International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

BER analysis of DFT And Wavelet Based OFDM By Using SUI Channel CompareWith AWGN Channel

K.GOPAL SWAMY
Research Scholar
SITAMS,CHITTOOR
k.gopal422@gmail.com

K.MANJUNATH, M.Tech,
Guide designation
Asst.professor,Dept of ECE
SITAMS, CHITTOOR
manjunathak83@gmail.com

Abstract

The OFDM communication model overcomes the drawbacks of conventional communicational model and offers the high data rate, and high spectral efficiency. Compared to conventional approaches the 4th generation Long term evolution application has better spectral efficiency in terms of accuracy and high data rate, the 4th generation Long term evolution approach is formed by the collaboration of OFDM and MIMO. Although OFDM has many advantages over FDM but it suffers from inter carrier interference and inter symbol interference when multiple carriers are used and due to this interferences loss of Orthogonality happens, in order to overcome these interferences usage of cyclic prefix has became mandatory. But usage of cyclic prefix shows huge negative impact on bandwidth efficiency as the cyclic prefix approach consumes nearly 20% of bandwidth and BER performance too affected. The main objective of this paper is to get better performance of Wavelet based OFDM system using SUI channel. Considering this goal, the simulation has been done. The performance is analyzed, which shows satisfactory BER for higher SNR. This result is compared with the performance of wavelet based OFDM using AWGN channel. This article shows the better performance of Wavelet based OFDM system using SUI channel than AWGN channel.

KEYWORDS: OFDM, MIMO, LTE, Cyclic prefix, wavelet transform, AWGN channel, SUI channel.

1. INTRODUCTION

In olden days people used to communicate with distant counterparts by make usage of traditional approaches like sending the information with birds, sending people as ambassador to convey the information. Most of the researchers termed 21st century as Communication arena due to the high end technological advancement in this area which makes communication fast and reliable. The intense research classified communication into two categories a) wire based communication b) wireless based communications. Wire based communications is considered as most useful tool in world wars to convey information from one end to another in

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

1940's and optical fiber plays a crucial role in wire based communication mechanism and after completion of war the dominance of United States of America (USA) and Union of Soviet Socialist Republics (USSR) over the world makes the research on communication so fast that in two decades communication research grows from daily life communication to satellite communication and this development mainly because of wireless communication.

2. RELATED CONTENT

2.1 OFDM AND ITS ORTHOGONALITY

In orthogonal frequency division multiplexing communication model the sub carrier used are orthogonal to each other. The Orthogonality helps in employing the overlapping between the sub carriers in the respective frequency domain. The accuracy of communication model is based on how effective the bandwidth is used and this is technically termed as spectral efficiency or bandwidth efficiency, the acquired bandwidth efficiency is free of Inter carrier interference and the absence of Inter carrier interference (ICI) is mainly because of usage of Orthogonality in orthogonal frequency division multiplexing.

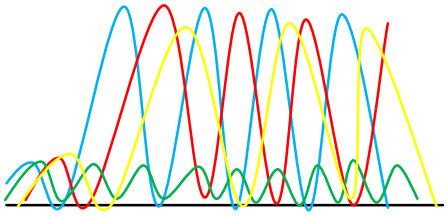


Figure 1: Orthogonality in orthogonal frequency division multiplexing (OFDM)

2.2 BASIC OFDM SYSTEM

The orthogonal frequency division multiplexing block diagram is illustrated as follows in figure 3. The input random signal data rate streams (high) are converted into data rate streams (low). The important aspect in the OFDM block diagram is the modulation technique which modulates the low data rate streams in parallel way and this parallel stream given input to the IFFT block which transforms the frequency data to time data before it reaches the channel. Adding the cyclic prefix acts as the guard interval and the reverse of transmission is accomplished at receiver end.

Figure 2: Block diagram of Basic OFDM system

2.3 MIMO OFDM SYSTEM

The below block diagram represents the MIMO-OFDM system which comprises of transmitters and receivers in multiple way. The input data (digital) is generated by binary source generator as shown in below figure and the binary data is modulated with modulation approach such as BPSK, QPSK and QAM with several different constellations. The serial to parallel performs the task

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

to convert the serial data to the parallel mode in N various sub streams. Then these various sub streams are modulated through the IFFT modulation block.

