INTERNATIONAL JOURNAL FOR TRENDS IN ENGINEERING & TECHNOLOGY
VOLUME 36 ISSUE 1 – MAY 2019 - ISSN: 2349 – 9303

An Efficient and Secure Communication with Relaying Network Using AF and DF Policies

M.SOWNDARIYA[1]
[1]ANNA UNIVERSITY, Communication systems,
ammuriya25@email.com

V.VIVEK[2]
ASSISTANT PROFESSOR, Department of ECE
viveknvv@email.com

Abstract— In this paper, a dual-hop decode-to-forward and Amplify and forward adaptive cooperative system is considered where multiple relays with finite energy storage and can harvest energy from the destination. In our analysis, the relays are spatially randomly located with invoking stochastic geometry. In an effort to improve spectral efficiency, an optimal source-relay link (OSRL) scheme is employed. Assuming Nakagami-m fading, two different scenarios are considered: 1) the single-antenna source with perfect channel state information (CSI); and 2) the multiple-antenna source with transmit antenna selection and imperfect CSI. In both scenarios, the destination node is equipped with a single transmit antenna to forward power via frequency radio signal to the relay candidates. For improving the system performance, multiple antennas at the destination are considered to process the multiple copies of the received signal from the best relay. For characterizing the performance of the proposed scenarios, exact closed-form analytical expressions for the outage probability are derived. To obtain further insights, we carry out diversity gain analysis by adopting asymptotic relative diversity. We also derive the exact closed-form analytical expression for the system throughput. Finally, simulation results are presented to corroborate the proposed analysis and to show that: i) The system performance is improved by enlarging the area of the circle and the density of the relays. ii) The energy storage size has impacts on the performance of considered networks, which determines the maximal transmit power at relays.

Index Terms— decode-to-forward, Amplify and forward, Nakagami-m fading, OSRL, CSI, outage probability, diversity gain.

1. INTRODUCTION

As people grow to depend on wireless technology as their main medium for connectivity, demand for high data rate in wireless communication grows even more. This issue is caused not only because of increase in the number of wireless communication users, but also because of the fact that the information which has to be transported has also grown significantly. Although development in the wireless technology has been rapid, certain physical parameters are still limiting the utility of the wireless communication technology. In many cases, limited frequency band, battery life, energy consumption,QoS and severe fading channel are factors which have become challenges for researchers to overcome.

Cooperative communication has become one of the popular research topics as the solution to the battery life problem and increasing the transmission capacity and performance. The key idea in user-cooperation is that of resource-sharing among multiple nodes in a network. The reason behind the exploration of user-cooperation is that willingness to share power and computation with neighbouring nodes can lead to savings of overall network resources.

As shown in Figure 1.1. the source node broadcasts information to both the relay node and the destination node. The relay node then forwards the transmission to the destination node. The cooperative communication scheme is not only capable of increasing the capacity performance of the system.

Suppose that the channel between the source node and the destination node suffers from severe fading channel, and then direct transmission from the source node to the destination node will have low performance. By using the cooperative communication scheme, the source node can find relay nodes which have good channels to the destination node, use it to relay the transmission to the destination node, and increasing the reliability of the whole transmission. By selecting relay nodes based on back off timer, the source node can also save energy, since it does not have to transmit at high power and can use the relay devices power to perform the transmission instead.

