Efficient Joint User-Relay Selection for Multi-User Multi-Relay MIMO Uplink with LTE

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Abstract - For non-regenerative and altruistic relays presets a reduced complexity joint scheme, integrating with the long term evolution (LTE) technology framework selects simultaneously multiple relays and associated users for cooperation as well as assigns the selected users to different selected relays for service. The proposed scheme is sub-optimal and utilizes only the channel gains between the nodes, which leads to reduced feedback and overhead in comparison to schemes that require full channel knowledge. Furthermore, the complexity of the scheme scales directly as the result of the aggregate number of relays, the total number of users and the number of selected users. Simulation result demonstrates the performance of the proposed Joint User-Relay Selection for Multi-User Multi-Relay MIMO Uplink with LTE is batter compared to existing base work. The ideal execution and low-complexity of the proposed scheme make it extremely attractive for possible implementation in emerging broadband wireless relay networks.

Keywords – MIMO, LTE, relay selection, Multi-Relay, Multi-User, wireless communication system.

I. INTRODUCTION

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. However, practical wireless relay networks are delay sensitive due to two or more hops required to convey information from the source to the destination.

During the past decade, multi-antenna systems, which are also referred to as multiple- input multiple-output (MIMO) systems, have attracted significant interest. The benefits of multiple antennas arise from the use of extra spatial dimension. By employing multiple antennas at the transmitter and/or receiver in a wireless system, the rich scattering channel can be exploited to create a multiplicity of parallel links over the same radio band. This novel property provides MIMO with several advantages, including array gain, spatial diversity gain, and spatial multiplexing gain

Although prone to noise and interference enhancement, amplify-and-forward (AF) relays are simpler, hence more attractive than decode-and-forward (DF) ones. Quite recently, the possibility of leveraging the spatial dimensions of multi-antenna AF relays to pre-cancel interference from unintended sources before forwarding the useful signals to the destination has been investigated In practical multi-user multi-relay systems, not all nodes arable 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.

Relay selection and user scheduling have been separatelyand extensively reported in the literature.

For example, relay selection was studied for networks with the same type of relays and for networks with different types of relays. Similarly, user-scheduling in MIMO networks employing zero-forcing beamforming has been studied.

Recently, 2-step single-user single-relay selection schemes in which the user with the best channel is selected in the first step, while the relay with the best channel to the selected user is selected in the 2nd step, for networks with single-antenna nodes have been studied.

However, transceiver nodes are envisaged to have multiple antennas in the emerging wireless broadband networks.

Most recently, user relay association in a multi-user multi-relay MIMO cellular network has been investigated.

Considering the existing architecture of the present day cellular networks and to maintain stringent requirements envisioned for future mobile systems, MIMO systems are likely to play a major role in the future mobile systems. In addition, the cooperative communication has recently emerged as a new communication paradigm for wireless networks such as wireless ad hoc networks, sensor networks, and cellular networks to exploit the spatial diversity gain inherent in multiuser wireless systems.

The use of additional relay nodes is considered, where, use of relaying has been discussed for a long time in academia [16] and has been included in IEEE 802.16j standard as well. Relaying is also an integral part of the WINNER air interface, a beyond 3G system concept. The main advantage of relaying is that coverage can be increased and the capacity can be extended to distant users. A better user experience can be achieved by managing the capacity with improved fairness of the system. Fig. 1.1 shows a basic MIMO multi-hop relay arrangement. Relay technologies are also being actively considered in 3GPP LTE-Advanced and IEEE 802.16j.

