ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 2, Issue 12, December- 2013

Performance Comparison of OFDM and QAM system On Multipath Channel Environment

Mr.Lambodar Patel,
Student,M.Tech
RCET,Bhilai(C.G.)

Mr. Majid Ahmed Siddiqui
Asso. Professor
RCET, Bhilai(C.G.)

Abstract-

The main aim of this paper is to compare the performance of OFDM and QAM system in multipath channel. A simulation program is developed for OFDM system as well as for multipath channel. Single carrier QAM and multi-carrier OFDM has been compared visually, graphically and Bit error rate has also been computed for quantitative analysis.

Keywords :

ISI, OFDM , QAM,IFFT FFT Orthogonal frequency ,multipath distortion.

I. INTRODUCTION

With the growth in the information network and day by day increasing use of these network demands a new communication technique which give high data rate while maintaining the low bit error rate. Orthogonal Frequency division multiplexing (OFDM) technique is one such modulation technique which provides high data rate. Most of the high speed communication techniques suffer from inter-symbol interference(ISI).ISI occurs when original signal are interfered by the reflected version of the original signal which is produced when original signal is reflected with large objects such as mountain, buildings its. When receiver receive this original signal along with the reflected versions (multipath signals) then it cannot decode the signal correctly. This phenomena is known as inter-symbol interference and it is significant in high speed transmission. Low speed transmission never suffer such problems. Since the delay produced in multipath remain constant, ISI poses a limitation in high speed communication[1].

OFDM is able to overcome this problem by carrying out many low speed transmission simultaneously. In other words, an OFDM is digital modulation technique which perform data transmission by using several narrow-band sub-carrier instead of single wide-band carrier. In OFDM multiplexing is performed to independent signal which are sub-set of one main signal. In short, OFDM is the combination of modulation and multiplexing operation with better impulse noise and ISI immunity, high spectral efficiency and low complexity [2].

OFDM is different from FDM in the sense that in FDM

Different frequency band is allotted to different channel and a guard band is provided between different channel to avoid adjacent channel interference. A band pass filter is used in to separate out the different channel in the receiver side. But in OFDM, the

scenario is totally different. In OFDM, the adjacent channel spectrum are overlapped to each other which seem to create the adjacent channel interference but since in OFDM, the sub-carriers are orthogonal to each other therefore this technique is able to avoid the adjacent channel interference smartly. Due to its advantage of sending the more information in a limited band width and its ability to transmit the data in reliably in multipath environment [3-5], OFDM technique is used in almost all new broadband communication schemes. The Bit error rate analysis shows that the performance of OFDM is better than the CDMA and hence OFDM is replacing the CDMA which is being used in current existing 3G system[6][7].

A typical OFDM system is shown in figure 1,In this system first of all the high speed serial data is converted to parallel form of low speed data by using serial to parallel converter block based on [8][9].these parallel data is then arrange in frequency spectrum in a suitable manner. An inverse fast fourier transform[10-12] convert these frequency domain data set into time domain. Here IFFT is used because it satisfy the condition of orthogonality for different frequency spectrum. In this system since the transmitted signal is the vector sum of orthogonally modulated channels which require high peak to average power ratio, therefore it require a device of large dynamic range[13-15].This paper present a performance of multicarrier OFDM over single carrier QAM. A matlab program has been written to simulate the OFDM and QAM.

