An Overview on Multiple Antenna Relay Selection in Multiuser network MIMO system

Saif Ali
Sardar Vallabhbhai Institute of Engineering and Technology (SVIT)
Vasad, Gujarat, India

J. N. Patel
Communication System Engineering
Sardar Vallabhbahai Patel Institute Of Technology
Vasad, Gujarat , India

Abstract—The use of multi-antenna relays has emerged as a very promising technique for combating fading, enhancing throughput and extending coverage in emerging wireless broadband networks.In practical multi-user multi-relay systems, not all nodes are able (or allowed) to cooperate during data transmission. Selecting subsets of advantageous relays and users simultaneously for cooperation and communication will not only enhance the system performance by leveraging the inherent cooperative and multiuser diversity in the network, but also reduce signaling overhead and complexity. In order to have any practical relevance, user-relay selection and/or association schemes must be of acceptable complexity and fit within a small fraction of the coherence time of the channel. In this paper, we will present a brief literature review on two-hop relaying, full duplex relaying and multiuser network MIMO systems. First, we investigate the major challenges in user and relay selections and further we show various techniques respect to MIMO and Multiuser MIMO system.

I. Introduction

In recent days rapid growth of wireless communication has resulted in increase in spectral efficiency and improvement in capacity of the system. The high spectral efficiency and capacity improvement in wireless fading channel has led a widespread interest in MIMO communication [1] and [2]. The increasing demand for mobile and live streaming applications has triggered great interest in relay-aided multicast networks [3]. In relay-aided multicast networks, a relay forwards the source's packets to a pool of users interested in the same content. Relaying techniques can be classified, based on their forwarding strategy and required processing at the relay ter-minals, as decode and forward (DF) or amplify and forward (AF).

In DF relaying, the relay decodes the source packet, prior to re-encoding and transmitting it to the destination, whereas in the AF relaying, the relay amplifies and retransmits the received packet without decoding it. Occasionally, a relay may have poor channel conditions to either the source or the users or both, therefore, the source has to employ selective relaying techniques that take advantage of the nature of the fading channel and preserve the diversity gains of relay networks. In selective relaying, the source selects a single relay, among multiple relays, with a relatively good channel condition to forward its packets to a group of users. To achieve this, all relays feed back their minimum equivalent (source-relay-user) signal-to-noise ratio (SNR) to the source. This results in significant transmission delays (especially for a large number of relays) since more resources have to be allocated for feedback traffic rather than data transmission.

In practical multi-user multi-relay systems, not all nodes are able (or allowed) to cooperate during data transmission. Selecting subsets of advantageous relays and users simultaneously for cooperation and communication will not only enhance the system performance by leveraging the inherent cooperative and multiuser diversity in the network, but also reduce signaling overhead and complexity. In order to have any practical relevance, user-relay selection and/or association schemes must be of acceptable complexity and fit within a small fraction of the coherence time of the channel. This work, shows the survey on two-hop relaying, full duplex relaying and multiuser network MIMO systems. First, we investigate the major challenges in user and relay selections and further we show various techniques on selection of relay respect to MIMO and Multiuser MIMO system.

The rest of this paper is organized as follows: Section II contains transmission or types of relay transmission. The Section III contains relaying techniques used in different networks and its effects. The Section IV relay selection technique. Section ?? contains comparision of different techniques and Section V contains conclusions of demonstrated work.

II. Classification of Relay

There are basically two types of relay

A. DF (Decode and Forward) Relay

DF relaying is an example for regenerative system. DF based relay node decodes the received signal and re-encodes, modulates and sends to the destination. Figure 1 illustrates simple schematic of the DF relying system. The main ad-vantage of DF method is that, it eliminates the noise at relay node with the expense of processing delay due to modulation/demodulation and encoding/decoding. In the DF system, the relay demodulates the received signal y to estimate x. Then the estimated signal x^ is forward to the destination in order to complete the transmission. This signal estimation can be carried out in symbol by symbol or for the entire codeword by cosidering the required system performance and the complexity at the relay. Recieved signal yrd at the destination can be obtained as,

$$y_{rd} = \sqrt{P_R}\, h_{rd} \hat{x} + n_d \qquad (1)$$

Where, PR is the average transmit power at the relay and nd is the noise at the destination.