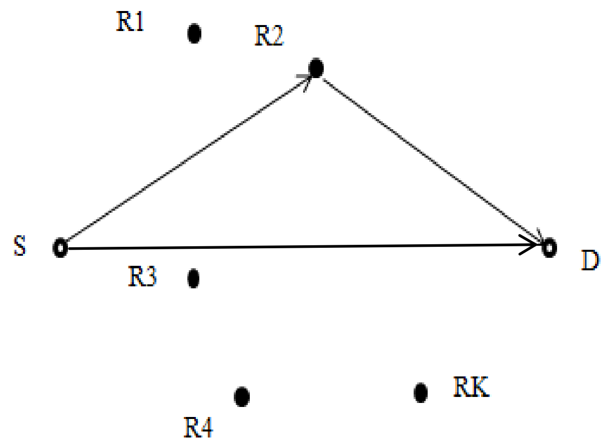

Figure 1.1: Network model for cooperative communication

Cooperative relay communication allows different users or nodes in a wireless network to share resources and to create collaboration through distributed transmission and processing, in which each user's information is sent out not only by the user but also by the collaborating users. Cooperative relay communication promises a significant capacity and multiplexing gain increase in the wireless system. It also realizes a new form of space diversity to combat the detrimental effects of severe fading. There are mainly two relaying protocols: Amplify and forward(AF) and Decode and Forward(DF).
Based on this model,the number of relays that participate in each cooperation depends on the channel conditions and the cooperation relay strategy. It is often assumed that a interference occurs when two or more relays happen to transmit the packet at the same time. Hence, the cooperation gain can vary considerably with the relay selection strategy and the medium access control protocol. The relays are prioritized with shorter backoff timer. Such backoff timer based methods can greatly reduce interference and offer a good match in support of green multimedia communications.

2. SYSTEM MODEL

2.1 System Description

Consider a wireless network with *M S–D* pairs and *K*relay nodes, as shown in Figure 2.1. assume that the relays are uniformly distributed in a given region and the relay distribution is time stationary. This assumption is generally valid for a variety of scenarios, e.g., under random direction mobility. The sources refer to the nodes that generate data, whereas the destinations refer to the nodes that receive data traffic. Relay nodes have no interferance demands. Since the relays are shared by multiple *S–D* pairs, consider that the relays are energy capability. When a relay using more energy, it is not eligible for transmission. The source nodes can communicate with their destination nodes only through these selected relays using a two-hop DF protocol; other cooperative communication protocols can be also considered in a similar way.

Assume that each node knows its own position, which can be obtained either from a positioning technique based on signal capacity, time-of-arrival, or angle-of-arrival measurements with nearby nodes or through a GPS receiver, which is becoming increasingly ubiquitous in mobile devices. Further, the relay nodes can obtain the locations of the sources and destinations from the piggybacked information within the overheard packets.

It should be noted that the sources do not have knowledge of the locations of the relays, and one relay does not have the location information of the other relays either.

Moreover, assume that the locations of all the nodes in the network do not change significantly during the short cooperative transmission period, which is a typical assumption that generally holds.For the data transmission between a transmitter located at *x* and a receiver located at *y*, the SNR of the received signal can be written as

$$\gamma_{xy} = {}^{P_0}/_{N_0}\, h_{xy}\, g_{xy} \quad (2.1)$$

where *P*0 is the transmit power, *N*0 is the power of additive white Gaussian noise, and *hxy* denotes the small-scale channel fading that is exponentially distributed with unit mean. The Path-loss effect is captured by,

$$g_{xy} = \|x-y\|^{-\alpha} \quad (2.2)$$

Where **||x-y||** is the Euclidean distance, and α is the path-loss exponent. We assume that the receiver is able to decode correctly the received signal only when the instantaneous SNR is no less than a threshold *T*0. Therefore, the probability that a packet is successfully received is given by

$$P_{xy} = P_r\{\gamma_{xy} \geq T_0\} = exp\left(-\frac{T_0}{P_0/_{N0}}\|x-y\|^{\alpha}\right) \quad (2.3)$$

Since the location information of the sources and destinations is available to the relays, the distances between them can be calculated.

