Performance Enhancement of DWT Based LTE Wireless Communication System using SUI Model

Prateek Tripathi[1], Prof. Aizaz Tirmizi[2] , Prof. Mohd. Sarwar Raeen[3]

[1]M-Tech Research, [2]Research Guide, [3]HOD, Department of Electronics and Communication Engineering,

All Saints College of Technology, Bhopal

Abstract - Upcoming of the 4th generation LTE (Long Term Evolution) which is a standard of the wireless communications that are engaged with the two techniques that are namely Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input and Multiple Output (MIMO) . 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 doesn'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 compared the performance of the BER .As an extension of this paper equipped with the SUI channel model is done where the channel consist of the optimized output compare to general channel like AWGN channel model by the result.

Keywords : LTE; OFDM; DFT; Wavelet; BER.

Introduction

The requirement for higher data speed is exponentially increasing, main reason being the availability of smart phones, 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. 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 as Rel-6 by 3GPP (third generation partnership project) since then LTE-Advanced standard been in development and finally in March 2009 it was finalized by 3GPP. Table 1 provides an overview of LTE-Advanced items and its requirements. 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.

The fourth generation (4G) of wireless cellular systems has been a topic of interest for quite a long time, probably since the formal definition of third generation (3G) systems was officially completed by the International Telecommunications Union Radio communication Sector (ITU-R) in 1997. A set of requirements was specified by the ITU-R regarding minimum peak user data rates in different environments through what is known as the International Mobile Telecommunications 2000 project (IMT-2000). The requirements included 2048 kbps for an indoor office, 384 kbps for outdoor to indoor pedestrian environments, 144 kbps for vehicular connections, and 9.6 kbps for satellite connections.

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.

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.

In this paper we have compared the performance of wavelets based OFDM system with performance of conventional OFDM system for different LTE modulation techniques. For wavelet based system we have used daubechies2 and haar wavelets. Additive White Gaussian Noise (AWGN) channel is used for transmission. The paper is organized as first of all the conventional OFDM system and wavelet based OFDM system. The proposed wavelet based OFDM design is presented and then the performance evaluation and the results obtained from the simulation are discussed and Conclusion is summarized.

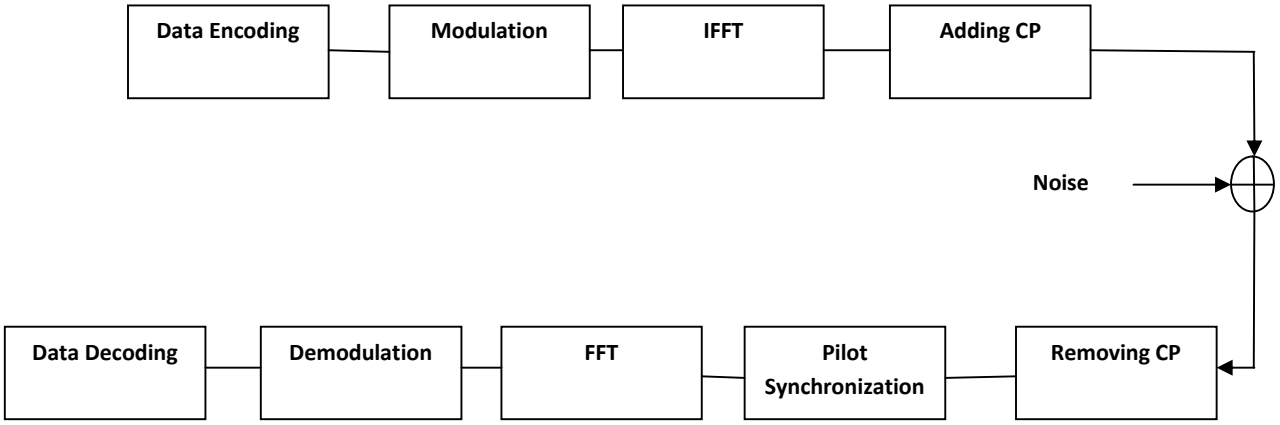

Fig 1. DFT based OFDM transmitter and receiver

Background - The revolution of wireless communications certainly was one of the most extraordinary Changes underlying our contemporary world although we may not realize it, everyday our lives are profoundly affected by the use of radio waves. Radio and television transmissions, radio-controlled devices, mobile telephones, satellite communications, and radar and systems of radio navigation are all examples of wireless communications happening around us. However, less than a hundred years ago, none of these existed, while the telegraph and telephone were most common for communication, which required direct wire connection between two places

