RESEARCH ARTICLE OPEN ACCESS

Ber Performance OF Improved Algorithm

Hema R. Kale *, Chandrashekhar G.Dethe **,Milind M. Mushrif ***
*(ETC Department , Jhulelal Institute of Technology Nagpur , India. hema.kale72@gmail.com)
** (ECE Department, Priyadarshni Institute of Engineering and Technology, Nagpur, India. cgdethe@yahoo.com)
*** (ETC Department, Yashwantrao Chavan College of Engineering, Nagpur, India milindmushrif@yahoo.com)

ABSTRACT
The Multi-Carrier Code Division Multiple Access (MC-CDMA) is becoming a very significant downlink multiple access technique for high-rate data transmission in the fourth generation wireless communication systems. In this paper Bit Error Rate (BER) performance of an Improved Algorithm is studied. In the design of proposed algorithm a fixed modulation technique is used i. e. Quadrature Amplitude Phase Shift Keying (QPSK) . Paper presents a comparison of Bit Error Rate (BER) performance of Improved algoriyhm with that of Adaptive Channel Allocation algorithm. . Both the schemes employed QPSK modulation technique. It is observed that BER performance of the Improved algorithm is far better as compared to ACA algorithm.Wireless channels vary rapidly with time, the fixed modulation scheme is spectrally inefficient.To achieve spectrally efficient communication adaptive modulation is used.
Keywords - LTE, MC-CDMA , Autoregressive model , SNR, BER, ACA,CSI

I. INTRODUCTION

To support the time varying QoS in multiuser environment for 4G systems multicarrier CDMA (MC-CDMA) is the strong candidate. An Improved algorithm for spectrum allocation is proposed in[1]. In this paper Bit Error Rate (BER) performance of this Improved Algorithm is evaluated for LTE advanced standard and channel model is Rayleigh fading channel model. Improved algorithm for throughput maximization in MC-CDMA is proposed in [1]. Channel fading is different at different subcarriers , this feature has been exploited for allocating the subcarriers to the users according to the instantaneous channel state information (CSI).In [2] an Adaptive Channel Allocation (ACA) algorithm is proposed for maximizing throughput in which the sub channels are divided in groups, and these groups are allocated to the users depending on required transmit power. This is a contiguous channel allocation in which channel fading feature is not fully exploited. The concept of sub-carrier selection is introduced to counter the problem of high power consumption. Instantaneous CSI refers to the amount of channel fading user experiences on particular channel. Some schemes have been proposed for subcarrier selection according to CSI which includes, Selecting the subcarrier receiving maximum power on it, Selecting the sub-carrier with maximum SNR, Selecting the subcarrier requiring least amount of transmit power on it. An appropriate sub-carrier selection technique results in high spectrum efficiency, reduction in high power consumption at the mobile terminal, high data throughput in a multicell environment, improvement in BER performance, reduction in signal processing at the mobile terminal.

G.K.D.Prasanna Venkatesan, and C.Ravichandran, has suggested a dynamic sub-carrier allocation technique for adaptive modulation based MCCDMA system in [4] which results in improvement in throughput and BER performance. In this paper water filling algorithm is used to select the best sub-carrier, over the existing subcarriers. In this the principle of adaptive modulation consists of allocating many bits to carriers with a high SNR, whereas on carriers with low SNR only a few or no bits at all are transmitted. However there will be a possibility that when many channels suffer deep fading, there will be no transmission or very few bits are transmitted.

In [5] modulation scheme changes with change in no. of users satisfying the BER requirement. In this paper In the proposed algorithm [1] the method of group allocation to the users has been modified which will result in producing global minima. This will result in further saving of the power and higher throughput as compared with the ACA algorithm[2]. In section II the Improved algorithm proposed in [1] is presented in a simplified manner. Then BER performance of Improved algorithm is discussed by considering simulation environment of LTE-A standards in section III. At the end conclusions are drawn in section IV.

II. IMPROVED ALGORITHM

An Improved algorithm is proposed in [1] for the channel allocation in the downlink transmission of multi-user MC-CDMA systems for throughput maximization under the constraints that the total transmit power should not exceed the maximum transmit power and each channel's SNR should not be less than a pre-defined value i.e. target SNR (β). It is a contiguous spectrum allocation technique. In this scheme neighboring subcarriers constitute the successive groups and the number of subcarriers per group is equal. The modified technique of allocating these groups of subcarriers to the users is proposed in Improved algorithm.

