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Allocating power efficiently for Decentralized Distributed Space-Time Block Coding

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Abstract - Two ad-hoc, power allocation strategies for a decentralized distributed Space Time Block Coding (Dis-STBC) system is proposed in this paper where knowledge about the Channel State Information (CSI) is not available at the transmitter. The first is an open-loop strategy which requires no control signaling; the second is a feedback-assisted strategy which requires some control signaling, but which can achieve better power-efficiency. Focusing on a particular decentralized Dis-STBC scheme, the asymptotic outage probability is derived and the power-efficiency advantages of the proposed strategies over a uniform-power strategy are illustrated by evaluating the outage and link failure probabilities.

Keywords: Channel State Information, decentralized distributed Space Time Block Coding, power allocation, outage and link failure probabilities.

1.INTRODUCTION

Cooperative diversity is a diversity technique which is obtained when relay nodes are used for transmitting the signals. The source node transmits two independent signals to the relay node and the destination node, and the destination node receives signal from the source and the retransmitted signal from the relay node. With the help of relaying node the quality of the signal received at the destination can be improved. For notational simplification, system with three nodes namely source, relay and destination is considered.

The history of the cooperative communication can find its deep roots to the groundbreaking work of [1], when the concept of relay channel model was introduced. The channel model consists of a source, destination and relay; and who's major purpose was to facilitate the information transfer from source to destination. Later, [2] deeply investigated the relay channel model, which provided a number of fundamental relaying techniques such as Decode and Forward (DF) and Compress and Forward (CF). In conventional communication, data is transmitted between the source and destination, and no user provides assistance to one another.

2.RELATED WORK

A number of anonymous routing schemes have been proposed for ad hoc networks, and they provide different level of privacy protection.

In [3], a distributed space-time block code (Dis-STBC) was proposed in which each relay transmits one unique column of the underlying STBC matrix. So that each selected relay knows which column to transmit, most of the proposed Dis-STBC schemes [4-7] require a central control unit or full inter-node negotiations.

Several decentralized Dis-STBC schemes have been pro-posed to implement code-assignment at the relays without control signaling [8-10]. One approach to implement relay selection without control signaling is for each node in the decoded set to retransmit the source message; this is called the All-Select strategy. To also implement power allocation in a decentralized way, one possible scheme is for all nodes to use the same fixed transmit power; we call this the Uniform strategy.

In [11], for centralized Dis-STBC, a near-optimal power allocation was proposed. In this strategy, by assuming each potential relay knows its local mean channel gain to the destination, some decoded nodes which have good mean channel gains are selected as the relays. With the help of centralized control, each relay obtains knowledge about the number of relays and which column of the underlying STBC matrix to transmit.

3.PROPOSED SYSTEM

Consider a two stage protocol that uses a selective decode-and-forward relaying strategy. In particular, a network is considered with M single-antenna nodes. When one source-destination (s, d) pair is active, all the remaining M-2 nodes can serve as potential relays. The decoded set is defined as the set of N (N ≤ M-2) decoded nodes. The decoded set is random, varying with the instantaneous channel gains. Assume that the All-Select strategy is used; then, all the N decoded nodes will act as relays to forward the source message. It is assumed that nodes cannot transmit and receive simultaneously. In addition, a quasi-static propagation environment and perfect synchronization is assumed.

The Open-Loop strategy can asymptotically achieve better outage performance than the Uniform strategy; this is reflected by the factor 1/L. The Feedback-Assisted strategy can asymptotically achieve much better outage performance than the other two strategies; this is reflected by the factors 2 L+1/N and 2 L+1L/N which are much smaller than 1 when L is a given finite number and N is an asymptotically large number.

Since the non-asymptotic analysis is mathematically intractable, the asymptotic analysis is used to provide some analytical results for the two proposed power allocation strategies. In a practical network, the number of all the potential relays M-2 will always be a reasonable number; thus, even when the SNR tends to infinity so that N=M-2, N will not be very large. In addition, when the SNR is not very large, the first stage cannot be perfect; then, for any one particular power allocation strategy, the decoded set might be only a subset of the set of all the potential relays so that N<M-2. Thus, in practice, when the SNR and the value of N are not very large, the asymptotic outage performance will not be that tight when compared with the practical performance; but, the asymptotic outage analysis still provides an indication of the maximum advantages of the proposed strategies under ideal scenarios.

When the number of columns L is a given finite number, as the SNR and the number of relays N tend to infinity, m-group Dis-STBC achieves an asymptotic diversity order of, that is, the number of randomly selected distinct columns V (1≤V≤L) is asymptotically equal to L. Then, by exploiting results given in for m-group Dis-STBC, for any given decoded set and particular random column-selection by then relays, when both the SNR and N tend to infinity.

