple independent relay paths and thus, the probability that the message fails to reach the destination is reduced significantly. In cooperative communications, users share and coordinate their resources and thus enhance the transmission quality. Cooperation allows the users that experience a deep fade in their link towards the destination to utilize quality channels provided by their partners to achieve the desired quality of service (QoS).Suppose the transmission fails when the channel has a deep fade, i.e., when the signal-to-noise ratio(SNR) of the received signal falls below a certain threshold. If the two users cooperate by relaying each others' messages provided the inter-user channel is sufficiently reliable, the communication outage occurs only when both users experience poor channels simultaneously. The advantages of relay cooperation usually depend on sufficiently reliable inter-user channels. For example, in the Decode and Forward scheme, a node relays the message from the source only if the decoded message is reliable. Likewise, in the case of Amplify and Forward scheme, the quality of the relayed signal is limited by the quality of the source-relay link since both the signal and noise are amplified at relays. This means that relays should be adopted only if the source-relay channel is sufficiently reliable. These cooperative communication schemes can be readily extended to a large network for different applications.

III. TYPES OF RELAYING PROTOCOLS

The different protocols by which the information is being relayed to the destination in Cooperative Communication System can be classified into three main categories as follows [5]:

A. Amplify and Forward

The basic mechanism of Amplify and Forward is based on the principle of amplifying repeaters. This protocol was introduced by Lane man et al. Under this cooperative protocol, the signal received by a user from the source node/transmitters is first amplified and then forwarded to the destination node. This is the simplest protocol used for relaying and hence it gets attention due to its simplicity.

1) *Decode and Forward:* This basic idea of this protocol was first introduced formally by Thomas M. Cover and Abbas A.El Gamal. The idea wathen further explored by many other authors by the name of Decode-and-Forward. Under this relaying protocol, the relay node first receives the information from the source node, decodes this information and then re-encodes it. Finally, the re-encoded information is forwarded to the desired destination by the relay node.
2) *Compress and Forward:* This type of relaying protocol also involves decoded information. The main difference of Compress and Forward protocol from Decode and Forward is that the relay node forwards the compressed version of the decoded information from the source node. This is to obtain the diversity benefits. Hence, in this case, the destination node gets a compressed version of the information from the relay node. Of all these schemes, the Amplify-and-Forward (AF) approach, due to its simplicity, is of particular interest. The amplify-and-forward approach has been extended to develop space-time coding strategies for relay networks. While the other cooperative approaches assume different levels of CSI availability in the network, they all share the common assumption that the relay nodes operate at their maximum allowable power. It has been observed that different relaying schemes outperform one another for different range of relay power. When the relay has a low power budget, it is seen that three-phase schemes outperforms two-phase ones. This is due to the dominating contribution from the direct links.

IV. SIMULATION DETAILS

In cooperative communication, we can say that the source node is transmitting the data to the destination node; while the relay node (another mobile user) is also helping in the transmission. The relay station also processes and then forward this message to the destination, where both of the received signals are combined. Since both of the signals are transmitted through independent paths, this results into spatial diversity. Hence, each wireless user is assumed to transmit its own data as well as act as a cooperative agent (relay) for the other user in cooperative communication.

Firstly, a conventional communication system is developed in which 1000 channel realizations has been used for simulations in Matlab. Then SNR values from -10 to 20 dB has been used. This conventional communication system has no relay node. Keeping this in mind, the throughput graph is generated. Then, for the same number of channel realization and SNR values from -10 to 20dB are used while developing the cooperative communication system. In this design, a relay node is present between the source and the destination. The throughput graph for this system is then generated. The main aim is to prove that the cooperative communication can produce better throughput than the conventional communication system due to the presence of the relay node. Several simulations are performed observing the throughput rates in both the Conventional communication system as well as the system with relay nodes. Comparisons of the throughput are done in both cases, taking the same number of source nodes and destination nodes.