Improved algorithm is a modification over the Adaptive Channel Allocation (ACA) scheme presented in [2]. With the available transmit power at the base station, the objective is to allocate maximum number of subcarriers to the users maintaining the channel SNR above the threshold SNR. Initially it is assumed that the groups of subcarriers are already formed and are available at the base station. So there is no need of computational measures for forming the groups before allocation of the groups to the users. These groups are formed by adjacent subcarriers, also the number of subcarriers per group is same as shown in fig. 1 below,

One group will be assigned to one user only. S number of symbols of one user will be transmitted in parallel over S number of subcarriers in one group i.e. spreading factor is S. Each user experiences different fading on different channel. Instantaneous CSI is assumed to be available at the base station. Using this channel gain information the required amount of transmit power on one channel of every group is calculated for all users. Then user requiring minimum transmit power amongst all on one channel of a group will be assigned that group. Continuing in this manner all the groups will be allocated to the users. Then the group with the lowest required transmit power is selected first for channel allocation for transmission. Equal power is allocated to all the channels within the group. Continuing in this manner next groups are selected for channel allocation depending on required transmit power and channels are allocated. This will continue till all the transmit power at the base station get allocated.

If
N – Total number of sub-carriers.
S - Total number of subcarriers in g^{th} group.
U - The total number of users
G - The total number of groups

Then the steps involved in proposed Improved algorithm[1] are given below, assuming that the instantaneous CSI is available at the base station,

Step 1: Calculate required amount of transmit power on one channel of every group for all users as per equation (2), again given here for reference,

$$p_g^u = \sum_{s=1}^{S}\left(\beta N_o S^{-2} \sum_{s=1}^{S}\left|\omega_{g,s}^u\right|^2 \sum_{s=1}^{S}\left|\omega_{g,s}^u f_{g,s}^u\right|^{-2}\right)$$

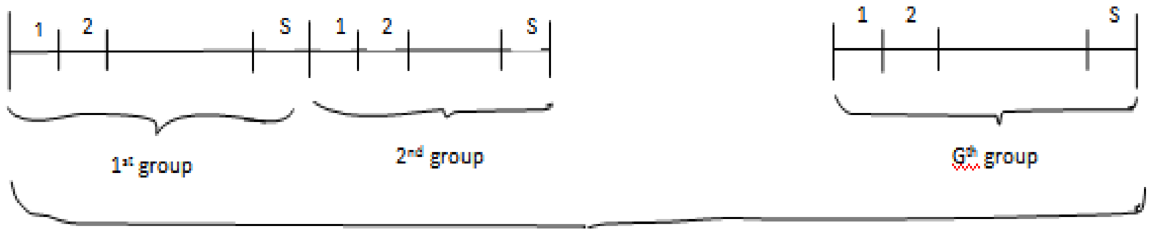

Fig. 1: contiguous sub-carrier grouping in MC-CDMA

Where
β - Target threshold of SNR.
p_g^u - The required transmit power for u^{th} user on one channel of the g^{th} group.
$f_{g,s}^u$ – u^{th} user's channel fading (path gain) on the s^{th} subcarrier of the desired group.
$\omega_{g,s}^u$ - u^{th} user's frequency domain combining weight for the signal on the s^{th} subcarrier of the desired group.

Step 2: Group allocation to users
1.All the G number of groups will scan all the U number of users at the same time and the user requiring minimum transmit power amongst all, on one channel of a particular group will be allotted that group.
2.Next remaining (G -1) number of groups will scan all the remaining (U -1) number of users and so on.......
3.Continuing in this manner all the groups will be allotted to the users.

Initialization
$P_R = P_T^{max}, C = \{1,2,\dots,G\}, c_g^u = 0$ for $u = 1,\dots,U$ and $g = 1,\dots,G.$
Group assignment
while $C \neq \emptyset$
$u = 1:U$
$g = 1:G$
$[p_{min}, u_{gmin}] = \min(\min\{p_g^u\})$ % allocate a group to a user requiring least power on one hannel of that group.

end

Step 3: Select the group with the lowest transmit power requirement.
$(\min\{p_g^u\})$

Step 4 : Allocate the channels within the selected group as given below,
Channel allocation
while $C \neq 0$

$t = \min_{\forall g \in C}\{p_g^{u_{gmin}}\}$; % select the group with lowest transmit power requirement.

$c_t^{u_{tmin}} = \min\left(\left\lfloor \frac{P_R}{p_t^{u_{tmin}}} \right\rfloor, S\right)$; % calculate the available channel number

$P_R = P_R - c_t^{u_{tmin}} p_t^{u_{tmin}}$; % calculate the residual transmit power

$C = C \setminus \{u_{tmin}\}$; % decrease the group counter

If $c_t^{u_{tmin}} = 0$ % since the residual transmit power is not enough , terminate channel allocation.
break;
end If
end while

III. BER PERFORMANCE EVALUATION

BER Performance of the proposed Improved algorithm is evaluated using software tool MATLAB. The computer simulations are carried out for the simulation environment (Table I) selected to meet the specifications of LTE-A standards. Long Term Evolution (LTE) advanced standards is the 3GPP candidate for 4G . It is assumed that the CSI is available at the base station. CSI is continuously changing with time, correspondingly user experiences different fading (f) on different channels. Stationary channel gain samples are produced using the autoregressive model of correlated Rayleigh fading processes [7].

