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Performance Evaluation of Bit Error Rate for Conventional and Wavelet Based OFDM

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Abstract**:** The paper represents performance evaluation of Bit Error Rate (BER) for conventional (DFT) and wavelet (DWT) based orthogonal frequency division multiplexing (OFDM) with various modulation techniques. There are different modulation schemes such as Binary Phase Shit Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). The performance in between these modulation techniques is evaluated and analyzed to obtain lowest possible Bit Error Rate (BER) to be transmitted. Simulation is performed on the software named MATLAB.

Keywords: Bit Error Rate, Discrete Fourier transform, Discrete Wavelet Transform, Orthogonal frequency division multiplexing.

I. INTRODUCTION

The higher data speed requirement is increasing in exponential manner, due to easy availability of smart phones [5], 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.

OFDM is one of the prime method which enable non-seen sight of wireless [2] services makes it possible to extend wireless access method over wide-areas. It is nothing but deviation of the Frequency Division Multiplexing scheme which have frequency channel divided into multiple smaller sub channels. Sub-channelization in FDM requiring provision of guard bands between two sub-channels to avoid interference between them. OFDM [4] divides bandwidth of frequency in narrow orthogonal sub-parts called subcarriers. A sub-channel is the combination of these sub-carriers numbers. The sub-carriers comprise data carriers and pilot carriers along with a DC. The data carriers are utilized to transmit data and pilot carriers are used for sensing purpose. Subcarriers are usually modulated with Quadrature Amplitude Modulation or Phase Shift Keying. (PSK) .Every user is provided with a number of sub-channels, each of them is composed of a number of sub-carriers. Data of the user is carried parallel on every sub-carrier with a low rate. The combination of the parallel sub-carriers at the destination provide for higher data rates. Since the sub-carriers transmit data at a low rate and thus higher symbol time it is durable to the effects of multipath, so this makes more suitable for wide-area non-line of Sight wireless access and also, use of orthogonal sub-carriers which is overlapped without guard bands make it more capable than FDM scheme. OFDM resembles CDMA in which it is a spread-spectrum expertise in which energy generated at a particular bandwidth is spread across the wide bandwidth which makes it more durable to intrusion and ”jamming”.

Multiple Input Multiple Output (MIMO) is one of the popular Advanced Antenna Technologies which is used in LTE [5] and Ultra Mobile broadband (UMB).One of the attractive features of MIMO is its 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 over the multiple transmit antennas 9 of 15 and each transmitted flow goes through different paths to reach every receiver antenna. The different paths taken by the same flow to reach multiple receivers allow cancelling errors by using advanced signal processing techniques.

On the same frequency MIMO obtains spatial multiplexing to differentiate among various symbols. Thus MIMO is beneficial in obtaining higher spectral efficiency. The DWT-COIFLET OFDM has to fulfil the ortho-normal basis and for OFDM the best restoration properties to be considered. For different wavelet families the BER concert comparison is done with the conventional FFT-OFDM method for an AWGN. The results prove that the DWT-OFDM method operates at its finest concert with variety of wavelets. Results also show that DWT-OFDM is advanced than that of the FFT-OFDM [7] with regards to the bit error rate (BER) concert in AWGN channel.

II. OFDM SYSTEM DESIGN

It is well known that occupied bandwidth is of course directly related to data rate to be transmitted. But it needs to verify the minimum bandwidth required to be taken in order to get sufficient diversity and avoid the loss off all the frequency selective fading signals. On the other side much bandwidth means much transmitting power. Optimal bandwidth calculation is done by channel simulations and field test trials. For the Digital Audio Broadcasting

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(DAB), the bandwidth of value 1.5 MHz is a good compromise for the type of propagation conditions that apply. We have observed that the greater the carriers number, the greater the symbol period on each carrier and so less equalization is required and the greater is the diversity offered by the system. In case of differential modulation, the channel does not change too much during one symbol period. This is not the case when the receiver is moving due to the Doppler Effect as well as short term fading. Here number of carriers will reduce the moving speed. This one is another trade off of OFDM excellent opportunities for quick execution in parallel hardware

III.CONVENTIONAL OFDM 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. Orthogonal Frequency Division Multiplexing (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 1.

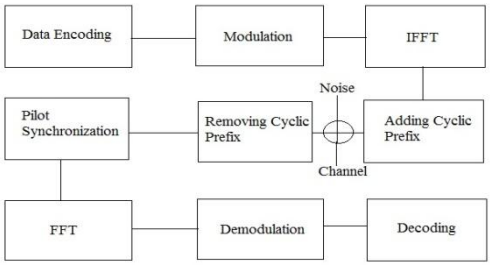

Fig. 1 DFT Based OFDM system

IV. WAVELET 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.

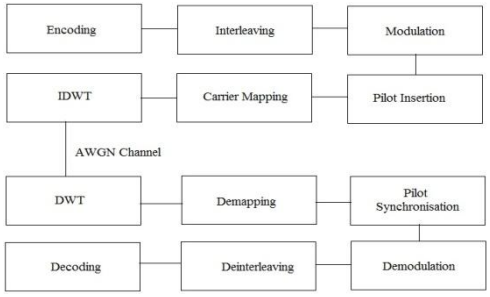

Fig. 2. Wavelet based proposed OFDM system design

Figure 2 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.