The IFFT block in the block diagram in design to transform the frequency to time domain for obtaining the delay related issues at the channel and then guard interval named CP is inserted to tackle the issues like ICI/ISI. The OFDM symbols are initialized in the time domain which has specified length before giving it to the channel then the operation is performed in the inverse direction to remove all the operations which are performed and gets the output as OFDM signal in MIMO format.

3. EXISTING METHOD AND ANALYSIS

3.1 OVERVIEW OF EXISTING METHOD

High speed communications has became part of human daily lives to transfer the data from one entity to another entity hassle free. As 21st century is regarded as high speed communication era by international standards and agencies, an international standard named ITU (International telecom union) for the radio communication designed number of standards for high speed communication with high data rate. The data rate (communication speed) plays a crucial role in high speed communications and the prominence of data rate and its requirement as specified by International Mobile Telecommunications Advanced project (IMT-Advanced).

The revolution of high data rate communications initialized in the year 1998 by the evolution of 3GPP and in the latter years the research work of 3GPP has been carried out on revolutionary project namely Long term evolution (LTE) to show the immense importance of two networks namely Radio access network(RAN) and core network. On the other contrary the 4G application based on 3GPP network was far more advanced than conventional 3GPP in terms of data rate and efficiency and these two reasons makes 4G more advanced. In order to make the access of 3GPP and 4G application possibility in real time scenario an advance communication model is required and compared to all communication methods. The orthogonal frequency division multiplexing is one of the techniques employed in Long term evolution for better data rate by enhancing it with appropriate parameters.

The requirements of high speed data communications are perfect utilization of spectrum and spectrum efficiency are two different parameters for different wireless applications and in order to meet the practical requirement as shown below

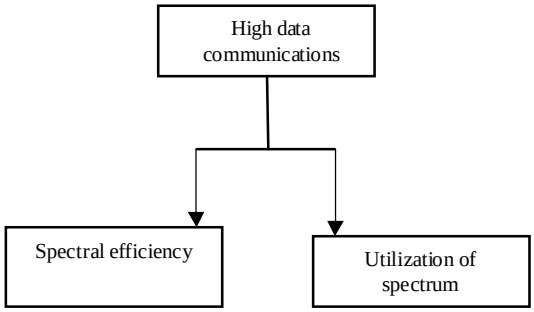


Figure 3.1: High data communication requirements

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

The term spectral efficiency is plays a prominent role in the high speed communications, as the speed of the communications mainly depends on the two important aspects namely the effective utilization of the of the spectrum and secondly the spectral efficiency which mainly reveal the statistics of the how effective the available bandwidth is utilized. The usage of the multi carrier approach has been the revolutionary idea to meet the practical requirements using high speed communications. The usage of multi carrier has two important advantages in the area of the high speed communications as follows

(1) Generally in conventional approaches when compared to the orthogonal frequency division multiplexing the enhancement techniques usage plays an important role to remove the impact of noise and noise related contents on the signal, but on the other end the enhancement techniques usage dramatically increases the run time complexity. But in the multi carrier approach there is no need of enhancement technique and the absence of enhancement technique help to improve the performance.

(2) The signal fading has been a unresolved issue in most of single carrier based communication techniques, although number of approaches has been reported in the literature but none can meet the practical requirement. The multi carrier modulation has one innovative characteristic which increases the symbol time duration by which the fading impact can reduce in reliable way.

