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Performance analysis of FFT based and Wavelet Based SC-FDMA in Lte

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Abstract—Single Carrier Frequency Division Multiple Access (SC-FDMA) are the multiple-access version of OFDM and a another modulation technic, Single-Carrier Frequency-Domain Equalization (SC-FDE). SC-FDMA and OFDM are two technics in Long Term Evolution (i.e 4G). The parameters used for comparison will be Bit error rate (BER).OFDMA is use for downlink communication and SC-FDMA is use for uplink. OFDMA have a major drawback which is high PAPR due to this it not much preferable to be used in uplink broadband wireless systems. To overcome this SC-FDMA is use which has low PAPR. Single carrier FDMA (Frequency division multiple access) has become most popular in broadband uplink wireless systems. In analysis of conventional and wavelet based OFDM it is found that the output BER curves obtained from wavelet based OFDM are good in performance than that of DFT based OFDM. That is the discrete wavelets proves to be the best when substituted instead of FFT analysis. So in this paper we are checking the performance of conventional and wavelet based Scfdma.

Keywords— SCFDMA, OFDM, LTE etc..

I. INTRODUCTION

In this article we will provide a performance analysis of both uplink candidates for fft based SC-FDMA and wavelet base SCFDMA. OFDMA transmits data over a large number of subcarriers. Due to Orthogonality these signals are perpendicular to each another and their summation will be null which removes mutual interference. SC-FDMA aggregates multipath interference and flexible subcarrier frequency assignment which provides only one carrier at a time instead of multiple carriers in transmission. The Multiple Access technics in Advanced Mobile radio system has to meet the challenging requirements for example efficient Bit Error Rate (BER), high throughput, good robustness, low Peak to Average Power Ratio (PAPR), low delays, low computational complexity, low error probability high spectral efficiency, etc. Wavelet transform is used to analyze signals by the coefficients of wavelets in both frequency and time domain. One type of wavelet transform is DWT (Discrete Wavelet transforms) have been considered as alternative platforms for replacing IFFT and FFT. ISI and ICI are generally caused by no orthogonality between the carriers caused by multipath propagation of the signals in OFDM using Discrete Fourier Transform (DFT). ISI is arise in between successive symbols of same sub-carrier and ICI is arise in different signals at different subcarriers. ISI and ICI are avoided by using cyclic prefix which causes power loss and bandwidth inefficiency in DFT based OFDM. This paper is organized as: in Section I introduction, II as brief Literature review of the previous work demonstrated on OFDM and SCFDMA.III SCFDMA Transmitter, IV Receiver, V Wavelet based transmitter and receiver, VI Summary, and References.

II. LITERATURE REVIEW

In this paper authoranalysed LTE transceiver in downlink (PDSCH) and uplink (PUSCH)

transmissions. The simulation results obtained from the LTE System Toolbox further analysed the performance of the LTE transceiver by the measured throughput and BER graphs.These results show clearly the throughput and BER that can be expected for different SNR values. Further work can bedone by carrying out various downlink and uplink end to end simulations, and modeling with the LTE System Toolbox.

In this paper it is shown that multicarrier transmission is a very attractive technique for high-speed transmission over a dispersive communication channel. The PAPR problem is one of the important issues to be addressed in developing multicarrier transmission systems in LTE. In this article author describe PAPR reduction technique for multicarrier transmission. From the computer simulations author can come to the conclusion that this clipping method reduced the PAPR significantly as well as increase average transmitted power improve amplifier efficiency and reduced cost.

In this paper author analyzed the wavelet based OFDM system and compared it with the DFT based OFDM system. From the output curve it is observed that the BER curves obtained from wavelet based OFDM are good than that of DFT based OFDM. Here three modulation techniques for implementation are use, that are QPSK, 16 QAM and 64 QAM, which are used in LTE. We can use different types of filters with the help of different wavelets available. In this paper daubechies2 and haar wavelets are used, at different intervals of SNR both provide their best performances.