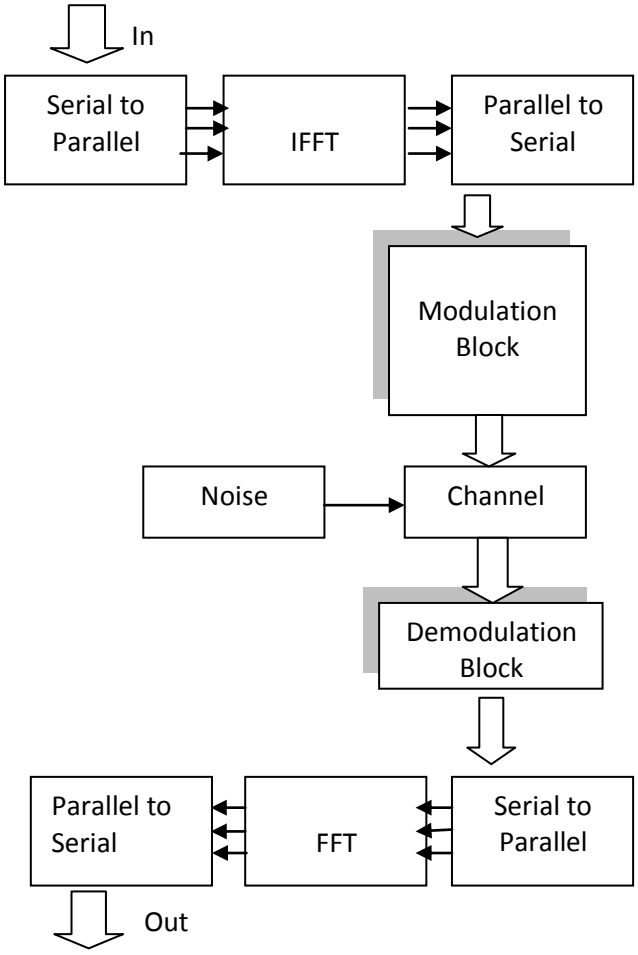

Figure 2 OFDM System

II. METHODOLOGY

In order to evaluate the performance of OFDM over QAM, a simulation program has been designed using MATLAB as a platform.

Basic Block diagram of OFDM system is shown in Figure 1 while the simulation flowchart is shown in Figure2 and figure 3

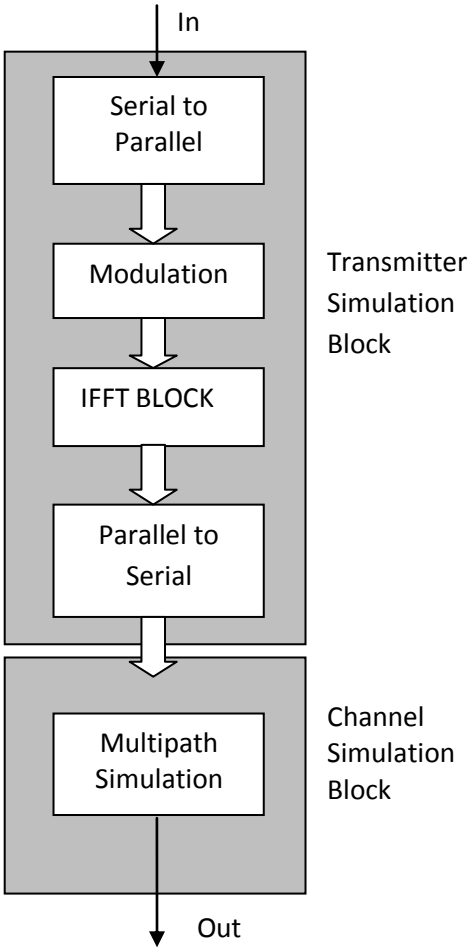

Figure 3 OFDM Simulation Flowchart (Transmitter and Channel section)

Steps of the algorithm n the Transmitter side are as follows-

Step-1 Input the Data (Binary, text, audio).

Step-2 Convert the serial data into parallel form.

Step-3 Modulate the parallel data to orthogonal frequencies.

Step-4 Convert the parallel data in to time domain waveform using inverse Fourier transform (IFFT).

Step-5 Combined all these parallel waveform to create the single time domain waveform for transmission.

Step-5 Transmit this signal over the simulated channel which has predefined multipath characteristics.

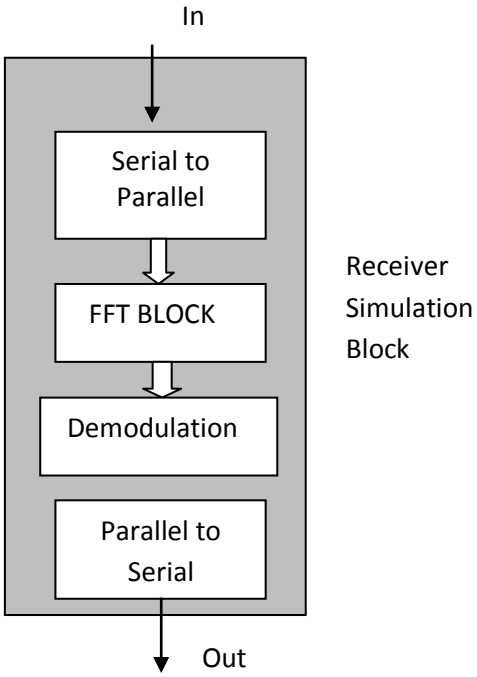

Figure 4 OFDM simulation Flowchart (Reciever Section)

Steps of the algorithm in the Reciever side are as follows-

Step 1 Get the OFDM signal.

