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BER Analysis For Wavelet Based MIMO In LTE Using Various Modulation Techniques

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Abstract: **Recent trends of multicarrier systems using wavelets outperform MIMO systems using the FFT, in that they have well-contained side lobes, improved spectral efficiency and BER performance, and they do not require a cyclic prefix. Here we study the wavelet packet and discrete wavelet transforms, comparing the BER performance of wavelet transform-based multicarrier systems for multipath Rayleigh channels with AWGN. 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). Wavelet based system does not require cyclic prefix, so spectrum efficiency is increased. It is proposed to use wavelet based MIMO at the place of Discrete Fourier Transform (DFT) based OFDM in LTE. We have compared the BER performance of wavelets and DFT based MIMO.**

Keywords: **OFDM; BER; Discrete Wavelet Transform (DWT); Wavelet Packet Transform (WPT); Multiple Input Multiple Output (MIMO); LTE;**

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 themto modulate 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 flavours 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 signal processing techniques. More recently, the proposed DWT for multi-carrier modulations using time domain equalization. In

this study we present a new way of channel equalization when working with wavelets. We 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.

II. 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.

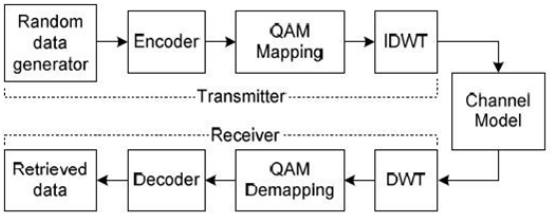


Fig 1. Wavelet based proposed MIMO system design.

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 $g^*(-n)$ 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 2, in this proposed model we are using IDWT and DWT at the place of IDFT and DFT. Rayleigh channel is used for transmission and cyclic prefixing is not used. Here first of all conventional encoding is done followed by interleaving then data is converted to decimal form and modulation is done next.

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 2.

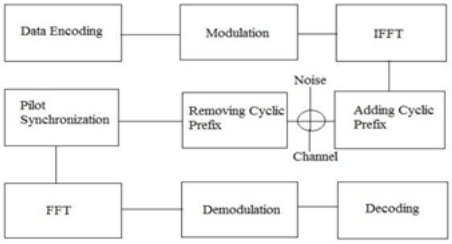


Fig.2. DFT Based OFDM system.

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.

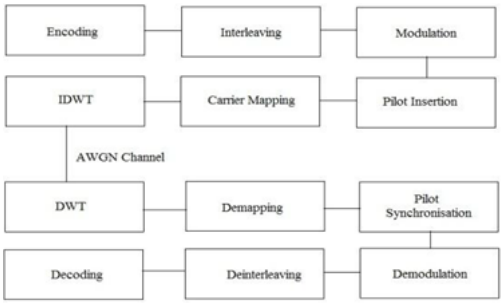


Fig. 3. Wavelet based proposed OFDM system design.

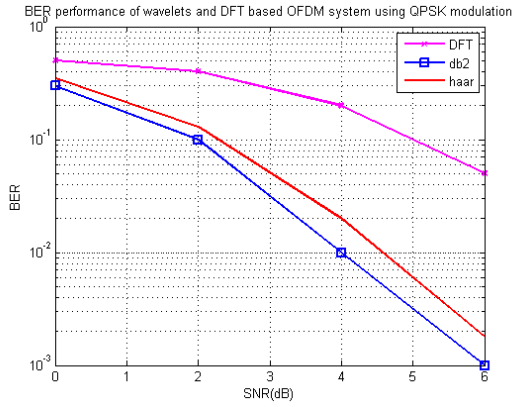
Figure 3 describes that in proposed model we are using IDWT and DWT at the place of IDFT and

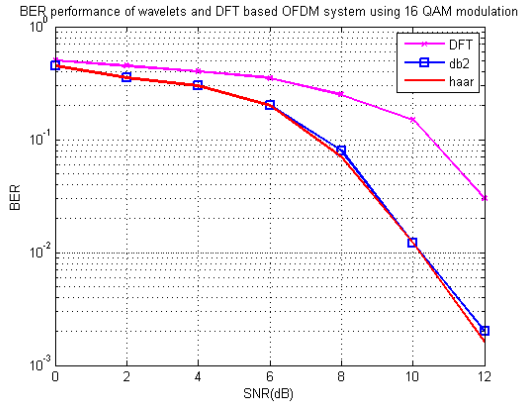
DFT. Rayleigh channel is implemented for transmission and cyclic prefixing is not used. Here first of all conventional encoding is performed followed by interleaving after that data is converted into the decimal form and modulation is done next.

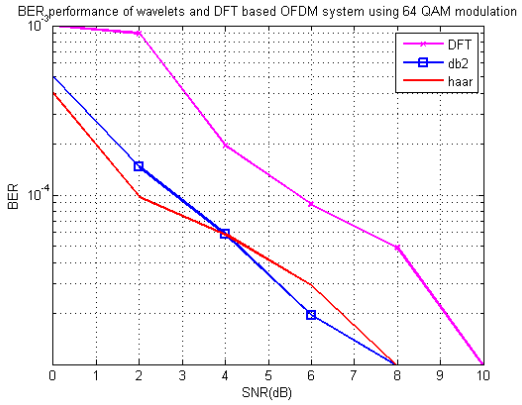
C. BER PERFORMANCE EVALUATION

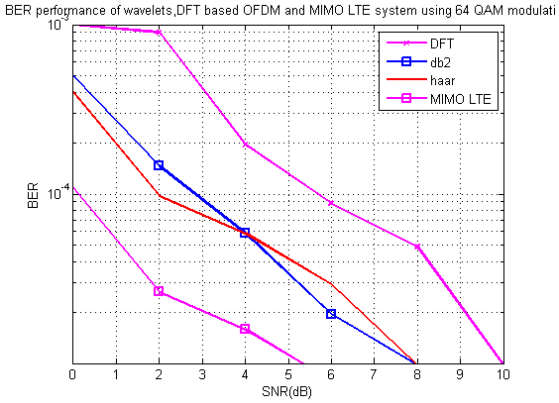
By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different modulations that are used for the LTE, as shown in figures 3-5. Modulations that could be used for LTE are QPSK, 16 QAM and 64 QAM (Uplink and downlink). QPSK does not carry data at very high speed. When signal to noise ratio is of good quality then only higher modulation techniques can be used. 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 BERs 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.

III. SIMULATION RESULTS









Simulations have been done in MATLAB. For performance evaluation of DFT based OFDM and DWT based MIMO different modulation schemes are opted such as BPSK and QPSK.

IV. CONCLUSION

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 DWT based MIMO can be suitable for all applications of the next generation wireless systems and it has a capability of delivering a high speed packet access (HSPA) capabilities. Wavelets are using in many advanced applications such as Nuclear Engineering, Image Synthesis, Biomedical Engineering, Music's, Fractals, Pure Mathematics, Data Compression, Computer Graphics, Human Vision, Radar, Optics, Astronomy, Acoustics and Seismology etc

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