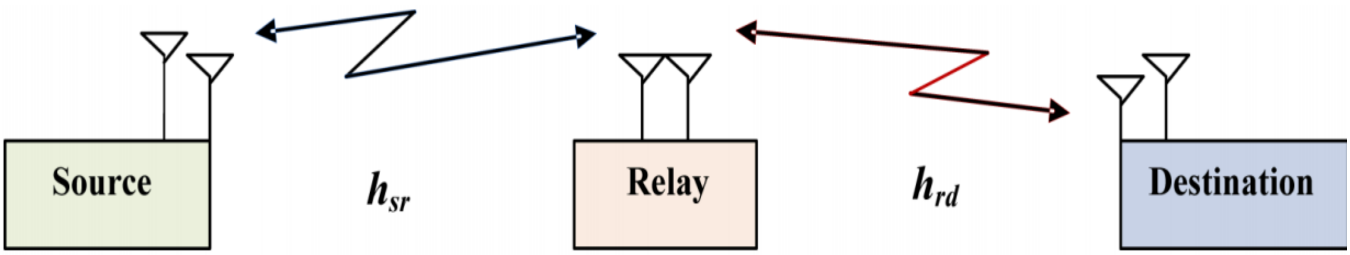

Figure 1.1 A Basic MIMO multi-hope relay arrangement.

II. MIMO SYSTEM

The MIMO technology which uses multiple transmitting and receiving antennas to transfer more data at same time on same link. MIMO systems have the ability to exploit Non Line-of Sight (NLoS) channels and hence they can increase spectral efficiency compared to SISO systems.

According to the number of the antennas used at the transmitter and the receiver, multi-antenna systems are divided into four schemes: single-input single-output (SISO), single input multiple-output (SIMO), multiple-input single-output (MISO), and MIMO. SISO, SIMO, and MISO can be treated as special cases of MIMO. Figure 2.1 shows a typical block diagram of the MIMO system with N_t transmit antennas and Nr receive antennas. The input information stream s is assumed to be symbols that have been coded and mapped onto constellations. The input symbols are first divided into Ns data streams denoted by s, and then are pre-processed in space (and in time) domain into N_t x K blocks X, which are transmitted via the radio channel. Here K is the length of the space-time codewords. If no space-time coding is applied, K = 1.

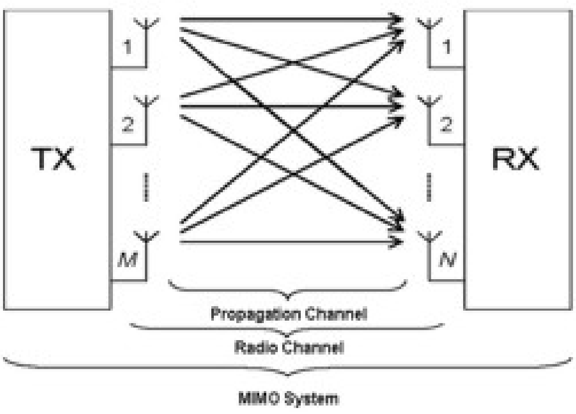

Figure 2.1 MIMO wireless model block diagram.

The transmit streams go through a matrix channel which consists of all M +N paths between M at transmitter and N at receiver. Then receiver gets the received signal vectors by the multiple receiving antennas and decodes the received signal vectors into the original information. A narrowband flat fading MIMO system is modeled as

$$y(t) = H(t) * s(t) + n(t) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .1$$

s(t) = transmitted signal.

y(t) =received signal.

n(t) =additive white Gaussian noise (AWGN),

H(t) = N by M channel impulse response matrix and

(*) denotes convolution.

The corresponding input output relationship simplifies to

$$y = Hs + n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where H is the narrowband MIMO channel matrix

III. METHODOLOGY

Analysis has been done with the use of different channel using LTE codes.

The analysis is done in MATLAB 11.1. (R2011a). MIMO multi relay using LTE technique developed for both adaptive and constant modulation schemes (for better power utilization average network sum rate. Figure 3.1 illustrated the proposed work with multiple relay system. A cooperative system with one relay between source and destination and direct link between source and destination is studied, with corresponding upper and lower bounds derived.

Both an asymptotic upperbound and lower-bound was derived for multiple relay MIMO systems for perfect CSI at relays and receiver and no CSI at the source as follows: a source with M antennas, a destination with M antennas and K relays each with N ≥ 1 antennas, two time slots are employed with the first time slot to transmit data from the source to the relays and the second time slot forward data from the relays to the destination as described in Figure 3.1.

