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BER Analysis of OFDM in LTE using Various Modulation Techniques

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Abstract: The paper represents analysis Bit Error Rate (BER) performance of various modulation techniques. There are various modulation schemes such as Binary Phase Shit Keying (BPSK) and Quadrature Phase Shift Keying (QPSK). The performance in between these modulation techniques is analysed and best suited with respect to low Bit Error Rate (BER) is transmitted. Simulation is carried out on the software named MATLAB.

Keywords: OFDM, BPSK, QPSK, PSK, BER, SNR.

I. INTRODUCTION

The requirement for higher data speed is exponentially increasing, main reason being the availability of smart phones [5], at low cost and social networking websites. Constant improvement in wireless data rate is in demand. Long Term Evolution-Advanced (LTE-A) is the solution for wireless broadband services. LTE-Advanced also known as 4G wireless networks and it is an evolution of LTE Rel-8. IMT-Advanced (International Mobile Telecommunication-Advanced) refer to a family of mobile wireless technologies, which is also known as 4G.

OFDM is one of the key technologies which enable non-line of sight wireless [10] services making it possible to extend wireless access method over wide-areas. It is a deviation of the Frequency Division Multiplexing scheme in which the frequency channel is divided into multiple smaller sub channels. Sub-channelization in FDM requires provisioning of guard bands between two sub-channels to avoid interference between them. OFDM [4] divides the frequency bandwidth in narrow orthogonal sub-parts called subcarriers. A sub-channel is the combination of a number of these sub-carriers. The sub-carriers comprise data carriers and pilot carriers along with a DC. The data carriers are used to transmit data and pilot carriers are used for sensing purpose. Subcarriers are usually modulated with usual modulation techniques such as 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 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 [5] 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.

On the same frequency MIMO achieves spatial multiplexing to distinguish among different symbols. Thus MIMO helps in achieving higher spectral efficiency. The DWT-COIFLET OFDM has to satisfy the ortho-normal basis and for OFDM the perfect restoration properties to be considered. For different wavelet families the BER concert is compared with the conventional FFT-OFDM method for AWGN. The results show that the DWT-OFDM method operates at its finest concert with different wavelets. Results also show that DWT-OFDM is advanced as compared to FFT-OFDM [7] with regards to the bit error rate (BER) concert in AWGN channel.

II. OFDM SYSTEM DESIGN

Occupied bandwidth is of course directly related to the data rate to transmit. However, the question is, what is the minimum bandwidth required to be taken in order to obtain enough diversity and avoid the loss off all the signal in frequency selective fading environments. On the other hand much bandwidth means also much transmitting power. There is a trade off between bandwidth and transmitted power. The optimal bandwidth is found by channel simulations and field test trials. In Digital Audio Broadcasting (DAB), for example, a bandwidth of 1.5 MHz is a good compromise for the type of propagation conditions that apply.
We have seen that the greater the number of carriers, the greater the symbol period on each carrier and so less

equalization is needed and the greater is the diversity offered by the system. However, with differential modulation, it is important that the channel dose not vary too much during one symbol period. This is not the case when the receiver is moving because of Doppler Effect and short term fading. In such cases number of carriers will limit the moving speed. This is another trade off of OFDM excellent opportunities for quick execution in parallel hardware.

III.CONVENTIONAL OFDM SYSTEMS

For conventional OFDM system sinusoids of DFT form an orthogonal basis function set. In DFT the transform correlates its input signal with each of sinusoidal basis function [13], here orthogonal basis functions are the subcarriers used in OFDM. At the receiver the signals are combined to obtain the information transmitted.

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique in which the spectrum of the subcarriers overlap on each other. The frequency spacing among them is selected in such a way that orthogonality is achieved among the subcarriers. The block diagram of a basic OFDM system is shown in Figure 1.

