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Analysis of Various Modulation Techniques Based on Bit Error Rate for Conventional and Wavelet Based OFDM in LTE

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ABSTRACT: OFDM has been widely adopted in many more applications due to its good spectral performance and low sensitivity to impulse noise andmultipath channels. In OFDM that a cyclic prefixes (CP) is appended to each symbol in order to mitigate the effect of Inter-Symbol-Interference (ISI) and intercarrier interference (ICI). However, this reduces the spectral efficiency. A perfect reconstruction using wavelet based OFDM provides good orthogonality and with its use Bit Error Rate is improved. Wavelet based system does not require CP, so spectrum efficiency is increased. In this paper, I am presenting BER analysis of conventional and wavelet based OFDM in LTE using different modulation techniques like QAM, 4 QAM, 16 QAM, 64 QAM and 256 QAM.

KEYWORDS*:* LTE; OFDM; DFT; Wavelet; BER.

I.INTRODUCTION

The higher data speed requirement is increasing in exponential manner, due to easy availability of smart phones [1], with inexpensive cost and social websites. Continuous improvement in wireless data rate is in demand. Long Term Evolution-Advanced (LTE-A) is the ultimate solution for wireless broadband services. LTE Advanced commonly known as 4G wireless networks and it is an evolution of a LTE Rel-8. IMT-Advanced(International Mobile Telecommunication-Advanced) is related to a family of mobile wireless technologies, known as 4G.Spectrum efficiency and flexible utilization of spectrum is highly required today for different wireless communication related applications. In multicarrier communication the main idea is to divide the data into several streams and using themtomodulate different carriers. The two main advantages of multicarrier communication are, first one is there is no requirement of signal enhancement for noise which is required in single carrier because of the equalizers and second is because of long symbol duration reduced effect of fading [2]. The wavelet-based system achieves orthogonality through the use of orthogonal wavelet filters, also referred to as filter banks [19]. The DWT produces narrow side lobes with large power spectral density. No cyclic prefix insertion is required, which can save up to 25% of the bandwidth making wavelet based multicarrier systems more bandwidth efficient [20]-[24] and enabling improved BER performance. The wavelet transform represents signals jointly in the time and frequency domains, using multi-resolution analysis.This property of wavelets also makes them suitable for treating signals with exotic spectral properties, for example signals that have time dependent spectral properties.Data of the user is carried parallel on each sub-carrier at a low rate. The combination of the parallel sub-carriers at the destination provide for the high data rates. Since the sub-carriers transmit data at a low rate and thus higher symbol time it is more durable to multipath effects, so this makes more suitable for wide-area non-line of Sight wireless access and also, the use of overlapping orthogonal sub-carriers without guard bands make it more capable than FDM scheme. OFDM resembles CDMA in that it is also a spread-spectrum expertise in which energy generated at a particular bandwidth is spread across a wider bandwidth making it more durable to intrusion and ”jamming”.Multiple Input Multiple Output (MIMO) is one of the most popular Advanced Antenna Technologies which is used in LTE and Ultra Mobile broadband(UMB). The attractive feature of MIMO is,it offers good throughput. The transmitter and receiver have multiple antennas in MIMO giving multiple flavors based on the number of antennas present on both sides. The input idea is that a transmitter sends multiple flows on multiple transmit antennas 9 of 15 and each transmitted flow goes through different paths to reach each receiver antenna. The different paths taken by the same flow to reach multiple receivers allow cancelling errors using advanced

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signal processing techniques. Most recently the proposed DWT for multi-carrier modulations are using time domain equalization. Inthis study I present a new way of channel equalization when working with wavelets. I examine the ISI, and compare the performance of different wavelet families in terms of signal reconstruction. DWT and WPT methods are studied in terms of processing time and performance. Another major contribution of this study is the extension of the DWT technique into the MIMO environment where the performance of the system has been evaluated using both receive and transmit diversity techniques.
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II. RELATED CONTENT

2.1 OFDM and its Orthogonality

In orthogonal frequency division multiplexing communication model, the sub carrier used are orthogonal to each other. The Orthogonality helps in employing the overlapping between the sub carriers in the respective frequency domain. The accuracy of communication model is based on how effective the bandwidth is used and this is technically termed as spectral efficiency or bandwidth efficiency, the acquired bandwidth efficiency is free of Inter carrier interference and the absence of Inter carrier interference (ICI) is mainly because of usage of Orthogonality in orthogonal frequency division multiplexing.