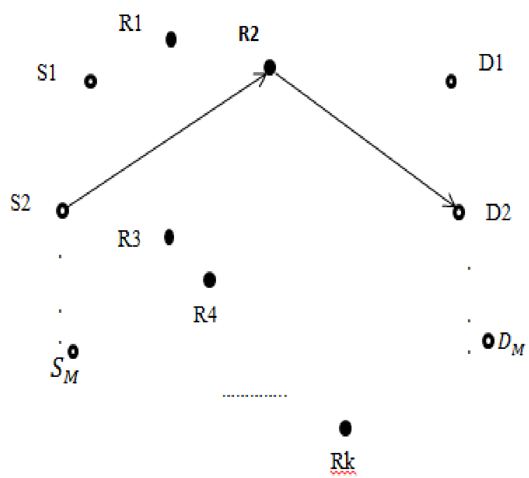

Figure 2.1: System model for cooperative transmission.

Thus, we can estimate the transmission success probabilities from the *M* sources to the relay *Ri* by

$$P_{s,Ri}=[P_{s1Ri},\ P_{s2Ri}, \dots\dots, P_{sMRi}],\ i = 1,2,\dots\dots k.$$
(2.4)

Similarly, the transmission success probabilities from the relay Ri to the M destinations are given by

$$P_{Ri,D}=[P_{RiD1},\ P_{RiD2},\dots, P_{RiDM}],\ i = 1,2,\dots\dots k.$$
(2.5)

3. ENERGY-AWARE COOPERATION STRATEGY

3.1 Cooperation Criteria

For a backoff-based cooperation strategy, the determination of the backoff timer is critical to reduce collisions because a collision may occur when the backoff timers of the first two or more relays expire within an indistinguishable small interval. To improve the achievable performance, the backoff timer is often based on the cooperation capability of the relay. Hence, their needs to properly choose the metrics that characterize the cooperation capability, so that the backoff timers of the group of relays can be appropriately scattered to decrease the collision probability.

First, consider the distance between a relay and a destination, which can be estimated from the location information without incurring extra cost. This distance can capture the transmission success probability of the relay-to-destination channel according to (2.3). This is because the potential relays that have correctly overheard the packet from the source and thus only focus on the relay-to-destination channel condition.

In Figure 3.1. shows the solid lines indicate the cooperative transmissions without considering the energy status, and the dashed lines indicate the cooperative transmissions with the energy status taken into account.

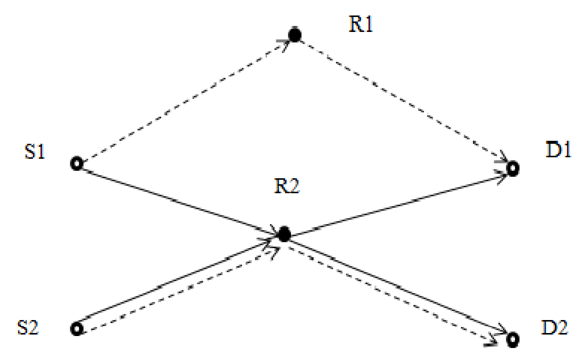

Figure 3.1: Effect of the energy constraint of the relays to relay selection.

Denoting the distance between relay *Ri* and destination *Dj* by *dij* , define the cooperation capability of *Ri* for *Dj* with respect to the distance as

$$W_{ij}^{d} = \begin{cases} 1 - (d_{ij}/L)^2, & \text{if } d_{ij} \le L \\ 0, & \text{if } d_{ij} > L \end{cases} \qquad (3.1)$$

Where *L* is the largest distance to the destination for a node to be considered a potential relay. As such, a relay with a smaller distance to the destination is characterized with a greater cooperation Capability because of a higher transmission success probability over the relay-to-destination channel. Second, the energy status of the relay is also included in the estimation of the cooperation capability since the shared relays are energy constrained.