V. RESULTS

The simulation has been done in Matlab (R2011a) and the results are given. 1000 channel realizations has been used for simulations in Matlab. Then SNR values from -10 to 20 dB has been used. These conditions are used in common for both a system without relay and a system with relay. The throughput graphs shows the difference between conventional communication systems and a simple cooperative communication system. Cases are taken for both systems with different number of source nodes (Ns) and number of destination node (Nd).

A. *Performance of a system without relay*

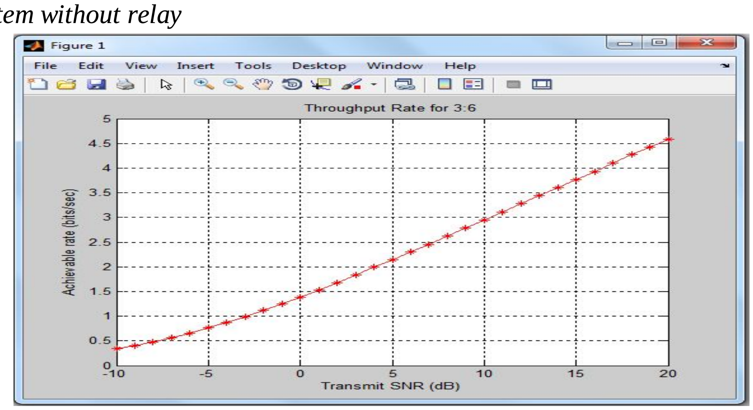


Fig.3: Throughput graph for system without relay with Ns=3 Nd=6

Volume 5 Issue VI, June 2017
ISSN: 2321-9653

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The Fig. 3 shows the throughput graph for a conventional communication system obtained from the path analysis i.e, without relay. A MIMO system is taken with three transmitters and three receivers.The graph is plot between the achievable rate and the corresponding SNR. The Achieveable rate can be observed from the figure. The maximum point in the plot is found to be approximately 4.7 bits/sec when the SNR value is 20dB.

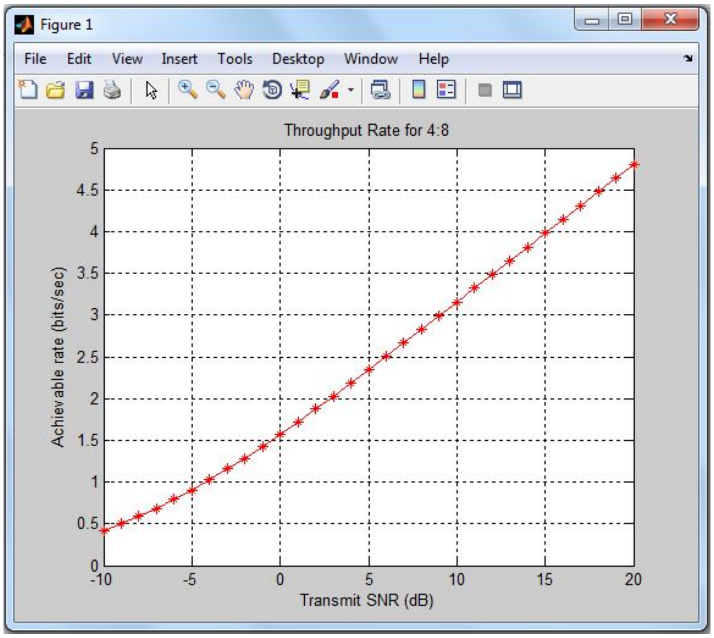


Fig.4: Throughput graph for system without relay with Ns=4 , Nd=8.

In this case, there are four source nodes and 8 destination nodes. It is found that the maximum achievable rate is approximately 4.8 bits/sec when the SNR value is 20dB. This result will be compared with the system having a relay with the same number os source nodes and destination nodes.