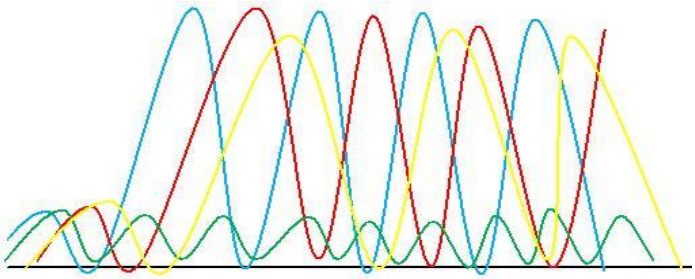

Figure 1: Orthogonality in orthogonal frequency division multiplexing (OFDM)

2.2 Basic OFDM System

The orthogonal frequency division multiplexing block diagram is illustrated as follows in figure 2. The input random signal data rate streams (high) are converted into data rate streams (low). The important aspect in the OFDM block diagram is the modulation technique which modulates the low data rate streams in parallel way and this parallel stream given input to the IFFT block which transforms the frequency data to time data before it reaches the channel. Adding the cyclic prefix acts as the guard interval and the reverse of transmission is accomplished at receiver end.

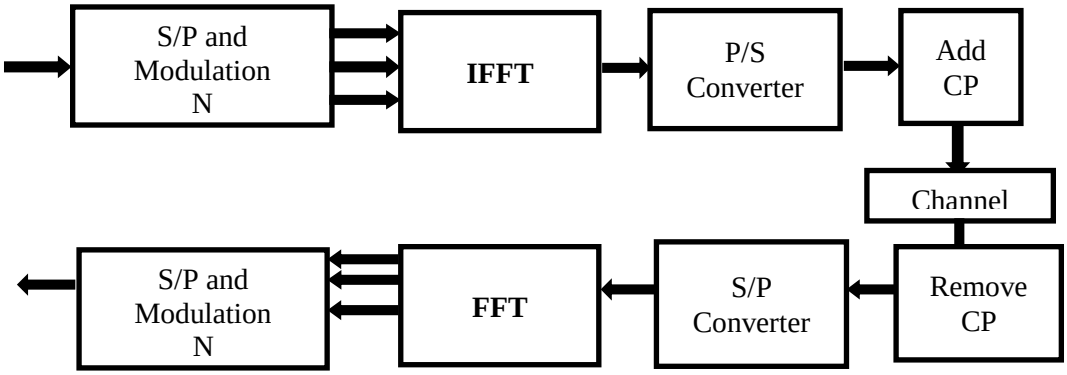

Figure 2: Block diagram of Basic OFDM system

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2.3 MIMO OFDM System

The below block diagram represents the MIMO-OFDM system which comprises of transmitters and receivers in multiple way. The input data (digital) is generated by binary source generator as shown in below figure and the binary data is modulated with modulation approach such as BPSK, QPSK and QAM with several different constellations. The serial to parallel performs the task to convert the serial data to the parallel mode in N various sub streams. Then these various sub streams are modulated through the IFFT modulation block.The IFFT block in the block diagram in design to transform the frequency to time domain for obtaining the delay related issues at the channel and then guard interval named CP is inserted to tackle the issues like ICI/ISI. The OFDM symbols are initialized in the time domain which has specified length before giving it to the channel then the operation is performed in the inverse direction to remove all the operations which are performed and gets the output as OFDM signal in MIMO format.

