

Research Article

Performance Analysis of Synchronous and Asynchronous Mode in LTE-Advanced Network using Joint Sub Carrier and 2 Relays for Cooperative Communications

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Abstract

Multiple Input and Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM) system have the potential to attain very high capability depends upon the propagation surroundings. The target of this paper resource allocation on LTE exploitation is that the reconciling resource allocation in MIMO-OFDM system exploitation the water filling formula. Water filling resolution is enforced for allocating the ability so as to decrease the data rate for power consumption. A LTE-Advanced cooperative cellular network wherever a sort II relay station (RS) is deployed to reinforce the cell-edge turnout and to increase the coverage space. To higher exploit the present resources, the RS and also the eNodeB (eNB) transmit within the same channel (In-Band) with decode-and-forward relaying strategy. For such a network, this paper proposes joint Orthogonal Frequency Division Multiplexing (OFDM) subcarrier and power allocation schemes to optimize the downlink multi-user transmission the aim.

Keywords: Synchronous and Asynchronous Mode, LTE etc.

Introduction

LTE (Long Term Evolution) is the latest mobile communications technology responding to the high demand for broadband data access. Based on MIMO-OFDMA technology, LTE Downlink system provides 100 Mbps (SISO), 172 Mbps (2x2 MIMO) and 326 Mbps (4x4 MIMO). The performance evaluation of MIMO-OFDM systems depends on many parameters. Channel estimation plays a key role in the performance of MIMO-OFDM systems. It has attracted a lot of research interest as in (S. Peters et al, 2009; A. Lo et al, 2011) Most of these research works assume that the power want to be allocated equal to base station users. So that they need to improve power allocation using bit allocation, channel estimation, block coding and pre-coding on spatial diversity functions. In this paper, we have investigated the performance of power allocation for a Cooperative Communication node which is far from near base station. The Cooperative Communication node which is far away from PU may not perform spectrum sensing with great efficiency due to severe fading in channel and may create interference to PU. In this condition, to improve the power allocation efficiency, we propose a cooperative network based on relay nodes. The performance has

been investigated in terms of capacity, throughput, optimal throughput and optimal sensing time. The probability of detection can be improved by cooperative communication, which in turn reduces power allocation of the system.

If the sensing time reduces, the transmission time for Cooperative Communication increases which results in improvement of throughput of the CR user. Hence we highlight the major contributions of our paper: We have investigated the power allocation of a MIMO in the proposed model with respect to a number of users and capacity consumption on MIMO Using Water filling process.

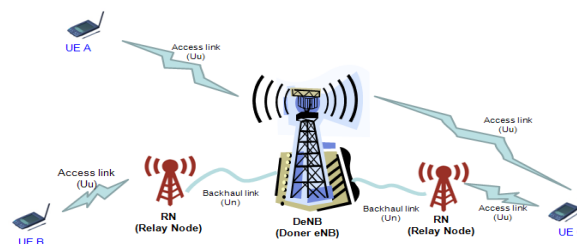


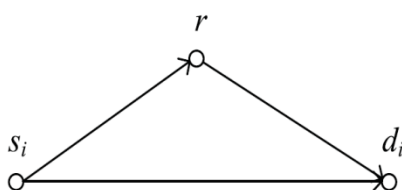
Fig.1 LTE advanced network architecture

Existing Method Analysis

In multiuser OFDM or MIMO-OFDM systems, dynamic resource allocation continually exploits multiuser

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diversity gain to boost the system performance and it's divided into 2 forms of optimisation problems: 1) to maximise the system turnout with the whole transmission power constraint; 2) to reduce the general transmit power with constraints on knowledge rates or Bit Error Rates (BER). To the most effective of our data, most dynamic resource allocation algorithms, however, solely think about unit cast multiuser OFDM systems. In wireless networks, several transmission applications adapt to the multicast transmission from the bottom station (BS) to a bunch of users. These targeted users incorporates a multicast cluster that receives the information packets of identical traffic flow. At the same time possible transmission rates to those users were investigated. Recently scientific researches of multicast transmission within the wireless networks are paid additional attention.



Amplify Forward methodology for Co-Operative MIMO-OFDM Communication

In Phase 1, the supply node transmits the signals by approach of broadcasting, whereas the destination node and also the relay node receive the signals. In Phase 2, the relay node amplifies the powers of the signals received from the supply node and forwards them to the destination node. In Phase 3, the destination node combines and decodes the signals received from the supply node in part one and also the relay node in part a pair of therefore on restore the initial info. AF is additionally known as non-regenerative relaying theme and it's primarily a process methodology for analog signals. Compared with different schemes, AF is that the simplest. Besides, because the destination node will receive freelance weakening signals from the supply and relay nodes, full diversity gain and smart performance is achieved with this theme. However, AF theme is prone to noise propagation impact as a result of the relay node amplifies the noise on the source- relay channel once the retransmitted signals square measure amplified.

