BER Performance for Joint Transmission CoMP with SFBC algorithm

Maryam Kareem Noor[1], Dr. Buthainan Mosa Omran[2]
[1,2]Department of Electronics and Communication Engineering, University of Baghdad, Baghdad, Iraq

Abstract- LTE-A provide higher capacity and data rate. However, it suffers from interference especially at the cell edge.Joint transmission is one of coordinated multi point transmission (CoMP) which reduce the interference at the edge of cells.It reduce the interference by the data simultaneous transmission from multiple cells to a singleuser on the sametime and frequencyresource. Also Space Frequency Block Coding (SFBC) is the transmit diversity method used to provide both spatial and frequency diversity. In this paper the performance of Joint transmission was tested and evaluated using different detection methods under different channels specified by LTE standard.The results show that the Joint transmission has improved system performance by approximately 5.5 dB over not using Joint transmission. With using SFBC in this work, the performance of the system improved at high Signal to Noise Ratio by approximately 0.8 dB. The results also show that the BER of DF decoder has the best performance among the rest of the other algorithms but it has the highest complexity. The SML detector has the least performance. Also the results showed that the BER performance degraded as the channel turns from EPA to EVA.
Keywords –

I. INTRODUCTION

For the fourth generation (4Gx) wirelessnetworks,oneof the latest standards is Long-TermEvolution (LTE). It is a development of the UniversalMobileTelecommunicationsSystem(UMTS) standardized by the 3rdxGenerations Partnerships Projects (3GPPx) in its 8th release for the development of wireless broadband networks with very high data rates [1]. Technically, a high data rate is offered by LTE and can operate in differentbandwidths ranging from 1.4MHz to 20MHz. LTE provides low latency, high spectral efficiency, high-speed data transmission, also it support for high mobility [2]. The default feature in LTE systems to increase the overall data rates is Multiple Input Multiple Output (MIMO) which offers higher data rates without additional bandwidth and transmit power required. The number of data streams supported will be selected throughthe number of antennas at the transmitter or receiver. The best performance under line-of-sight conditions is provided by traditional cellular systems but MIMO attempts to provide thebest performance under rich scattering situations [3].

A multi-carrier modulation technique where the total bandwidth is split into a large number of smaller and narrower bandwidth units identified as subcarriers which they are orthogonal to each other is known by OFDM (Orthogonal Frequency Division Multiplexing). It used instead of Frequency Division Multiplexing (FDM) which was a technique introduced in parallel data transmission.

Considering that the system frequency bandwidth is the most valuable component in any communication system, OFDM system has met the aim of occupying the communication system spectrum efficiently.

II. TRANSMITXDIVERSITY SCHEMES IN LTE

There are two flavors of MIMO with respect to how data is transmitted across the given channel. Existence of multiple antennas in a system, means existence of different propagation paths. Aiming at improving the reliability of the system, we may choose to send same data across the different propagation (spatial) paths. This is called spatial diversity or simply diversity. Aiming at improving the data rate of the system, we may choose to place different portions of the data on different propagation paths (spatial-multiplexing).

In spatial multiplexing, each spatial channel carries independent information, thus increasing the data rate of the system. While in diversity techniques, same information is sent across independent fading channels to combat fading. When multiple copies of the same data are sent across independently fading channels, the amount of fade suffered by each copy of the data will be different. This guarantees that at-least one of the copy will suffer less fading compared to rest of the copies. Thus, the chance of properly receiving the transmitted data increases.

Figure 1 illustrates the difference between diversity and spatial multiplexing. In the transmit diversity technique shown below, same information is sent across different independent spatial channels by placing them on three different transmit antennas. While in the spatial multiplexing technique, each bit of the data stream (independent information) is multiplexed on three different spatial channels thereby increasing the data rate [4].

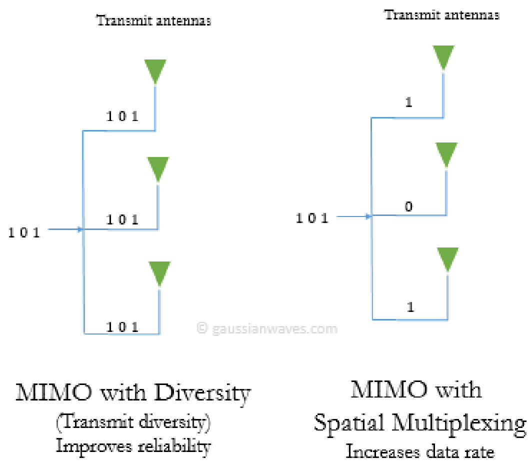
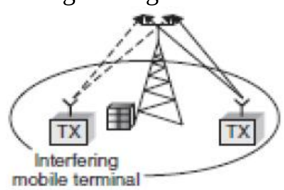


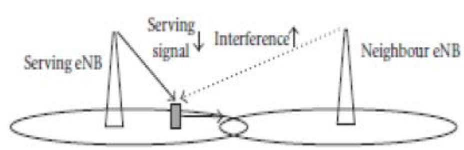
Figure 1: Difference between transmit diversity and spatial multiplexing [4].