III. PROPOSED METHODOLOGY

A. Proposed Wavelet based Multicarrier System

The proposed implementation has similarities to Wavelets in the MIMO-LTE has a analysis period as well as synthesis period ,the analysis period measured by sub-band filter of down sampler while synthesis period is measured by sub-band filter of up sampler. The sub-band filter period used through the channel filter exists exact restoration of Quadrature mirror filter [QMF], subsequently the low pass as well as high pass operation is performed on each level of the individual signal bands and double out puts are taken even for the small sequence. The IDWT as a modulator operation performed at the transmitter and DWT as a demodulator perform at the receiver side.

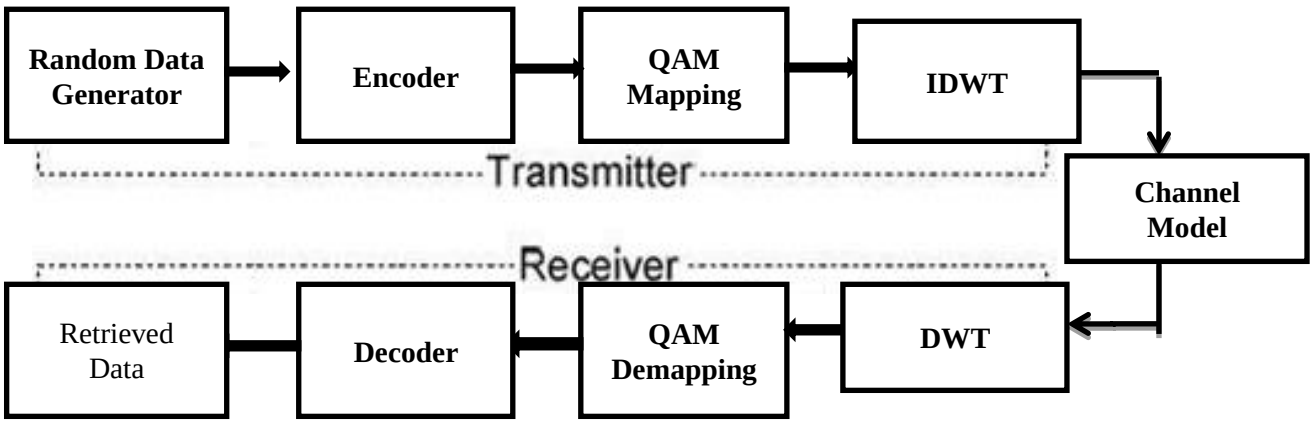

Figure 3: Wavelet based proposed MIMO systemdesign

Once the received signal is successfully equalized in the frequency domain it is converted back to time domain using IFFT and then analyzed using discrete wavelet transform process. This involves conjugate high pass *h*(-n)* and low pass filters *g*(*-followed by down-sampling by a factor of 2. This process is repeated until the initial *N* parallel streams are obtained, which are passed through a parallel to serial convertor and demodulated.Wavelet transform show the potential to replace the DFT in OFDM. Wavelet transform is a tool for analysis of the signal in time and frequency domain jointly. It is a multi resolution analysis mechanism where input signal is decomposed into different frequency components for the analysis with particular resolution matching to scale. As shown in figure 4, in this proposed model, IDWT and DWT are used instead of the IDFT and DFT. Rayleigh channel is used for transmission and cyclic prefixing is not used. Here first of allconventional encoding is done followed by interleaving then data is converted to decimal form and modulation is done next.

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B.CONVENTIONAL OFDM LTE SYSTEMS

For conventional OFDM system, an orthogonal basis function set is comprised of DFT sinusoids. In DFT the transform correlates the input signal with that of each sinusoidal basis function [4], here orthogonal basis functions are the subcarriers used in OFDM technique. At the receiver side the signals are combined to obtain the information transmitted. OFDM is a technique of multicarrier modulation in which the spectrum of the subcarriers overlap with each other. The spacing in frequency among them is selected in such a manner that orthogonality is obtained among the subcarriers. The basic OFDM system block diagram is shown in Figure 4.

