Evaluate Comparative of Cooperative Relaying Protocols in Wireless Communication

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Abstract— future generations of cellular communications require higher data rates and more reliable transmission link .Cooperative communications have a great significant in modern communications as they improve the information transmission between the source and the destination by using the relays. The relaying schemes are Amplify-and-Forward (AF) in which the relay sends an amplified copy of its receive signal and consequently serves as a repeater. In contrast, for Decode-and-Forward (DF) the relay performs a complete decoding of the receive signal and transmits the re-encoded message. This paper is a complete study of cooperative systems, analyzing its performance and comparing the use of two protocols amplify and forward (AF) and decode and forward(DF) with single and multi relays scenarios by measuring bit error rate using matlab.

Index Terms— wireless network, Relay, AF,DF,simulation

1 INTRODUCTION

Cooperative communications is a new communication technique which allows single-antenna mobiles to share their antennas and to produce virtual multiple-antenna system. Cooperative communication is built on the broadcast nature of wireless communication which suggests that the transmitted signal between source and destination can be overheard at neighbouring nodes.The basic idea of cooperative relaying is to introduce intermediate nodes (relays) that forward the received data from the source to the destination [1].Cooperative relaying has large numbers of advantages, it provides spatial diversity since the relay terminals form a distributed antenna array, increasing the range of communication and it is used to provide spatial multiplexing in multiuser communication scenarios [2].the cooperation signalling schemes include amplify and forward ,in this method the partner simply scales its received signal, to satisfy its own power constraints, and retransmit to cooperate. Each user receives a noisy version of the transmitted signal and then amplifies and retransmits it. Though noise is amplified by cooperation, the destination can make better decision on the transmitted bits by combining the two independently received faded versions of the signals [1].In Decode and Forward strategies, the relay tries to detect the received information, re-encodes and retransmits the signal after detection. If detection is unsuccessful the relaying can be harmful when detecting at the destination, therefore the strategy should be implemented such that the relay only retransmits the information when detection is successful. DF requires more complex devices than AF methods, but the noise at the receiver is much lower [3]. In detect and forward method the user tries to detect a partner bits and then retransmit the detected bits. In case of compress and forward , the relay performs a non-linear transformation on the received signal and then retransmits to destination [3].

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2 RELATED WORK

Fading affects the performance of wireless network by having an effect on the signal amplitude. To overcome the problem, the joint use of MIMO(Multiple input Multiple output) and cooperative schemes is proposed as an alternative means of alleviating the problem arrived because of robust fading.
MIMO which is used to improve the performance of wireless communication in adverse propagation conditions such as fading, multi-path and interference. However, one limitation of MIMO is that installing multiple antennas on mobile station may not be feasible because of limitations in power, cost, and size .To overcome drawbacks of MIMO, distributed wireless nodes (active terminals or fixed relays) can be engaged in a cooperative fashion to extract antenna diversity.
In cooperative transmission, nodes can share their time, frequency, and/or other resources to form a distributed or virtual MIMO [4]. Transmitting independent copies of the signal generates diversity and can effectively combat the fading, which cooperative diversity generates this diversity [5].

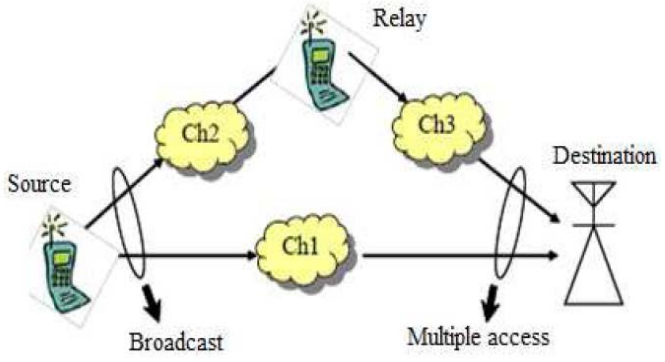

Figure 1: Illustration of cooperative diversity [6]

As shown in the Figure 1, Source information is broadcasted to relay and destination nodes. Then, the relay node either amplifies-and-forwards (AF) or decodes-and-encodes the received information and forwards to the destination node [14].cooperative diversity system, each wireless user is assumed to transmit data as well as act as a cooperative agent

for another user [5].