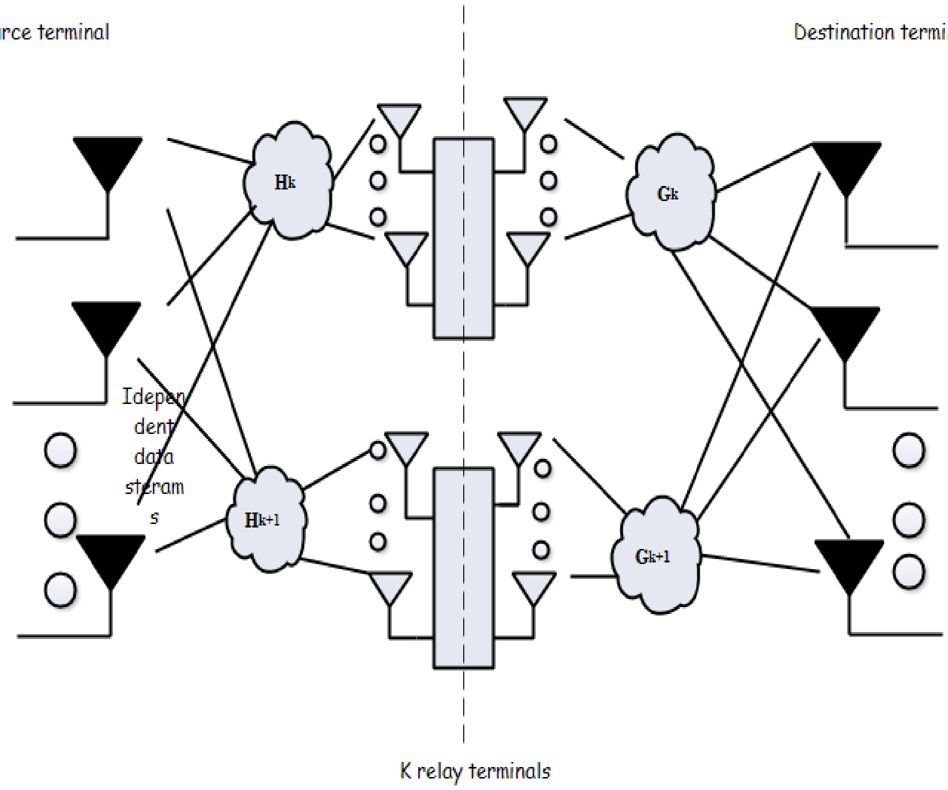

Figure 3.1 Architecture of propose model.

Relay system based on orthogonal frequency division multiplexing access (OFMDA) has been in LTE Advanced. To limit in-band interference, it is important to limit the transmission power at both base stations and relays, The design of linear precedes broadcasting to given MIMO receivers using signal to-noise plus average network sum rate of design has been studied for the uplink and for the downlink. Transceiver design that takes imperfect channel state information into account has also been studied in work.

Multi-user multi-relay wireless networks with single-carrier frequency division multiple access (SC-FDMA) at the terminals is and Joint relay selection and power allocation for cooperative system has been utilized. Transmission techniques for broadcast channels have been extended to cooperative networks. Relays cooperatively transmit to a receiver where amplitudes and phases of transmitted signals are coherently combined.

However, in the LTE system which is based on OFDMA with cyclic prefix (CP), any multi-path arrival of signals can be coherently combined at the receiver. The propagation delay for typical dense urban scenarios with inter-site distance of 500m) is negligible compared with CP.

IV. RESULT ANALYSIS

The performance of the proposed scheme by simulation assumes the same numbers of antennas and transmits powers. (Normalized bynoise power) at similar nodes. Performance analysis of proposed work has given in table 4.1 Results Comparison of Average Network Sum Rate with previous existing approach to proposed approach.

Average sum rate (averaged over 500 channel realizations) in a Rayleigh fading environment is shown in all simulations. For the user-relay beamforming designs, the favorable performance and relatively low complexity of the proposed scheme makes it very attractive for implementation in emerging broadband wireless relay networks.

In spite of the emphasis on the uplink in this work, the proposed multirely LTE selection and association scheme is also applicable to the downlink of a multi-user multirelay network.