III. INTERFERENCE IN LTE

In Long Term Evolution (LTE/LTE-Advanced) system, inter-cell interference is a serious issue. Increasing the network capacity is one of the main challenges for developing networks of LTE. However, significant system capacity improvement is resulted from dense frequency reuse. Also due to the increase in interference caused by adjacent cells, it remarkably reduces the performance of the system [5]. Generally two kinds of interference need be taken into consideration in the communicationsystem of cellular mobile, such as intra-cell interference and inter-cellinterference. The interfering mobile terminalin intra-cell interference as shown in Figure 2 (a)is located in the same cell. The spillovertransmissionbetween the adjacent channelswithin a cell results in intra-cellinterference. The interfering mobile terminal in inter-cellinterference (ICI) as shown in Figure 2 (b)is located in adjacent cell. Inter-cellinterference (ICI) is happen because of the neighboringcells use the same frequency channel [6].



[a]



[b]

Figure 2: (a) Intra-cellinterference (b) Inter-cellinterference [7]

In LTE/LTE-Advancedsystems, several CoMP feature has been introduced as one of the most attractivemethods toimprove throughput at the cell-edgeand capacity of the system and to decrease inter-cell interference.

When a user is in the region of cell-edge, it might receive from the neighboringcells a number of strong signals inaddition to the signal from the servingcell is the main idea of CoMP. Known that, the performance of downlink can be improvedsignificantly by coordinating the transmitted signals are byeither allowingsimultaneous transmissions or silencingsome. Actually, a usefulsignal can be obtained by this coordination, also it reduces theinterference so as to enhance not only the experience of users but also the overallperformance of the downlink system[8].Joint transmission is one of the CoMP techniques where data from severalsites are actually transmitted at the exact time using the sametime-frequency radioresources.

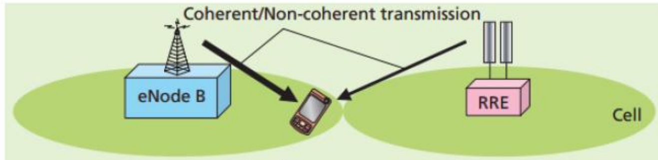


Figure 3: Jointtransmission [11].

IV. PROPOSED ALGORITHM

In LTE, the diversityscheme is named SpaceFrequencyBlockCoding When a physical channel is configuredfor the operation of transmit diversityusing twoeNodeBantennas. In fact, the SFBC diversity scheme is the frequency domain implementation of the well-known SpaceTimeBlockCodingtechnique, developedby Alamouti[9]. For the transmission of SFBC in LTE, the symbolstransmitted from two eNodeB antenna portsfor each pair of adjacentsubcarriers as follows [10]:

$$\begin{bmatrix} y^{(0)}(2j) & y^{(0)}(2j+1) \\ y^{(1)}(2j) & y^{(1)}(2j+1) \end{bmatrix} = \begin{bmatrix} x_{2j} & x_{2j+1} \\ -x^{*}_{2j1} & x^{*}_{2j} \end{bmatrix} \quad (1)$$

On the k-th subcarrier, the symbols transmitted from antenna port (p) are denoted by y (p) (k). In the OFDM modulated signal, the two adjacent subcarriers are x2j and x2j+1(j = 0, 1, 2, ..., N/2 - 1 . a simple linearreceiver can be used for signal detection and decoding since the streams of transmittedsignal are orthogonal.

The technique implemented to reduce the effect if ICI is joint transmission. In general case, the signal receivedfrom a given user with multiple antennas and single outputlink can be expressed as:

$$y = \sum_{n \epsilon K} h_n \sqrt{P_n}\, x_n + \sum_{k\ K} h_k \sqrt{P_k}\, x_k + s \quad (2)$$

Where, in thesystem, the base stations set that serves a givenuser is denoted by K, n refers to transmitting antennas, s is the additivewhite Gaussiannoise with a σs standarddeviation, k denotes the cellsnot belonging to Kx which specifiesthe interferencesignal to the givenuser in cell nx, hn and hk denote the channel matrix, xn and xk refer to the transmission data, andPn and Pk are the average received power [11].

The detectorought to be able to accept only the desired signals and remove the errors to get the correctdata that had beentransferred. Different detection methods used in this work to obtain the original data bits were transmitted are stated below:

Simplemaximum-likelihood(SML) detector

JointMaximum Likelihood (JML) detector

The Zero-forcing(ZF) detector

Decision-feedback(DF) detector

The main goal in this work is to study the performance of joint transmission after Space Frequency Block Coding (SFBC) implementation with different detection methods and under different multipath channel modelspecified by LTE standard [12].

V. RESULT

The results that examine the performance of joint transmission in LTE downlink with clustering and by using SFBC with different decoding algorithms and under different channel conditions are discussed in this chapter. LTE Downlink is simulated using MATLAB simulation R2015b m-file

The Bandwidth used in the simulation is 10MHz with IFFT (Inverse Fast Fourier Transform) points 1024. Normal cyclic prefix is used and QPSK modulation. As shown in figure 4, in the presence of the inter cell interference, the result shows that the performance of the system degraded by approximately 5.5 dB over using joint transmission.

