

# Similitude Explication of MIMO- OFDM by using Various Fading Channels with QAM Modulation Scheme

Chandrakant Tiwari

Assistant Professor, Department of CS & EC, Christian Eminent College Indore, MP, India. [tiwarick009@gmail.com](mailto:tiwarick009@gmail.com)

## Abstract

The Modeling and Simulation can play a most- vital role during all phases of the design and engineering of communication systems. Orthogonal Frequency Division Multiplexing (OFDM) is predicted to be implemented in future broadcasting and systems due to its robustness in transmitting a high data rate was originally developed from the multicarrier modulation techniques used in high frequency military radios. It is modulated data streams are divided into number of parallel sub-streams which occupies a very less bandwidth. However, full justice was done in proper utilization of bandwidth in OFDM where subcarriers overlap orthogonally. A multiple-input multiple-output (MIMO) communication System combined with the orthogonal frequency division multiplexing (OFDM) modulation technique can achieve reliable high data rate transmission over broadband wireless channels. 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 In this paper, simulation system is implemented using different channel like Additive White Gaussian Noise channel (AWGN) and fading channel with QAM modulation scheme and the performance analysis of Bit Error rate (BER) verses Signal to Noise ratio (SNR). The performance of MIMO-OFDM is tested for modulation techniques namely QAM using MATLAB-2013.

**Keywords:** MODULATION, OFDM, MIMO, AWGN, BPSK, QAM, BER, SNR, etc.

## 1. INTRODUCTION

The rapid evolution of hodiernal communication techniques, the requisition for credible high data rate transmission is increased signification, which stimulates much interest in modulation technique also the necessity for forthcoming communication systems to endorsement mobile users with complete real time access to broadband services calls for robustness against fast frequency-selective multipath fadings. An effective solution to this impairment is to adopt the orthogonal frequency division multiplexing as the multiplexing strategy. OFDM is based on the principal of transmitting data by dividing the stream into several parallel bit streams of multi-carrier transmission. OFDM is an important wideband transmission technique for wireless communication systems. Compared with the other competing wideband transmission technology i.e. multicarrier code division multiple access (MCDA) an OFDM system can reduce or eliminate inter symbol interference and is particularly suitable for transmission over fading channel (Rayleigh & Rician etc.) requiring only a relatively simple equalizer at the receiver for a good performance. OFDM is a key technology for next-generation cellular communications (3GPP-LTE, Mobile WiMAX, IMT-Advanced) as well as wireless LAN (IEEE 802.11a, IEEE 802.11n), wireless PAN (MB-OFDM), and broadcasting (DAB, DVB, and DMB) [4]. The basic block diagram is shown in figure 1 and sub-carrier diagram is figure 2.