Table 4.1 Results Comparison of Average Network Sum Rate

Relay Power	Previous Method	Proposed Method
-5	11.78	13.39
0	12.53	14.14
5	13.53	15.14
10	14.63	16.24
15	15.83	17.44

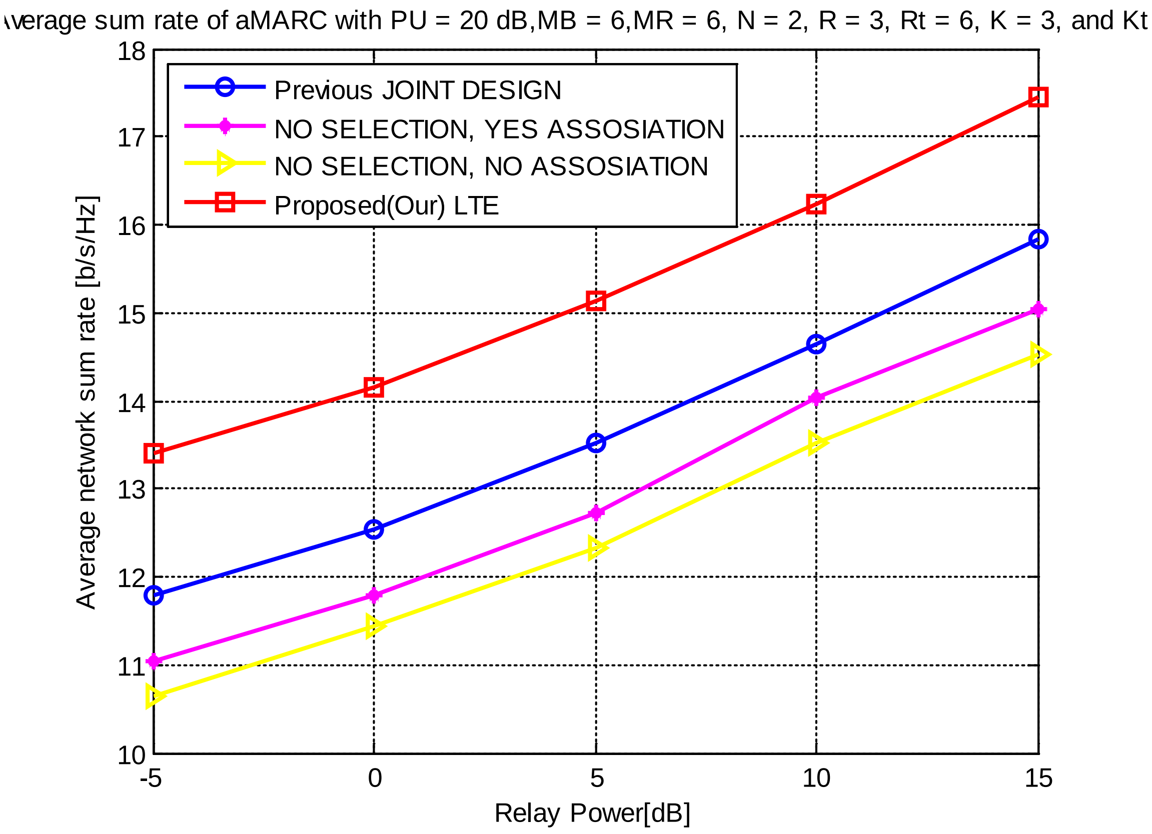

Figure 4.1. MIMO-LTE system with relay power consumption.

V. CONCLUSION

In this research we have worked on the LTE based joint user-relay selection and association in a MIMO multiple access relay channel (MARC), where average network sum rate is better than the Joint User Selection Scheme alone. The Sum rate increased with the increase in the Relay power shown in the simulation results. The implementation of LTE technology the existing network became more reliable and strong. The work can be successfully extended with addition of different codes like STC, LDPC to enhance the BER performance using multi relay LTE system. Performance of the system can be analyzed by using different convolution code rates to decrease Bit Error Rate. Performance of the system can also be analyzed using different fading channels.

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