Scientific Journal Impact Factor (SJIF): 1.711

e-ISSN: 2349-9745
p-ISSN: 2393-8161

International Journal of Modern Trends in Engineering and Research
www.ijmter.com

# Comparative Analysis of BER Performance under QAM-OFDM System Over AWGN and Rayleigh Fading Channel

Chandrakant Tiwari[1], Mr. Abhishek Garg[2]

M.Tech Student[1], Associate Professor[2]
*[1,2]Department of Electronics and Communication*
*Sushila Devi Bansal College Of Technology Indore (M.P.), India*

***Abstract* -** The fast development of modern communication techniques, the demand for reliable high data rate transmission is increased signification, which stimulate much interest in modulation technique. The QAM is one of the adaptive modulation techniques that are commonly used for wireless communications. Different order modulations allow sending more bit per symbol and thus achieving higher throughput or better SNR are needed to overcome any interference and maintain a certain BER. This paper at developing a simulink model to simulate different types of QAM modulation and demodulation techniques at different bit rates. Orthogonal Frequency Division Multiplexing (OFDM) was originally developed from the multi-carrier modulation techniques used in high frequency military radios. Also we are used Orthogonal Frequency Division Multiplexing (OFDM) technique with AWGN channel and Rayleigh channel. Result presented in this paper the BER tool under Matlab R2013a is used to evaluate the performance of modulation technique through draw the BER versus SNR ($E_b/N_0$).
***Keyword* -** QAM, OFDM, AWGN, BER, SNR

## I. INTRODUCTION

WiMAX is the system for wireless broadband access. It is based on IEEE 802.16 standards which are mainly based on Orthogonal Frequency Division Multiplexing (OFDM) technology[1]. OFDM is a wideband modulation scheme using multicarrier digital communication. The fixed and mobile versions of WiMAX have slightly different implementations of the OFDM physical layer. Fixed WiMAX, which is based on IEEE 802.16-2004, uses a 256 FFT-based OFDM physical layer. Mobile WiMAX, which is based on the IEEE 802.16e-20055 standard, uses a scalable OFDMA-based physical layer. In the case of mobile WiMAX, the FFT sizes can vary from 128 bits to 2,048 bits. Table below shows the OFDM-related parameters for both the OFDM-PHY and the OFDMA PHY. The parameters are shown here for only a limited set of profiles that are likely to be deployed and do not constitute an exhaustive set of possible values. The demand for high-speed mobile wireless communications and use of the radio spectrum is rapidly growing with terrestrial mobile communication systems being just one of many applications vying for suitable bandwidth. These applications require the system to operate reliably in non-line-of-sight environments with a propagation distance of 0.5 - 30 km, and at velocities up to 100 km/hr or higher. This operating environment limits the maximum RF frequency to 5 GHz, as operating above this frequency results in excessive channel path loss, and excessive Doppler spread at high velocity[1].

 

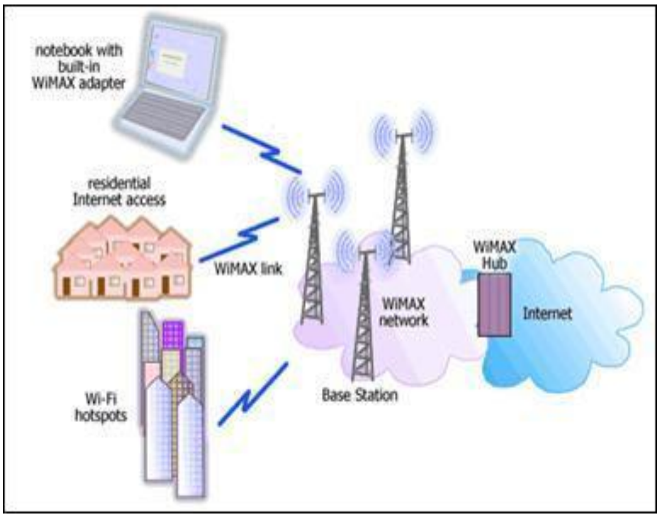


*Fig. 1: Typical Network using WiMAX*

*Table 1: Characteristics of WiMAX simulation model[2]*

| Sr. No. | Parameter | Value |
|---|---|---|
| 01 | Standard | 802.16e |
| 02 | Data Rate (speed) | 70Mbps |
| 03 | Modulation scheme | BPSK, QPSK, 8QAM, 16PSK |
| 04 | Carrier Frequency | 11GHz |
| 05 | Channel size (BW) | 1.5MHz to 20MHz |
| 06 | Topology | Mesh |
| 07 | Radio Technology | OFDM & OFDMA |
| 08 | Distance | 10 km |
| 09 | Frequency Bands | 5.7GHz, 3.5GHz, 2.5GHz |
| 10 | RS Code Rate | 3/4 |

