Literature Survey of Wavelet Based OFDM in Long Term Evolution (LTE) Systems

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Abstract-Wireless communication is one of the fastest developing technologies of current decade. Achieving high data rate under constrained condition demand sophisticated signal processing algorithms that in turn demand complex computational processing. Modern wireless communication techniques using OFDM demand substantial computational resources. An OFDM system with 2048 subcarriers typically requires a point DFT for transmission and point FFT for reception. When signal processing techniques like DFT, pre-equalization, equalization, pilot carrier insertion are analyzed, the complexity increases considerably. This large complexity demands use of high performance computing systems for efficient. This research proposes the use of GPU architecture for efficient analysis of Long Term Evolution (LTE) Physical Layer, Multiple Input Multiple Output (MIMO) OFDM system and Partial Transmit sequence (PTS) technique for Peak-to-Average Power Ratio (PAPR) reduction in OFDM system.

Keywords: Long Term Evolution (LTE), OFDM, Wavelet and BER..

I. INTRODUCTION

The multiple-input multiple-output (MIMO) wireless technology in conjunction with OFDM is perceived as a very promising technique to support high data rate and high performance. Specifically, coding over the space, time, and frequency domain in MIMO-OFDM provides a much more reliable and robust transmission over the harsh wireless environment. In OFDM the total available bandwidth is divided into a set of orthogonal subchannels. At the receiver, the received signal at each antenna for each subcarrier comprises of a signal that is a combination of data streams from multiple transmit antennas. Hence a higher complexity detector is required to reconstruct the transmitted signal vector as compared to single antenna systems.

Performance comparison of space-time (ST) coded MIMO-OFDM detection with the classical Maximal Ratio combining scheme (MRC) under GPU environment is presented.

Fig 1: Block diagram of general communication system

In telecommunication engineering channel may be classified as

• Wired channel
• Wireless channel

In case of GPR the nature of channel is wireless, but there are lots of practical difficulty with wireless networks

• Wireless media is not a reliable media.
• It doesn't support very high bandwidth.
• Spreading loss and multipath fading comes into the picture.
• If multiple reflectors are present in the wireless medium then there is chance of destructive interference that causes deep fade, in that case the SNR of the signal becomes very low. But in case of GPR our prime intention is to resolve proper information from the reflected signal. Both Tx and Rx are placed adjacently in GPR hardware. Air media and dielectric media make a wireless channel for GPR application. Make a synthetic model of ground for two different cases, and observe the theoretical power at the receiver end.

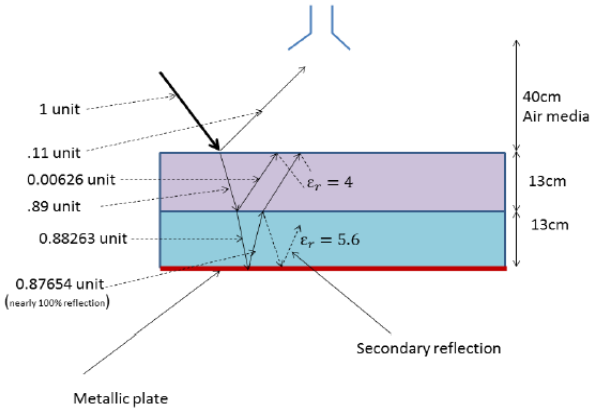

Fig 2: Ground model 1 and transient response analysis

Case 1: Layered surface model where bottom surface is a metallic plate

Case 2: Layered surface model where bottom surface has infinite distance with fix electrical parameter

A Gaussian pulse is taken as the reference transmitted pulse having pulse width 1ns that is shown in 1st subplot of Fig. 4. When it passes through the air as well as dielectric media then effect of channel influences the behavior of signal that has been mentioned below;

II. MIMO-OFDM SYSTEM MODEL

The goal of future broadband wireless systems is to provide high data rate and high performance over wireless channels that may be time selective and frequency-selective. OFDM combined with MIMO is considered to have the potential of meeting this stringent requirement. MIMO can boost the capacity and the diversity of the system and OFDM can mitigate the detrimental effects caused due to multipath fading. A general MIMO-OFDM system is shown in Fig 4, where Mt transmit antennas, Mr receive antennas, and N subcarriers are used.