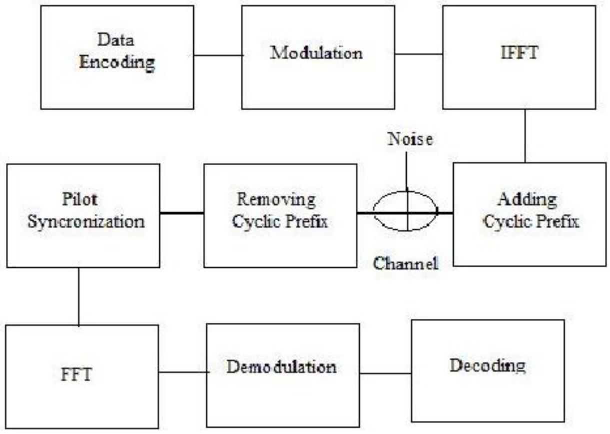

Fig.1. basic OFDM system

IV. WAVELET BASED OFDM SYSTEM

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.

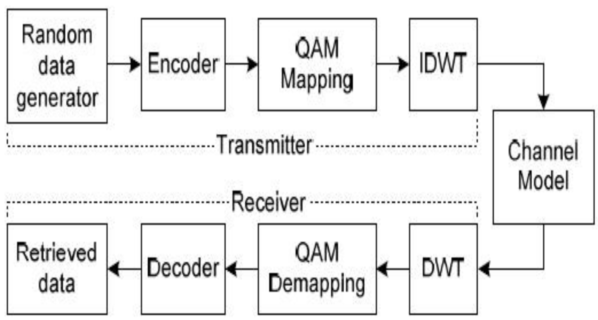

Fig 2. Wavelet based proposed OFDM system design

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

V. BER PERFORMANCE EVALUATION

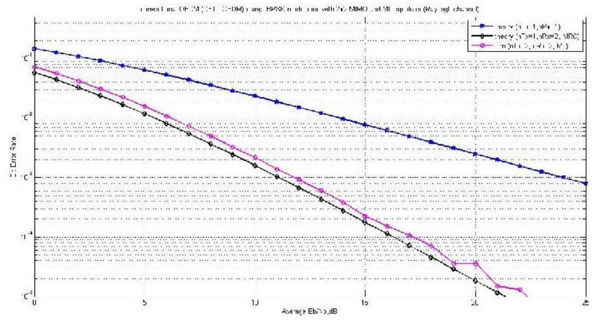

Fig. 3. Bit Error Rate of BPSK with OFDM with Rayleigh Channel

Simulations have been done in MAT LAB for performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for different modulations that are used for the LTE. Modulations that could be used for LTE are BPSK, QPSK.

For the purpose of simulation, signal to noise ratio (SNR) of different values are introduced through Rayleigh channel. The simulation results for Bit Error Rate of BPSK and QPSK with OFDM with Rayleigh Channel are shown in figure below. Using MATLAB Figure 3 shows the comparison of BER performance for conventional OFDM (DFT - OFDM) using different modulation techniques. This figure shows the relationship between BER and SNR.

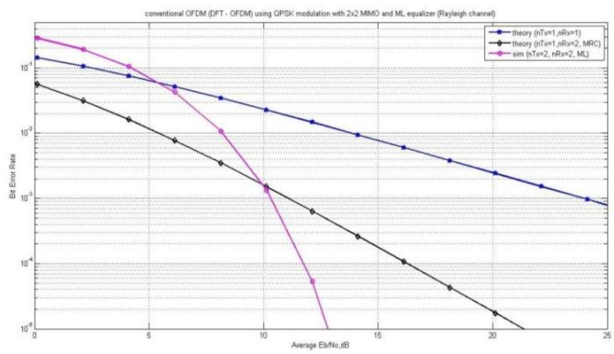

Fig. 4 Bit Error Rate of QPSK with OFDM with Rayleigh Channel

Using MATLAB Figure 3 shows the comparison of BER performance for conventional OFDM (DFT - OFDM) using various modulation techniques. This figure shows the relationship between BER and SNR.

V. CONCLUSION

In this paper we have analyzed the performance of wavelet based OFDM system and DFT based OFDM system. From the performance curve we have observed that the BER curves obtained from DFT 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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