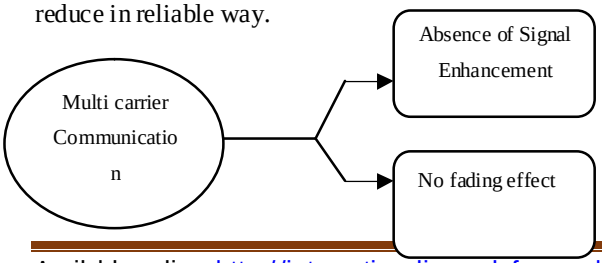
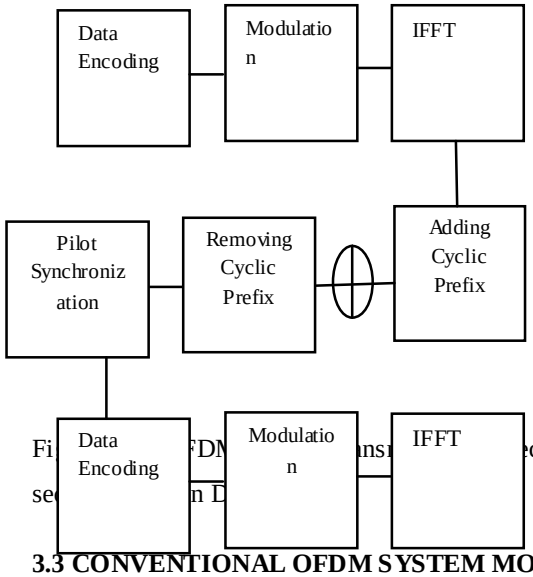


Figure 3.2: Advantages of multi carrier communication approach

3.2 ANALYTICAL APPROACH OF DFT BASED OFDM SYSTEM

The proposed analytical framework compares the OFDM system performance based on wavelet with the traditional OFDM system with various long term evaluation modulation techniques. In order to calculate the wavelet based OFDM system in this proposed we make use two wavelets namely as follows

(a) Haar wavelet(b) Daubechies2 wavelet



Fi FDM ansr eceiver se n D

3.3 CONVENTIONAL OFDM SYSTEM MODEL

The conventional orthogonal frequency division multiplexing (OFDM) has a basis set which is orthogonal in nature which is formed by using the sinusoids of the discrete Fourier transform. In traditional orthogonal frequency division

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

multiplexing (OFDM) approach the sinusoids of the DFT is correlated with the respective input signal and this correlation is done with the each and every sinusoidal basis function.

Here the sinusoids which are used to correlate with input signal are the sub carriers of orthogonal frequency division multiplexing (OFDM) itself. Some of the important points in the DFT based orthogonal frequency division multiplexing (OFDM) are as follows

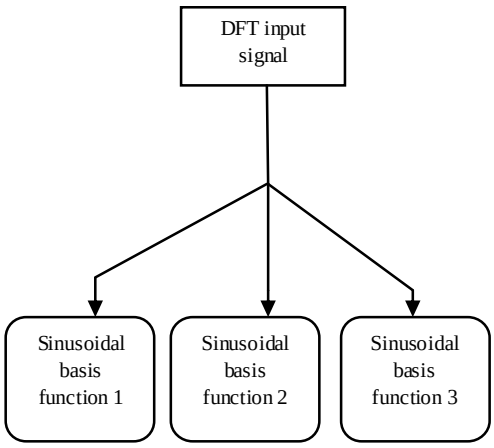


Figure 3.4: Correlation between input signal with sinusoidal basis functions

Once the transmitted information successfully transmitted at the receiver end, the receiver receives the data in combined form of signals. In order to meet the practical requirement and to accomplish the task in fast way, in OFDM fast Fourier transform (FFT) usage and inverse fast Fourier transform (IFFT) is encouraged. The main advantage of the fast Fourier transform usage is it completes the task in less number of computations when compared with traditional approaches.

Due to dispersive time intervals nature at the receiver section the drawbacks like selective fading and as this multipath fading results in the ICI and ISI, and at the receiver end in order to remove this drawbacks from the OFDM system usage of (Cyclic prefix) CP is encouraged. Cyclic prefix (CP) is generally occupies around 20% of the bandwidth means it is copy of selective part of symbol. As long as the delay spread of channel remains in the limit of the cyclic prefix there would not any loss of orthogonality in the OFDM signal. For long term evolution LTE) application the data related to different users in the downlink scenario is multiplexed in the frequency domain and this all process is termed as the orthogonal frequency division multiplexing (OFDM).