Step 2 Convert these parallel data into frequency domain with the help of FFT. The data is now available in different orthogonal carriers in modulated form.

Step-3 Demodulate these signal to get the baseband signal.

Step-4 Convert these data in to serial form to get back the original signal.

III. EXPERIMENTAL RESULT

A MATLAB Simulation program is written to compare the performance of multi carrier OFDM and single carrier-QAM modulation techniques under multipath channel environment. A multipath channel is

simulated by adding attenuated and delayed copies of the transmitted signal to the original signal. User can set the strength of the multipath in a channel in three level i.e. zero multipath environment, small multipath environment and large multipath environment. A sound file and a text message has been taken as the signal and fed to the OFDM system and QAM system and the output obtained by both the system is compared visually and by computing the Bit error rate (BER).

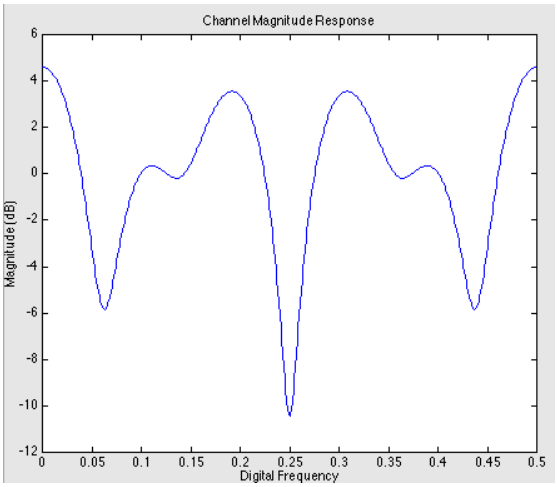

Figure 4 Characteristic of simulated multipath channel.

Figure 4 shows the magnitude response of simulated multipath channel through which the OFDM and QAM transmission takes place. Frequency domain representation of the input data file in QAM is shown in figure 5 while the spectrum of received data file(in Brown color) in QAM is shown in figure 6 along with the spectrum of original data file. From these figures it is clear that QAM produced a lot of distortion during transmission. On the other hand the spectrum of original sound file in OFDM system is shown in Figure 7. Figure 8 depicts the spectrum of received data file (in gray color)along with the original data file (in black color). From this figure it is clear that OFDM also produced some multipath distortions.

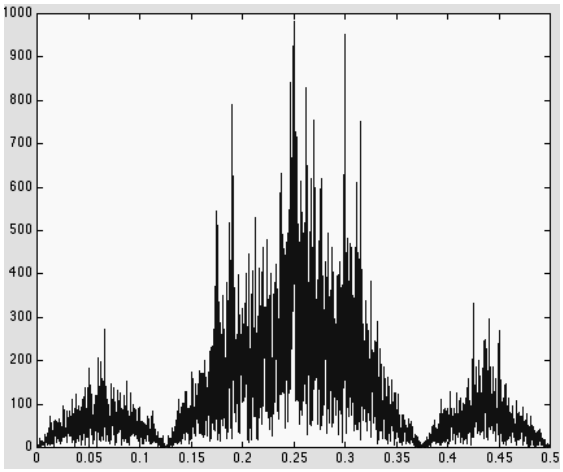

Figure 5 Frequency domain representation of transmitted sound file in QAM.