After modulation the insertion of pilot and sub carrier mapping is done then comes the IDWT of the data, which provides the orthogonality to subcarriers effectively. IDWT will convert time domain signal to the frequency domain. After passing through the channel on the signal DWT will be done and then pilot synchronization where the inserted pilots at the transmitter are removed then the demodulation is performed. Demodulated data is converted to binary form and the de-interleaved and decoded to obtain the original data which is transmitted.

V. BER PERFORMANCE EVALUATION

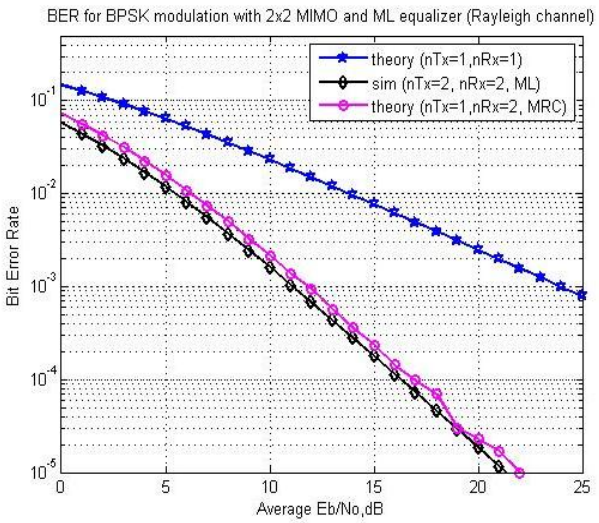

Fig. 3.BER Evaluation for DFT based OFDM using BPSK

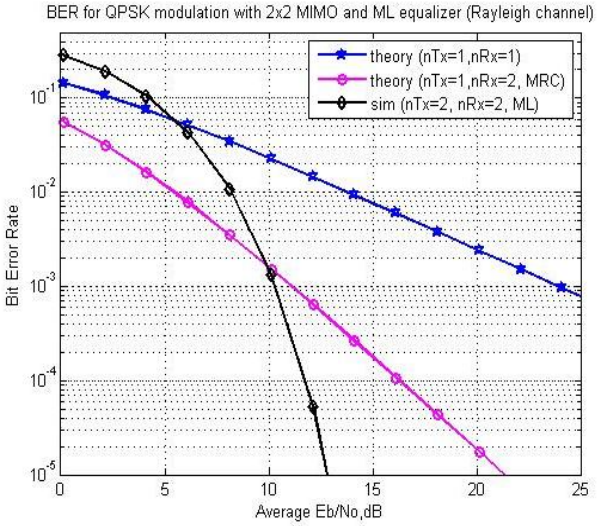

Fig. 4. BER Evaluation for DFT based OFDM using QPSK

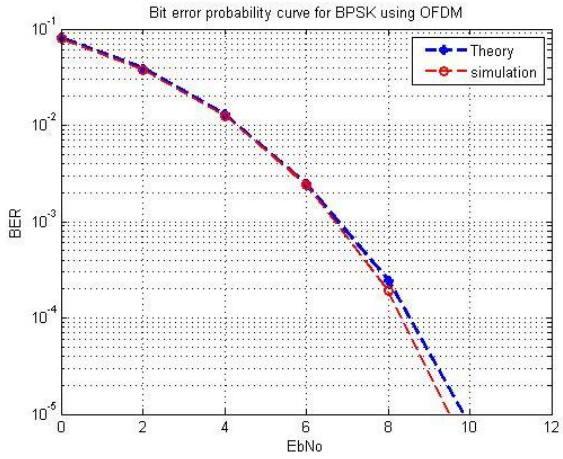

Fig.5. BER Evaluation of DWT Based OFDM using BPSK

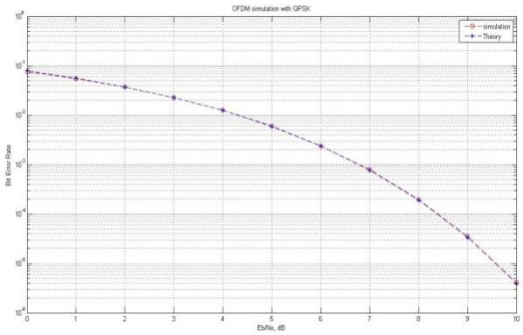

Fig.6. BER Evaluation of DWT Based OFDM using QPSK

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

VI. CONCLUSION

In this paper we have evaluated the performance of wavelet based OFDM system and DFT based OFDM system. From the performance analysis we have observed that the BER performance graph curves obtained from DFT based OFDM and DWT based OFDM using various modulation techniques. We conclude that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM.

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