Generally the drawbacks like PAPR occurs in the orthogonal frequency division multiplexing (OFDM) due to random nature of the constructive approach of addition of subcarriers. In order to overcome the problems above mentioned a power linearization technique and a point amplifier needs to compress the abnormal power fluctuations and all this process is done at the base station(BS). But in practical all this equipment increases the cost so the usage of SC FDMA approach is encouraged in order to reduce the PAPR and all this happen because of the presence of the single sub carrier. Although single carrier has far more advantages over its traditional approaches but it too suffers from drawback. In single carrier introduction of ICI is happens at the uplink scenario and in order to remove it an low complexity equalizer is required but the SC FDMA

not sensitive to the parameters like Doppler shift and frequency offset.

3.4 WAVELET BASED OFDM SYSTEM MODEL

The usage of wavelets has potential to replace the traditional discrete Fourier transform (DFT) and the following analysis proves the importance of wavelets over traditional discrete Fourier transform (DFT) in detailed way

As traditional discrete Fourier transform (DFT) takes more time to accomplish task in both frequency and time separately but in wavelets both frequency and time domain signal analysis is accomplished jointly. The main advantage of the wavelets over traditional discrete Fourier transform (DFT) is multi resolution analysis where the respective input signal is decomposed into frequency components for the accurate analysis with different resolution matching to scale. The wavelet transformation has an innovative system with lot features one such feature is wavelet filter by using this system can be designed as required. One more advantage of wavelets over conventional approaches is generation of the multi resolution signal.Wavelets has good orthogonality and the localization of the signal is done in both time and frequency domain simultaneously. Because of the unique nature of the wavelets the power related to the ISI and ICI can reduce dramatically.

To reduce the impact of ISI and ICI in the system the usage of CP is used which literally consumes the 20% power which shows adverse effect on the spectral efficiency. The usage of the wavelets reduced complexity O[N] when compared to the Fourier transform complexity O[N log2N].The system design of the wavelet based OFDM system is simple while compared with the DFT based OFDM mechanism.The absence of the cyclic prefix gives more bandwidth efficiency in the wavelet based OFDM than traditional DFT based approach. The input signal in the wavelet transformation is passed through various filters and latter the signal is decomposed into low pass sub bands and high pass sub bands will form when the signal is passed through the filters. The wavelet transformation approach divides the input into below the highest frequency and above the highest frequency, the high pass filter starts analysis on the input signal and remove the all frequencies which are localized at the below half of the highest frequency. Simultaneously the low pass filter analyzes the signal and removes the all frequencies above the level of highest frequency. The two main advantages of the wavelet decomposition are as follows

(a) The wavelet decomposition halves the time resolution of the signal

(b) The resolution in terms of the frequency are doubled and it repeats till final

In wavelets processing two types of coefficients obtained, initial coefficients are termed as detailed coefficients which are obtained through the high pass filter and latter coefficients are termed as coarse approximations which are obtained through low pass filter with processing in terms of scaling process. Till

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

the desired level the process continues.The respective wavelet decomposition is as follows

$$y_{high}[k] = \sum_n x[n]\, g[2k-n]$$

$$y_{low}[k] = \sum_n x[n]\, h[2k-n] \quad (1)$$

The above equation notations are termed as follows

The input signal is notated by, input signal =$x[n]$,

The impulse response function of the low pass filter is notated by, impulse response function = $h[n]$,

The filtering and decimation factor by 2 is given by $y_{high}[k]$ and $y_{low}[k]$

The inverse DWT process is initialized by fist step up sampling and then the signal is passed through filters to accomplish the task. The reconstruction of data is done by combining the signal after filtering. The number of levels used in the reconstruction process should be same as number of steps performed at the decomposition step

3.5 DISCRETE WAVELET BASED OFDM SYSTEM MODEL

(1) In traditional approaches we make use DWT and IDWT and the conventional approaches are replaced with DWT and IDWT.

(2) The main advantage of the proposed method is absence of the cyclic prefix which increases the bandwidth efficiency.

(3) In proposed method make use of the additive white Gaussian channel is used

After modulation approach latter two steps are performed one in insertion of pilot is done and secondly the sub carrier mapping, after performing these two steps the IDWT process performed by which Orthogonality is preserved is preserved. The IDWT process the signal from the time domain to the frequency domain.