There mark able advancement in communication of today is the result of an Italian scientist, Gugliemo Marconi, as he began experiments using radio waves for communication in 1895. These invisible transmittable waves traveled in air, and since the receiving and transmitting equipment was not connected by wires, the method of communication used was then recognized as wireless communication. Marconi's first success was in 1897,as he Demonstrated radio's ability to provide continuous contact with ships sailing the English channel.

By 1920,radio circled the globe and the first radio transmitter was developed and broadcasted programs for the public. Later, the idea of the radio was adopted by Television, radar and communication systems, due to the advancement in electronics Equipment and enabled radio waves to be sent over greater distances.

II. 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 remodel (FFT) and Inverse quick Fourier remodel (IFFT) are used for the implementation of the OFDM system as a result of less range of 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 . Cyclic prefix is copy of the some fraction of image finish. As long because the channel 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) . within the transmission of the LTE access technique used is Single Carrier-Frequency Division Multiple Access (SC-FDMA). High Peak Average Power quantitative relation (PAPR) happens because of random constructive addition of subcarriers and leads to spectrum spreading of signal resulting in adjacent channel interference. So power linearization techniques and compression purpose electronic equipment got to be wont to overcome this downside. These strategies are often implemented at base station (BS), however ar high-priced to implement at user instrumentality (UE). thus LTE uses SCFDMA with cyclic prefix on transmission, which is able to end in reduction of PAPR attributable to the presence of single carrier. Due to single carrier modulation impact of Inter-Services Intelligence are high in uplink and to beat from its impact low complexness equalizer are needed however SC-FDMA isn't sensitive to frequency offset and propagation.

III. WAVELET BASED OFDM SYSTEM

In previous works use of distinct Fourier rework was proposed for the implementation of OFDM . Wavelet transform show the potential to switch the DFT in OFDM. 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 . 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. quality also can be reduced by victimisation ripple transform as compared with the Fourier rework as a result of in wavelet quality is O[N] as compared with quality of Fourier rework of O[N log2 N] . 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 decomposition the high pass filter can take away the 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.

IV. 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. 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.

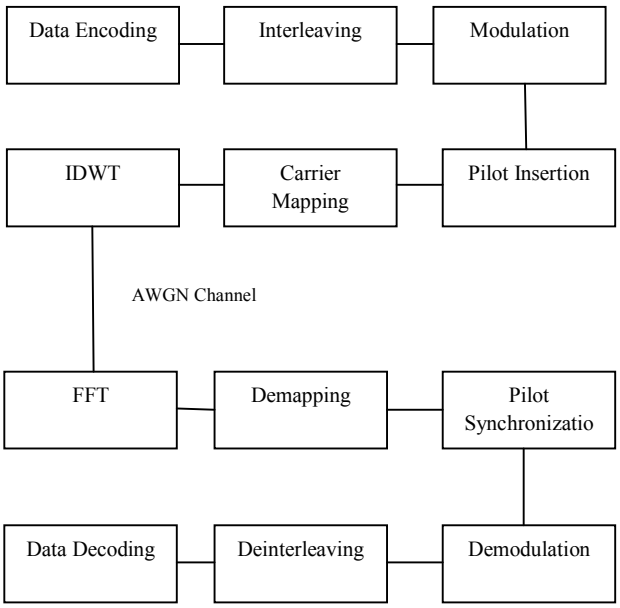

Fig 2. Wavelet based proposed OFDM system design

V. SIMULATION RESULTS

By using MATLAB performance characteristic of DFT based OFDM and wavelet based OFDM are obtained for QPSK modulation that are used for the LTE, as shown in figures 3. Modulation 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 but lower error rate. 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.