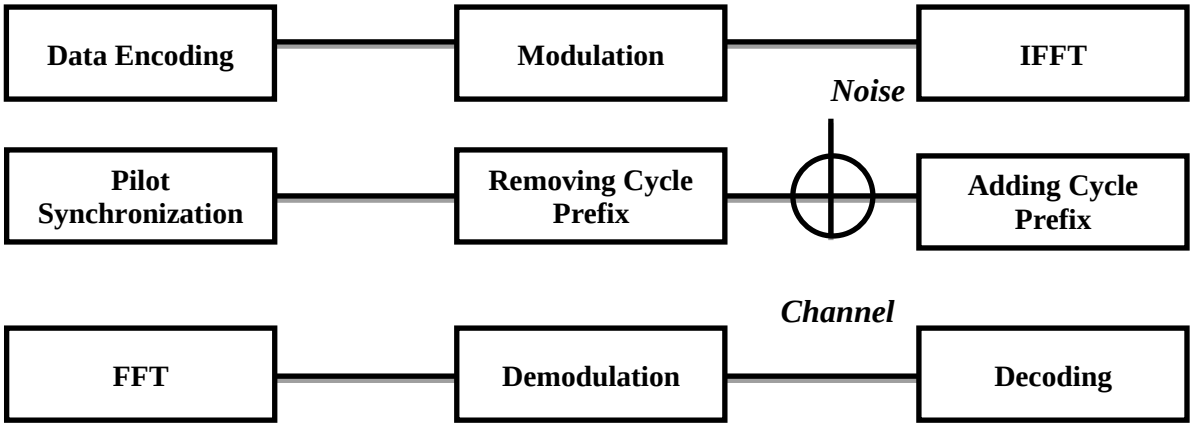

Figure 4: DFT Based OFDM system

Wavelet transform have the ability to completely replace the DFT in OFDM. Wavelet transform is a tool for analysis of the signal in time as well as frequency domain. It is a multi resolution analysis mechanism where input signal is decomposed into various frequency components for the performance evaluation with particular resolution matching to scale. Wavelet transform have the ability to completely replace the DFT in OFDM. Wavelet transform is a tool for analysis of the signal in time as well as frequency domain. It is a multi resolution analysis mechanism where input signal is decomposed into various frequency components for the performance evaluation with particular resolution matching to scale.

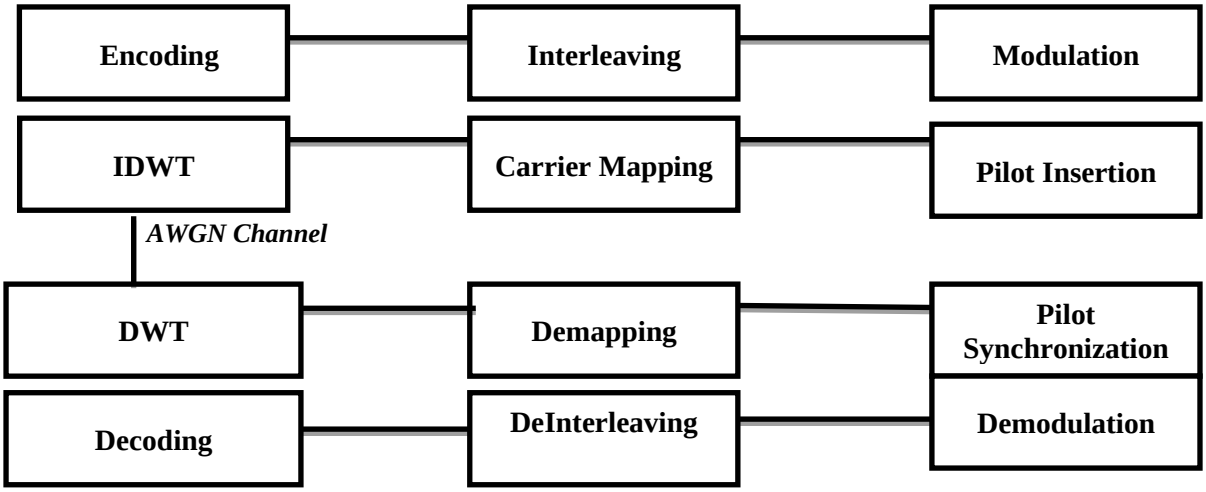

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Figure 5: Wavelet based proposed OFDM system design

Figure 5 describes the proposed model with IDWT and DWT instead of IDFT andDFT. AWN channel is implemented for transmission and cyclic prefixing is not used. Here first of all conventional encoding is performed followed by interleaving after that data is converted into the decimal form and modulation is done next.

