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Performance Improvement of 3GPP LTE System with MC-CDMA Technique

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Abstract

Forthcoming generation of wireless communication system demands high data rate, high spectral efficiency and high capacity to deliver multimedia traffic. Third Generation Partnership Project (3GPP) Long Term Evolution-Advanced (LTE-A) meet these requirements. LTE-A is an advancement of original LTE standard. Air interface in LTE standard is based on OFDM multiple access technology. In this paper Multicarrier Code Division Multiple Access (MC-CDMA) technique is used instead of OFDM multiple access technology to increase the system capacity. MC-CDMA is a combination of OFDM and CDMA techniques to provide the benefit of both the techniques. This study investigates the BER performance of 3GPP LTE release 13 with MC-CDMA for different channel conditions. The results show that the Bit Error Rate (BER) performance of LTE system with MC-CDMA technique is improved in comparison with the OFDM multiple access technique. Also, a BER performance comparison is made among the different channel conditions and different number of users.

Keywords: *3GPP, LTE-A, OFDM, MC-CDMA, BER*

1. Introduction

Future wireless communication system requires high data rate and high capacity to deliver multimedia traffic. To meet these requirements Third Generation Partnership Project (3GPP) developed Long Term Evolution (LTE). 3GPP release 8 is also named as LTE. The modification of some features of LTE release 8 introduces LTE release 9. The next release of 3GPP is release 10 in which significant modification have been made. 3GPP release 10 recognized as the LTE-Advanced standard. The latest version of LTE-A is 3GPP release 13. LTE-A is an advancement of original LTE standard. LTE-A uplifted the capacity, spectral efficiency and throughput of the LTE system. LTE-A is backwards compatible with LTE and uses the same frequency bands, whereas LTE is not backwards compatible with 3G systems. LTE standard is based on OFDM [1-4]. OFDM provides high capacity, high data rate, high spectral efficiency and frequency diversity [5].

In this work to increase the system capacity CDMA combines with the OFDM. The combination of both the scheme is known as MC-CDMA. For upcoming generation of wireless communication MC-CDMA is an appropriate option as it exploits high capacity, high data rate and high spectral efficiency with additional benefit of immunity against narrow band interference [6,7].

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So, in this paper BER performance of 3GPP LTE release 13 physical layer with MC-CDMA technique is investigated. Also, a comparison of BER performance is made among the different channel conditions and different number of users. The simulation results show that the Bit Error Rate (BER) performance of LTE system with MC-CDMA technique is improved in comparison with the OFDM multiple access technique.

The rest of the paper is organized as follows: Section 2 describes the 3GPP release 13 LTE system with MC-CDMA. Results and discussion are shown in section 3. Finally, conclusion is given in section 4.

2. 3GPP release 13 LTE system with MC-CDMA

Consider the LTE physical layer of LTE-A downlink transmitter as shown in Fig-2. In this model MC-CDMA system is used in place of OFDM system. Randomly generated *K* user data are individually processed in Downlink Shared Channel (DLSCH) which is a transport channel. In DLSCH processing data deals with the CRC, code block segmentation, turbo-coding, rate-matching and codeword reconstruction. The DLSCH coded data are modulated by 16QAM modulation, and then spreading by *Walsh Hadamard (W-H)* code. Superposition is performed on *K* user spreaded data. The resultant spreaded data are mapped in resource mapping. This resource mapped data are multicarrier modulated by *IFFT*. This multicarrier modulated signal is transmitted through the channel.

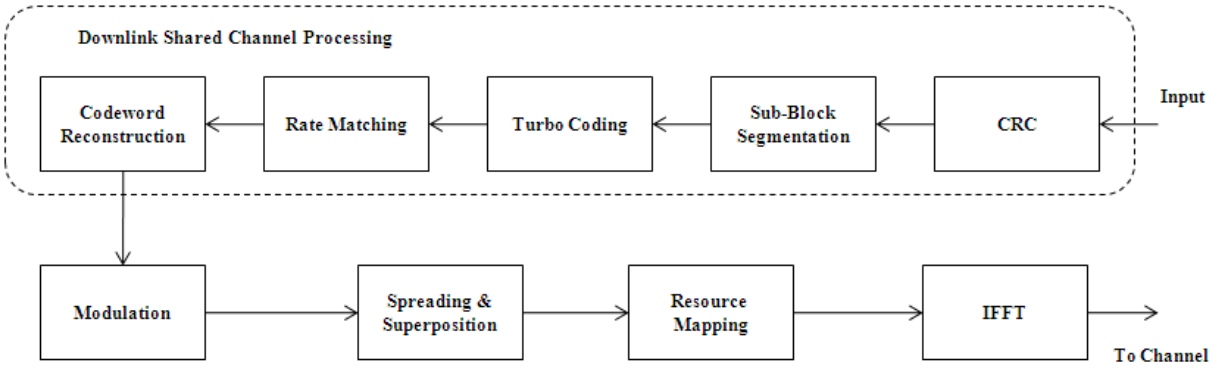

Fig-2 LTE downlink transmitter with MC-CDMA

In this work three different channels are considered for simulation. These are AWGN channel, flat fading with low mobility and frequency selective with low mobility. At receiver the received signal is processed as multicarrier demodulation by *FFT* operation, de-spreading, demodulating and decoding to obtain the users data.