The example in Figure 3.1. shows the importance of incorporating the energy status into the Characterization of the cooperation capability. As shown, relay *R*2 is the best relay for both *S*1–*D*1 and *S*2–*D*2 pairs if only the distance to the destination is concerned. Consequently, *R*2 will run out of energy quickly. The *S*1–*D*1 and *S*2–*D*2 pairs will need to switch to relay *R*1. The performance of the *S*1–*D*1 pair will remain almost the same, whereas the *S*2–*D*2 pair will suffer from performance degradation since

*R*1 is far from *S*2 and *D*2. On the other hand, if both the distance and the energy status are taken into account, *R*1 and *R*2 should serve *S*1–*D*1 and*S*2–*D*2, respectively. Thus, the relaying capacities are utilized in a more balanced manner. Therefore, further consider the energy status of *Ri* to characterize its cooperation capability by

$$W_i^e = {}^{E_i}/_{E_c} \qquad (3.2)$$

where Ei is the energy level of Ri with an energy upper limit of Ec. Here, assume that all the relays have the same energy upper limit and their energy levels are uniformly distributed. Therefore,follows a uniform distribution between 0 and 1, which is denoted U(0, 1). As shown, a relay of a higher energy level thus has a greater cooperation capability. Based on the two metrics in (3.1) & (3.2) the overall cooperation capability of relay Ri for destination Dj is defined as

$$W_{ij} = \theta . W_i^e + (1-\theta) . W_{ij}^d \qquad (3.3)$$

Where $\theta \in [0, 1]$ is a weighting parameter to the tradeoff between the importance of the energy status and that of the distance metric. As shown,
Wij ∈[0, 1].

3.2. Distributed Cooperation Strategy

Figure 3.2. Shows the proposed energy-aware cooperation strategy in detail. Based on the cooperation capabilities of the relays, the optimal relay for the *Sj*–*Dj* pair is defined as

$$R_i = arg\ max_{i \in \{1,.....,k\}} \{1 A_j(i) . W_{ij}\} \qquad (3.4)$$

Where *Aj* is the set of relays that correctly overhear the data packet from *Sj* , and

$$1A_j(i) = \begin{Bmatrix} 1, if\ R_i \in A_j \\ 0, if\ R_i \in A_j \end{Bmatrix} \qquad (3.5)$$

To ensure that the optimal relay has the fastest access to the channel, the relay *Ri* sets an initial backoff time inversely proportional to its cooperation capability for the *Sj*–*Dj* pair as in which

$$T_{ij} = 1 - W_{ij} \quad (3.6)$$

the maximum backoff time is taken to be one unit time.

As such, the optimal relay of the highest cooperation capability sets the smallest backoff time. If the first two or more relays time out within an indistinguishable small interval *c*, a collision happens. To account for the energy consumption of packet forwarding of *Ri* for any *S*–*D* pair, update the cooperation capability of *Ri* for all *S*–*D* pairs as follows

$$W_{ir} = W_{ir} - \theta . \eta, \quad r = 1, 2, \ldots\ldots M \qquad (3.7)$$

where η is the update step length. This is to yield the forwarding opportunities to other relays and thus balance the energy consumption. A problem occurs when a collision happens among the relays. If all the relays involved in the collision update their cooperation capabilities according to (3.7), a collision will happen again in the succeeding transmission. Therefore, need to penalize these relays by updating their cooperation capabilities to

$$W_{ij} = W_{ij} - (1-\theta) . W_{ij}^d . \eta, \ i = c_1, c_2, \ldots \ldots c_n \qquad (3.8)$$

where *c*1, *c*2, . . . , *cn* are the indexes of relays *Rc*1, . . . , *Rcn* that collide when forwarding the packet for the *Sj*–*Dj* pair. As a higher W_{ij}^d implies a lower energy level when a collision happens, the corresponding relay is punished more to achieve the energy balance and to avoid further collisions.

