International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3, Issue No.3, pp : 222-226 1 march 2014

Evaluating the performance of OFDM transceiver for image transfer using 16PSK and 16QAM modulation schemes

Zain ul Abidin Jaffri[1], Muhammad Tahir[2], Sundas Rauf[3]

[3]School of Economics and Business Administration, Chongqing University, China
[1]School of Communication Engineering, Chongqing University
[2]School of Software Engineering, Chongqing University
Email: zainulabidin.jaffri@gmail.com

Abstract— In this paper, we investigates the effects of two different modulation schemes for image transmission using an OFDM (Orthogonal Frequency Division Multiplexing) transceiver. The main aim is to evaluate the performance between 16PSK (Phase Shift Keying) and 16QAM (Quadrature amplitude modulation) in context of BER (Bit Error Rate) in AWGN (Additive White Gaussian Noise) channel. We evaluate the performance of these modulation schemes using MATLAB simulations. The results show that QAM is a better modulation scheme than PSK for the image transfer using OFDM transceiver. The data modulated by PSK modulation technique gets more affected by the channel effects and more number of errors occur, as compared to QAM.

Keywords—Phase Shift Keying, Quadrature Amplitude Modulation, Frequency Division Multiplexing, Bit Error Rate.

1. Introduction

Over the past few years, Telecommunication emerged as a rapid growing industry. A boom can be seen in the number of mobile communications subscribers, and it will continue in the future. In fact, if we talk about some countries, the mobile subscribers are more than the population. Talking about the future, in the upcoming years, the future will be of Fourth Generation systems.

Due to the huge progress in the field of Wireless communication, the demand of high capacity wireless networks was felt, either by upgrading present technology or by devising new methods and techniques.

The use of Orthogonal Frequency Division Multiplexing (OFDM) technology in the newer WLAN technologies promises a much improved and higher data rate and with further improvements, higher data rates can be achieved. The use of OFDM in LTE offers peak data rates of 100 Mbps for the cellular purposes [9].

The main goal of 3rd and 4th generation wireless technologies is to entertain people with higher data rates along with the provision of wide range of services, like voice communication, video services (e.g. video call) and internet services, over the same platform.

The use of OFDM in LTE has provided a complete convergence of cellular technology, multimedia applications such as video and high quality audio and high speed internet. Thus OFDM has a strong capability of taking over other technologies for the enhancements in mobile and wireless technology for the 4th generation (4G) systems [9].

In this paper we are using the OFDM transceiver for the image transfer over an AWGN channel and we will examine the performance of two OFDM modulation schemes i.e. 16PSK and 16QAM in this context.

The rest of the paper is organized as follows: OFDM modulation schemes are discussed in Section 2. OFDM design and simulation is given in Section 3. Lastly conclusion is drawn in Section 4.

2. Modulation schemes of OFDM

There are many modulation techniques used in OFDM like BPSK, QPSK or some form of QAM. In BPSK, each data symbol modulates the phase of a higher frequency carrier.

An example of BPSK modulation of symbol 01011101 is shown in the Fig.1 below:

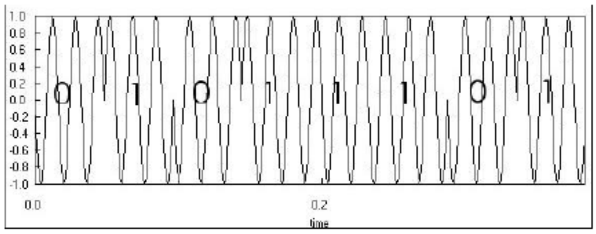


Figure 1 Binary Phase-Shift Key (BPSK) Representation of “01011101” [12]

QPSK stands for Quadrature Phase Shift Keying. In QPSK the signal shifts among phase states that are separated by 90 degrees. The signal is divided into even and odd parts and then phase shifts are applied. The shifts are from 45° to 135°, -45° (315°), or -135° (225°). Data is separated into two channels in the modulator i.e. In-phase and Quadrature phase called I and Q

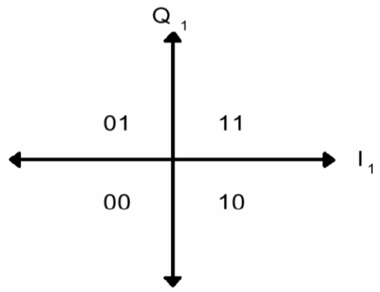


Fig. 2 QPSK Symbol Mapping [15]

channels. Two bits are transmitted simultaneously, one per channel. Each channel modulates a carrier whose frequency is same; however, there is a phase difference of 90 degrees i.e.