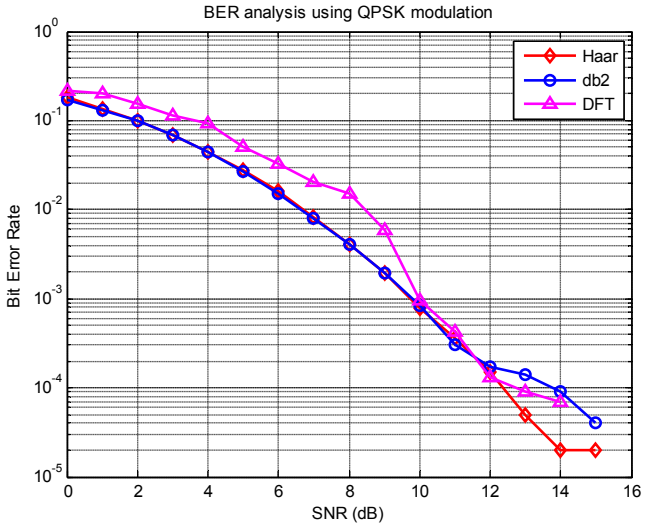

Fig 3. BER performance of wavelets and DFT based OFDM system using QPSK modulation

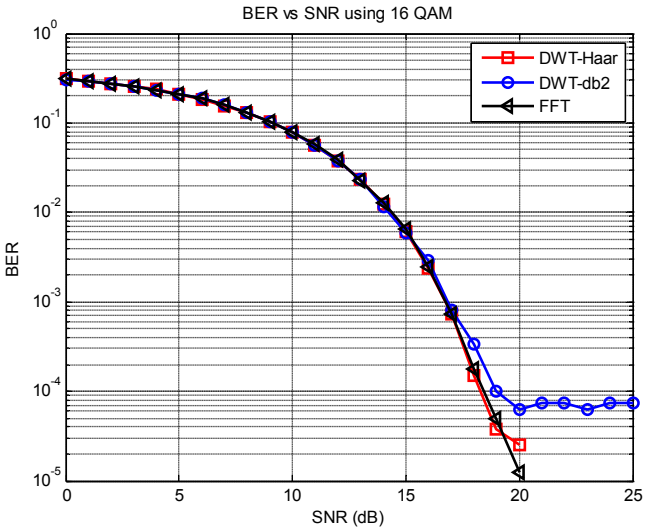

Fig 3. BER performance with 16-QAM modulation

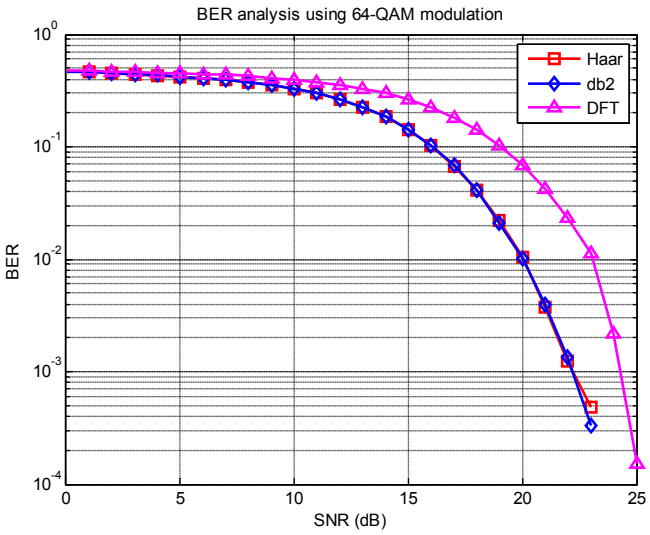

Fig 3. BER performance with 64-QAM modulation

Firstly the performance of DFT based OFDM and wavelet based OFDM are obtained for different modulation techniques. Different wavelet types daubechies2 and haar is used in wavelet based OFDM for QPSK.

