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Analytical Approhes of BER using conventional and wavelet based OFDM in LTE for different modulation techniques.

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Abstract:

Orthogonal Frequency Division Multiplexing (OFDM) is considered as an advanced communication model which has wide range of applications such as 3G, 4G, and Wi-Fi etc. Comparing with Frequency Division Multiplexing (FDM), we are providing a higher level of spectral efficiency by using the OFDM Multiple Carriers. To overcome the problems of the Inter carrier interference (ICI) and inter symbol interference (ISI), using of the cyclic prefix which uses the available bandwidth of 20% for the loss of the Orthogonality between the sub carriers in OFDM. Providing of better Orthogonality which is based on the wavelet of OFDM and improving of BER (Bit Error Rate) is also used in it. Increasing of the spectral efficiency we don't require the cyclic prefix which is based on the wavelet system. In the upcoming of the 4th generation LTE, using of wavelets in place of Discrete Fourier Transform (DFT) based OFDM is proposed. Using of the wavelets and DFT based OFDM Systems we have compare the performance of the BER.

Keywords

LTE (long term Evolution), OFDM (orthogonal frequency division multiplexing) DFT (discrete fourier transform) Wavelet, BER.(Bit Error ratio)

1. Introduction

LTE-Advanced also known as 4G wireless networks and it is an evolution of LTE. IMT Advanced (International Mobile Telecommunication-Advanced) refers to a family of mobile wireless technologies, which is also known as 4G. In 2010, LTE-Advanced/4G is ratified as IMT-Advanced technology. It will allow the cellular provider to complement their 3G services by offering higher data rates, lower latency and packet –based network. The standard for LTE was first published in 2005 by 3GPP (third generation partnership project) since then LTE Advanced standard been in development and finally in March 2009 it was finalized by 3GPP. There are significant amount of improvement that were made to be qualified as LTE Advanced.

To improve the user experience 3GPP is considering various aspects which include higher order MIMO, carrier aggregation, and a deployment strategy called heterogeneous network. Het Net combines macro-cell, microcell, relays, Pico-cell, and Femto-cell deployment in a single cell to increase spectral efficiency per unit area. It will also provide better broadband experience in a cost effective manner to users . The 4G technology can also significantly increase the spectral efficiency by adapting carrier aggregation that supports the bandwidth from 1.4MHz to 20MHz. In carrier aggregation multiple component carriers can be jointly used for transmission to/from user equipment. It is done such a way that it will be compatible with the previous releases of LTE.

With the target of creating a collaboration entity among different telecommunications associations, the 3rd Generation Partnership Project (3GPP) was established in 1998. It started working on the radio, core network, and service architecture of a globally applicable 3G technology specification. Even though 3G data rates were already real in theory, initial systems like Universal Mobile Telecommunications System (UMTS) did not immediately meet the IMT- 2000 requirements in their practical deployments. The combination of High Speed Downlink Packet Access (HSDPA) and the subsequent addition of an Enhanced Dedicated Channel, also known as High Speed Uplink Packet Access (HSUPA), led to the development of the technology referred to as High Speed Packet Access (HSPA) or, more informally, 3.5G.

2. Motivation

Motivated by the increasing demand for mobile broadband services with higher data rates and Quality of Service (QOS), 3GPP started working on two parallel projects, Long Term Evolution (LTE) and System Architecture Evolution (SAE), which are intended to define both the radio access network (RAN) and the network core of the system, and are included in 3GPP Release 8. LTE/SAE, also known as the Evolved Packet System (EPS), represents a radical step forward for the wireless industry that aims to provide a highly efficient, low-latency, packet optimized, and more secure service. The main radio access design parameters of this new system include OFDM (Orthogonal Frequency Division Multiplexing) waveforms in order to avoid the inter-symbol interference that typically limits the performance of high-speed systems, and MIMO (Multiple-Input Multiple- Output) techniques to boost the data rates. At the network layer, an all-IP flat architecture supporting QOS has been defined.