International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3, Issue No.3, pp : 222-226 1 march 2014

they are in quadrature. There are four states in QPSK as $2^2=4$. The theoretical bandwidth of QPSK is two bits/seconds/Hz. Fig.2 and Fig.3 shows the QPSK symbol mapping and signal constellation. The QPSK constellation points are shown in Table. 1.

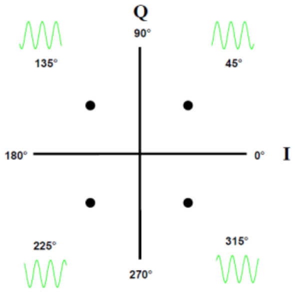


Fig. 3 QPSK Signal Constellation [15]

Table 1 QPSK Constellation Points

Symbol Transmitted	Carrier Phase	Carrier Amplitude
00	225°	1.0
01	135°	1.0
10	315°	1.0
11	45°	1.0

Another important modulation scheme used in OFDM is QAM. QAM stands for Quadrature Amplitude Modulation.16-QAM is the modulation scheme used in this paper.

16-QAM is 16-state Quadrature Amplitude Modulation shown in Fig. 4. It has four I values and four *Q* values that are used, yielding four bits per symbol. It has 16 states because 2^4 = 16.The theoretical bandwidth efficiency 16-QAM is four bits/second/Hz. Data has been is split into two channels, I and Q. Each channel can take on two phases same as the QPSK. However, two intermediate amplitude values are also accommodated by 16QAM. To each channel, two bits are routed simultaneously. The two bits to each channel are added and applied to the respective channel's modulator.

Symbol Transmitted	Carrier Phase	Carrier Amplitude
0000	225°	0.33
0001	255°	0.75
0010	195°	0.75
0011	225°	1.0
0100	135°	0.33
0101	105°	0.75
0110	165°	0.75
0111	135°	1.0
1000	315°	0.33
1001	285°	0.75
1010	345°	0.75
1011	315°	1.0
1100	45°	0.33
1101	75°	0.75
1110	15°	0.75
1111	45°	1.0

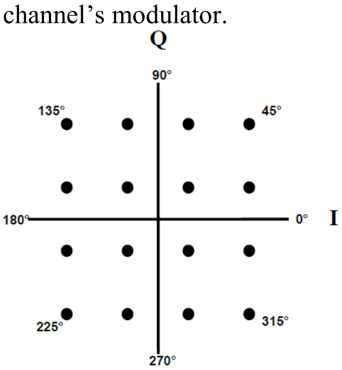


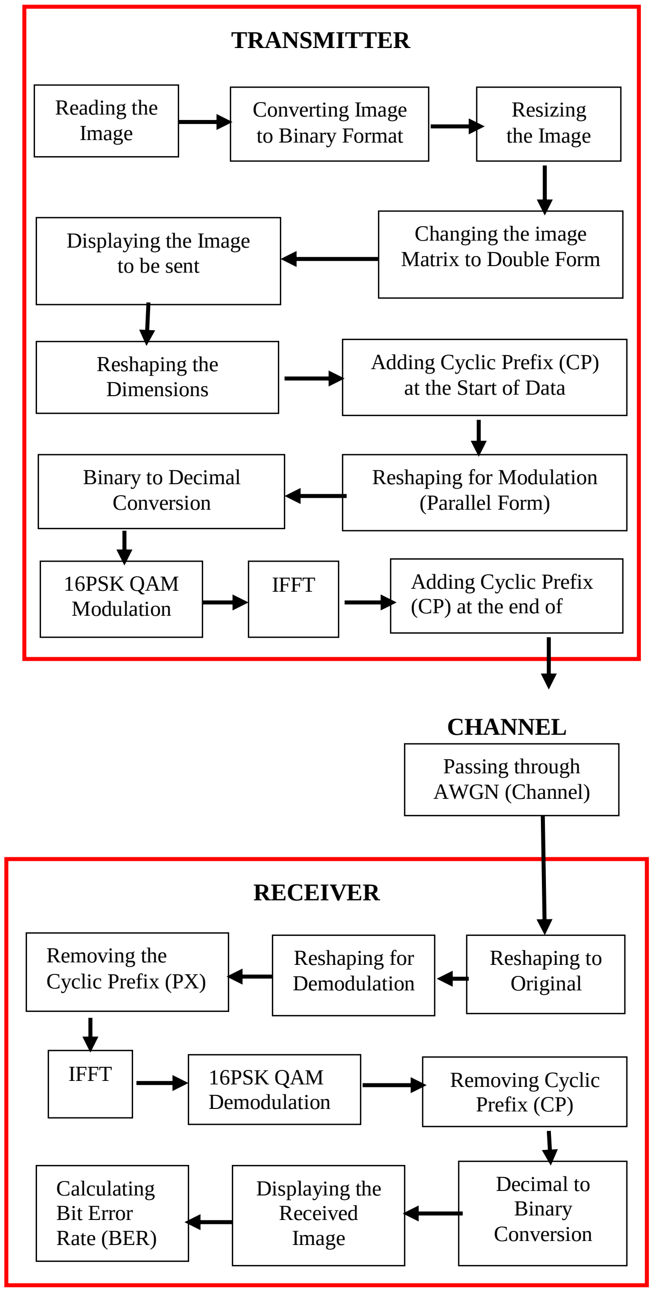
Fig. 4 16-QAM Signal Constellation [15]

