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Analysis BER for 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 Shift 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. In OFDM two types of interferences will be there are, Inter Carrier Interference (ICI) and Inter Symbol Interference (ISI) due to the orthogonality loss of subcarriers, to achieve this problem cyclic prefix (CP) is used. CP is a guard band in OFDM system that uses 20% of required subcarrier. OFDM system based on wavelet provides better orthogonality between subcarriers the purpose of analyzing OFDM performance; we have taken a two-fold approach. Different types of modulation schemes such as QPSK and 16-QAM with OFDM are studied for their Bit Error Rate (BER). A noisy channel adversely affects data transmission. For this work, we study the modulation schemes with OFDM over two types of noise channels, BER rates for both these channels has been simulated in MATLAB simulation

KEYWORDS: QPSK, QAM, OFDM, BER, DFT

I. INTRODUCTION

Basic concept of OFDM is the orthogonality principle. Orthogonality principle can be explained that any two vectors must be linearly independent from each other. Here the subcarriers must be orthogonal to each other. This means that even if waveforms overlap, the orthogonality ensures zero interference. An overlap of sub carriers is seen in frequency domain of sub carriers; hence we don't have ICI in the band efficiency [2][5][7] OFDM is a digital modulation technique which uses multiple carriers, that use abundant tightly spaced orthogonal subcarriers. Initial data is sent in form of a single stream which is then converted to parallel form [3][10][11][17]. The parallel data or small chunks of data is then coded and then modulated on to a sub-carrier. These sub-carriers are modulated using any modulation schemes, usually quadrature amplitude modulation. These subcarriers are modulated at a low symbol rate maintaining same data rates similar to convention single carrier modulation scheme for same bandwidth. This is the reason we observe lower bit rates on sub carrier compared to single carrier. This modulated data is transmitted on multifading channels such as Rayleigh fading channel. In this

Project, we use Additive White Gaussian Noise (AWGN) channel. Conventionally, OFDM uses fast Fourier transform for generation and detection. Wavelet Transform seems to have the potential to replace DFT. Using Wavelet transform we can have time-frequency localization. Wavelet transform is able to provide the time as well as the frequency information simultaneously, hence it gives us a time-frequency representation of the signal. Wavelet transforms works almost same as Short-time Fourier transform (STFT) to find the unknown data in particular bandwidth. The problem with STFT is that the window size is fixed for all the data. The problem arises when we take a window size less than that the interested Bandwidth, we cannot completely find out the information from that signal. This is where Wavelet Transform comes in. Wavelet Transform provides us with a variable window size. The advantage of this is we can extract any large chunks of data. Because of this variable size, the resolution of time frequency signals is improved [4].

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Wavelet Transform can be briefly described as follows. On passing the time domain signal through several high pass and the low pass filters, which results in either a high frequency or a low frequency signal. This entire process is repeated several times every single time a small part of a signal related to its respective frequency will be removed. This is how it works, on considering a frequency of a signal to be in the range between 1000 Hz. This 1000Hz signal is passed through high pass and low pass filters and divided into two parts. Outputs of this level is a signal with 0-500Hz frequency range and the other part with 500-1000 Hz. The same process is repeated for both signals and further[19][14]

II. EXISTING WORK

In the existing system the discrete Fourier transform is used for the orthogonal basis function. First the Random data is generated and then the data is encoded by the encoder and the corresponding modulation is processed. The modulated signal is applied with the inverse Fourier transform is performed. After that the cyclic prefix data is added to the modulated signal and then the signal is passed into the channel with the noise. And the aforementioned process are performed on the transmitter side and then the reversal operations of the aforementioned processes are performed[12][6][8]. In the receiver side the cyclic prefix is removed from the channel output data and then the pilot synchronization is performed after that the Fourier transform is applied on the synchronized data and then the demodulation is performed. And the demodulated data is decoded at the receiver. Finally the BER performance is estimated.[1][9]

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. 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[15][14][13]

OFDM TRANSMITTER: To ensure frequency multiplexing and orthogonality, OFDM uses a range of multi-access technologies. Symbols are modulated with chosen modulation schemes and coded for the appropriate channel conditions. It also provides for high spectral efficiency at a Nyquist symbol rate and a suitable baseband signal. Orthogonality gives it an ability to use the whole spectrum and still maintain enough carrier spacing to avoid inter-carrier interference. One of the major advantages of using OFDM is that it has high spectral efficiency. In other words, its large bandwidth can be used to transmit and receive datathat requires higher speeds such as multimedia, video, audio, and so on. On the other hand, due to its usage