3.3 Backoff Timer Based Relay Selection

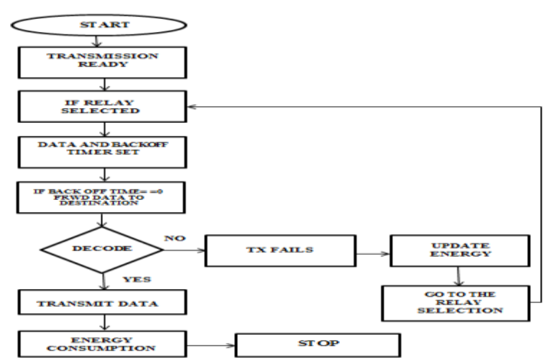

Figure 3.2: Energy-Aware Cooperation Strategy

4. *BLOCK DIAGRAM AND DESCRIPTION*

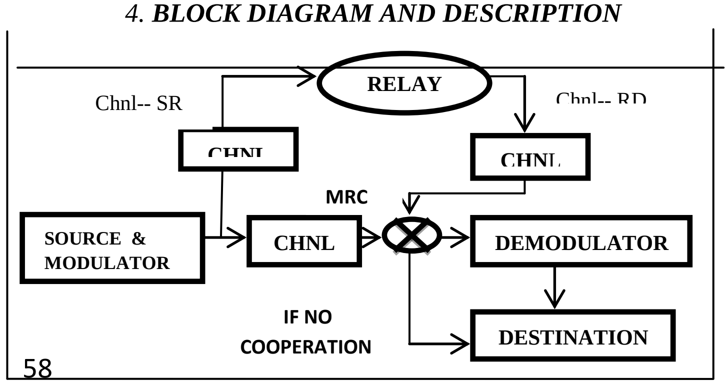

Figure 4.1: Simulation blockdiagram

This block diagram 4.1 shows graphical representation of our simulation. Consider a wireless network with M S-D pairs and K relay nodes. Assume that the relays are uniformly distributed in a given region and the relay distribution is time-stationary. First a Data is generated by the source which is modulated by a modulator, latter it is sent to both destination as well as relay (In case of Co-Op Communication). Relay nodes have no intrinsic traffic demands. Since the relays are shared by multiple S-D pairs, consider that the relays are energy constrained. When a relay runs out of energy, it is not eligible for future relaying. The sources can communicate with their destinations only through these shared relays using a two-hop. Finally relayed & direct path signals are combined at destination, demodulated & delivered to Destination.

The Maximum Ratio Combiner (MRC) achieves the best possible performance by multiplying each input signal with its corresponding conjugated channel gain.Maximal-ratio combining is the optimum combiner for independent AWGN channels. MRC can restore a signal to its original shape

5.RESULT

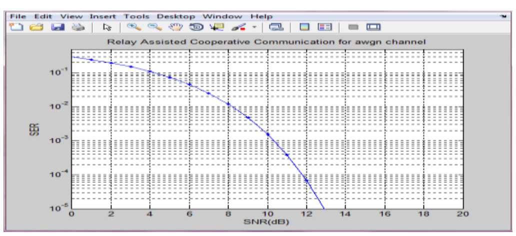

Figure 5.1: Relay communication in awgn channel

5.1. AWGN Channel

Figure 5.1 shows the simulation results of SER for AWGN channels. These results vary with the SNR values.

5.2.Collision Probability

Figure.5.2 shows the simulation results of the collision probability. As shown, when the collision interval *c* increases, the collision probability increases accordingly. Further, when the number of relays *K* increases, the collision probability increases as well. Moreover, it is observed that the collision probability of the proposed strategy is smaller than 10%, even when the collision interval and the number of relays are large. In contrast, the probability-based algorithm has a collision probability greater than 18%, which is much higher than that of the proposed strategy. It should be noted that the collision probability of the probability-based algorithm has been minimized by normalizing the forwarding probability of each relay, which makes the approach not purely distributed.

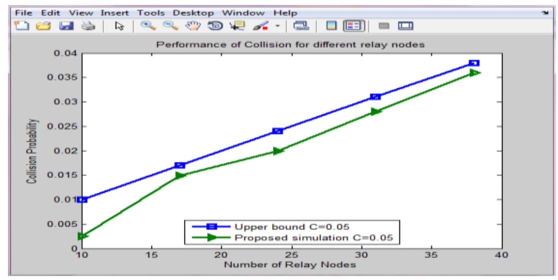

Figure 5.2: collision probability

5.3.Transmission success probability

Figure 5.3 compares the transmission success probability of different strategies with the analytical bounds. The backoff-based strategy can easily achieve a transmission success probability higher than the probabilistic strategy because of the reduced collision probability.