Greater the number of points in the modulation constellation diagram, the more they are difficult to be demodulated at the receiver. As the IQ vector points become spaced closer together, a small amount of noise can cause errors in the transmission. This problem can be solved by using efficient encoding techniques.

3. OFDM Design and Simulation

In this section the OFDM design for the image transmission is enlightened. How the image is transferred using 16PSK and 16QAM and a comparison for both the modulation schemes is made.

We create a simulation for the image transfer using OFDM including the AWGN channel effects. Firstly we performed it using 16PSK modulation scheme but the results are not good enough. The image is received but having significant errors. Then we change the modulation scheme to 16QAM and the results improve a lot. The block diagram of the model is given in Fig. 5.



The table 2 (a) and (b) shows the results of OFDM image code from which we can easily see the total number of errors and Bit error rate of both the schemes.

International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)
Volume No.3, Issue No.3, pp : 222-226 1 march 2014

Table 2(a) Results of OFDM Image Code

S. No.	Input	Data Rate	Number of Sub-carriers	Number of Errors	
				16PSK	16QAM
1	Test Image 1	65,536	16,384	26,064	6
2	Test Image 2	65,536	16,384	26,091	13
3	Test Image 3	65,536	16,384	25,817	10
4	Test Image 4	65,536	16,384	25,177	12
5	Test Image 5	65,536	16,384	22,945	12
6	Test Image 6	65,536	16,384	27,188	6
7	Test Image 7	65,536	16,384	18,094	12

Table 2(b) Results of OFDM Image Code

Sr. No.	Input	Data Rate	Number of Sub-carriers	Bit Error Rate (BER)	
				16PSK	16QAM
1	Test Image 1	65,536	16,384	0.3977	9.1553e-005
2	Test Image 2	65,536	16,384	0.3982	1.9836e-004
3	Test Image 3	65,536	16,384	0.3939	1.5259e-004
4	Test Image 4	65,536	16,384	0.3842	1.8911e-004
5	Test Image 5	65,536	16,384	0.3501	1.8311e-004
6	Test Image 6	65,536	16,384	0.4149	9.1553e-005
7	Test Image 7	65,536	16,384	0.2761	1.8311e-004

The simulation results for the 'test image 1' are given below. Firstly the image to be sent using OFDM is shown in the Fig. 6 given below.

Fig.6 Image to be sent

The constellation diagrams after 16QAM and 16 PSK modulation schemes are shown in Fig. 7 and Fig. 8.

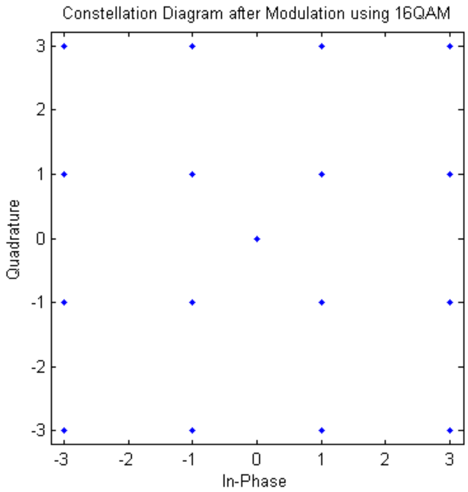


Fig.7 Constellation Diagram after 16QAM Modulation

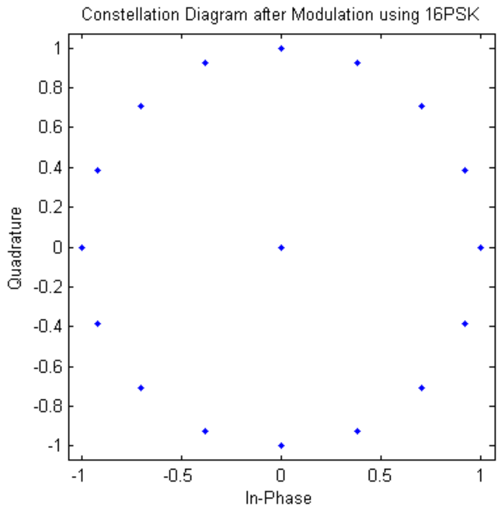


Fig.8 Constellation Diagram after 16PSK Modulation

The constellation of the data to be demodulated using 16QAM and 16PSK is shown in Fig. 9 and Fig. 10 respectively.

