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Cooperative Diversity: A Review

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***Abstract:* In recent times, because of factors such as signal multi path-propagation and fading the wireless transmissions are severely degraded. So in order to avoid such problems in ad-hoc network, cellular network, or WSNs, the concept of cooperative diversity can be used. Cooperative diversity uses a multiple antenna environment for improving or maximizing total network channel capacities for any given set of bandwidths which exploits user diversity by decoding the combined signal of the relayed signal and the direct signal in wireless multi-hop networks.**

There are several relaying strategies to implement cooperative diversity, and some of the basic strategies are Amplify-and-Forward and Decode-and-Forward and Compress- and Forward. Each of them have their own advantage and they can provide different performance results with different environment

I. INTRODUCTION

In any wireless networks, signal fading arising because of multipath propagation is a severe form of interference that can be encountered through the use of diversity. Diversity 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. 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. [1]

Contrary to the more usual forms of space diversity with physical arrays [2]–[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".

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.

The outage probability of the various protocols can be given as [8]

Protocol	$P_{out,}$ high ρ_{norm}
Direct	
Amplify-and-Forward	
Decode-and-Forward	

Table1. Outage probability for large scale rate normalized SNR,

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II. SYSTEM MODEL

Several models have been developed to show the performance of cooperative diversity. The simplest way to describe the system is t o consider a source node (SN), a destination node(DN) and one relay node(RN).[10]

In the figure, h_{SR}, h_{SD} and h_{RD} represents channel state between source and relay, source and destination and relay and destination res pectively. The channel coefficients are assumed to follow block rayleigh fading. The information transfer is divided into two phases. In phase 1, SN broadcasts the signal to both RN and DN. The signal received by RN and DN can be given respectively by

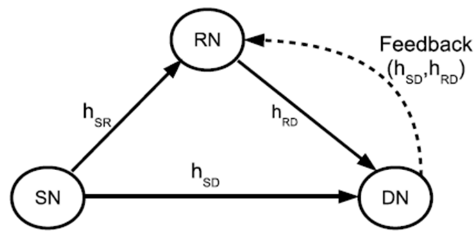

Fig. 1. Threshold Selection Link Adaptive Regenerative Relaying System

, and , where P_1 is the transmitted power at the source, x is the transmitted signal with $E\{|x|^2\} = 1$, n_{SR} and n_{SD} are complex white gaus sian noise with variance N_0. The fading between SN and RN considered as Rayleigh,

Then in phase 2, information is sent from RN to DN. This information is either sent without decoding or by decoding and then re-enc oding. Both the methods correspond to different protocols, amplify-and-forward and decode-and-forward namely. At the destination both the signals are processed to give the output.

III. RESULTS

As the number nodes increase, outage probability of the network also varies. The figure given below plots the relationship between SNR and outage probability.