3. Conventional OFDM System

For typical OFDM system sinusoids of DFT type associate orthogonal basis perform set. In DFT the remodel correlates its signaling with every of curving basis perform, here orthogonal basis functions are the subcarriers utilized in OFDM. At the receiver the signals are combined to get the information transmitted. Much, quick Fourier (FFT) and Inverse Fourier (IFFT) are used for the implementation of the OFDM system as a result of less range o computations needed in FFT and IFFT. Multiple replicas of the signal are received at the receiver finish attributable to the time dispersive nature of the channel, thus frequency selective fading results and to scale back this interference guard interval is used that is termed cyclic prefix. As long because the channels delay unfold remains among the limit of the cyclic prefix there would not be any loss in Orthogonality. For LTE, in the downlink information of various users is multiplexed in frequency domain and access technique is termed Orthogonal Frequency Division Multiple Access (OFDMA).
In the uplink of the LTE access technique used is Single Carrier-Frequency Division Multiple Access (SC-FDMA). High Peak Average Power Ratio (PAPR) occurs due to random constructive addition of subcarriers and results in spectrum spreading of signal leading to adjacent channel interference. So power linearization techniques and compression point amplifier need to be used to overcome this problem. These methods can be implemented at base station (BS), but are expensive to implement at user equipment (UE). Hence LTE uses SCFDMA with cyclic prefix on uplink, which will result in reduction of PAPR because of the presence of single carrier. Due to single carrier modulation effect of ISI will be high in uplink and to overcome from its effect low complexity equalizer will be required but SC-FDMA is not sensitive to frequency offset and Doppler shift.

4. Proposed method

In this section we have to compare the performance of wavelets based OFDM system with performance of conventional OFDM system for different LTE modulation techniques. For wavelet based system we use daubechies2 and Haar wavelets. Additive White Gaussian Noise (AWGN) channel is used for transmission. The work is organized as first of all the conventional OFDM system and wavelet based OFDM system.

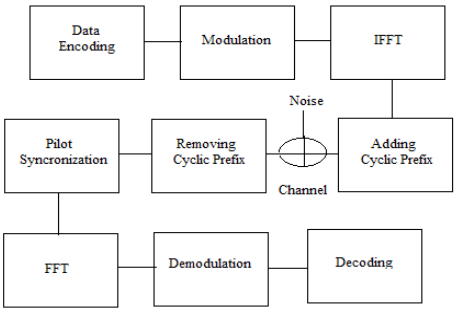

Fig. 1. DFT based OFDM transmitter and receiver.

5. Wavelet Based OFDM System

Wavelet rework could be a tool for analysis of the signal in time and frequency domain together. It's a multi resolution analysis mechanism wherever signal is rotten into completely different frequency elements for the analysis with explicit resolution matching to scale. Using any explicit sort of ripple filter the system will be designed in line with the necessity and additionally the multi resolution signal will be generated by the utilization of wavelets. By the utilization of varying ripple filter, one will style waveforms with selectable time/frequency partitioning for multi user application. Wavelets possess higher Orthogonality and have localization each in time and frequency domain and because of good Orthogonality wavelets area unit capable of reducing the power of the international intelligence agency and ICI, which ends from loss of Orthogonality. To cut back international intelligence agency and ICI in typical

OFDM system use of cyclic prefix is there, that uses 2 hundredth of available information measure, therefore leads to information measure unskillfulness however this cyclic prefix isn't needed in ripple primarily based OFDM system. Ripple primarily based OFDM is simple and also the DFT primarily based OFDM is complicated. Wavelet based OFDM is versatile further and since higher Orthogonality is provided by it, there's no a need of cyclic prefixing in ripple primarily based OFDM that is needed in DFT based OFDM to take care of Orthogonality therefore ripple based system is a lot of information measure economical as compared with the DFT based OFDM.