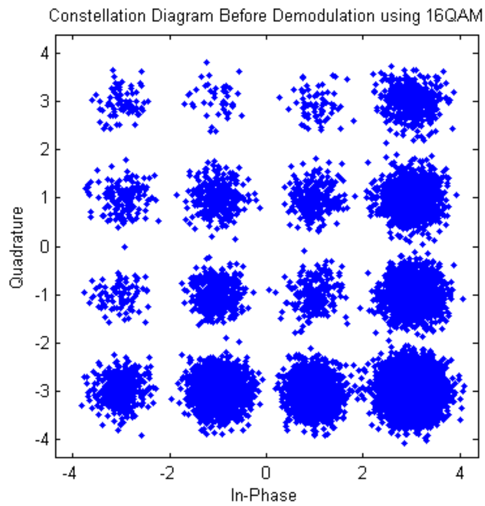


Fig. 9 Constellation Diagram before Demodulation using 16QAM

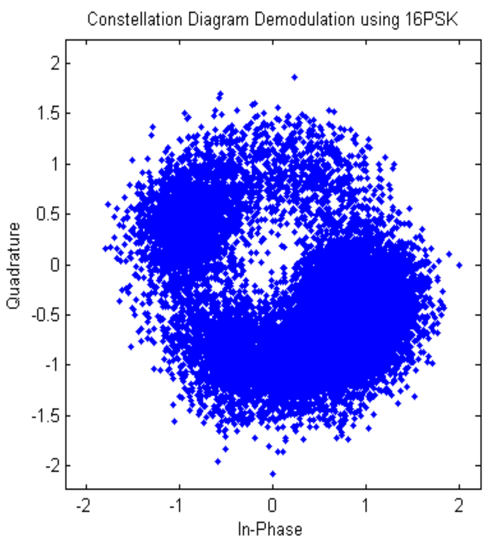


Fig. 10 Constellation Diagram before Demodulation using 16PSK

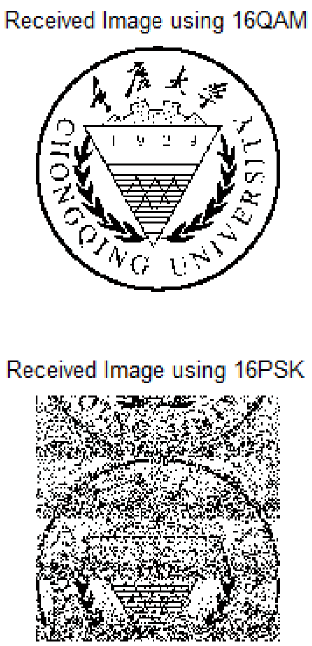


Fig. 11 Received Image using 16QAM and 16PSK

Lastly Fig. 12 shows the error in image using 16QAM and 16PSK.

We use the digital modulation technique 16PSK for the image transfer. The results are very poor and the received signal has very distortions. It is very hard to recognize the image as shown in Fig. 11. Fig.12 also shows that there are a lot of errors due to AWGN channel effects as the error image has majority of non-zero values. We turn to the other digital modulation scheme i.e. 16QAM. The results improve a lot. The image is received with fidelity as clear from Fig. 11. Fig. 12 shows that there is very little number of non-zero values in the 16QAM error image and those are almost negligible. The number of errors in QAM is

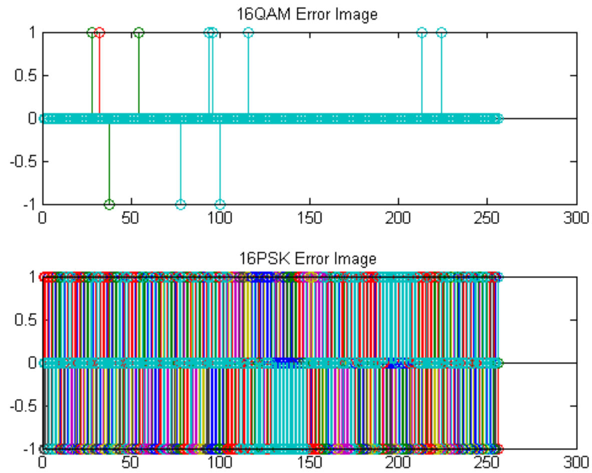


Fig. 12 Error Image for 16QAM and 16PSK

almost negligible and the original image is received. Thus the Bit Error Rate (BER) decreases too.