B. Performance of a system with relay (Cooperative Communication)

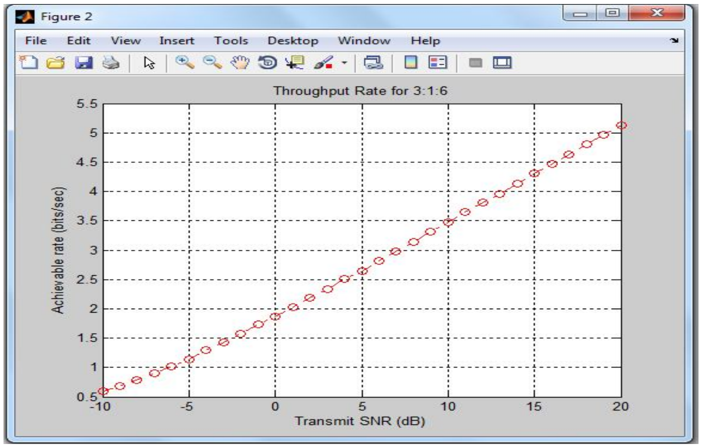


Fig.5: Throughput graph for system with relay Ns=3, Nr=1, Nd=6

The above Fig. 5 is obtained by taking a MIMO system with three source nodes and six destination nodes along with a single relay node. The other parameters under which the system is implemented is exactly same as the case of conventional MIMO systems. It can be clearly observed from the figure above, that the achievable rate in the case of Cooperative Communication is significantly higher than that of Conventional Communication systems. The obtained maximum achievable rate is approximately 5.3 when the SNR is 20dB.

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

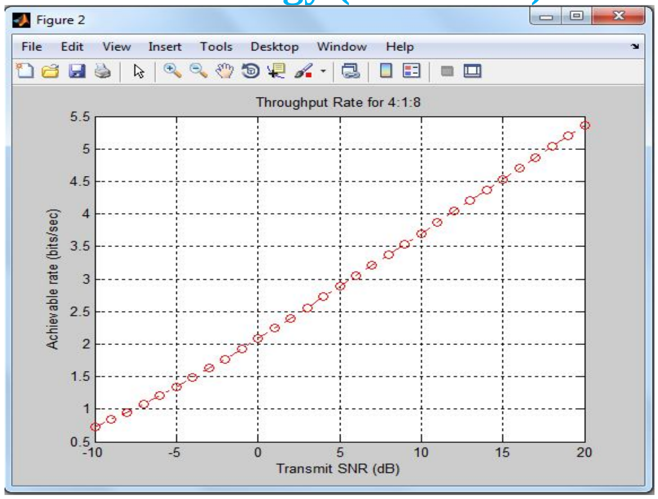


Fig.6: Throughput graph for system with relay Ns=4, Nr=1, Nd=8

In the above Fig.6, we can observe that the maximum achievable rate when there are four source nodes, a single relay node and eight destination nodes. The achievable rate is found to be approximately 5.4 bits/sec when the SNR is 20dB.

We can also observe that the achievable rate in both Conventional and Cooperative Communication changes when the number of source and destinations are changed. Also, the amount of increase or decrease in the achievable rates are almost similar in both the cases whenever the number of source nodes and destination nodes are the same. This means that in both cases i.e., Ns=3, Nd=6 and Ns=4 , Nd=8, it is found that the achievable rate is higher in Cooperative Communication at each instant respectively. Thus, this helps us make a fine conclusion that the case of Cooperative Relay Based Communication has significant improvement in energy effiency as well.

C. Performance of a system with multiple relay nodes (Cooperative Communication)

In addition to the simulation on both systems without relays and with single relays, we can widen our scope of observation by taking a simulation based on a system with multiple relays. The changes with increase in the number of relay nodes can be seen by taking the same number of source nodes and destination nodes and then forming a comparison amongst all the cases taken.