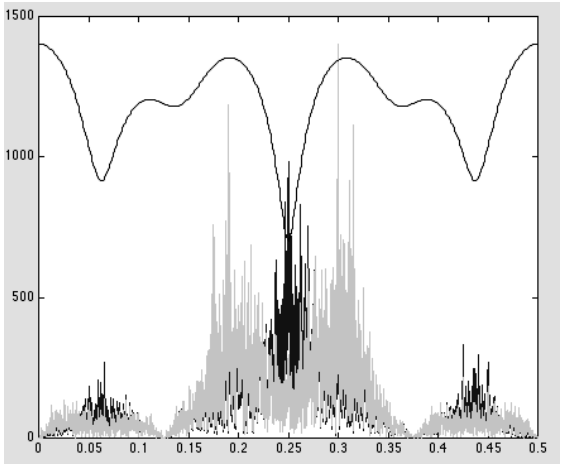

Figure 6 Data received by QAM system (Brown) overlayed on the original data (Black).

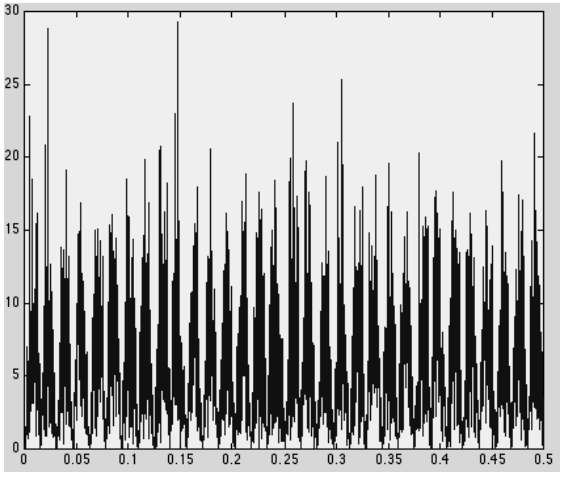

Figure 7 Frequency domain representation of the transmitted sound file in OFDM.

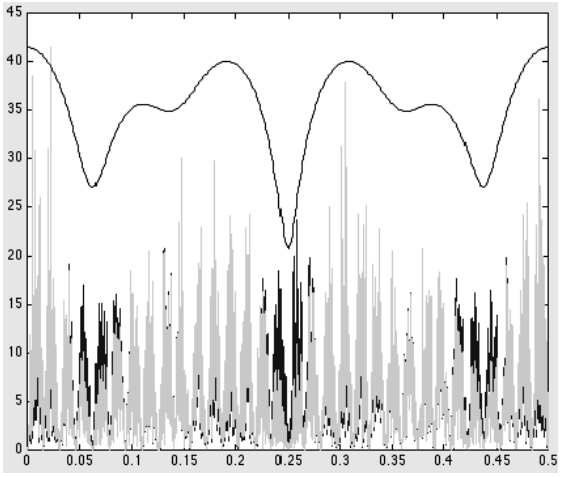

Figure 8 Data received (In gray) in OFDM system over-layed on the original data (Black)

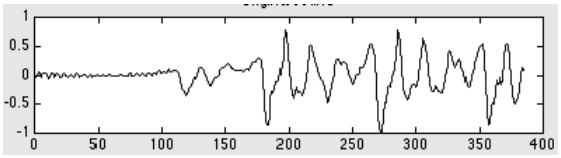

Figure 9 Original Sound file

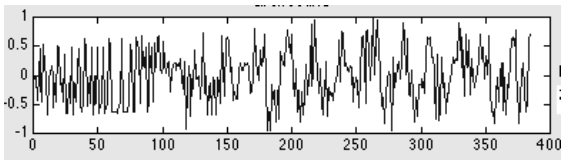

Figure 10 Sound file obtained by QAM

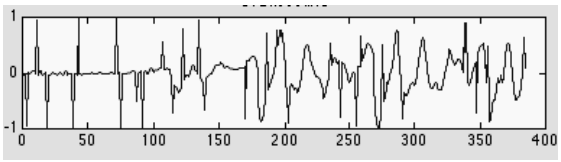

Figure 11 Sound File obtained by OFDM

Similarly if we input the sound file in OFDM system then the recovered sound file spectrum in QAM and OFDM is shown in figure 10 and figure 11 respectively while the original sound file spectrum is shown in fig. 9.

The response of OFDM system on text message is shown in Figure 12 and figure 13.