In distinct ripple rework (DWT), signal presented can experience many completely different filters and can be decomposed into low pass and high pass bands through the filters. Throughout frequencies below 1/2 the best frequency and low pass filter can take away frequencies that area unit on top of 1/2 the highest frequency. The decomposition halves the time resolution as a result of 1/2 the samples area unit accustomed characterize the signal equally frequency resolution are doubled and this decomposition method are perennial once more for getting the ripple coefficients of needed level. 2 forms of coefficients area unit obtained through process, 1st ones area unit called elaborated coefficients obtained through high pass filter and second ones area unit referred to as coarse approximations obtained through low pass filter connected with scaling method. After passing the info through filters the destruction method are performed. The entire procedure can continue till the required level is obtained.

6. Proposed Wavelet Based OFDM Design

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.

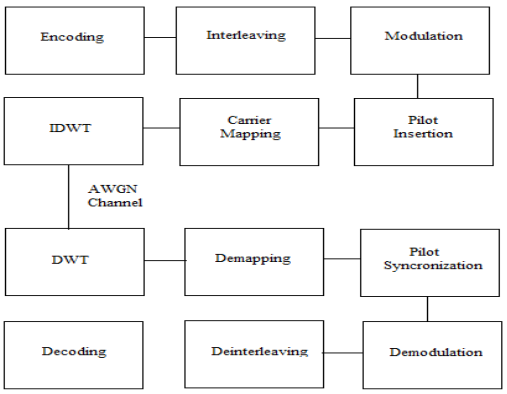

Fig. 2. Wavelet based proposed OFDM system design.

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.

7. Ber performance Evolution

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

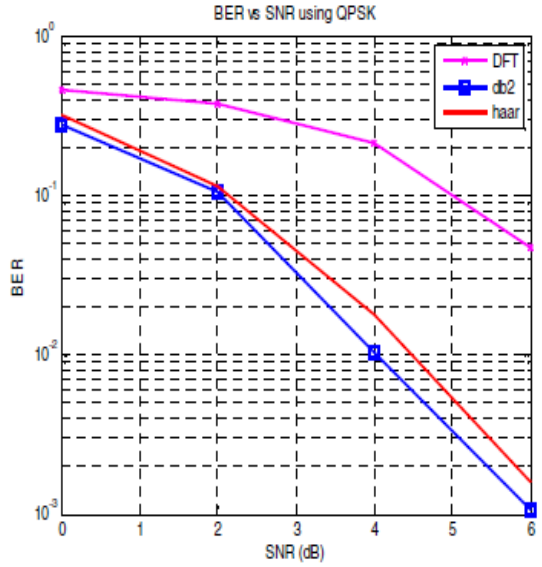

Fig. 3. BER performance of wavelets and DFT based OFDM system using OPSK modulation.

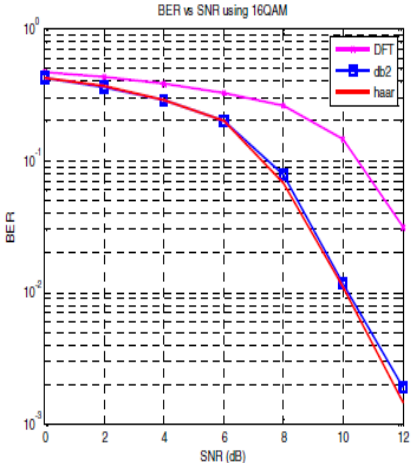

Fig. 4. BER performance of wavelets and DFT based OFDM system using 16-QAM modulation.

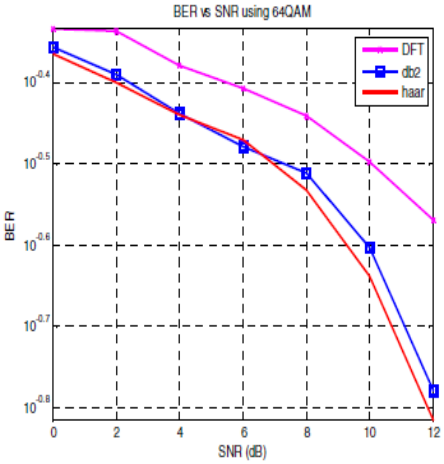

Fig. 5. BER performance of wavelets and DFT based OFDM system using 64-QAM modulation.

8.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. We have used daubechies2 and haar wavelets, both provide their best performances at different intervals of SNR.

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