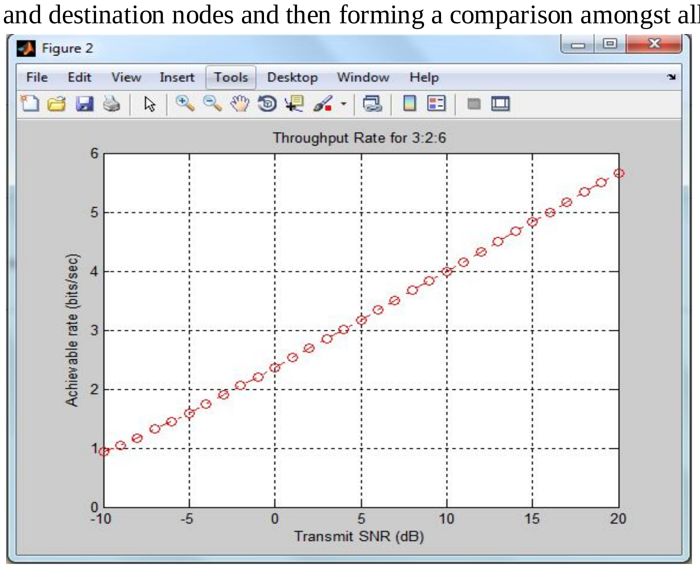


Fig.7: Throughput graph for system with relay Ns=3, Nr=2, Nd=6

Fig. 7 shows the throughput graph for a system with two relay nodes. It can be seen that the achievable rate is found to be 5.7 bits/sec, which is a significant increase in comparison to a system with single relay and the same no. of source and destination nodes.

Volume 5 Issue VI, June 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

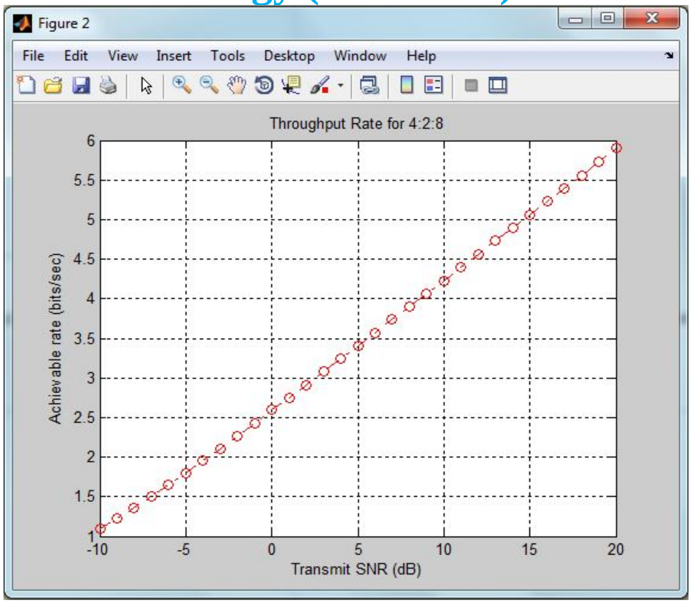


Fig.8: Throughput graph for system with relay Ns=4, Nr=2, Nd=8

The graph shown in Fig.8 gives the maximum achievable rate in the case of two relay nodes when Ns=4 and Nd=8. The achievable rate is found to be 6 bits/sec. This is a significant improvement when compared with the system with a single relay node.

VI. PERFORMANCE COMPARISON

The system performances of a conventional MIMO communication system and Cooperative Communication system can be compared respectively for each cases where the number of source and destination are different and summarized in a tabular form.