## II. OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is a digital encoding and modulation technology. It has been used successfully in Wire-line access applications, such as cable modems, Digital Subscriber Line (DSL) modems and as well as Wireless-Fidelity (Wi-Fi). Products from Worldwide Interoperability for Microwave Access (WiMAX)[3] is a Broadband Wireless Access (BWA).

Technology, Forum member companies are using OFDM-based 802.16 systems to overcome the challenges of (Non-line of side propagations) NLOS propagation. OFDM achieves high data rate and efficiency by using multiple overlapping carrier signals instead of just one. All future technologies for 4G will be based upon OFDM technology. It is a spectrally efficient version of multicarrier modulation, where the subcarriers are selected such that they are all orthogonal to one another over the symbol duration, thereby avoiding the need to have non-overlapping subcarrier channels to eliminate inter-carrier interference.

 

Orthogonal Frequency Division Multiple Access (OFDMA) is enhanced OFDM and used in Mobile WiMAX technology and the IEEE 802.16e-2005 standard, and it is the foundation for the next-generations of mobile broadband to come. It is a multi-user version of Orthogonal Frequency-Division Multiplexing (OFDM). The difference between the two technologies is that OFDMA assigns subsets of sub-carriers to individual users allowing simultaneous low data rate transmission from several users. The architecture of an OFDM transmitter was described using sinusoidal components. Generally, an OFDM signal can be represented as:

$$OFDM\ Signal = C(t) = \sum_{n=0}^{N-1} S_n(t)\sin(2\pi f_n t)$$

(1)[2] S(t) = symbols mapped to chosen constellation,
$F_n$ = orthogonal frequency.

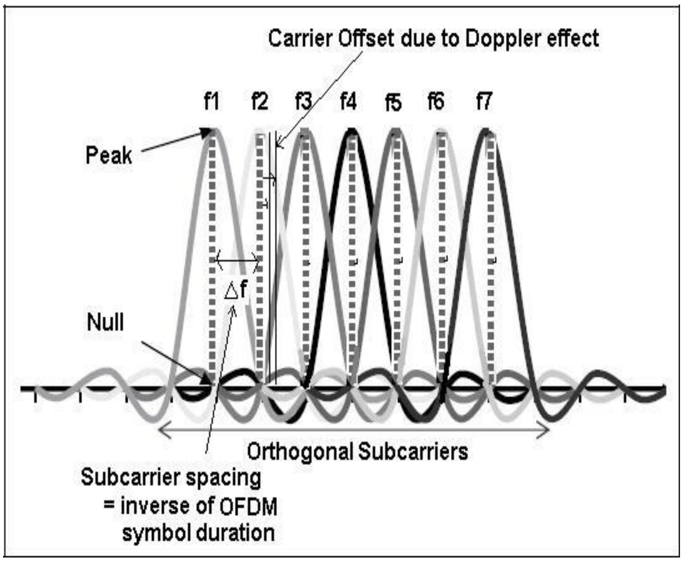


Fig.2:OFDM spectral setting [1]

## III. MODULATION

QAM (Quadrature amplitude modulation) is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. QAM is used with pulse amplitude modulation (PAM) in digital systems, especially in wireless applications. In a QAM signal, there are two carriers, each having the same frequency but differing in phase by 90 degrees (one quarter of a cycle, from which the term Quadrature arises). One signal is called the I signal, and the other is called the Q signal. Mathematically, one of the signals can be represented by a sine wave, and the other by a cosine wave. The two modulated carriers are combined at the source for transmission. At the destination, the carriers are separated, the data is extracted from each, and then the data is combined into the original modulating information.