Figure 12 depicts the spectrum of text message (left) and the spectrum of transmitted text message while the figure 13 shows the spectrum of recovered text and the spectrum of recovered data. Similarly the response of QAM system for the same text message is shown in figure 14 and figure 15.

Figure 16 shows the original text message and recovered message from OFDM and QAM transmission.

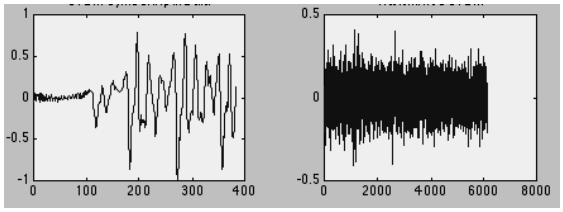

Figure 12 OFDM Text input data (left) and transmitted OFDM data (Right)

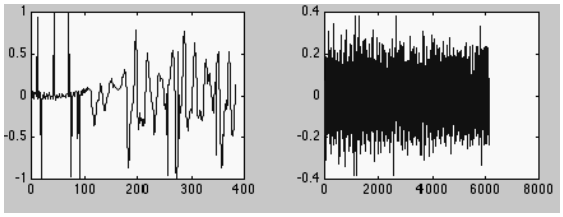

Figure 13 OFDM recovered text (Left) and Received OFDM (Right).

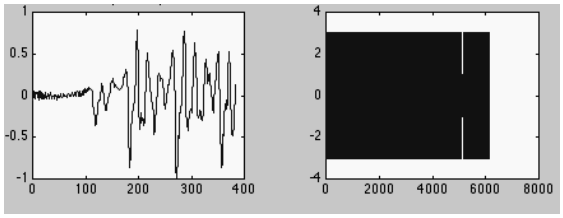

Figure 14 QAM text input data(Left) and Transmitted QAM (Right)

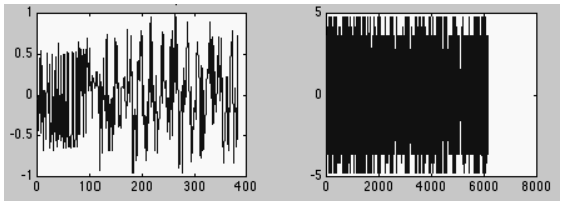

Figure 15 QAM recovered text (Left) and Received QAM (Right).

Original Text file	OFDM Transmission	QAM Transmission
This is a text file for testing OFDM	This is a toxt file for testing OFDM.	Tlismse$xext$ªile $jo" xesdingOGDM

Figure 16 Text file comparison for OFDM and QAM

In order to evaluate the performance of both the system quantitively, Bit error rate(BER) also computed for different multipath environment and tabulated in table 1 and table 2. A graph is also plotted for comparing the bit error rate for text and sound file and shown in figure 17 and figure 18.

Table 1 Bit Error rate (BER) for sound file

Multipath Environment	Bit Error Rate (BER)	
	OFDM	QAM
zero	0.070%	0.993%
small	0.901%	5.38%
large	1.58%	23.176%

Table 1 Bit Error rate (BER) for Text file

Multipath Environment	Bit Error Rate (BER)	
	OFDM	QAM
zero	0.038%	0.077%
small	1.047%	8.62%
large	1.478%	22.10%