C. BER PERFORMANCE EVALUATION

By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different modulations that are used for the LTE, as shown in figures 3-5. Modulations that could be used for LTE are QPSK, 16 QAM and 64 QAM (Uplink and downlink). QPSK does not carry data at very high speed. Lower forms of modulation (QPSK) does not require high signal to noise ratio. For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through AWGN channel. Data of 9600 bits is sent in the form of 100 symbols, so one symbol is of 96 bits. Averaging for a particular value of SNR for all the symbols is done and BER is obtained and same process is repeated for all the values of SNR and final BER's are obtained. Firstly the performance of DFT based OFDM and wavelet based OFDM are obtained for different modulation techniques. Different wavelet types daubechies2 and Haar is used in wavelet based MIMO for QPSK, 16-QAM, 64-QAM.

IV. SIMULATION RESULTS

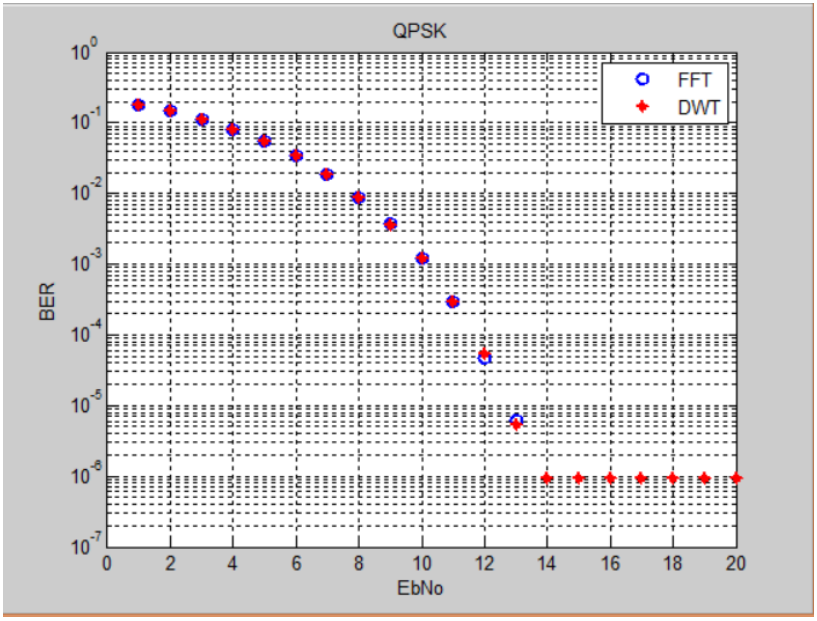

Figure 6:BER performance of wavelets and DFT based OFDM system using QPSK Modulation

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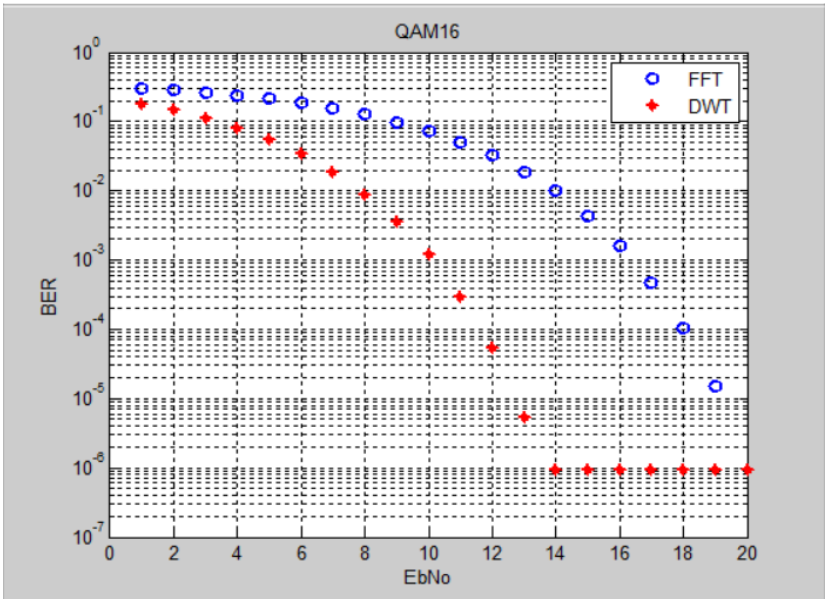