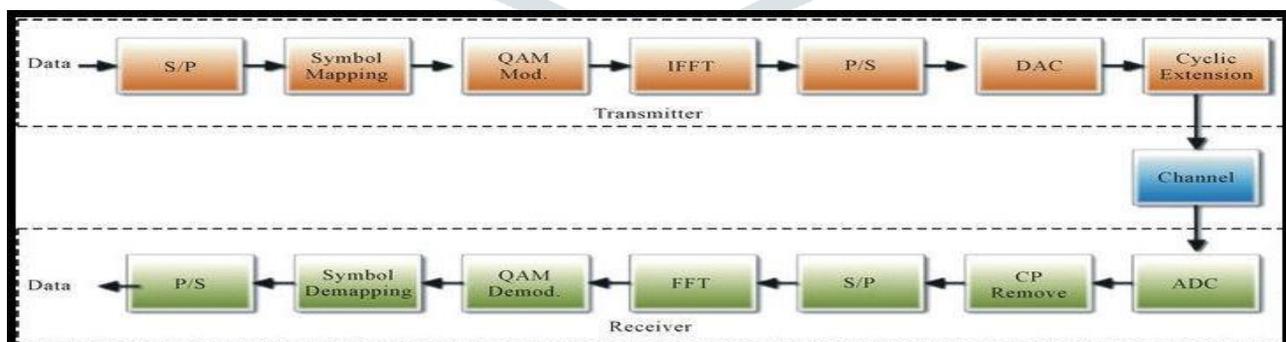


Fig-1: Basic Orthogonal Frequency Division Multiplexing (OFDM) system

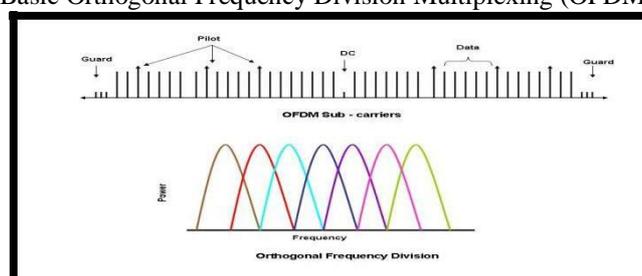


Fig-2: OFDM sub-carriers

## 2. MODULATION TECHNOLOGY

**2.1 BPSK Modulation:** This is also known as two-level PSK as it uses two phases separated by  $\pi$  to represent binary digits. This kind of phase modulation is very effective and robust against noises especially in low data rate applications as it can modulate only 1bit per symbol.

**2.2 QPSK Modulation:** This is also known as four-level PSK where each element represents more than one bit. Each symbol contains two bits and it uses the phase shift of  $\pi/2$ , means  $90^\circ$  instead of shifting the phase  $180^\circ$ .

**2.3 QAM Modulation:** Quadrature amplitude modulation (QAM) is a method of combining 2-Amp.modulated signals into a single channel, thereby doubling the effective bandwidth. Quadrature amplitude modulation (QAM) is used with pulse amplitude modulation in digital systems, especially in wireless applications.

In a Quadrature amplitude modulation (QAM) signal, there are two carriers, each having the same frequency but differing in phase by  $90^\circ$ . The general form of M-ary QAM is as following:

$$S_i = A_i \cos(2\pi f_c t + \theta_i), 0 \leq t \leq T_s, I = 1, 2, 3, \dots, M \quad (1)$$

Where  $T_s$  is the symbol duration,  $A_i$  is the amplitude and  $\theta_i$  is the phase of the  $i$ th signal in the M-ary QAM signal set.

## 3. WIRELESS COMMUNICATION CHANNEL

In wireless communication, the data are transmitting through the wireless channel with respective bandwidth to achieve higher data rate and maintain quality of service.

**3.1 AWGN Channel:** The AWGN channel block adds white Gaussian noise to real or complex input signal. When the i/p signal is real, this block AWGN and produces a real o/p signal. Additive white Gaussian noise (AWGN) is a channel model in which the only impairment to communication is a linear addition of wide-band or white noise with a constant spectral density and a Gaussian distribution of amplitude (Amp.). If the average received power is  $P$  [w] and the noise power spectral density is  $N_0$  [W/Hz], the AWGN channel capacity is following equation (2).

$$C_{\text{awgn}} = W \log_2 (1 + P/N_0W) \text{ bits/Hz} \quad (2)$$

Where  $P/N_0W$  is received signal-to-noise ratio (SNR).

**3.2 Fading Channels:** Rayleigh and Rician fading channels are useful models of real-world phenomena in wireless communications. These phenomena include multipath scattering effects, time dispersion, and Doppler shifts that arise from relative motion between the transmitter and receiver. Typically, the fading process is characterized by a Rayleigh distribution for a non-line-of-sight (NLOS) path and a Rician distribution for a line-of sight path.

**Fading Channel Using an Object:** A baseband channel model for multipath propagation scenarios that you implement using objects includes:

- N discrete fading paths, each with its own delay and average power gain. A channel for which  $N = 1$  is called a frequency-flat fading channel.
- A channel for which  $N > 1$  is experienced as a frequency-selective fading channel by a signal of sufficiently wide bandwidth.