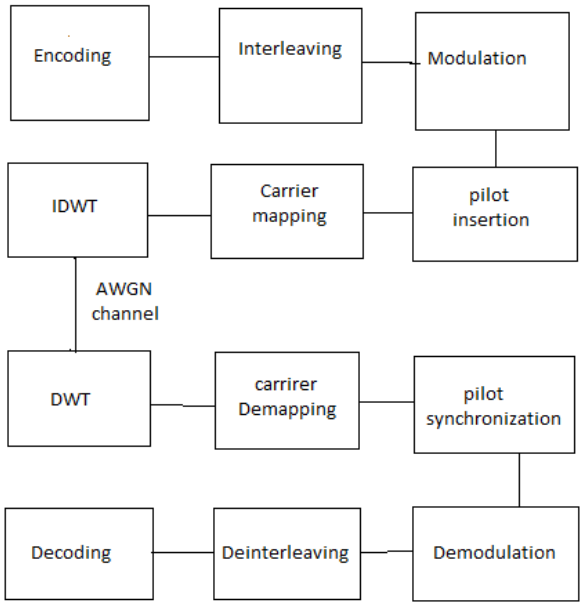


Figure 3.5: wavelet based OFDM

After passing through the channel the signal is processed by using the DWT then removal of pilot insertion is done and finally demodulation is done, then the decimal data is converted in to binary form then de interleaved. The transmitted data is decoded at the receiver end.

4 PROPOSED METHOD

In our Existing method AWGN Channel is used to analyze BER performance. In proposed method

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

Stanford University Interim (SUI) Channel is used to analyze BER performance. SUI Channel is used rather than AWGN because AWGN is used only for indoor applications, while SUI is used for both indoor and outdoor applications. Compared to AWGN channel, SUI Channel provides better performance.

The figure 4.1 structure is general for Multiple Input Multiple Output (MIMO) channels and includes other configurations like Single Input Single Output (SISO) and Single Input Multiple Output (SIMO) as subsets. The SUI channel structure is the same for the primary and interfering signals.

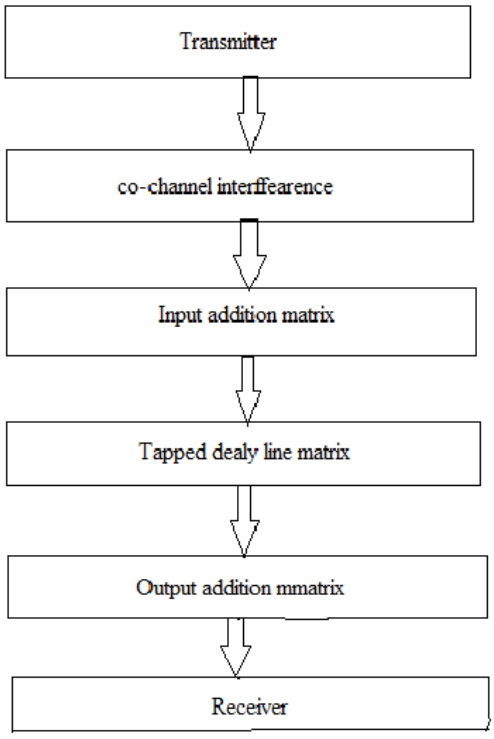


Figure 4.1:General structure of SUI channel

Input Mixing Matrix: This part models that correlation between the input signals if multiple transmitting antennas are used.

Tapped Delay Line Matrix:This part models the multipath fading part of the channel. The multipath fading is modeled as a tapped-delay line with 3 taps with non-uniform delays. The gain associated with each tap is characterized by a distribution (Ricean with a K-factor > 0, or Rayleigh with K-factor = 0) and the maximum Doppler frequency.

Output Mixing Matrix: This part models the correlation between the output signals if multiple receiving antennas are used.