Figure 7:BER performance of wavelets and DFT based OFDM system using 16 QAM Modulation

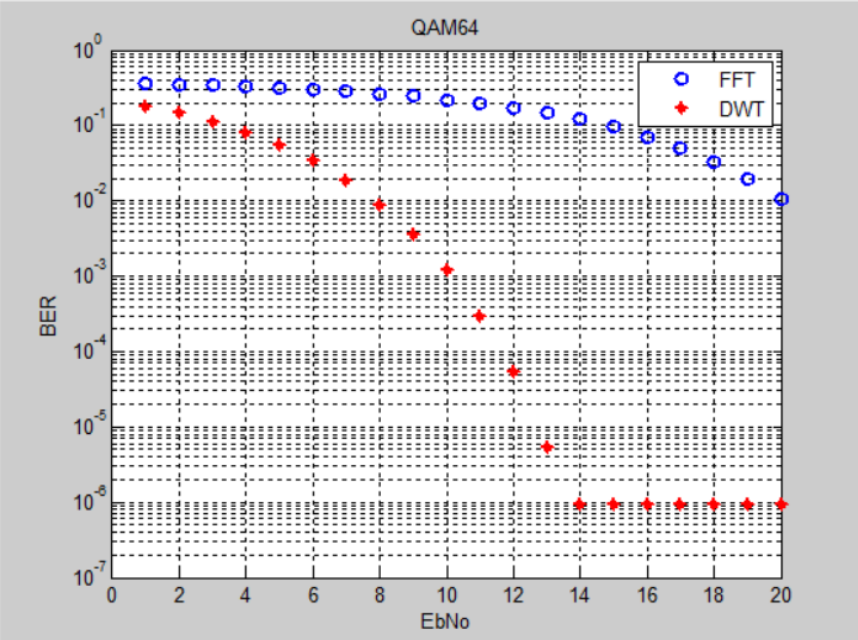

Figure 8:BER performance of wavelets and DFT based OFDM system using 64QAM Modulation

Simulations have been done in MATLAB and also analyzed the performance of various modulation schemes based DFT and DWT.

V. CONCLUSION AND FUTURE SCOPE

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The proposed system exploits the special property of wavelet transforms such that filter distortions and signal aliasing is completely cancelled using the analysis and synthesis filters. This resulted in the perfect reconstruction of the original input data signal and perfect extraction of the multiplexed input signals. The aliasing cancellation condition that is imposed in the filter banks ensures no cross talk in the corresponding Trans multiplexer. Meanwhile, the proposed wavelet transform multicarrier modulation scheme brought increased spectral efficiency, consequent on the non-inclusion of cyclic prefixing which needs up to 25% of the transmit bandwidth in the conventional FFT-based MIMO. Comparison between two different types of wavelet-based modulations was also presented which showed that the DWT performs better than WPT both in terms of BER performance, and in terms of processing times as WPT decomposition is performed at each node. Diversity techniques were then studied using the proposed DWT-MIMO with frequency domain equalization.

The contribution work continuous to proposed method is accomplished on ETU channel.ETU channel has adoptability approach in it and acts in both environments (indoor &outdoor). The BER analysis is carried out based on ETU instead of AWGN channel to yieldhigh performance and low complexity.

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BIOGRAPHY

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