The principle of joint transmission is similar to transmit diversity, with using a number of cell sites for each connection, there are more than one copy of data. So if one copy I damaged or have errors, there will be another copy of it. Hence it reduce the data lost and therefor the system performance.

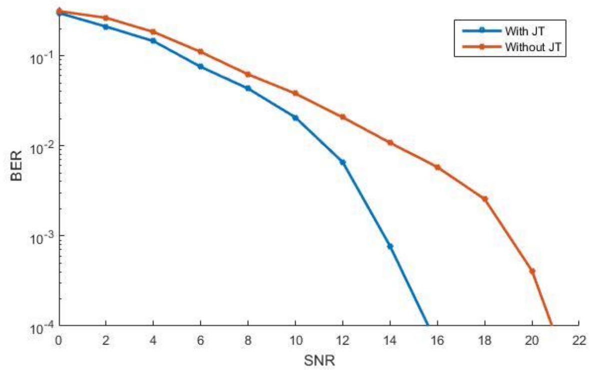


Figure 4: System performance with and without using JT

The proposed schemeof using Joint transmission implemented with SFBC shows that at low SNR the BER is nearly the same but at high SNR the performance improved by approximately 0.8 dB as shown in the figure below.

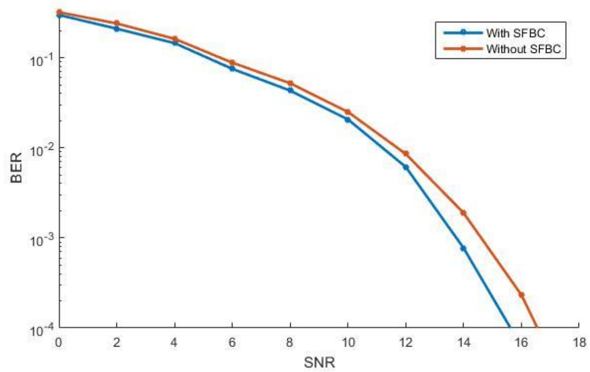


Figure 5: Joint transmission with and without SFBC

Also the performance of joint transmission is tested using four different decoding algorithms (SML, JML, ZF, and DF) and under EPA, EVA and ETU channel model.
As figure 6 shows the BER of joint transmission with the different decoding algorithm of SFBC under EPA channel model. DF decoder has the best performance among them but its complexity is high. The SMLdetectorhas least performance. ZF has the lowest complexity and it is a little bit lower performance than DF algorithm by approximately 0.5 dB.

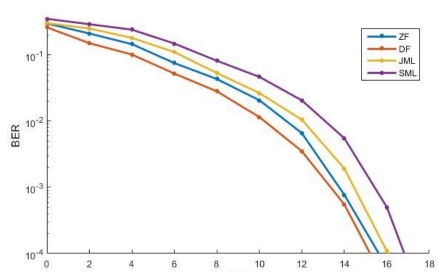


Figure 6: joint transmission with different decoding techniques under EPA channel

The performance of joint transmission with different decoding techniques under EVA channel shows thatDF decoder has the best performance among them. The SML detector has the least performance. ZF has the lowest complexity and it is a little bit lower than DF algorithm by approximately 0.8 dB.

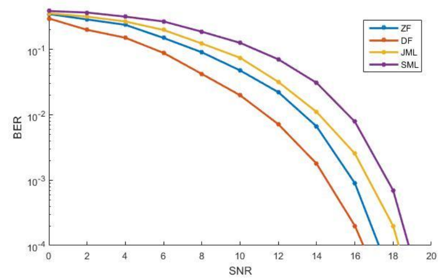


Figure 7: joint transmission with different decoding techniques under EVA channel

The last result shown in figure 8 displays that DF decoder has the best performance among them. The SML detector has the least performance about 7 dB from DF detection. ZF has the lowest complexity and it is a little bit lower performancethan DF algorithm by approximately 1.2 dB.

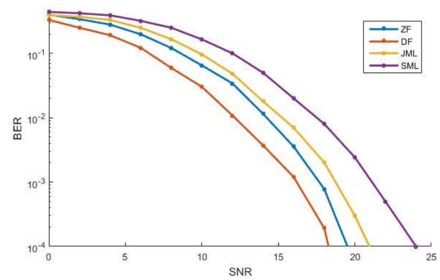


Figure 8: joint transmission with different decoding techniques under ETU channel

VI. CONCLUSION

Coordinated multi point transmission and reception is characterized as one of the methods used in inter-cell interference mitigateand increase the performance of the system particularlyat the celledge. The conclusions of the project are: Joint transmission offers better performanceparticularly at the celledge.

DF detection algorithm has best BER performance among the four algorithms used in this work but it is more complex. The SML detector has the highest number of bits in error and hence least performance.

The BER performance of all the decoding algorithms that tested in this thesis degraded as the speed of mobile increased.

VII. REFERENCE

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