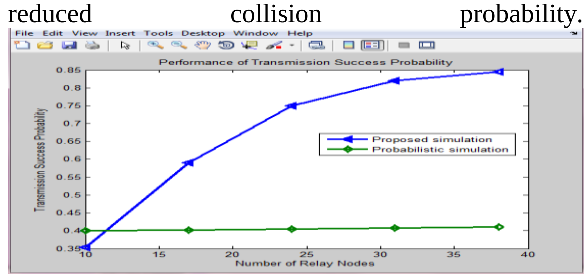

Figure 5.3: Transmission success probability

6.CONCLUSION

In this paper the relay was selected based on the uncoordinated cooperative strategy with backoff timer. Thus, the relay of a higher cooperative capability ends up with a shorter backoff time. The best relay times out first and wins the contention. The power level usage in relays is calculated. As shown in the simulation results, proposed strategy can achieve a much lower collision probability and, thus, a higher transmission success probability, compared with a probability based reference strategy. Therefore, it is safe to conclude that the proposed algorithm can serve as an energy-efficient cooperation strategy for delay-sensitive multimedia services. Further, investigate the scalability of this proposed strategy and that can be scalable solution for a large-scale network.In future design a UWB channel for larger bandwidth and higher transmission.

REFERENCES

[1] Q. Du and X. Zhang, "QoS-aware base-station selections for distributed MIMO links in broadband wireless networks," IEEE J. Sel. Areas Commun., vol. 29, no. 6, pp. 1123–1138, Jun. 2011.

[2] C. Zhai, W. Zhang, and G. Mao, "Uncoordinated cooperative communications with spatially random relays," IEEE Trans. Wireless Commun., vol. 11, no. 9, pp. 3126–3135, Sep. 2012.

[3] L. Xiong, L. Libman, and G. Mao, "Uncoordinated cooperative communications in highly dynamic wireless networks," IEEE J. Sel. Areas Commun., vol. 30, no. 2, pp. 280–288, Feb. 2012.

[4] F. R. Yu, X. Zhang, and V. C. M. Leung, Green Communications and Networking. Boca Raton, FL, USA: CRC, 2012.

[5] M. Gursoy, D. Qiao, and S. Velipasalar, "Analysis of energy efficiency in fading channels under QoS constraints," IEEE Trans. Wireless Commun., vol. 8, no. 8, pp. 4252–4263, Aug. 2009.

[6] B. P. Crow, I. Widjaja, L. G. Kim, and P. T. Sakai, "IEEE 802.11 wireless local area networks," IEEE Commun. Mag., vol. 35, no. 9, pp. 116–126, Sep. 1997.

[7] D. Gesbert, M. Shafi, D.-s. Shiu, P. J. Smith, and A. Naguib, "From theory to practice: An overview of MIMO space-time coded wireless systems,"IEEE J. Sel. Areas Commun., vol. 21, no. 3, pp. 281–302, Apr. 2003.

[8] D. Wang, J. Wang, X. You, Y. Wang, M. Chen, and X. Hou, "Spectral efficiency of distributed MIMO systems," IEEE J. Sel. Areas Commun., vol. 31, no. 10, pp. 2112–2127, Oct. 2013.

[9] J. N. Laneman, D. N. C. Tse, and G. W. Wornell, "Cooperative diversity in wireless networks: Efficient protocols and outage behavior," IEEE Trans.Inf. Theory, vol. 50, no. 12, pp. 3062–3080, Dec. 2004.

[10] A. Nosratinia, T. E. Hunter, and A. Hedayat, "Cooperative communication in wireless networks," IEEE Commun. Mag., vol. 42, no. 10, pp. 74–8.