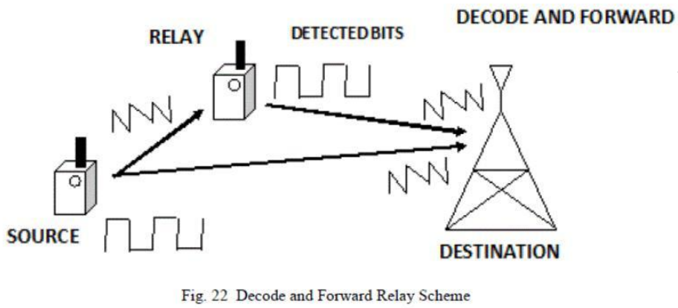

Fig. 1: DF relaying

B. Amplify-and-Forward Relay

In the AF protocol, the relay node forwards the amplified version of the received signal to the destination node, and provides significant gains with using less complicated processing. AF protocol can be implemented in practice and it is less complex and has lower implementation loss. Simple AF relaying system is illustrated in Figure 2. In the AF system, received signal y at the relay is subject to the amplification factor G at the relay node before forward it to the destination.

Then received signal $y_S r$ at the destination can be obtained as

$$y_{rd} = G\sqrt{P_R}\, h_{rd} y_{sr} + n_r: \qquad (2)$$

Depending on the availability of instantaneous CSI at the relay node, the AF relaying can be categorized into two schemes. Those are variable gain AF relaying and fixed gain AF relaying. In variable gain relaying, it amplifies the received signal at the relay node based on the instantaneous CSI. On the other hand, fixed gain is applied in AF fixed gain method considering the average behavior of the channel.

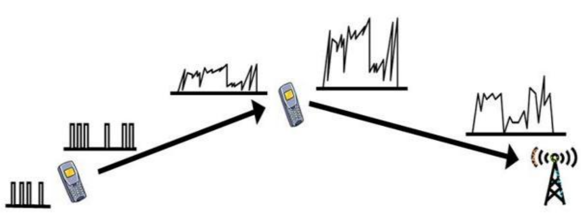

Fig. 2: AF relaying

III. Application of Relay in different Communication

A. MIMO Relaying

MIMO relaying is an interesting research direction that can optimally utilize key resources of wireless fading, and achieve the benefits of both MIMO and cooperative communication. We investigate different types of MIMO relaying systems in this thesis work, such as optimal single stream beamforming based AF relaying, OSTBC based AF relaying and TB/MRC based AF relaying.

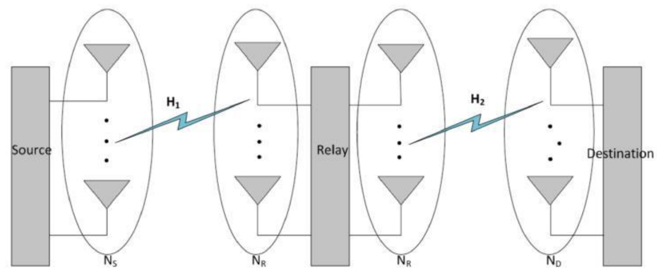

Fig. 3: MIMO relaying

B. Cooperative Communication

Co-operative communication, a concept that takes advantage of the possible cooperation among multiple nodes in a net-work to form virtual multiple-input-multiple output (MIMO) configuration, has received significant attention in the wireless community [4]. For cooperative networks with multiple relays, relay selection (RS) is an important and effective technique because properly designed RS can achieve full spatial diversity with low complexity and overhead. RS problems have been extensively studied in the open literature for networks with single source-destination pair, referred to as single-user net-works. Recently, there is increasing interest in relay networks with multiple source-destination pairs, referred to as multiple-user networks. Typical multiple-user networks include ad-hoc, sensor, and mesh networks. However, RS schemes proposed for single user networks cannot be extended to multiple-user networks straightforwardly due to the challenges in the performance evaluation, the competition among users, and the increased complexity.

C. Multiple user multiple relay network

For a multiple-user multiple-relay network, under amplify-and-forward (AF) relaying and decode-and forward (DF) relaying respectively, joint user selection and relay selection is considered. The user with the best direct link quality is first selected, and then a relay is selected for this user to obtain the maximum end-to-end receive signal-to-noise ratio (SNR). Other users are not allowed to transmit. So only one user with its best relay is selected at a time, and there is no user competition. For a multiple-user multiple-relay network, a relay grouping algorithm is proposed to maximize the network sum-rate or the minimum achievable rate among users.

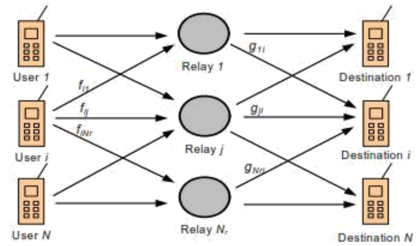

Fig. 4: A multiple-user multiple-relay network model.