4. Conclusion

We evaluated the performance of OFDM transceiver for image transmission using OFDM modulation schemes and observed that QAM is a better modulation scheme than PSK. The data modulated by PSK modulation technique get more affected by the channel effects and more number of errors occur, as compared to QAM. The simulation results of OFDM image show that there is a remarkable difference in performance of both the schemes. QAM outperforms against the channel effects and noise.

Acknowledgement

The authors are thankful to Dr. Ghulam Qambar Jaffri for valuable suggestions and support.

References

i. Lawrey, E. P. (2001) *Adaptive Techniques for Multiuser OFDM*. Thesis for the degree of Doctor of Philosophy in Electrical and Computer Engineering, School of Engineering, James Cook University.

ii. Stallings, W. (2005) *Wireless Communications and Networks*, 2nd editon. New Jersey: Pearson Education, Inc.

iii. J.W. Choi, Y.H. Lee (2007) “Design of a Channel-aware OFDM Transceiver” *IEEE Transactions on Wireless Communication*, Vol.6, pp1813-1822.

iv. S.H. Karabetsos, P.D. Stavrou, E.K. Pikasis, A. Nassiopoulos (2005) “Design and Implementation of an OFDM Transceiver framework using MATLAB and the TMS320C6713 DSK”. *IEEE International conference on Computer as a tool, EUROCON 2005*, Vol.1, pp554-557.

v. H.C. Fu, S.H. Wu, C.J.Kuo (2007) “Performance Analysis and Transceiver Design for Adaptive BIC-MIMO-OFDM systems”. *IEEE Wireless Communication and Networking Conference, WCNC 2007*, pp468-473.

vi. M. Zia, H. Mahmood, A. Ahmed, N. Abbas (2013) “Selective HARQ Transceiver Design for OFDM system”. *IEEE Communication Letters*, Vol.17, pp2229-2232.

vii. T. Kawamura, Y. Kishiyama, K. Higuchi, M. Sawahashi (2006) “ Comparisons of 16QAM modulation schemes considering PAPR for single carrier FDMA radio access in evolved UTRA uplink”.

9th IEEE International Symposium on Spread spectrum techniques and Applications, pp332-336.

viii. P.M. Ebert, S. B. Weinstein, (1971) "Data Transmission by Frequency Division Multiplexing Using the Discrete Fourier Transform", IEEE *Transactions on Communication Technology*, Vol. 19, No. 5, pp628-634.

ix. A.Ruiz, A. Palad, (1980) "Frequency Domain Data Transmission using Reduced Computational Complexity Algorithms". *In Proceedings of IEEE International conference on Acoustics, Speech and Signal Processing*, Vol. 5, pp964-967.

x. Sasase, C. Jun, (2002) "The effects of modulation combination, target BER, doppler frequency, and adaptation interval on the performance of adaptive OFDM in broadband mobile channel", *IEEE transactions on Consumer Electronics*, Vol. 48, pp167-174.

xi. Wang, X. (2005) "OFDM and Its Application to 4G*", 14th IEEE International conference on Wireless and Optical communications*. New York, USA.

xii. Kadiran, K. A. (2005*) Design and implementation of OFDM transmitter and receiver on FPGA hardware*. Masters thesis, Malaysia: Universiti Teknologi.

xiii. Mcqueen, D. (2009) "The momentum behind LTE adoption". *IEEE Communications Magazine*, Vol. 47, pp44-45.

xiv. http://home.dei.polimi.it/spagnoli/Last_minute/NI-OFDM/images/Manual42.jpg

xv. http://www.cisco.com

xvi. Stallings, W. (2005). *Wireless Communications and Networks, 2nd editon.* New Jersey: PearsonEducation, Inc.

xvii. http://www.cqu.edu.cn

xviii. http://www.cornerstonetech.biz/docs/WTP_Wallpaper_800x600.jpg

xix. http://www.fmepedia.com/attachments/Downloadable_Fun_Stuff/data_ wallpaper_800x600.png

xx. http://www.techdigest.tv/nokia-logo.jpg

xxi. http://www.apnimarzi.com/wp- content/uploads/2009/10/telenorlogo.jpg

APPENDIX

Test Image1 [17]

Test Image 2 [18]

Test Image 3 [18]

Test Image 4 [19]

Test Image 5 [15]

Test Image 6 [20]

Test Image 7 [21]