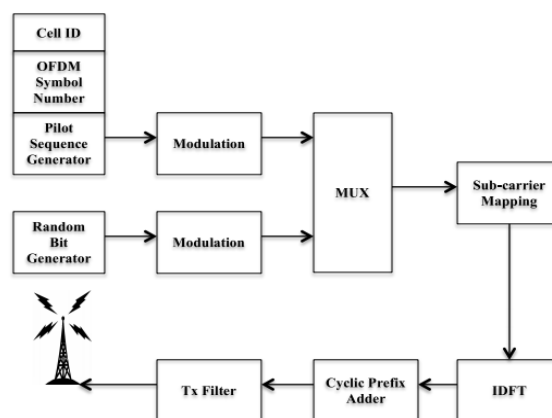


Figure1: OFDM Transmitter

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of several sub channels, the channel equalization is much simpler as compared to earlier generations of Communications system like CDMA. Because of multiplexing, OFDM has the capability to resist selective Fading channels. This happens due to the division of data and information of the overall channel over multiple narrowband signals.

OFDM Channel: A general time domain linearly equalized OFDM channel contains a channel model with an impulse response with a noise element as shown in Figure 3.14.

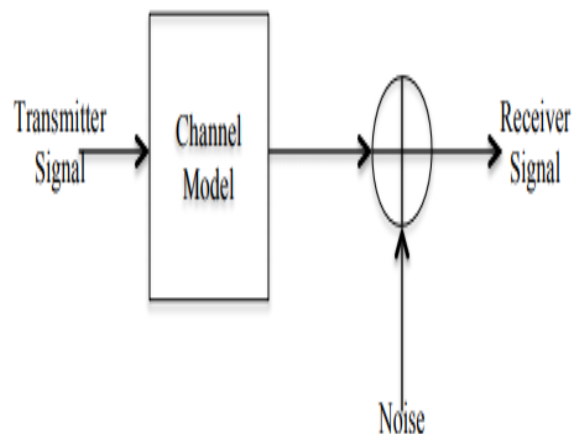


Figure2: OFDM Channel

In the proposed method, instead of DFT, DWT is used for implementing OFDM. Using DWT there is an increase in the efficiency of the channel and usage of bandwidth is reduced. In simulation of OFDM for this project, AWGN channel is used. Any other channel models that simulates fading can also be used. Replacing DFT also eliminates the use of cyclic prefix or guard band in between spectrum. In this process, firstly, input data is encoded. This encoded data is followed by interleaving which scrambles the order of data. Then data is then modulated and plot insertion is done. This data is then transmitted using IDWT. This provides orthogonality to subcarriers. DWT converts time domain signal to a frequency domain where unknown signal information can have extracted using wavelets. This signal is transmitted via AWGN channel. On the receiver side, the process is done in exact reverse order from the transmitter side. Once demodulation is done, the data is converted to binary and decoded to obtain original data. The proposed method is shown in block diagram below [6]. Fig. 1. Block Diagram of OFDM MATLAB is used to compare the performance characteristics of DFT based OFDM and DWT based OFDM. In this project, we used QPSK, 16 QAM and 64 QAM for simulation purposes.[16][11][4] These modulation techniques are suitable and can be used for LTE communication. But if data rate is too high, QPSK is not suitable because it doesn't carry high speeds. If SNR is high, then we can use higher modulation schemes like 64-QAM. Whereas, lower modulation scheme as QPSK doesn't require high SNR. For simulation purposes, we varied SNR for different values for AWGN channel. We used 100000 bits of data. For obtaining BER, we averaged the output for value of SNR and this is repeated for different values of SNR

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OFDM RECEIVER: An OFDM receiver consists of a receiver filter, CP removal block, DFT, sub-carrier demapper, DE-MUX, channel estimator, modulator, pilot bit generator, equalizer, frequency response, and slicer as shown in Figure 2. The receiver filter is similar to the one at the transmitter end, which is a band pass filter. It filters the incoming signal by convoluting it with already established filter coefficients and gives out a cleaner output As shown in Figure 2, to revert the effect of up-sampler used in the transmitter, the receiver has a down-sampler that samples down the incoming signal passed through the filter through the decimation factor of 4. Thus, the original frame dimensions of the frame are cyclic prefixes to strip the signal off of its CP module achieved once the received signal passes through the down-sampler. Similarly, the CP removal block removes.