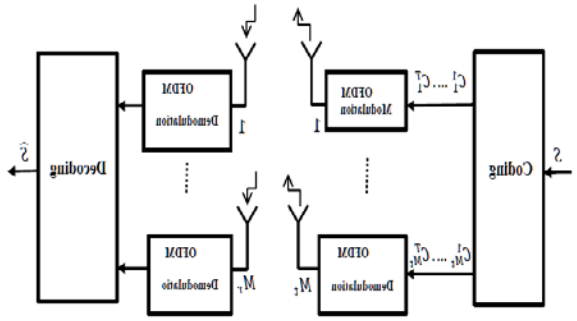

Fig. 3: Simplified Block Diagram of MIMO OFDM System

The input information bits are into data symbols using a specific modulation scheme. Following this blocks of data symbols are encoded into a code word matrix of size, that is then transmitted through antennas in T OFDM blocks. Each block of the matrix consists of N sub channels. Thus vectors … are transmitted from the transmit antenna j in OFDM blocks respectively, where denotes a vector of length N, for all and the codeword matrix is presented in Equation (4-1)

$$C = \begin{bmatrix} c_1^1 & \cdots & c_{M_t}^1 \\ \vdots & \ddots & \vdots \\ c_1^T & \cdots & c_1^1 \end{bmatrix}$$

After cyclic prefix is addition on each OFDM block, is transmitted from the jth transmit antenna in the nth OFDM block. The signals after passing through the MIMO channels reach the receiver. In the receiver OFDM demodulation is done that is followed by MIMO decoding.

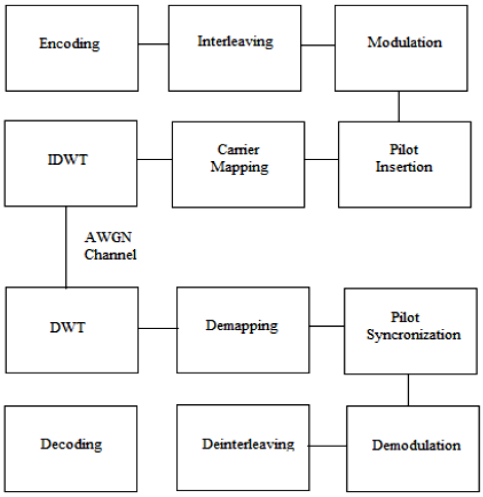

Fig .4: Wavelet based OFDM system design

Introduction to Long Term Evolution (LTE)

Long Term Evolution refers to the 3rd Generation Partnership Project (3GPP) Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access (E-UTRA) technology and its first version is documented in Release 8 of 3GPP specification.

LTE is considered as one of the most promising technologies to meet the growing demands for high data rate services with high spectral efficiency. This technology is designed to provide a peak data rate of 100 Mbps in downlink and 50 Mbps in uplink when operating in 20MHz bandwidth.

III. LITERATURE REVIEW

In the year of 2014 Anuradha; Kumar, N. [1] Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input and Multiple Output (MIMO) are two main techniques employed in 4th Generation Long Term Evolution (LTE). In OFDM multiple carriers are used and it provides higher level of spectral efficiency as compared to Frequency Division Multiplexing (FDM). In OFDM because of loss of orthogonality between the subcarriers there is intercarrier interference (ICI) and intersymbol interference (ISI) and to overcome this problem use of cyclic prefixing (CP) is required, that uses 20% of available bandwidth. Wavelet based OFDM provides good orthogonality and with its use Bit Error Rate (BER) is improved. Wavelet based system

does not require cyclic prefix, so spectrum efficiency is increased. It is proposed to use wavelet based OFDM at the place of Discrete Fourier Transform (DFT) based OFDM in LTE. Authors have compared the BER performance of wavelets and DFT based OFDM.