Scenario for SUI channels:

1.Cell size: 6.4 km (4 miles)

2.BTS antenna height: 17 m (50 ft)

3.Receive antenna height: 3 m (10 ft)

4.BTS antenna beamwidth: 120_o

5.Receive Antenna Beamwidth: omnidirectional (360_o) and 30_o

For a 30_o antenna beamwidth, 2.3 times smaller RMS delay spread is used when compared to an omnidirectional antenna RMS delay spread [10]. Consequently, the 2_{nd} tap power is attenuated additional 6 dB and the 3_{rd} tap power is attenuated additional 12 dB (effect of antenna pattern, delays remain the same). For the omnidirectional receive antenna case, the tap delays and powers are consistent with the COST 207 delay profile models.

6.Vertical Polarization only.

5SIMULATION RESULTS AND ANALYSIS

Although lot of progress has been made in the past to design the distortion less high speed communication mechanism by removing the commonly erupting drawbacks but still the BER

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

analysis in different transform based OFDM system and the performance analysis of the by using Matlab as source of medium in applications like LTE in the Discrete Fourier transform (DFT) based OFDM and Discrete wavelet transform based OFDM system model is still considered as concerned area in the field of high speed communications.

The proposed work mainly utilized two high transform techniques namely DFT and DWT based OFDM system model by using different modulation approaches in different conditions. The different modulation techniques used in the proposed work are used for the Long term evolution application which is used for the 4G high speed communications are QPSK, QAM in different levels like 16 QAM, 32 QAM, and 64 QAM etcThe important points belongs to different modulation approaches are as follows

(1) The commonly used Quadrature Phase Shift Keying (QPSK) has one common drawback over other modulation approaches. Generally Quadrature Phase Shift Keying (QPSK) does not have capability to carry the transmitted data at great speed levels.

(2) To evaluate the performance analysis of each and every communication model with respect to some performance evaluators namely peak signal to noise ratio, in practical scenario generally when good quality of peak signal to noise ratio is detected then obviously usage of modulation techniques which are higher in level are preferred over Quadrature Phase Shift Keying (QPSK)

(3) As many research works opts for higher level modulation approaches over Quadrature Phase Shift Keying (QPSK) then certainly Quadrature Phase Shift Keying (QPSK) does not require high PSNR value.

Figure 5.1: DFT and DWT based OFDM with various modulation techniques

(3) The simulation process shows that the averaging of the any value of SNR is performed and the task is accomplished in different step for different averaging values in order to yield the final BER value by repeating the task consistently till to reach final level.

(4) The BER analysis in DWT based OFDM does not required cyclic prefix and the main advantage of the wavelets over traditional discrete Fourier transform (DFT) is multi resolution analysis.

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

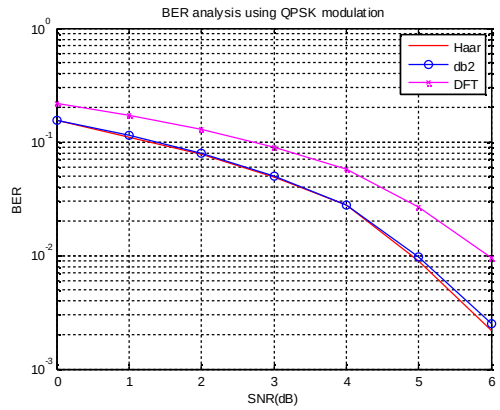


Figure 5.2: The analysis of the DFT based OFDM and DWT based OFDM in QPSK modulation using AWGN channel.

Analysis

(1) The analysis of the bit error rate (BER) performance of wavelet based orthogonal frequency division multiplexing is good than the conventional DFT based orthogonal frequency division multiplexing.

(2) The orthogonal frequency division multiplexing which is based on dB2 wavelets has better performance when the modulation used is QPSK

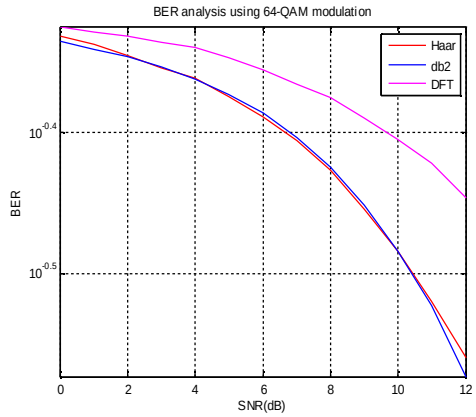


Figure 5.3: The analysis of DFT based OFDM and DWT based OFDM in 64-QAM modulation

Analysis

(1) The analysis of the bit error rate (BER) performance of wavelet based orthogonal frequency division multiplexing is good than the conventional DFT based orthogonal frequency division multiplexing.