TABLE 1

COMPARISON FOR DIFFERENT CASES WHEN NS=3 AND ND=6

Parameter	System without relay node	System with one relay node	System with two relay nodes
No. of nodes	Ns=3 Nd=6	Ns=3 Nr=1 Nd=6	Ns=3 Nr=2 Nd=6
SNR range	-10dB to 20dB	-10dB to 20dB	-10dB to 20dB
Achievable rate	4.7 bits/sec	5.3 bits/sec	5.7 bits/sec

TABLE 2

COMPARISON FOR DIFFERENT CASES WHEN NS=4 AND ND=8

Parameter	System without relay node	System with one relay node	System with two relay nodes
No. of nodes	Ns=4 Nd=8	Ns=4 Nr=1 Nd=8	Ns=4 Nr=2 Nd=8
SNR range	-10dB to 20dB	-10dB to 20dB	-10dB to 20dB
Achievable rate	4.8 bits/sec	5.4 bits/sec	6 bits/sec

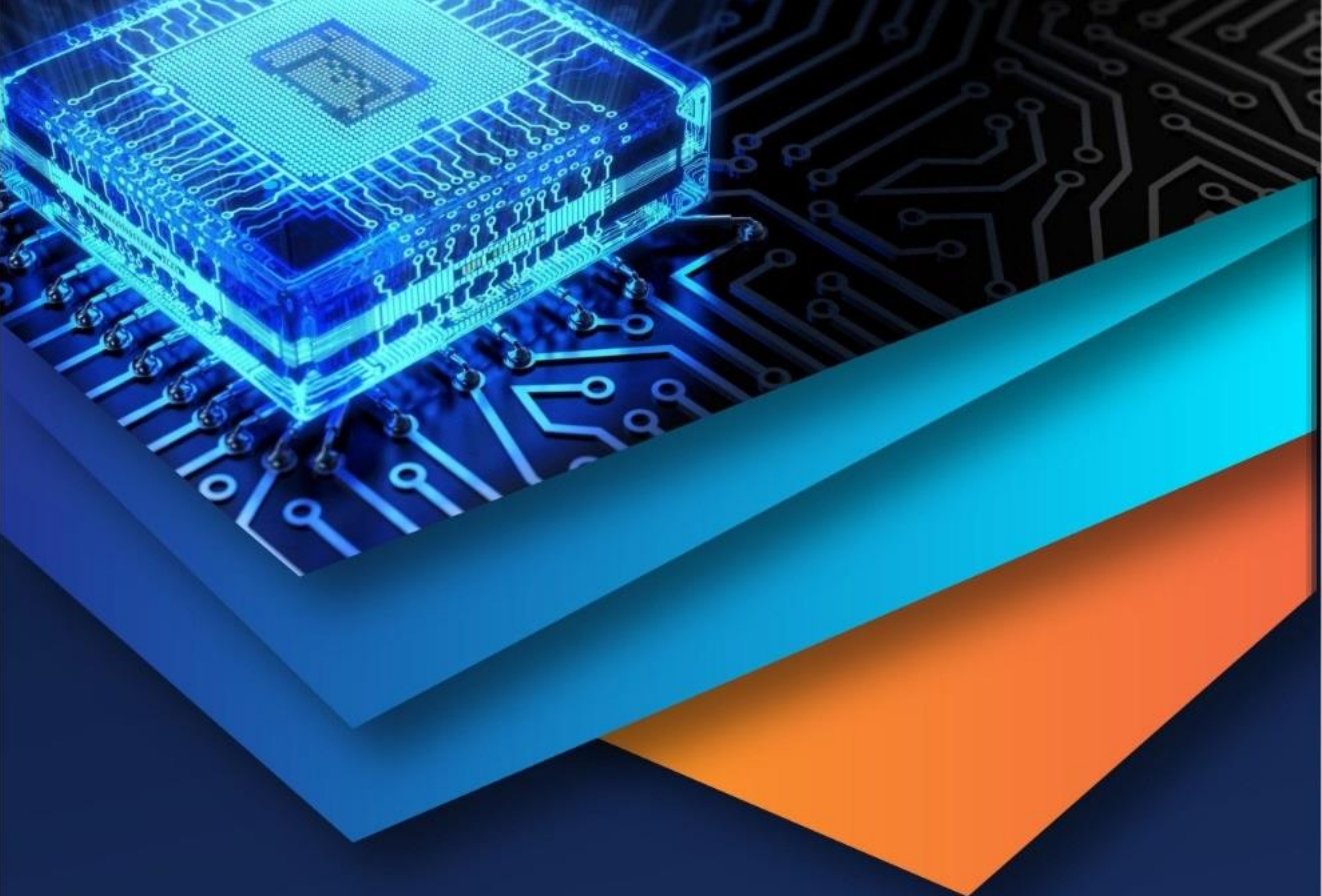
Volume 5 Issue VI, June 2017
ISSN: 2321-9653