In the year of 2014 Dawood, S.A.; Anuar, M.S.; Fayadh, R.A.; Malek, F.; Abdullah, F.S.,[2] In this paper, an over-sampling inverse discrete multiwavelet transform (IDMWT) is suggested as a modulator strategy instead of inverse fast Fourier transform (IFFT) in the realization of the multicarrier code division multiple access (MC-CDMA) system. The suggested strategy was applied on the MC-CDMA with additive white Gaussian noise (AWGN) channel, flat fading channel and frequency selective fading channel. Simulation results showed that, the proposed method gives a better bit error rate (BER) efficiency than the traditional MC-CDMA model based on fast Fourier transform (FFT) and MC-CDMA based on discrete wavelet transform (DWT).

In the year of 2014 Vaghani, H.; Dastoor, S.,[3] This paper is Bit error Rate (BER) comparison analysis of the FFT based Orthogonal Frequency Division Multiplexing (OFDM) and Wavelet Packet based OFDM. Nowadays, high bit rate, high capacity as demand for wireless communication systems to integrate in high speed data, video multimedia services as well as voice signals is consider. OFDM is multicarrier systems so efficient to high speed data transmission over multipath fading channel. In this paper comparison between conventional FFT based OFDM with DWPT based OFDM over AWGN and Rayleigh fading channel. Comparisons of OFDM different Modulation schemes conventional and non-conventional and with different family found that DWPT based OFDM db10 wavelet family better BER performance. To mitigate fading ISI and noise is minimized with channel equalizer used ZF, MMSE, technique used show with comparisons with Rayleigh channel. It concludes that channel equalizer technique is better BER improvement. The simulations results presented with MATLAB software.

In the year of 2013 Manasra, G.; Najajri, O.; Arram, H.A.; Rabah, S.,[4] Current researches tends to cope with challenges of increasing demand for higher data rate, better quality of service, and higher transmission capacity through wireless channel. Multicarrier Modulation (MCM) and multiple antenna system are proposed to overcome these challenges. In this paper, the performance of the Discrete Wavelet Transform (DWT) as MCM instead of using the conventional orthogonal frequency division multiplexing (OFDM) is studied in terms of bit error rate (BER) under the scenario of having multiple antenna system. The analysis is done for Haar mother wavelet, QAM as modulation scheme, and simulated over AWGN channel.

In the year of 2013 Anusuya, P.; Anitha, K.; Varughese, D.K.,[5] OFDM is a method of encoding digital data on multiple carrier frequency and it is one of the most popular scheme that is been widely used in most of the wireless and wired communication links. The fast growing communication for multimedia requires high speed and optimized area and power. Thus DMWT is designed to meets the above requirement. So this study proposes DMWT based orthogonal modulator. Even though DWT have the good properties but it is not satisfy the future needs. By implementing DMWT it is able to achieve good spectral efficiency and achieves good BER compare to FFT and DWT.

In the year of 2013 Kol, V.K.; Mishra, A.,[6] This paper presents a model that is Discrete Wavelet Transform based Orthogonal Frequency Division Multiplexing-Interleaver Division Multiple Access (OFDM-IDMA) system for next generation wireless communication system. Also compared for different wavelet families and found the suitable with Daubechie wavelet. The proposed model Comparisons with other alternative technologies such as DFT-OFDM-IDMA is provided. The proposed model is discussed for multi-user detection, flexible rate adaptation, frequency diversity, and significant advantages regarding spectral and power efficiency. This paper concludes with efficient performance of the system that can be considerable for next wireless communication system.

IV. PROBLEM IDENTIFICATION

We analyzed the performance of wavelet based OFDM system and compared it with the performance of DFT based OFDM system. From the performance curve we may observe that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM. We may use three modulation techniques for analysis that are QPSK, 16 QAM and 64 QAM, that are used in LTE. In wavelet based OFDM different types of filters can be used with the help of different wavelets available.

V. CONCLUSIONS AND FUTURE SCOPE

High Performance Computing using parallel processing with GPU is very essential to meet computational challenges in terms of complexity and scalability of signal processing in wireless communication systems. In this baseband processing of various wireless communication systems based

on OFDM and the signal processing techniques used in OFDM based systems such as MIMO-OFDM and PAPR reduction that require complex computations, were implemented using GPU. A basic study assuming a simple LTE model, MIMO-OFDM models and PTS technique for OFDM has been efficiently implemented on GPU.

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