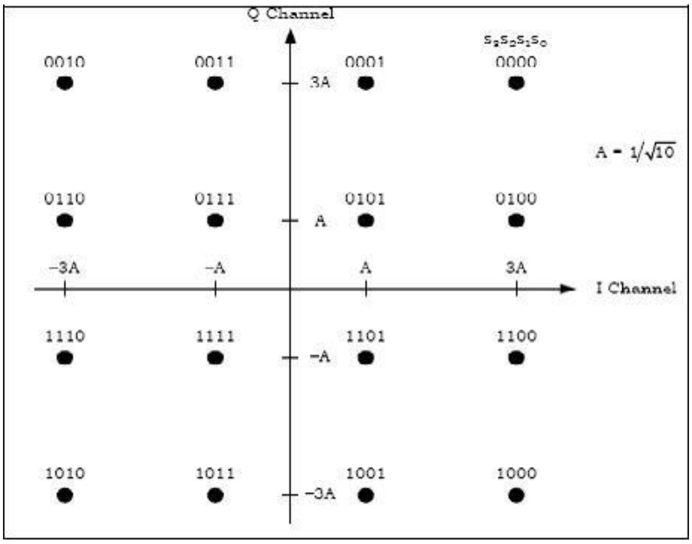


*Fig. 3: I-Q Mapping in 16-QAM Modulation*

## IV. IFFT

This equation can be thought of as an IFFT process ( Inverse Fast Fourier Transform). The Fourier transform breaks a signal into different frequency bins by multiplying the signal with a series of sinusoids. This essentially translates the signal from time domain to frequency domain. But, we always view IFFT as a conversion process from frequency domain to time domain.

FFT is represented by:

$$X(k) = \sum_{n=0}^{N-1} x(n) \sin\left(\frac{2\pi kn}{N}\right) + j\sum_{n=0}^{N-1} x(n) \cos\left(\frac{2\pi kn}{N}\right)$$

where as its dual , IFFT is given by:

$$X(n) = \sum_{n=0}^{N-1} x(k) \sin\left(\frac{2\pi kn}{N}\right) - j\sum_{n=0}^{N-1} x(k) \cos\left(\frac{2\pi kn}{N}\right)$$

(3)

The equation for FFT and IFFT differ by the co-efficients they take and the minus sign. Both equation does the same thing. They multiply the incoming signal with a series of sinusoids and separates them into bins.In fact, FFT and IFFT are dual and behaves in a similar way.IFFT and FFT blocks are interchangeable.

 

International Journal of Modern Trends in Engineering and Research (IJMTER)
Volume 02, Issue 03, [March - 2015] **e-ISSN: 2349-9745, p-ISSN: 2393-8161**

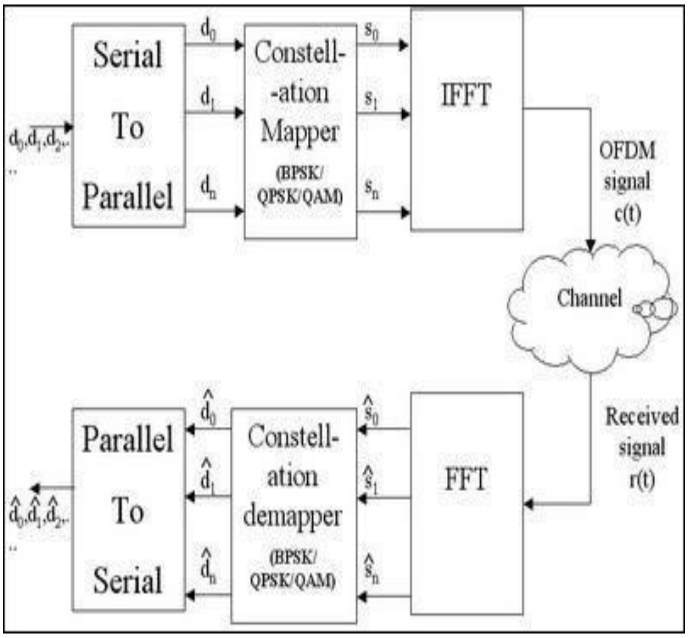


Fig. 4: Digital implementation of OFDM system using IFFT and FFT [2]

the input process X(t) is limited to B. If the average received power is P'[W] and the noise power spectral density is $N_0$ [W/Hz], the AWGN channel capacity is equation 4.

$$c_{awgn} = W \log_2\left(1 + \frac{P'}{N_0 W}\right) \text{ Bit/Hz} \tag{4}$$

Where $\frac{P'}{N_0 W}$ is the received signal-to-noise ratio (SNR).