When knowledge about the CSI is not available at the transmitter, either for power allocation among the relays or for power distribution between the first and second stages, the optimal strategy is not readily available. Here, numerical simulations are used to show that, when performing equal power allocation among the relays, Pr=Ps/N is a near-optimal choice. So, in this investigation, the power distribution is only focused between the first and second stages. In the simulations, the ratio of the power allocated to the first stage Ps is varied to the power allocated to the second stage NPr. This ratio is denoted as ρ=NPr/Ps, and the outage probability is plotted as a function of ρ.

One important QoS issue in a network is whether or not all of the active end-to-end link scan remain connected and maintain some specified level of quality. If an end-to-end link is regarded as disconnected when its outage probability is larger than a specified target value, a Link Failure Probability (LFP) can be defined as the ratio of the number of disconnected links over the total number of links in the network.

4.IMPLEMENTATION AND PERFORMANCE EVALUATION

In this section, under realistic propagation conditions, the outage and link failure probabilities of m-group Dis-STBC are evaluated for different power allocation strategies. The protocol is implemented on ns2, and evaluates their performance by comparing with STBC. In the simulation, 50 nodes are randomly distributed within a network. Mobile nodes are moving in the field according to the random way point model. The local session keys are updated every 40 seconds in the simulation. The performance is evaluated in terms of packet delivery ratio, packet delivery latency, and normalized control bytes.

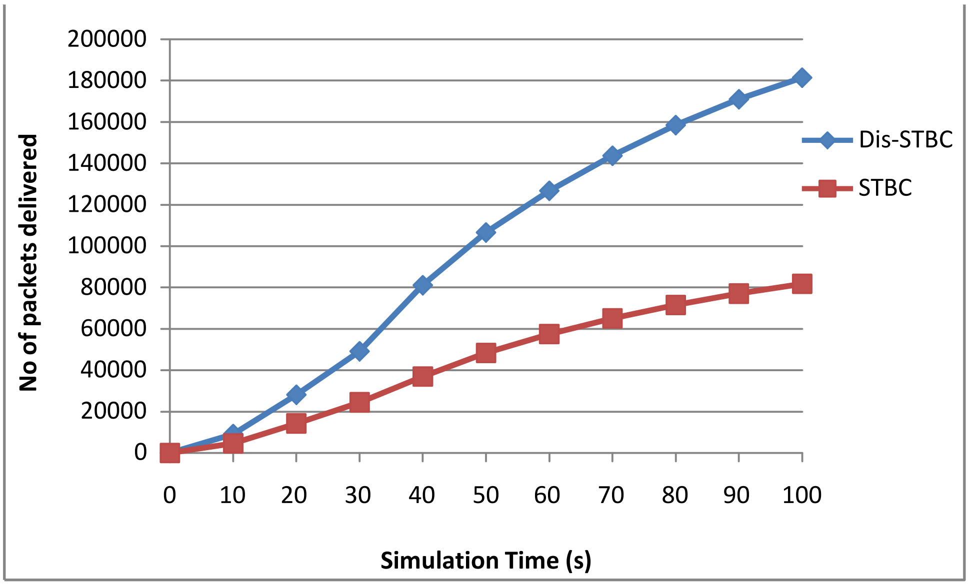

Figure 1: Packet delivery rate

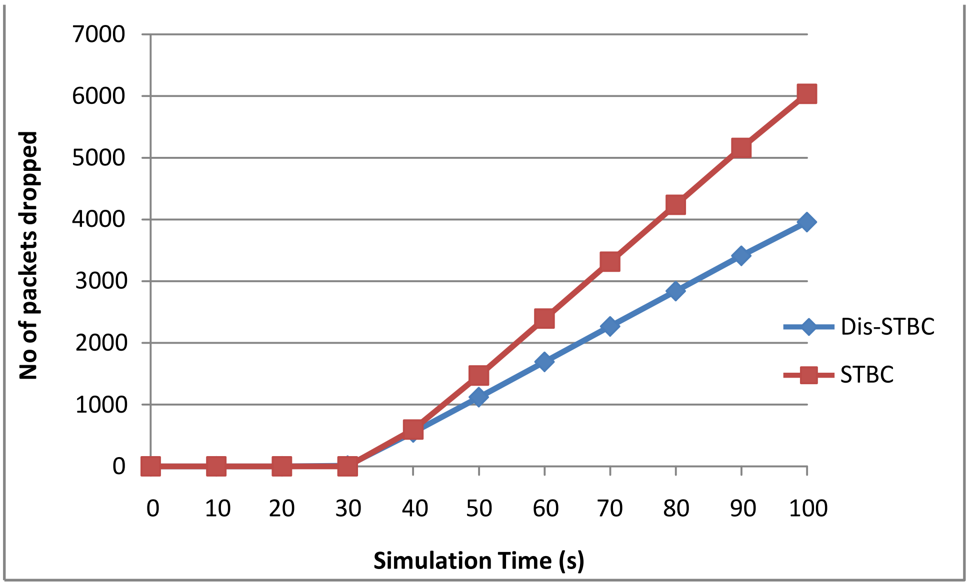

Figure 2: Packet Loss rate

According to Figure 1, Dis-STBC has the highest packet delivery ratio for both types of traffic load compared to STBC. The packet delivery ratio decreases as nodal speed increases and traffic load becomes heavier. Figure 2 illustrates the packet loss rate where USR has lesser packet loss compared to that of STBC. From Figure 3, it is clear that Dis-STBC has the least average delay compared to existing STBC. Figure 4 illustrates the throughput where Dis-STBC has lesser packet loss compared to that of STBC.