Some of the parameters employed in simulation are calculated as follows,

- **Target SNR (β) –**

Target SNR (β) is calculated using equation (3), repeated here again

$$BER_i = \frac{1}{5} \times \exp\left[\frac{-1.5 \times \beta}{M-1}\right]$$

where
M = 4 for QPSK modulation
Then
$\beta = -2\ln(5BER)$
when $BER = 10^{-3}$
Target SNR β = 10.5966 DB
For real time signal BER ranges between $10^{(-2)}$- $10^{(-6)}$.
In this comparison BER has been varied in steps and corresponding changes in throughput for the two algorithms(Improved and ACA algorithm) is observed for MRC scheme keeping other parameters constant as above.

TABLE I.
SIMULATION PARAMETERS

Parameters	**Environment**
Carrier frequency (fc)	5 GHz
Operating bandwidth	100 MHz
Subcarrier spacing	25kHz
No. of channels	128,1024
Symbol rate	64 Ksps
Receiver speed	100 km/hr
Maximum Doppler frequency	462.96Hz
Target SNR(β)	-2ln(5BER), -4dB
Noise power spectral density	-50dBm/Hz, -40.2 dBm/Hz.
One channel	0.76MHz,0.073MHz
Peak spectrum usage efficiency	30 bits/s/Hz
Fading margin	12dB
Channel Model	Autoregressive Rayleigh channel

For lower BER requirement, target SNR increases, consequently required transmit power increases, resulting in corresponding decrease in throughput for the given transmit power and Fig. 2.

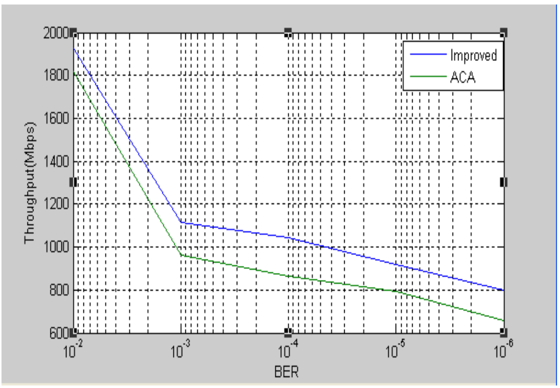

Fig. 2. Throughput versus BER requirement for MRC scheme, when the number of groups and the number of users are 32 and the MaxSNR is 33.13 dB.

The throughput versus the BER is depicted for the case when the number of users are 32, total number of channels N are 1024 and noise power spectral density N_o is -40.2 dBm/watt and maximum transmit power is 33.13dB.. Figure shows the throughput versus BER comparison between Improved algorithm and Adaptive Channel Allocation (ACA) algorithm. It has been found that proposed Improved scheme gives much higher throughput than ACA scheme for all BER requirements.

IV. CONCLUSIONS

This paper evaluates the BER performance of Improved algorithm proposed in [1].The performance is evaluated for Rayleigh channel model and Maximal ratio combining (MRC) scheme.

Numerical results shows that for the given transmit power BER performance of Improved algorithm is much better than ACA algorithm resulting in higher throughput.

For further Improving the throughput Adaptive modulation techniques can be combined with improved scheme of group allocation instead of using QPSK modulation scheme only.

REFERENCES

[1] Hema Kale1, C.G. Dethe2 and M.M. Mushrif3, “Improved Algorithm for Throughput Maximization in MC-CDMA”, International Journal of VLSI design & Communication Systems (VLSICS) Vol.3, No.4, August 2012.

[2] Jun-Bo Wang b, Ming Chen a, Jiangzhou Wang a, “Adaptive Channel and power allocation of downlink multi-user MC-CDMA systems” Computers and Electrical Engineering 35 (2009) 622–633 (Elsevier journal).

[3] Teruya Fujii, Noboru Izuka, Hiroyoshi Masui, and Atsushi Nagate,”A proposal of sub-carrier selecting MC-CDMA system for 4G systems”, 2005 IEEE.

[4] G.K.D.Prasanna Venkatesan, and V.C.Ravichandran, “Performance analysis of dynamic sub-carrier allocation technique for adaptive modulation based MC-CDMA system”, JCSNS International Journal of Computer Science and Network Security, VOL.7 No.2, February 2007.

[5] S. Chatterjee1, W.A.C. Fernando2, M.K. Wasantha1 “Adaptive Modulation based MC-CDMA Systems for 4G Wireless Consumer Applications”, IEEE Transactions on Consumer Electronics, Vol. 49, No. 4, NOVEMBER 2003.

[6] Kaiser S. OFDM code-division multiplexing in fading channels. IEEE Trans Commun 2002; 50:1266– 73

[7] Kareem E. Baddour, Student Member, IEEE, and Norman C.Beaulieu, Fellow, IEEE “Autoregressive Modeling for Fading Channel Simulation”.

[8] Jolly Parikh, Anuradha Basu, “LTE Advanced: The 4G Mobile Broadband Technology”,International Journal of Computer Applications (0975 – 8887) Volume 13– No.5, January 2011.

[9] http://www.radio-electronics.com