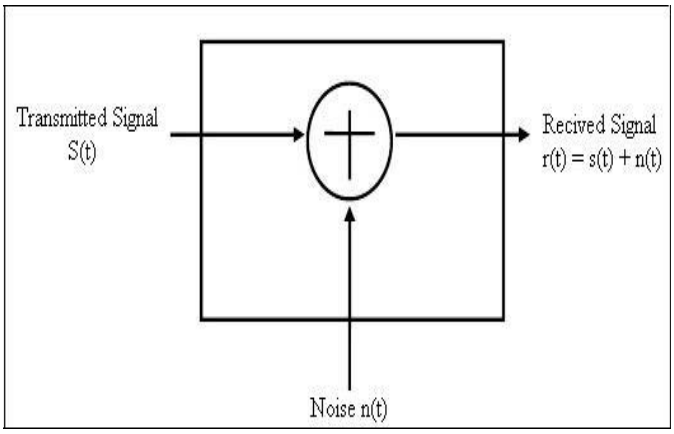


Fig. 5: Block Diadram AWGN Channel[1]

## V.AWGN AND FADING CHANNEL

*AWGN Channel:* The continuous-time AWG channel is arandom channel whose output is a real random process:

$$Y(t) = X(t) + N(t) \tag{4}$$

 

where X(t) is the input waveform, regarded as a real random process, and N(t) is a real white Gaussian noise process with single-sided noise power density N0 which is independent of X(t). Moreover, the input X(t) is assumed to be both power-limited and band-limited. The average input power of the input waveform X(t) is limited to some constant P. The channel band B is a positive-frequency interval with bandwidth W Hz. The channel is said to be baseband if B = [0, W], and pass-band otherwise. The (positive-frequency) support of the Fourier transform of any sample function x(t) of

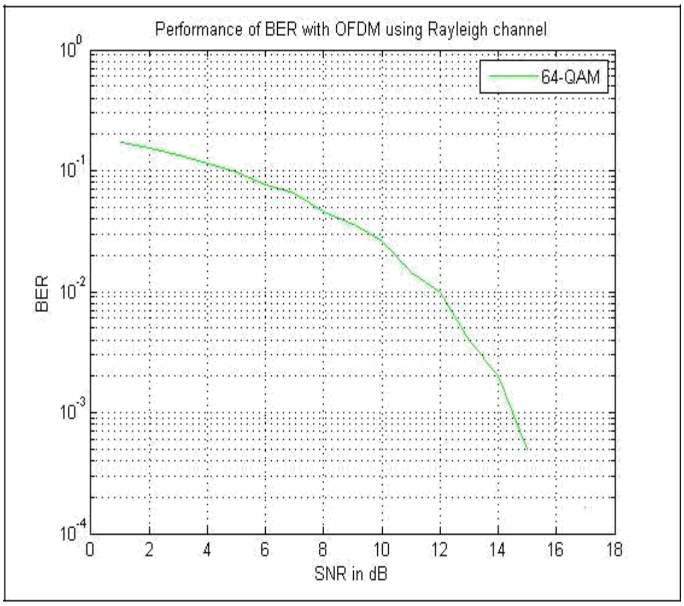


Fig. 6: Performance of OFDM with AWGN Channel using 16-QAM Modulation

*Rayleigh Channel:* The Rayleigh fading model is particularly useful in scenarios where the signal may be considered to be scattered between the transmitter and receiver. In this form of scenario there is no single signal path that dominates and a statistical approach is required to the analysis of the overall nature of the radio communications channel. Rayleigh fading is a model that can be used to describe the form of fading that occurs when multipath propagation exists. In any terrestrial environment a radio signal will travel via a number of different paths from the transmitter to the receiver. The most obvious path is the direct, or line of sight path. The Rayleigh distribution has a probability density function (pdf) given by:

$$P(r) = \begin{cases} \frac{r}{\sigma^2} \exp\left(-\frac{r^2}{2\sigma^2}\right), & (0 \le r \le \infty) \\ 0, & (r < 0) \end{cases} \quad (5)$$

## VI. Simulation Results

The simulation is based on OFDM with different modulation scheme (16-QAM, 64-QAM and 256-QAM) with different communication channel (AWGN and Rayleigh). The curve is draw between of Bit Error Rate (BER) versus Signal to Noise Ratio (SNR) used under tool Matlab R2013a. The simulation result is shown in figure 6 is used AWGN with 16-QAM modulation and figure 7, 8, 9 and 10 used Rayleigh channel with respectively 16-QAM, 64-QAM and 256-QAM.