Table I: Results Comparison (Haar Transform)

SNR	**BER with QPSK (Proposed)**	BER with 16-QAM	BER with 64-QAM
0	**0.1777**	0.3060	0.4621
1	**0.1343**	0.2922	0.4554
2	**0.0911**	0.2768	0.4451
3	**0.0648**	0.2567	0.4378
4	**0.0362**	0.2328	0.4386
5	**0.0192**	0.2088	0.4225
6	**0.0111**	0.1838	0.4085
7	**0.0050**	0.1609	0.3930
8	**0.0022**	0.1299	0.3750
9	**0.0010**	0.1025	0.3570
10	**0.0008**	0.0809	0.3300
11	**0.0002**	0.0560	0.3045
12	**0.0001**	0.0393	0.2735
13	**0**	0.0239	0.2242
14	**0**	0.0132	0.1840
15	**0**	0.0056	0.1424
16	**0**	0.0025	0.0968
17	**0**	0.0007	0.0569
18	**0**	0.0001	0.0301
19	**0**	0.0000	0.0131
20	**0**	0.0000	0.0056
21	**0**	0	0.0015
22	**0**	0	0.0003
23	**0**	0	0
24	**0**	0	0
25	**0**	0	0

VI. CONCLUSION

In this paper we have a tendency to analyzed the performance of rippling primarily {based} OFDM system and compared it with the performance of DFT based OFDM system. From the performance curve we've determined that the BER curves obtained from rippling primarily {based} OFDM area unit higher than that of DFT based OFDM. we have a tendency to used 3 modulation techniques for implementation that area unit QPSK, 16QAM and 64QAM, that area unit utilized in LTE. In rippling based mostly OFDM differing kinds of filters are often used with the assistance of various wavelets offered. we've used daubechies2 and haar wavelets, each offer their best performances at totally different intervals of SNR.

REFERENCES

[1] A. Ian F., G. David M., R. Elias Chavarria, "The evolution to 4G cellular systems: LTE-advanced", Physical communication, Elsevier, vol. 3, no. 4, pp. 217-244, Dec. 2010.

[2] B. John A. C., "Multicarrier modulation for data transmission: an idea whose time has come", IEEE Communications magazine, vol. 28, no. 5, pp. 5-14, May 1990.

[3] L. Jun, T. Tjeng Thiang, F. Adachi, H. Cheng Li, "BER performance of OFDM-MDPSK system in frequency selective rician fading and diversity reception" IEEE Transactions on Vehicular Technology, vol. 49, no. 4, pp. 1216-1225, July 2000.

[4] K. Abbas Hasan, M. Waleed A., N. Saad, "The performance of multiwavelets based OFDM system under different channel conditions", Digital signal processing, Elsevier, vol. 20, no. 2, pp. 472- 482, March 2010.

[5] K. Volkan, K. Oguz, "Alamouti coded wavelet based OFDM for multipath fading channels", IEEE Wireless telecommunications symposium, pp.1-5, April 2009.

[6] G. Mahesh Kumar, S. Tiwari, "Performance evaluation of conventional and wavelet based OFDM system", International journal of electronics and communications, Elsevier, vol. 67, no. 4, pp. 348-354, April 2013.

[7] J. Antony, M. Petri, "Wavelet packet modulation for wireless communication", Wireless communication & mobile computing journal, vol. 5, no. 2, pp. 1-18, March 2005.

[8] L. Madan Kumar, N. Homayoun, "A review of wavelets for digital wireless communication", Wireless personal communications, Kluwer academic publishers- Plenum publishers, vol. 37, no. 3-4, pp. 387-420, May 2006.

[9] L. Alan, "Wavelet packet modulation for orthogonally multiplexed communication", IEEE transaction on signal processing, vol. 45, no. 5, pp. 1336-1339, May 1997.

[10] K. Werner, P. Gotz, U. Jorn, Z Georg, "A comparison of various MCM schemes", 5th International OFDM-workshop, Hamburg, Germany, pp. 20-1 – 20-5, July 2000.

[11] IEEE std., IEEE proposal for 802.16.3, RM wavelet based (WOFDM), PHY proposal for 802.16.3, Rainmaker technologies, 2001.

[12] O. Eiji, I Yasunori, I Tetsushi, "Multimode transmission using wavelet packet modulation and OFDM", IEEE vehicular technology conference, vol. 3, pp. 1458-1462, Oct. 2003.