Fig-2 above shows the LTE downlink resource block, which contains 14 OFDM symbol and 12 subcarriers with 15 KHz spacing [1]. Depending on BW there may be 6 to 100 resource block. In this work BW is taken as 20 MHz and resource blocks are taken as 100. Each resource block consists of eight Cell-Specific Reference Signal (CRS), which are used for channel estimation.

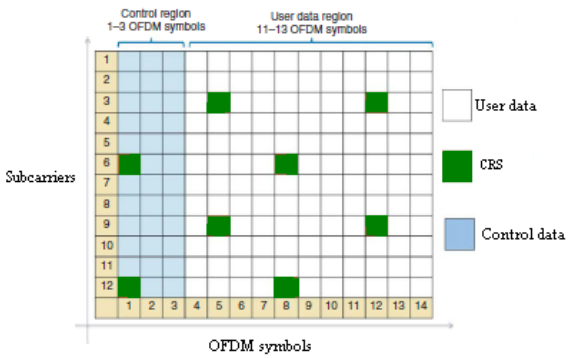

Fig-2 LTE Downlink resource block

3. Results and Discussions

LTE-Advanced system with MC-CDMA transmitter and receiver as described in section II has been simulated using MATLAB. For simulation considered LTE release 13 physical layer parameters. 16QAM modulation technique is selected for modulating the user data. Number of subcarriers are 2048, subcarrier spacing 15 KHz. Each radio frame occupies 10 ms and contains 20 slots [8,9]. For Spreading *W-H* code is used. Spreading code length is taken as 8.

Fig-3 shows BER performance comparison of LTE system with MC-CDMA and OFDM scheme for AWGN channel. In this figure it is observed that BER performance is significantly improved with MC-CDMA technique than the OFDM technique. Corresponding to 3dB SNR the BER is found to be 1.962×10^{-4} with MC-CDMA technique and 7.732×10^{-2} with OFDM technique.

BER performance comparison of LTE system with MC-CDMA and OFDM scheme for frequency selective low mobility channel is shown in Fig-4. For frequency selective low mobility channel Doppler frequency is taken as zero. It is clearly visible that BER performance is improved with MC-CDMA technique than the OFDM technique.

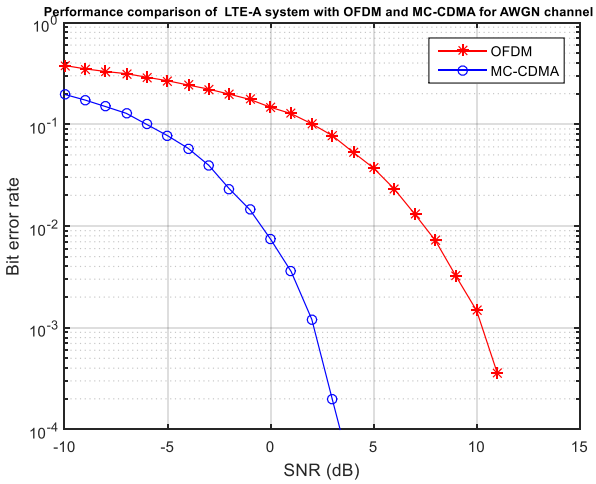

Fig-3 BER versus SNR for single user

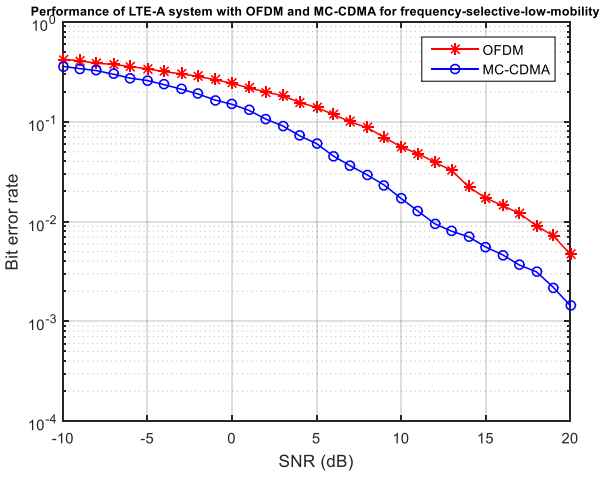

Fig-4 BER versus SNR for single user

Conclusion

This paper investigates LTE-A system with MC-CDMA technique over various channel. System capacity depends on BER. Improved BER performance will increase the capacity of the system. From the results it is noted that BER performance is substantially improved with MC-CDMA technique than the OFDM multiple access technique. A comparison of BER performance of LTE-A system with MC-CDMA scheme and OFDM scheme is made for the AWGN channel. Result shows that MC-CDMA outperforms than OFDM system. Similarly, a comparison of BER performance of LTE-A system with MC-CDMA scheme and OFDM scheme is made for frequency selective low mobility channel. BER performance for MC-CDMA system is better than the OFDM system.

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