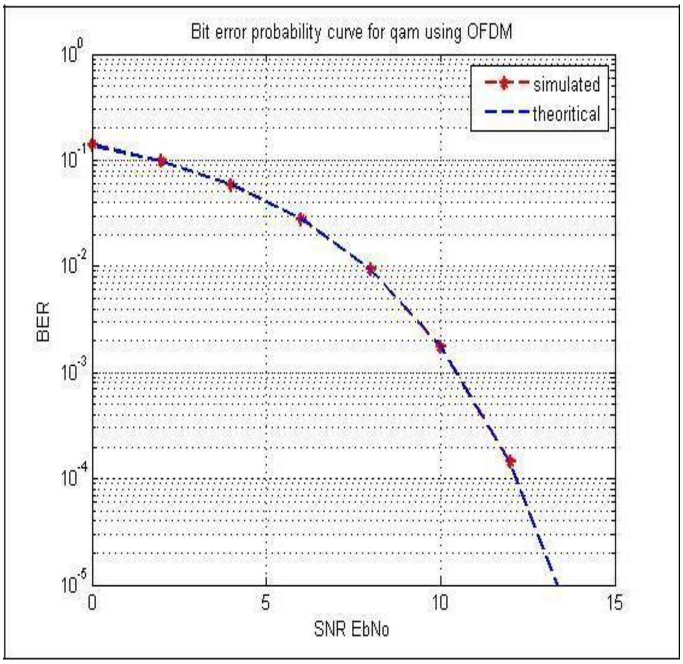


Fig. 8: Performance of OFDM with Rayleigh Channel using 64-QAM Modulation

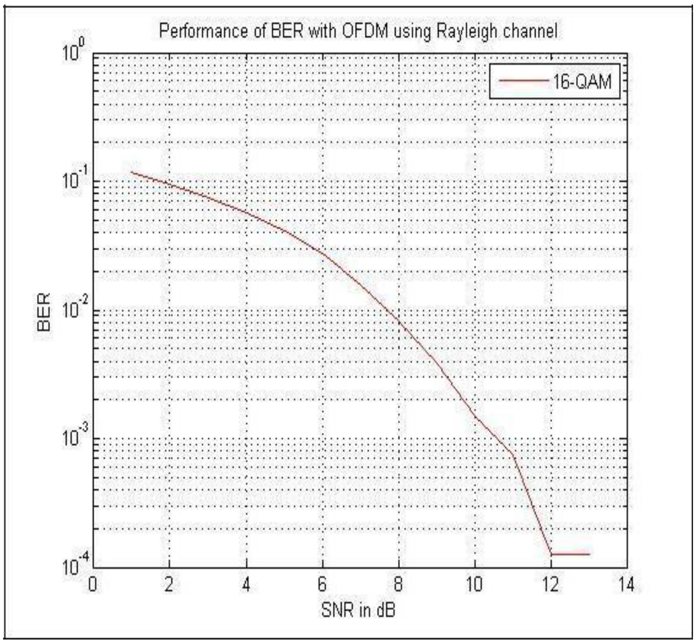


Fig. 9: Performance of OFDM with Rayleigh Channel using 256-QAM Modulation

 