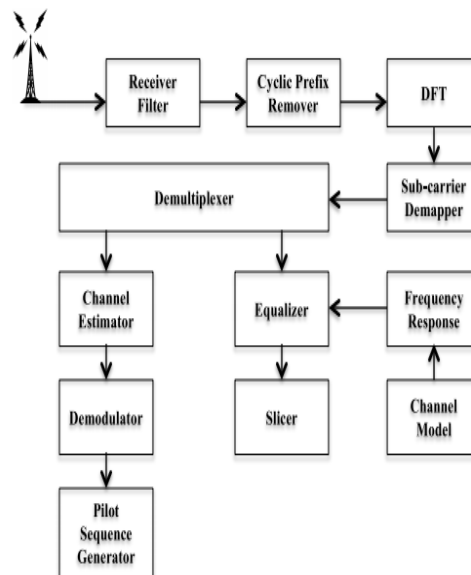


Figure 3. OFDM Receive

Attached to it at the transmitter. This is then fed to a DFT block that performs a discrete Fourier transform on the CP removal block's output. Although the transmitter filter and the receiver filter are used to minimize noise, the filter themselves add some effects to the signals. This, in combination with the channel noise, it gives a signal that has much more noise than what can be demodulated to get back the original data. The equalizer block is used to compensate for the effects induced by the filters as well as the channel. All the combined responses of Tx filter, Rx filter, and frequency response of channel filter are thus nullified with the equalizer. For QPSK demodulation, complex modulated symbols are demodulated to binary data by the demodulator. However, small variations are possible at the receiver end due to noise amplitudes. To neutralize this effect, soft de-mapping has to be performed at the receiver level too. Respective quadrants and mapping values are used for QPSK demodulation as was observed in Table 2.1. For 16 QAM demodulation, the received signals are first separated into real and imaginary parts [18]. They are then related to the tabular values that were used for 16 QAM mapping according to Table 2.2. Even in 16 QAM demodulation, the effect of noise induced by channel and possibly filters has to be considered. For this purpose, original amplitude ranges of each complex symbol is calculated and based on which, the original mapped complex symbol's value is obtained

III. PROPOSED METHOD

Wavelet Transform is an significant mathematical function, because as a tool for multi resolution dissolution of continuous time signal by different times and frequencies. In wavelet transform, higher frequencies are sophisticated

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decided in time, as well as lesser frequencies are better decided in frequency. Happening this intellect, the signal remains reproduced through an orthogonal wavelet intention, in growth the transform is calculated alone changed parts of the time domain signal. The wavelet transform can be classified as two categories, continuous ripple transform and discrete ripple transform. The Discrete Ripple Transform could be observed by way of sub-band coding. The signal is analyzed and it accepted over a filter bank succession. A sub-band coding method is defined as full-band source signal is spitted into distorted frequency bands as well as encrypt every band separately established on their spectrum energy. The sub-band coding methodology learning starts from the digital filter bank method; it can be defined as a set of filters with has distorted centre frequencies. Double channel filter bank is mostly used in growth the effective way to tool the discrete ripple transform. Generally, the filter bank plan has double steps which are used in signal transmission scheme. roposed Method Wavelet Transform is an significant mathematical function, because as a tool for multi resolution dissolution of continuous time signal by different times and frequencies.

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IV. CONCLUSION

In this paper we analyzed the performance of wavelet based OFDM system and compared it with the performance of DFT based OFDM system. From the performance curve we have observed that the BER curves obtained from wavelet based OFDM are better than that of DFT based OFDM. We used three modulation techniques for implementation that are QPSK, 16 QAM and 64 QAM, which are used in LTE. In wavelet based OFDM different types of filters can be used with the help of different wavelets available. The proposed technique can reduce the BER value by increasing the convolution encoder stages which also increase the cost and complexity. The future work for my work will focus on the different encoders than convolution encoder to give high reduction in BER. The effect of other channel type will also studied in this system as a future work scope.

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