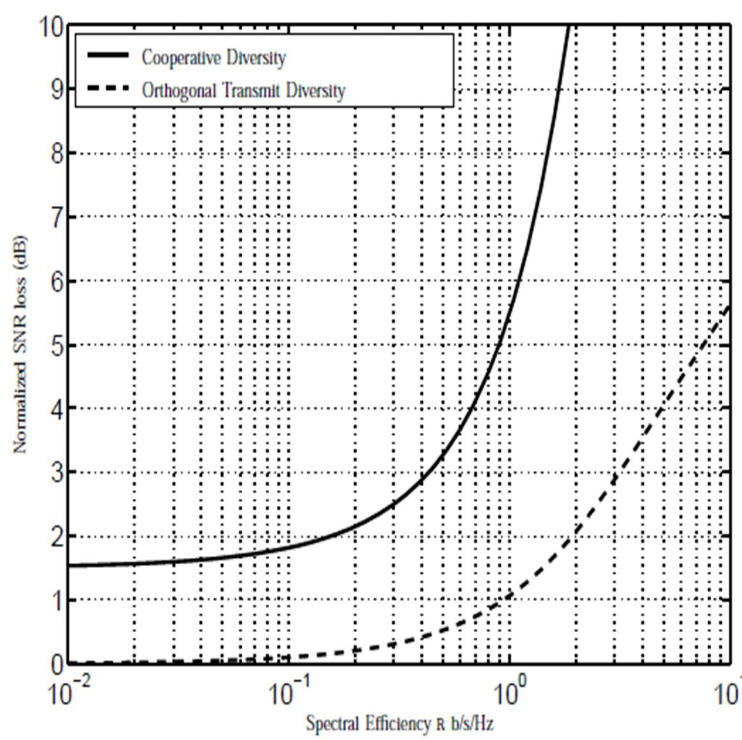

Fig. 2. SNR loss for cooperative diversity protocols (solid) and orthogonal transmit diversity bound (dashed) relative to the(unconstr ained) transmit diversity bound.[9]

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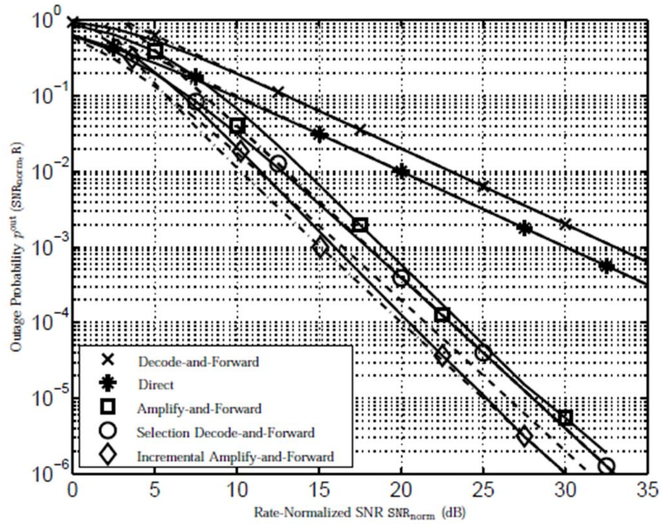

Fig. 5. Outage probabilities vs. SNRnorm, small R regime, for statistically symmetric networks,.[9]

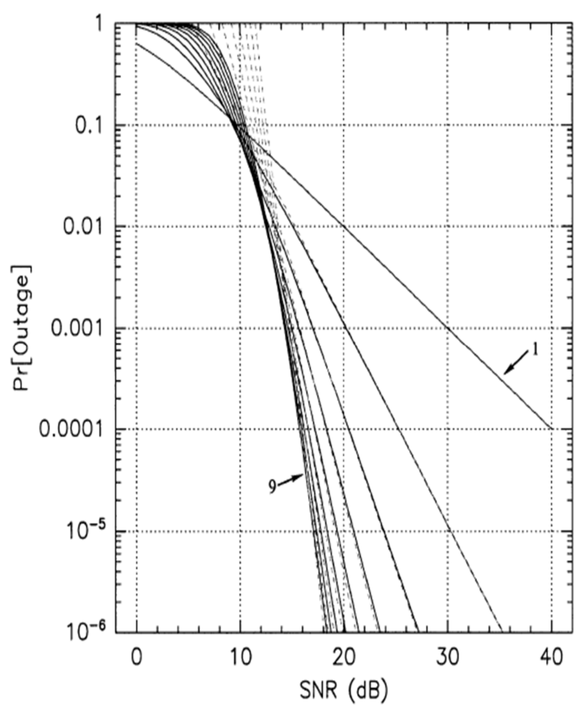

Fig. 2. Outage probability of cooperative diversity. Comparison of numeric integration of the outage probability (solid lines) to calc ulation of the outage probability approximation versus SNR for different network sizes the results can be readily updated to incorpor ate a model of the network geometry.[11]

IV. CONCLUSION

In normal transmission there is no relay station available just between the sender and the destination. The presence of a relay node af fects the outage probability of the entire network and do provide better performance than a normal network. The difference in perfor mance decreases as the number of nodes in the network increase, so having an optimum number of nodes in the network is best suite d for transmission.

Volume 5 Issue VI, June 2017
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