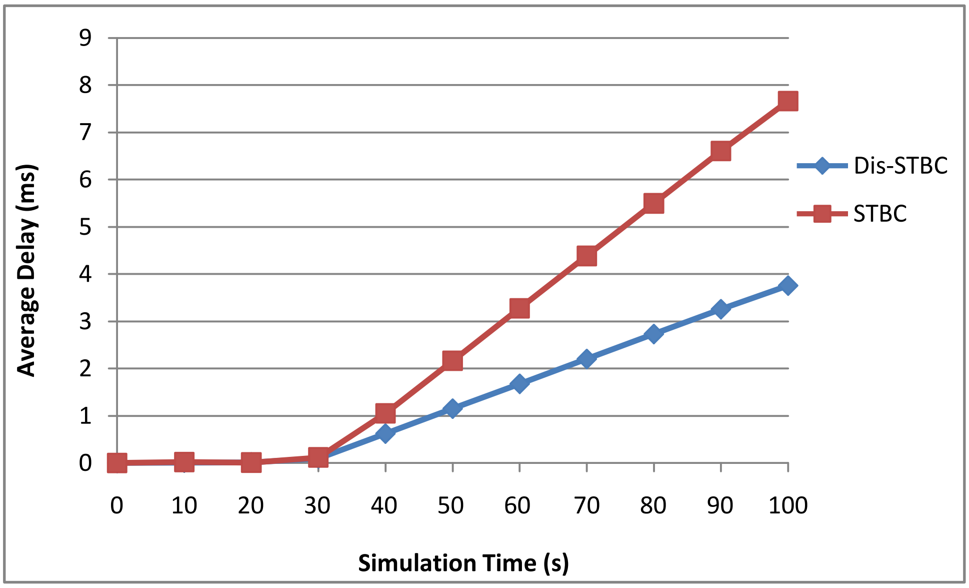

Figure 4: Average delay

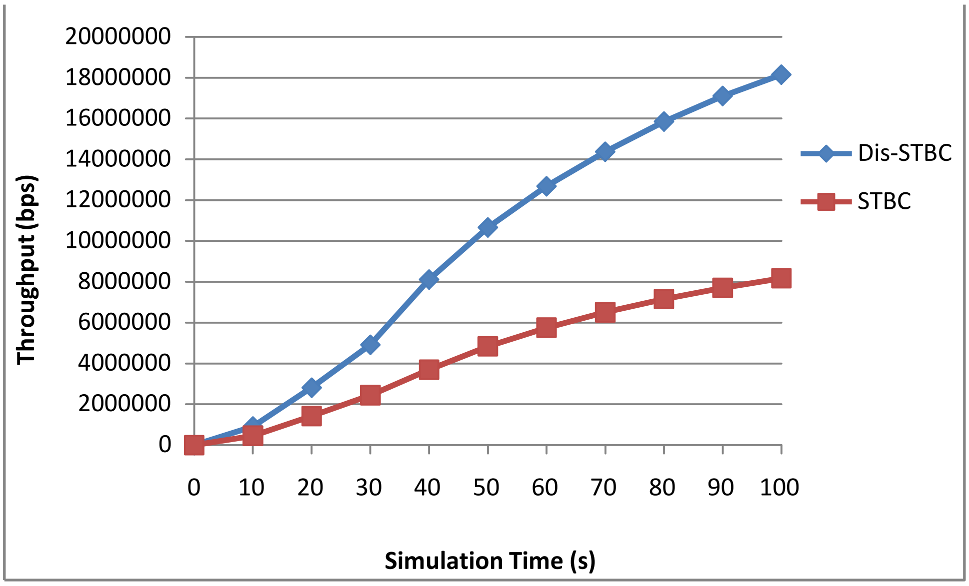

Figure 5: Throughput

5.CONCLUSION

In this paper, for a decentralized Dis-STBC system where the transmitter do not know the CSI and the decentralized relay selection strategy is employed, two ad-hoc power allocation strategies is proposed with the objective of minimizing overhead. The first is the Open-Loop strategy; this strategy does not require any control signaling. The other is the Feedback-Assisted strategy; this strategy requires additional control signaling to inform the relays about the number of actual relays. The power-efficiency advantages of the proposed strategies over the Uniform strategy are illustrated by asymptotic outage analyses for a particular decentralized Dis-STBC scheme. In a random network with realistic propagation conditions, the outage and link failure probabilities of them group Dis-STBC have also been evaluated for the different power-allocation strategies. Simulation results showed the advantages of the proposed strategies over the Uniform strategy.

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