The multi-hop communication in relay networks is a very promising approach to improve the transmission coverage of cellular and ad hoc networks. Because of transmit power constraints, multi-hop transmission also leads to remarkable coverage extensions by dividing a total end-to-end transmission into a group of shorter paths. The advantage of multi-hop relaying has been pointed out, especially for rural areas with low traffic density and sparse population [7].

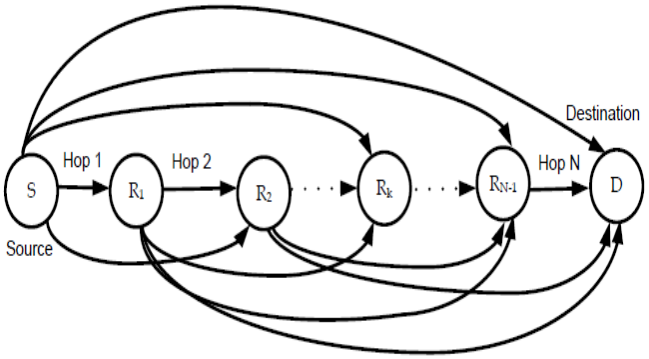

Figure 2: Example of a multi-hop relay system.

3 COOPERATIOVE MODEL

Cooperative relaying techniques can be realized in systems with either single relay or multiple relays per user [8].The basic model for cooperative system is a three terminal system model with on source, one relay and one destination.

Figure 3: Cooperative system model with single relay [9]

In multi relay model, requires multiple relays in the system, relays form a virtual antenna array and exploit some of the benefits of MIMO systems.

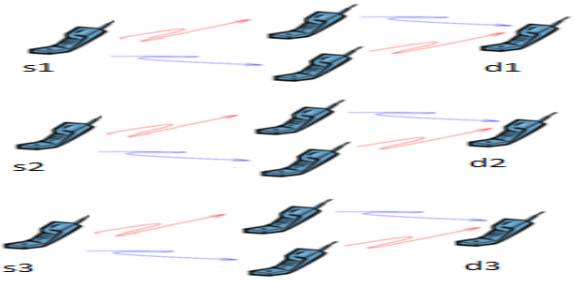

Figure 4: Cooperative system model with multiple relays [9]

4 SIMULATION DESCRIPTION

In this paper we model and simulated two Cooperative Communication protocols Amplify and Forward and decode and Forward with Single and Multi-Relay. Wireless system was modelled using the parameters in table.1 and table.2.

Table1: Simulation Parameter of AF-DF Single and multi-Relay

Protocol Used/Relay Mode	Fixed Amplify &Forward & Decode &Forward
Number of Bits	10000
Modulation Scheme	BPSK
Number of Relays	1,2
SNR Vector	0 to 20 dB
Combining Technique	Maximal Ratio Combiner

Table 2: Parameters for system configuration

Relay Mode	Parameters value
BS transmit power	27.3 dB
RS transmit power	20.3 dB or 17.3
BS to RS distance	10km
Power of additive noise	-130 dB
Path loss exponent	3.5
Modulation	Adaptive modulation and coding (AMC)

5 SIMULATION RESULTS

figure 5 shows that the BER decrease with increase of SNR, BER at the beginning is high and SNR is low because of amplifying noise of signal.

In figure 6 with Multi relay cooperation we have much better performance than that of single node cooperation & Source Only AF relaying scheme. In this case at .0001 BER improvement is achieved with the help of two Relay operating in AF mode. However, with noncooperation only .0061 BER is achieved.

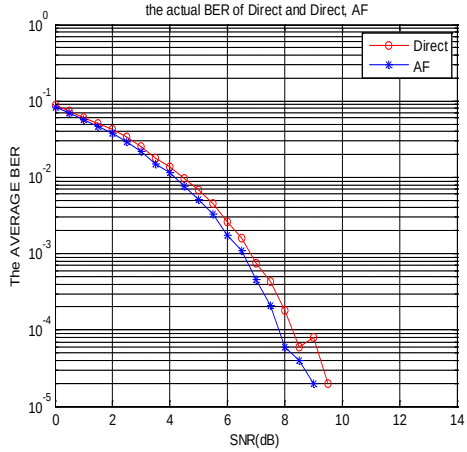

Figure 5: SNR versus BER at AF-Single Relay

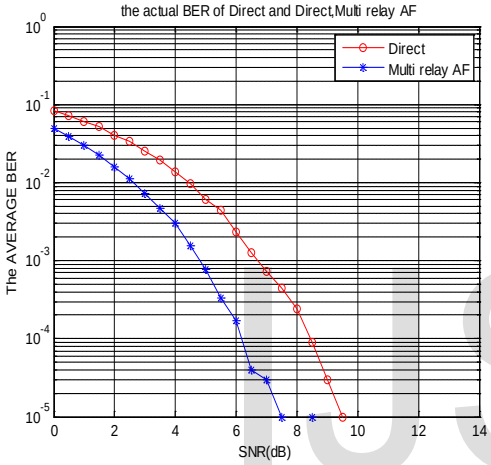

Figure 6: SNR versus BER at AF-Multi Relay

In figure 7,one relay is use with DF Scheme although significant gain is not achieved as compare to AF but fixed DF relaying has the advantage over AF relaying in reducing the effects of additive noise at the relay.

In figure 8 for example, at 6 dB .00005 BER is achieved .However, with non-cooperation almost .003 BER is achieved. Though Multi relay somehow improves the results but still significant gain is not achieved as compare to AF because DF protocol has a responsibility of reducing error propagation.

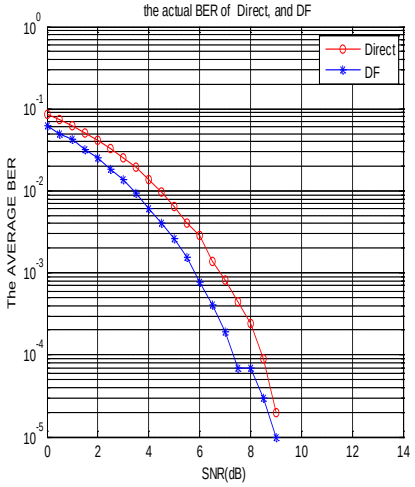

Figure 7: SNR versus BER at DF-Single Relay

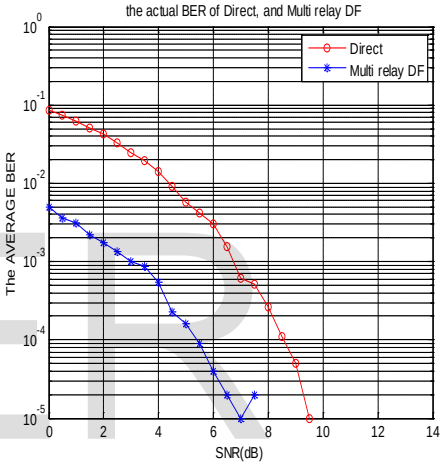

Figure 8: SNR versus BER at DF-Multi Relay

In these figures 9 and 10 the BS transmits to the RS in the first phase. While in the second phase the RS transmits to the MS. It is assumed that the RS is placed in such a way that it can use the maximum rate of 64-QAM 5/6 AMC.

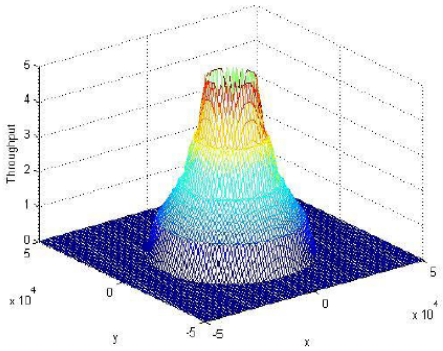

Figure 9: Time versus Throughput without relay

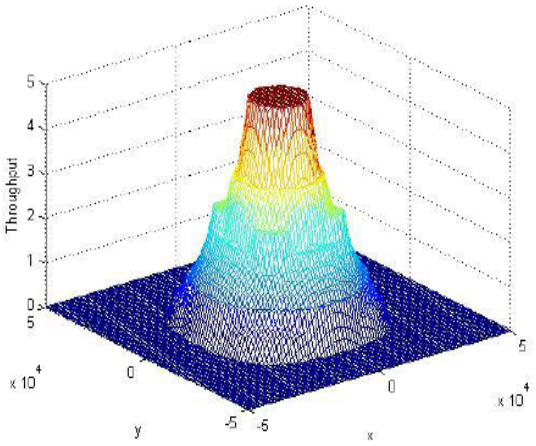

Figure 10:Time versus Throughput with Simple relay

In these figures 11 and 12 show where relaying actually improves performance for two scenarios: RS(relay station) transmit power 20.3 dB and RS transmit power of 17.3 dB.The relay transmit power should also be considered while choosing relays and the diversity scheme.

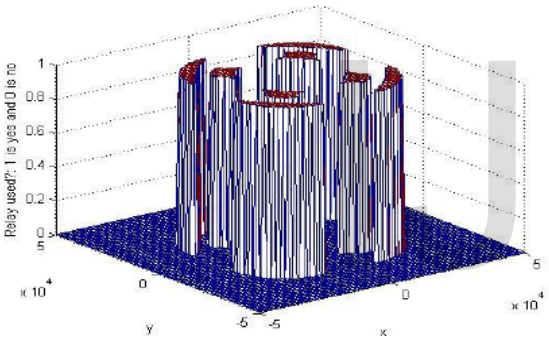

Figure 11:Time versus RS power of 20.3dB

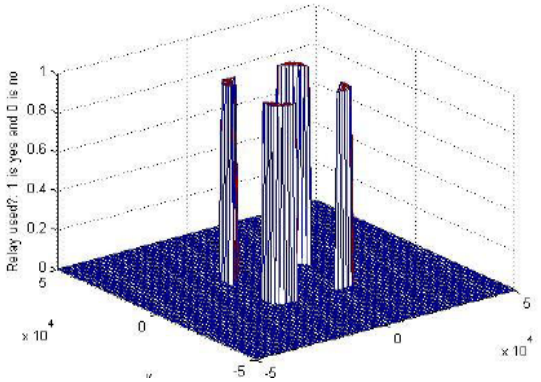

Figure 12:Time versus RS power of 17.3dB

Transmit diversity seems to perform better than receive diversity. However receive diversity does not need the BS to transmit during the second phase.

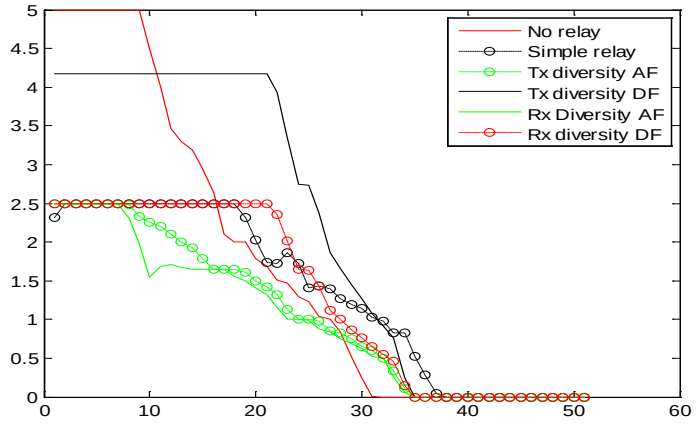

Figure 13: Throughput versus Time at diversity schemes

6 Conclusion

In this paper, the performance of wireless communication has been gained tremendous attention by using cooperative communication among wireless nodes.

The advantages of AF relaying scheme of simple implementation and low computation load for the relay nodes. Drawback of the AF protocol is that it amplifies the noise in the signal leading to some performance degradation. Benefit of the DF relaying scheme is not having any amplified noise in the transmitted signal to the destination .Drawbacks of the DF relaying scheme are error propagation at the relay due to the possibility of incorrect decoding of the coded signals and high computation load on the relay nodes.

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