VII. CONCLUSION

The results obtained shows that there is significant increase in the achievable rate when a Relay node is used. The throughput has been increased by significant amount. It is also observed that increasing the number of relay nodes can helo increase the throughput. This means that Cooperative Communication can help improve energy efficiency. It is emerging as an effective technique for reducing the effects of path loss, shadowing, and multi-path fading. Cooperative relaying provides diversity gain, reduces outage probability and improves BER performance. Although it is found to be a good technique, it also has its challenges. However, there is no doubt that it contributes a great deal in improving energy efficiency.

REFERENCES

[1] Ali Ramezani-Kebrya, Min Dong, Ben Liang, Gary Boudreau, and Ronald Casselman, "Per-Relay Power Minimization for Multi-user Multi-channel Cooperative Relay Beamforming'', IEEE Transactions on Wireless Communication Vol.15, no.5, May 2016.
[2] Yao-Win Hong, Wan-Jen Huang, Fu-Hsuan Chiu, and C.-C. Jay Kuo: "Cooperative communications in resource-constrained wireless networks": IEEE SIGNAL PROCESSING MAGAZINE MAY 2007
[3] Luca Sanguinetti, Member, IEEE, and Antonio A. D'Amico," Power Allocation in Two-Hop Amplify-and-Forward MIMO Relay Systems with QoS Requirements", IEEE transactions on signal processing, Vol. 60, NO. 5, May 2012
[4] Gurpreet Kaur1 and Partha Pratim Bhattacharya, "A survey on cooperative diversity and its applications in various wireless networks": International Journal of Computer Science & Engineering Survey (IJCSES) Vol.2, No.4, November 2011.
[5] Juhi Garg, Priyanka Mehta and Kapil Gupta:" A Review on Cooperative CommunicationProtocols in Wireless World": International Journal of Wireless & Mobile Networks (IJWMN) Vol. 5, No. 2, April 2013
[6] Min Chen, Student Member, IEEE, and Aylin Yener, Member, IEEE:" Power Allocation for F/TDMA Multiuser Two-Way Relay Networks": IEEE transactions on wireless communications, VOL. 9, NO. 2, FEBRUARY 2010
[7] Ronghong Mo, Member, IEEE, Yong Huat Chew, and Chau Yuen, Senior Member, IEEE: "Information Rate and Relay Precoder Design for Amplify-and-Forward MIMO Relay NetworksWith Imperfect Channel State Information": IEEE transactions on vehicular technology, VOL. 61, NO. 9, NOVEMBER 2012
[8] V. Havary-Nassab, S. ShahbazPanahi, A. Grami, and Z.-Q. Luo, "Distributed beamforming for relay networks based on second-order statistics of the channel state information," IEEE Trans. Signal Process., vol. 56, pp. 4306–4316, Sep. 2008.
[9] S. Chen and J. Zhao, "The requirements, challenges, and technologies for 5G of terrestrial mobile telecommunication," IEEE Commun. Mag., vol. 52, pp. 36–43, May 2014.
[10] T. Q. S. Quek, H. Shin, and M. Z. Win, "Robust wireless relay networks: Slow power allocation with guaranteed QoS," IEEE J. Select. TopicsSignal Process., vol. 1, pp. 700–713, Dec. 2007.
[11] Abdulkareem Adinoyi and Halim Yanikomeroglu:" Cooperative Relaying in Multi-Antenna Fixed Relay Networks": IEEE transactions on wireless communications, vol. 6, no. 2, February 2007.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY