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Bit Error Rare (BER) Analysis of Conventional OFDM (DFT - OFDM) and Wavelet Based OFDM (DWT – OFDM)

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Abstract:- OFDM has been widely adopted in many applications due to its good spectral performance and low sensitivity to impulse noise and multipath 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, we are presenting BER analysis of conventional and wavelet based OFDM in LTE using different modulation techniques like QAM 2, QAM 4, QAM 16, QAM 256 and PSK.

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

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1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation technique which divides the available spectrum into a number of parallel subcarriers and each subcarrier is then modulated by a low rate data stream at different carrier frequency. OFDM offers immunity, high spectral efficiency to the multipath delay and low inter symbol interference (ISI).

OFDM is a modulation technique which enables user data to be modulated onto the number of tones. The information is modulated on a tone by adjusting the phase of tone, amplitude, or both tone and amplitude. In the most basic form, a tone may be disabled or present to indicate a one or zero bit of information. However in such cases either phase shift keying (PSK) or quadrature amplitude modulation (QAM) is typically employed. An Orthogonal frequency division multiplexing system takes a data stream and splits it into N parallel data streams and each data stream at a rate 1/N of the original rate. Each stream is then mapped to a tone at a unique frequency and when combined together using the inverse fast Fourier transform (IFFT) yields the time domain waveform to be transmitted [4].

1.1 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 tradeoff 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 dopler effect and short term fading. In such cases number of carriers will limit the moving speed. This is another trade off of OFDM.

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2. CONVENTIONAL OFDM SYSTEMS

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.

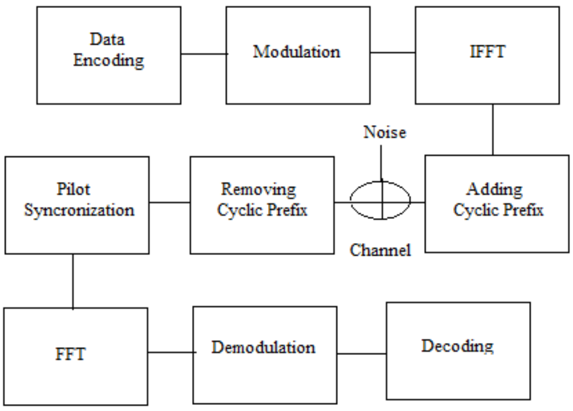

Figure 1 DFT based OFDM transmitter and receiver

3. 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.

As shown in figure 2, in this proposed model we are using IDWT and DWT at the place of IDFT and DFT. AWGN 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.

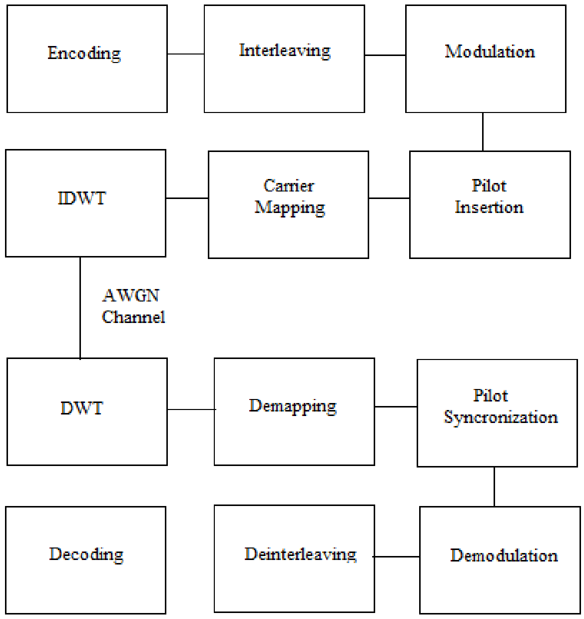

Figure 2. Wavelet based proposed OFDM system design.

4. BER PERFORMANCE EVALUATION

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 PSK, 2 QAM, 4 QAM, 16 QAM and 256 QAM (Uplink and downlink).

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.

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. The values of SNR are from – 30 db to 30 db and the scale of SNR is linear. The values of BER are from 0.01 to 1 and scale of BER is log.

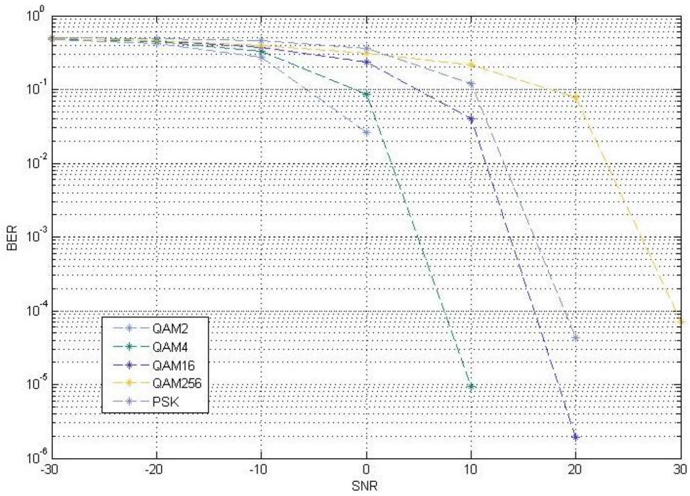

Figure 3 OFDM for AWGN Channel for DFT based

It is clear from the figure 3 that the BER performance of DFT based OFDM using QAM2 modulation technique is better than the DFT based OFDM using other modulation techniques.

Using MATLAB Figure 4 shows the comparison of BER performance for wavelet based OFDM (DWT - OFDM) using different modulation techniques. This figure shows the relationship between BER and SNR. The values of SNR are from – 30 db to 30 db and the scale of SNR is linear. The values of BER are from 0.01 to 1 and scale of BER is log.

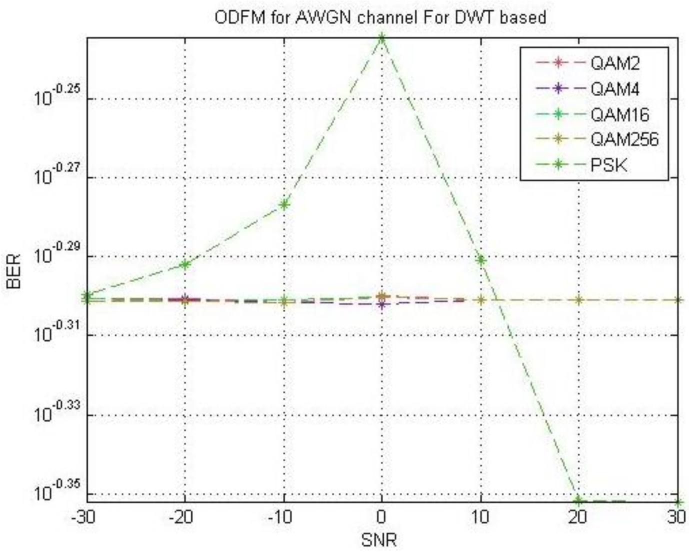

Figure 5 OFDM for AWGN Channel for DWT based

5. Conclusion

In this paper we analyzed the performance of wavelet based OFDM system and DFT based OFDM system. Then we compare these analyses. From the performance curve we have observed that the BER curves obtained from DFT based OFDM using different modulation techniques, QAM2 modulation technique gives the better result compare to other modulation techniques. We used five modulation techniques for implementation that are 2 QAM, 4 QAM, 16 QAM, 256 QAM and PSK. In wavelet based OFDM different types of filters can be used with the help of different wavelets available, they provide their best performances at different intervals of SNR. And we conclude that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM.

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