Delay Forward methodology for Co-Operative MIMO-OFDM Communication

In part one and part three, DF theme processes the signals identical approach as AF. In Phase 2, the relay node decodes and detects the signals received from the supply node before it forwards the signals to the destination node. Hence, DF is additionally known as regenerative relaying theme. Obviously, DF is basically a digital signal process theme. Though noise propagation downside won't happen, the signal

process in DF mostly depends on transmission performance of source-relay channel. If Cyclic Redundancy Check (CRC) isn't enforced in writing, full diversity orders cannot be obtained. Moreover, the errors brought by the relay node throughout signal reception and secret writing can accumulate with the rise of hops, so touching diversity advantage and relay performance. of these demonstrate that the transmission characteristics of source relay channel have nice impact on the performance of DF communication systems.

Proposed System Model

In this section, we elaborate on the system model of the multiuser fixed relay system. First we describe the system block diagram and main assumptions of the system, and then we present the downlink signal model.

1. MIMO System

Where there is more than one antenna at either end of the radio link, this is termed MIMO - Multiple Input Multiple Output. MIMO can be used to provide improvements in both channel robustness as well as channel throughput.

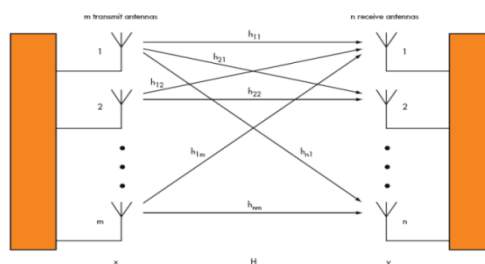


Fig.2 MIM O system consisting n transmitting antennas n receiving antennas

In order to be able to benefit from MIMO fully it is necessary to be able to utilise coding on the channels to separate the data from the different paths. This requires processing, but provides additional channel robustness / data throughput capacity.

2. Power Allocation on MIMO Using Water filling Process

Considering a multiuser MIMO-OFDM system with downlink beam forming, it is assumed that the base station can acquire perfect CSI, employed the SUS (Semi-orthogonal User Selection) algorithm proposed in to minimize the total transmit power satisfying the QoS of users. But in the size of OFDM group was fixed, therefore, the orthogonality of channels of users in a group was not well guaranteed. In order to guarantee the orthogonality of channels of users in a group. We derive bounds of achievable sum rates of the MIMO fixed relay system using coding, which has been shown to be sum capacity optimal. The sum rate using dirty paper coding can be expressed as a function of the pre-

coding matrix F and the relay processing matrix approach is to directly optimize the sum rate with respect to the matrices F and W, however, this approach optimizes large number of parameters and has very high computational cost. Further, in this formulation, the optimizers may not be unique. Thus finding a globally optimum solution is difficult. To resolve this problem, we introduce several design structures for the parameters F and W. Unfortunately, the computational complexity of the ideal solution explodes, because the two problems of allocating users to resources and distributing a user's transmit power budget are coupled. While the ideal solution is of interest for theoretical research, it has important flaws that prevent its use in a real-world application. Users are handled in a Round-Robin fashion, and the best free resource is tentatively allocated to the current user. Since the best resource is picked first, the signal-to-noise ratio reduces for each additional resource. The process stops, when the signal-to-noise ratio drops below a user-defined threshold. The number of resources for any user can be limited to improve the performance of cell-edge users at the expense of sum throughput. The algorithm takes the power budget of each user as a parameter (again, for example one may allocate more power to cell-edge users). The mode parameter switches between fixed-power allocation as shown in Figure 2 part 2) and water filling as in Figure 2 part 4). The code can be further optimized for fixed power allocation by replacing the iterative water fill () subroutine with another one that splits a user's power evenly between resources allocated to the user.

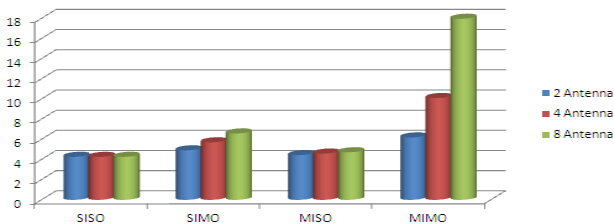


Fig.3 Power allocation in SISO,SIMO,MISO,MIMO

Relay Communication

1. No Co-operative communication

One Input One Output. This is effectively a standard radio channel or Mobile communication- this transmitter operates with one antenna as does the receiver. There is no diversity and no additional processing required. Signal strength is low in order to increase signal strength results in high cost.

$$R^{(k,l)} = \frac{\rho^{(k,l)}}{n} \log \left(1 + \frac{|h_{sd}^{(k,l)}|^2 P_s^{(k,l)}}{B/n} \right)$$