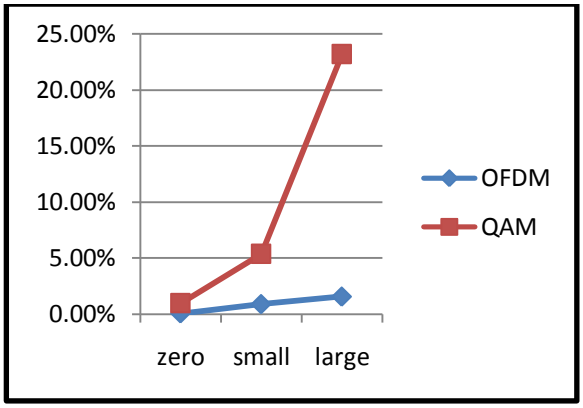

Figure 17 Graph for sound file for different multipath environment

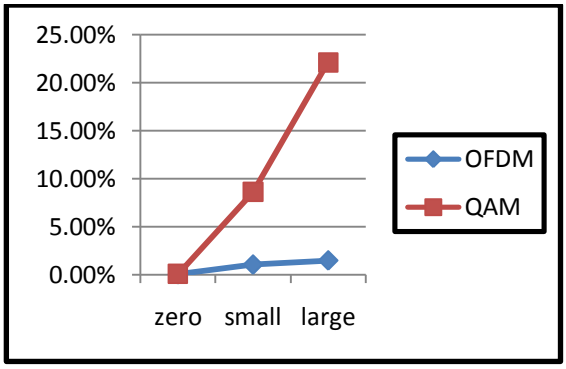

Figure 18 Graph for text file for different multipath environment.

From the Figure 1 to figure 16, Table 1, table 2 and Figure 17, figure 18, it is clear that the performance of OFDM system is far better than the QAM in different multipath environment.

References

[1] Keller, Thomas, and Lajos Hanzo. "Adaptive Multicarrier Modulation: A Convenient Framework for Time Frequency Processing in Wireless Communications." *IEEE Proceedings of the IEEE* 88 (May, 2000): 609-640

[2] Wang, Zhengdao, and Georgios B. Giannakis. "Wireless Multicarrier Communications." *IEEE Signal Processing Magazine* (May, 2000): 29-48.

[3] Shaoping Chen and Cuitao Zhu, "ICI and ISI Analysis and Mitigation for OFDM Systems with Insufficient Cyclic Prefix in Time-Varying Channels" IEEE Transactions on Consumer Electronics, Vol. 50, No. 1, February 2004.

[4] M. S. Islam, G. R. Barai, and A.Mahmood, "Perfor-mance analysis of different schemes using OFDM techniques in Rayleigh fading channel," International Journal of Funda-mental Physics Science, Vol. 1, No. 1, pp. 22-27, June, 2011.

[5] Van Wyk, J. and Linde, L., "Bit error probability for a M-ary QAM OFDM-based system," in IEEE Trans. On Wireless Comm., , pp. 1-5, 2007.

[6] Mehul Jain and M. Mani Roja, " Comparison of OFDM with CDMA System in Wireless telecommunication for multipath delay spread," The 1st IEEE and IFIP International Conference in Central Asia, 26-29 Sept., 2005, Pages 5.

[7]Bernard Sklar, Digital Communication Fundamentals and Applications, Second Edition, Pearson Education, Asia, 2000.

[8]B. J. Periris, R. M. A. P. Rajatheva, and V. Tralli, "Performance ofself ICI cancellation based OFDM systems with carrier frequency offset estimation", in *3rd Int. Symp. Wirel. Pers. Multimed. Commun.*, Bangkok, Thailand, 2000, pp. 680{683.

[9]P. H. Moose, \A technique for orthogonal frequency division mul-tiplexing offset correction", *IEEE Trans. Commun.*, vol. 42, no. 10,pp. 2908{2914, 1994.

[10] A. D. S. Jayalath and C. Tallambura, "Reducing the peak to average power ratio of an OFDM signal by interleaving" in *3rd Int.Symp. Wirel. Pers. Multimed. Commun*., Bangkok, Thailand, 2000, pp. 698{703.

[11] L. W. Couch, *Digital and Analog Communication Systems*. 6th ed. Singapore: Pearson Education, 2002.

[12] D. A. Wegandt, Z. Wu, and C. R. Nassar, "High through-put, high performance OFDM via pseudo-orthogonal carrier inter-formely spreading codes", *IEEE Trans. Commun.*, vol. 51, no. 7,pp. 1123{1134, 2003.

[13] A. F. Molish, *Wideband Wireless Digital Communications*. Singapore: Pearson Education, 2003, Chapt. 18 and 20.

[14] T. May, H. Rohling, and V. Engels, "Performance analysis of Viterbi decoding for 64-DAPSK and 64-QAM modulated OFDM signals", *IEEE Trans. Commun.*, vol. 46, pp. 182{190, 1998.

[15] D. H. Guo and Ch.-Y. Hsu, \Minimization of the PARP of OFDM by linear systematic block coding", in *Asia-Paci_c Conf. Commun.APCC*, Malaysia, 2003, pp. 129.