In this paper author have done a survey on different modulation schemes to know their suitability in high data rate uplink communication systems and it was found that SC-FDMA is suitable for that. SC-FDMA provides good PAPR reduction than OFDMA and can overcome many of its drawbacks. Besides uplink communication SC-FDMA is used in various applications like return-link of interactive broadband systems, land mobile satellite communication systems etc. It was also observed that PAPR of signal will changes with the modulation used and a trade-off between PAPR and out-of band signal energy has to be considered while choosing the roll-off factor for pulse shaping. Besides this, spreading in SC-FDMA can provide both features of SC-FDMA and CDMA which has good advantages than OFDM-CDMA.

In this paper Wavelet based single carrier FDMA system is proposed, experiments are conducted on different channels under different equalization techniques. Based on this it was found that the orthogonal wavelets can be replace for better band width preservation and the system provides outstanding performance under Rayleigh fading channel. Zero forcing algorithms may be adapted for better equalization. This work may be further extended with complex channeling models like ETU (extended terrain urban) channels and complex wavelet transforms like dual tree complex wavelets.

In this paper, author compare the Peak-average-power-ratio characteristics of LTE Frame Structure Type (LTE FDD & LTE TDD) of SC-FDMA and OFDMA. It is found that, LTE FDD has better performance than LTE TDD. PAPR of SC-FDMA and OFDMA in LTE FDD has lower values on average. Also FDD has a continuous reduction of BER (Bit Error Rate) and it minimizes the BER up to a certain values of SNRs. Comparing the Performance analysis it is conclude that LTE FDD is the better choice than in LTE TDD in uplink Transmission-SC-FDMA and downlink Transmission-OFDMA, because of its higher efficiency due to low PAPR.

III. SC-FDMA TRANSMITER

SC-FDMA uses an N-point DFT stage at transmitter and an N-point IDFT stage at receiver. The basic block diagram of SC-FDMA

transmitter is shown in figure 1. The input to transmitter is a stream of modulated symbols.

Figure 1: SC-FDMA Transmitter

In SC-FDMA, the data is mapped into signal constellation according to the QPSK, 16-QAM, or 64-QAM modulation, depending upon the channel conditions. Whereas, the QPSK/QAM symbols do not directly modulate the subcarriers. These symbols passes through a serial to parallel converter followed by a DFT block that produce discrete frequency domain representation of the QPSK/QAM symbols. Pulse shaping is followed by DFT element, but it is optional and sometimes needs to shape the output signal from DFT. If pulse shaping is active then in the actual signal, bandwidth extension occurs. The discrete fourier symbols from the output of DFT block are then mapped with the subcarriers in subcarrier mapping block. After mapping these frequency domain modulated subcarriers pass through IDFT for time domain conversion. A guard band is used between OFDMA symbols in order to cancel the Intersymbol Interference at receiver. In LTE, this guard band is called Cyclic Prefix (CP) and the duration of the CP should greater than the channel impulse response or delay spread. After digital to analog conversion signal is send to channel.The sub-carrier mapping plays an important role in the transmitter of SC-FDMA. It maps each of the N-DFT output on a single subcarrier out of M subcarriers, where M is the total number of subcarriers for available bandwidth. The subcarrier mapping is achieved by two methods; localized subcarrier mapping and distributed subcarrier mapping. The modulation symbols in localized subcarrier mapping are assigned to M adjacent subcarriers, whereas in distributed mode, the symbols are uniformly spaced across the whole channel bandwidth. Localized subcarrier mapping also referred as localized SCFDMA (LFDMA) whereas distributed subcarrier mapping referred as distributed SCFDMA (DFDMA).