2. Equal Power Allocation

We derive bounds of achievable sum rates of the MIMO fixed relay system using coding, which has been shown

to be sum power optimal. The sum rate using dirty paper coding can be expressed as a function of the pre-coding matrix F and the relay processing matrix approach is to directly optimize the sum rate with respect to the matrices S and R, however, this approach optimizes large number of parameters and has very low cost.

$$R^{(k,l)} = \frac{1}{n} \log \left(1 + \frac{|h_{sr}^{(k,l)}|^2 (|h_{sd}^{(k,l)}|^2 + |h_{rd}^{(k,l)}|^2) \cdot \frac{P^{(k,l)}}{B/n}}{|h_{sr}^{(k,l)}|^2 + |h_{rd}^{(k,l)}|^2} \right)$$

3. Synchronous Communication

A brief overview of the most common serial communication systems. Data passes through the combinatorial input source and on the relay path of , receiver register samples this data and passes it to the output. Basically relay events serve as logical ordering of the system functions. And the relay corresponding to the combinatorial logic path along with the register relay channel is going to determine the system speed. In case of multiple pipeline stages, the slowest combinatorial logic path is going to dictate the system speed. Thus the relay involved in one stage is going to affect the system speed if it experiences the maximum throughput. As said earlier worst case relay controls the throughput rate of the system. Synchronous communication acts when the relay path will be in the phase with the base station in order to achieve high throughput rate.

$$R^{(k,l)} = \frac{1}{n} \log \left(1 + \frac{|h_{sr}^{(k,l)}|^2 (|h_{sd}^{(k,l)}|^2 + |h_{rd}^{(k,l)}|^2) \cdot \frac{P^{(k,l)}}{B/n}}{|h_{sr}^{(k,l)}|^2 + |h_{rd}^{(k,l)}|^2} \right)$$

4. Asynchronous Communication

Asynchronous systems are the most common standard for serial communications and include your classic internet dial up modem systems. Asynchronous systems are character oriented. There is no global not(No other communication) involved in this case. Internally generated events/signals are going to take care of the ordering of the system functions. Once the sender (source signal) has sampled the input data, it sends a request to the next stage and waits for the acknowledgement. On receiving the acknowledgement, sender sends the data and it reaches the receiver register via the through increase channel. Asynchronous communication acts when the relay path will be in phase or out of phase with the base station in order to achieve high throughput rate.

$$R^{(k,l)} = \frac{1}{n} \log \left(1 + \frac{|h_{sr}^{(k,l)}|^2 |h_{rd}^{(k,l)}|^2}{|h_{sr}^{(k,l)}|^2 - |h_{sd}^{(k,l)}|^2 + |h_{rd}^{(k,l)}|^2} \cdot \frac{P^{(k,l)}}{B/n} \right)$$

Simulation Parameters

Parameter	Value
Cellular layout	Hexagonal grid, 6 sectors per cell
Relay station layout	1,2 relay station per sector
Relay protocol	Decode-and-Forward
Transmission bandwidth	20MHz
Subcarrier separation	15kHz
# of subcarriers in a resource block	12
Carrier frequency	2.7 GHz for downlink
Channel model	Frequency selective Rayleigh fading
UE distribution	Uniformly random
Number of UEs per sector	10
Total transmission power	80W

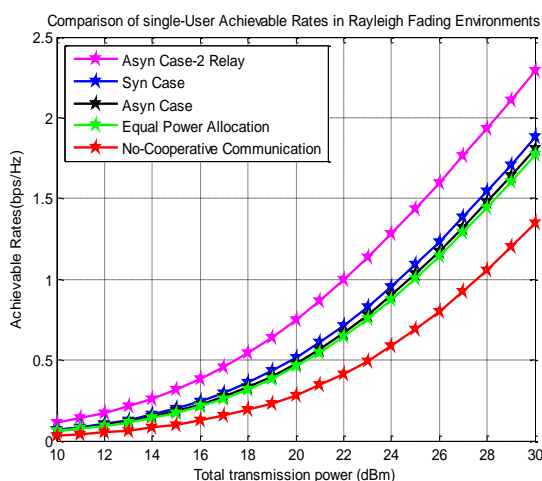


Fig.4 Comparison of Multi-user achievable rates in Rayleigh fading environments

Experimental Results

To evaluate the performance of our scheme, numerical results are generated using a MATLAB simulation. Relay selection is performed per RB since RB is the smallest resource unit for the LTE networks. The relay locations are varied to show the effect of relay locations on the performance. Here, we only consider random variations of the relay distance from the eNodeB as the first step. However, relay placement can be modelled as another optimization problem which is not studied in this paper. Then the effective channel gain over an RB is deduced from the subcarrier granularity. The 3GPP LTE path loss models with log-normal shadowing of an 8dB standard deviation are assumed.