D. mm-Wave Full-duplex (FD) relaying

Full-duplex (FD) relaying is a promising solution for fifth generation (5G) wireless communications due to its potential to provide high spectral efficiency (SE) transmission. However, FD relay nodes consume much higher power than half duplex (HD) relay nodes, especially in millimeter (mm)-wave band. Therefore, energy-efficiency (EE) is an important issue to address for mm-wave FD relaying systems, which highlights the green evolution of 5G wireless communications. Existing FD relaying related research is SE-oriented, which is not efficient in cutting carbon footprint. This article is different in that it addresses the critical EE challenges in implement-ing FD relaying in mm-wave systems, including low drain efficiency (DE) of power amplifier (PA), high circuit power consumption and additional power required by FD relays to mitigate self interference. Based on the features of mm-wave communications, we outline a number of promising EE-oriented solutions for designing FD relaying enabled systems, including adaptive self interference cancellation, transmission power adaptation, hybrid relaying mode selection, multi-input-multi-output (MIMO) and massive MIMO FD relaying. Some EE-oriented future research is also envisaged for mm-wave FD relaying systems.

IV. RELAY SELECTION TECHNIQUE

A. Single and Multiple Relay Selection Schemes

This work [5] is on relay selection schemes for wireless relay networks. First, we derive the diversity of many single-relay selection schemes in the literature. Then, we generalize the idea of relay selection by allowing more than one relay to cooperate. The SNR-optimal multiple relay selection scheme can be achieved by exhaustive search, whose complexity increases exponentially in the network size. To reduce the complexity, several SNRsuboptimal multiple relay selection schemes are proposed, whose complexity is linear in the number of relays. They are proved to achieve full diversity.

B. Best relay selection

In [6] the relay whose path has the maximum SNR is selected. This is obviously the optimal single relay selection scheme. The error rate of this scheme is first discussed in [7], in which an approximation on the cumulative density function of the receive SNR is used. Then, a rigorous upper bound on

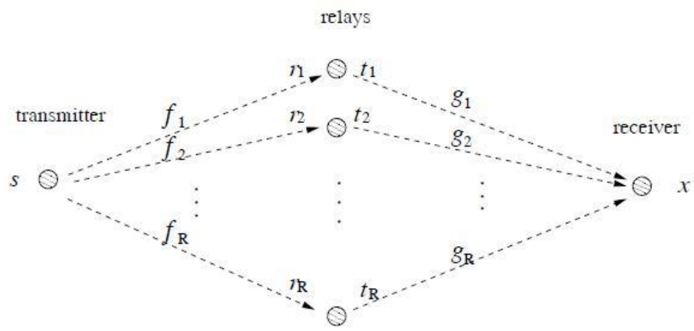

Fig. 5: Single and multiple relay selection.

the error rate of this scheme is given in [6]. Both papers show that this scheme achieves a diversity order of R.

C. Joint User-Relay Selection

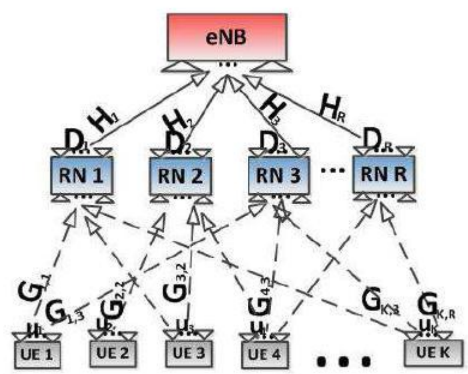

Fig. 6: Joint user relay selection.

In this a centralized user-relay selection and association scheme is considered in which the eNB makes the selection and association decisions and communicates them to all the nodes. We assume that R (out of Rt) RNs and K (out of K) UEs are to be selected with each selected RN serving at least one selected UE. Also, we assume that the maximum number of UEs each of the selected RNs can serve is the same (i.e., K), and each UE is associated with only one RN for service, which implies R = K1 = = KR = Kmax. Ideally, the selection and association scheme that maximizes the system throughput is desirable. However, to obtain such solution, the eNB needs to calculate the achievable sum rate for all possible UE-RN selections and associations. Unfortunately, for each possible user-relay selection and association, the user and relay beamforming design is highly complex, as explained in Section II. With exhaustive search, the number of possible selections and associations grows fast with the network size, which means that the number of user and relay beamforming optimization problems that need to be solved grows fast. Since the UE-RN selection and association ought to be done before data transmission, the throughput maximization selection and association is extremely difficult if not impractical to imple-ment in the already delay-sensitive multi-hop communication networks.

V. Conclusion

In this paper, it presented a review of relay, diferent types of relay. Moreover it has been reviewed different commonly used relay selection techniques that can be applied for selecting relay and improve the throughput. Further we considered the problem of relay selection for cooperative communication, joint user and relay selection.

In future, this work can be further extended to different environment considering fading effects. Moreover the bit error rate and performance should be improve.

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