IV. SC-FDMA RECEIVER

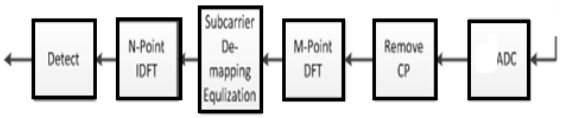

Figure 2: SC-FDMA receiver

A channel model is then applied to the transmitted signal. The model allows for the signal to noise ratio, multipath to be controlled. The signal to noise ratio is set by adding a known amount of white noise to the transmitted signal which is known as AWGN Additive white Gaussian noise. The Receiver basically does the reverse operation of the transmitter. The transmitted signals which pass through the channel are then converted by using Serial to parallel converter and cyclic extension is also removed. The signals pass through an N-point Fast Fourier Transform which converted time domain signal into frequency domain. Then the signal is demappedand performs parallel to serial conversion using Parallel to serial convertor block and the resultant signal is a M sample output

V. WAVELET BASE SCFDMA

Figure show the block diagram of transmitter and receiver of Wavelet base SCFDMA. The modulation processes are applied on the user data. The resulting signal is transformed by the wavelet transform via the DWT. The output of the single-level Haar wavelet transform consists of two signals.

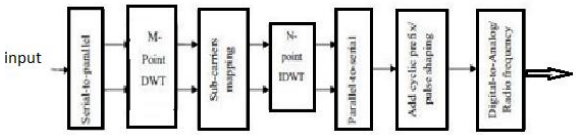

Figure 3: Wavelet based SCFDMA transmitter

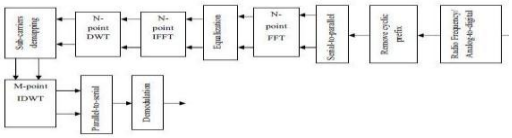

Figure 4 : Wavelet based SCFDMA receiver

The resulting signal from the sub-carriers mapping is inserted into the IDWT to produce the signal from the approximation coefficients signal and the detail coefficients signal. After that, we add the CP in order to prevent the ISI. Finally, the resulting signal is transmitted through the wireless channel At the receiver, the CP is removed from the received signal, and the signal is transformed into the frequency domain via an N-point FFT to apply the equalization process on the signal. The signal is transformed from the frequency domain into the time domain via an N-point IFFT and then it is passed through an N-point DWT to produce the approximation coefficients signal and the detail coefficients signal .Finally, the IDWT and the demodulation processes are performed.

Analysis of Results

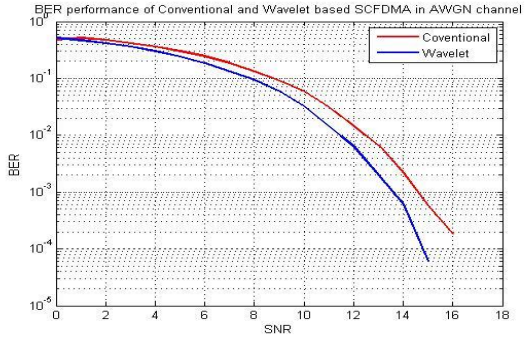

FIG.5. BER curve of conventional and wavelet based scfdma

VI. SUMMARY

In this work performance of conventional and wavelet base SCFDMA will be carry out by comparing BER. SCFDMA is a modulation technic use for uplink transmission in communication system .If we place N-point DFT in OFDMA then it is converted into SCFDMA structure. From the performance curve of DFT base and wavelet based OFDM it is found that wavelet based OFDM is better than the DFT based OFDM .Wavelet base SCFDMA system is obtain by replacing the DFT blocks by discrete wavelet transform (DWT). Wavelet transform is a new concept in transmission systems. In this a signal is expanded in an orthogonal set called as wavelets. Wavelets provide both frequency and time localization. Wavelet reduces the complexity and power consumption.Based on the above mentioned experimental analysis it can be concluded that the orthogonal wavelets can be substituted for better band width preservation and the system provides outstanding performance under Rayleigh fading channel. Zero forcing algorithms may be adapted for better equalization. This work may be further extended with complex channeling models like ETU (extended terrain urban) channels and complex.

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