(2) The orthogonal frequency division multiplexing which is based on Haar, dB2 and 16 QAM has better performance than DFT based OFDM almost similar in terms of statistics related to BER when the modulation used is QPSK

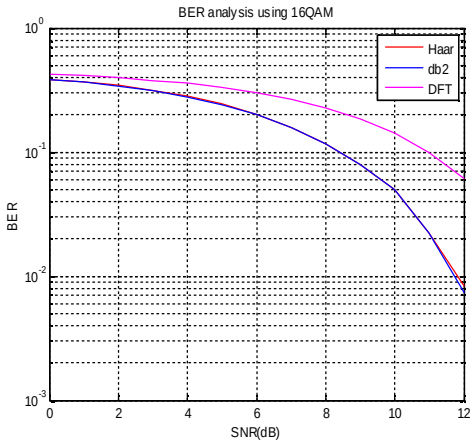


Figure 5.4: The analysis of DFT based OFDM and DWT based OFDM in 16-QAM modulation

Analysis

(1) The analysis of the bit error rate (BER) performance of wavelet based orthogonal frequency division multiplexing is good than the conventional DFT based orthogonal frequency division multiplexing.

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 11
July2016

(2) The orthogonal frequency division multiplexing which is based on Haar, dB2 and 64 QAM has better performance almost similar in terms of statistics related to BER when the modulation used is QPSK.

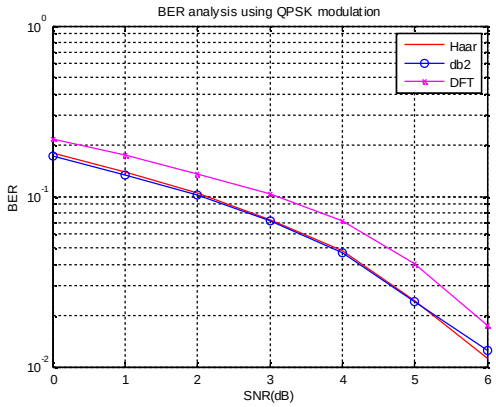


Figure 5.5: The analysis of the DFT based OFDM and DWT based OFDM in QPSK modulation using SUI channel.

Analysis

The analysis of bit error rate (BER) performance of wavelet based orthogonal frequency division multiplexing using AWGN Channel is shown in Fig.4.1. But the performance of BER using SUI is more efficient.

Comparition between AWGN channel and SUI channel values using different modulation techniques:

SNR	DFT BER	DWT based db2 BER	DWT based Haar BER
1	0.1893	0.1368	0.1368
2	0.1518	0.1031	0.1031
3	0.1158	0.0728	0.0728
4	0.0870	0.0482	0.0446
5	0.0475	0.0238	0.0226
6	0.0289	0.0111	0.0110

Table 5.1. AWGN channel values

SNR	DFT BER	DWT based db2 BER	DWT based Haar BER
1	0.1695	0.1123	0.1123
2	0.1274	0.0796	0.0796
3	0.0885	0.0507	0.0507
4	0.0563	0.0296	0.0296
5	0.0256	0.0096	0.0091
6	0.0086	0.0024	0.0020

Table 5.2. SUI channel values

The BER is better performance of wavelet based OFDM system using SUI channel compare to the AWGN channel.

6. CONCLUSION

In this work the main Aim is to reduce BER,ISI and ICI. The analytical performance of wavelet based orthogonal division multiple has better performance than traditional discrete Fourier transform OFDM. In this paper a novel wavelet based OFDM model is presented which is mainly intended to provide good Orthogonality and better spectral efficiency using various modulation techniques, in the SUI channel. The BER better performance of

wavelet based OFDM system using SUI channel compare to the AWGN channel.

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. TjengThiang, 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.