Throughput Calculation

To illustrate the superiority of our resource allocation scheme in terms of the cell overall throughput

improvement, we compare the throughput achieved by the optimal resource allocation with the following two resource allocation schemes (synchronous and asynchronous mode) are operated in multi RS.

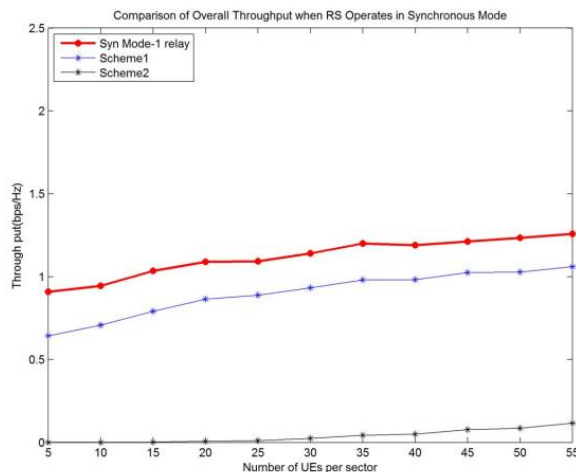


Fig.5 Comparison of overall throughput when RS operates in synchronous mode (1-relay)

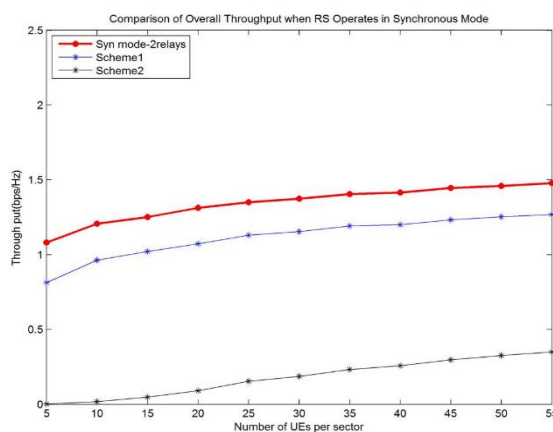


Fig.6 Comparison of overall throughput when RS operates in synchronous mode (2-relays)

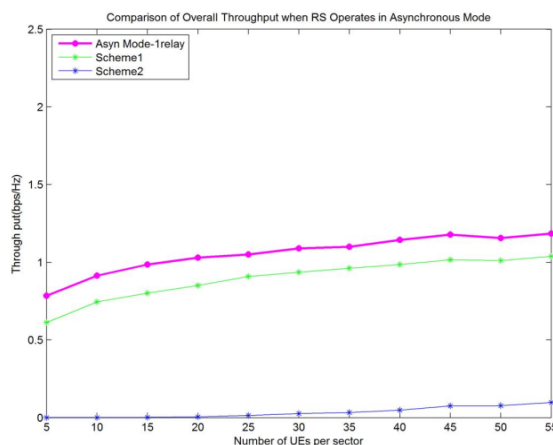


Fig.7 Comparison of overall throughput when RS operates in Asynchronous mode (1-relay)

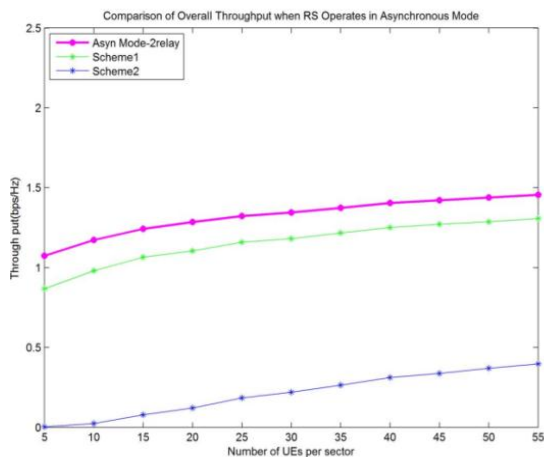


Fig.8 Comparison of overall throughput when RS operates in Asynchronous mode (2-relays)

Conclusion

Although the performance of RS has been studied in existing literature, its analysis in this paper shows the great impact it has on data transmission. More amount of data transmitted and signal strength is improved when the synchronous and asynchronous modes operates on multi relay mode (2-relays). Comparing throughput rate for both asynchronous and synchronous using multi relays the overall throughput we get high in asynchronous communication. The results show that by using Market Game and Shapley's theory, an improvement is made in radio resource allocation.

By analyzing the results of our proposed algorithm, we show here through our model that upon implementation, this algorithm would be efficient and also achieve its objectives of optimizing the data rate of both cell edge users and those close to the cell center that are however starved of resources. Our approach provides user satisfaction by sacrificing some amount of total system throughput. It supports heterogeneous traffic. The computational complexity of our algorithm is higher, but the base station can easily perform the optimization.

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