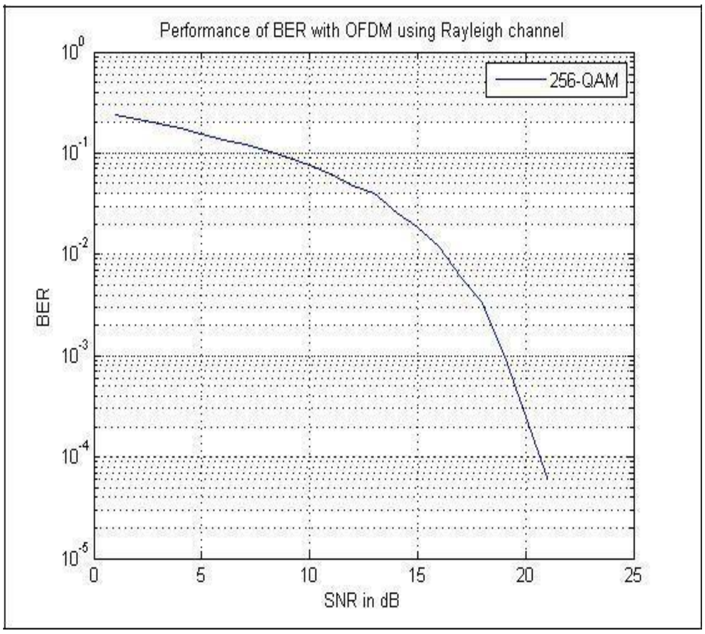


Fig. 10: Performance of OFDM with Rayleigh Channel using 16-QAM Modulation

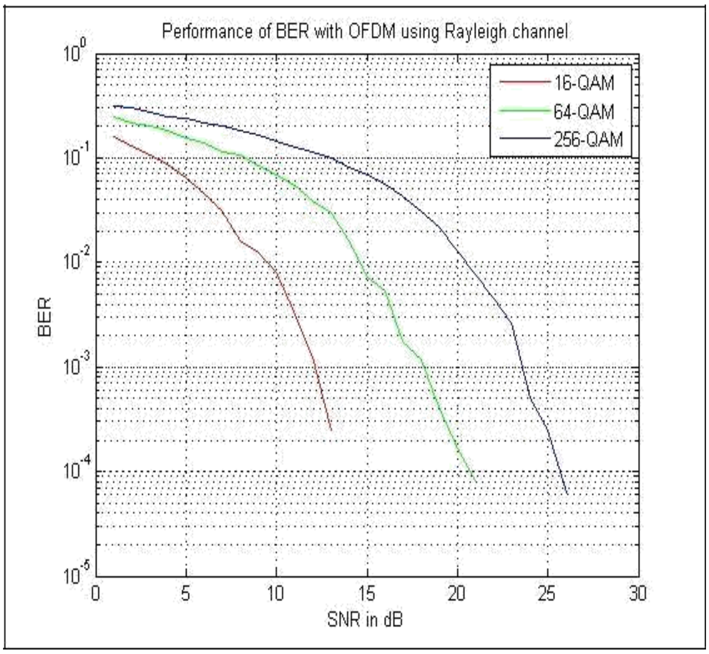


Fig. 10: Comparison Performance of OFDM with Rayleigh Channel using 16, 64 and 256-QAM Modulation

## VII. CONCLUSION

In WiMAX system we have analyses different parameter on based of wireless communication system.

 

The curve are shows on BER versus SNR in different value. In the figure 10 is conclude all modulation techniques with Rayleigh channel. The Modulation 256-QAM is better SNR in 5dB at BER $10^{-3}$, as compared to 64-QAM and another 64-QAM is better SNR in 5.4dB as compared to 16-QAM at BER is $10^{-3}$. The results performance is displayed in the figure in terms of the BER versus SNR (Es/No, db) logarithmic plot.

## REFERENCES

[1] U. D. Dalal[1] and Y. P. Kosta[2] *"Adaptive Parameters Based Transmission Control and Optimization in Mobile WiMAX at Physical Layer"* ISBN 978-953-7619-53-4, Published, December 1, 2009.

[2] Mukesh Patidar, Rupesh Dubey *"Performance Analysis of WiMAX 802.16e Physical layer model"* 978-1-4673-1989-8/12/2012 IEEE.

[3] T.P. surekha, T. Ananthapadmanabha "Modeling and Performance Analysis of QAM-OFDM System with AWGN Channel" 978-1-4577-0856-5/11/$26.00 ©2011 IEEE.

[4] Surekha, T.P "Modeling and Performance Analysis of QAM-OFDM System with AWGN Channel" 978-1-4577 0855-8, 17-18 July 2011

[5] Vineet Sharma, Anuraj Shrivastav "BER performance of OFDM-BPSK,-QPSK,- QAM over AWGN channel using forward Error correcting code" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622.

[6] Xu Zhang "Modeling & Performance Analysis of QAM-based COFDM System" University of Toledo August 2011.

[7] Sahasha Namdeo, Reena Rani "Designing and Performance Evaluation of 64 QAM OFDM System" IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834,p- ISSN: 2278-8735.

 