## 4. MIMO SYSTEM

In Wireless system, multiple input multiple-output antenna technologies play an essential role in meeting the 4G requirements. The application of multiple input multiple-output (MIMO) technologies is one of the most crucial distinctions between 3G and 4G. It is a large family of MIMO techniques has been developed for various links and with various amounts of available channel state information in IEEE 802.16e/m. The MIMO technology is one of the key benefits of the Mobile wireless systems. It is based generally on multiple-antennas configuration both at the transmitter and at the receiver end. It can be used to Increase the achievable data rate and hence the overall system capacity, Increase the coverage area, Decrease the required transmit power, Increase the system reliability (decrease the bit and packet error rate)[3]. The MIMO system is shown in figure 3.

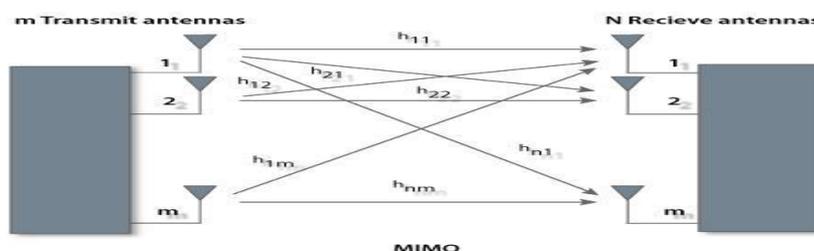


Fig- 3: multiple input multiple-output (MIMO) System

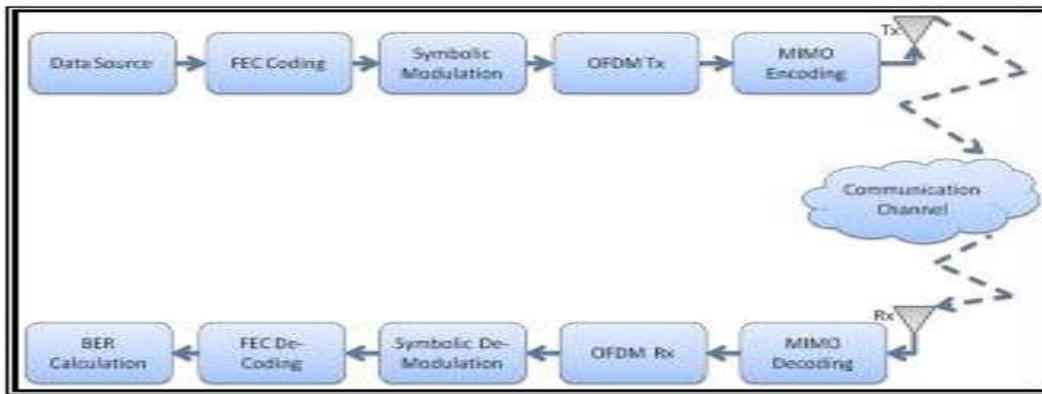


Fig. 4: Block Diagram for MIMO-OFDM System

### 5. SIMULATION RESULT

The model was implemented in MATLAB-2013a according to the above described system for convolution coding techniques. Performance analysis is done for different communication channel like AWGN, Rayleigh, Rician and Nakagami with QAM modulation scheme used. Here we transmit our data by using Orthogonal Frequency Division Multiplexing (OFDM) technique in which large numbers of closely-spaced orthogonal sub-carriers are used to carry data. And performance is plot by BER verses SNR.

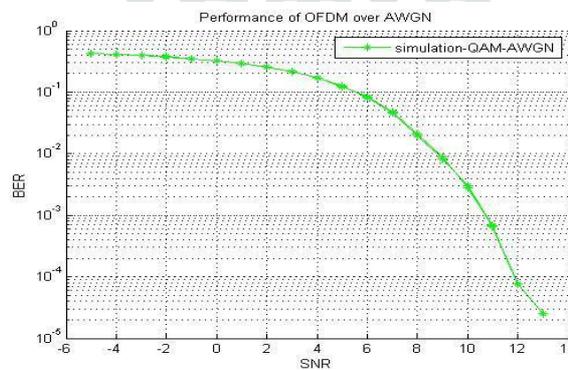


Fig- 5: Performance of Simulation Result QAM-OFDM using AWGN channel

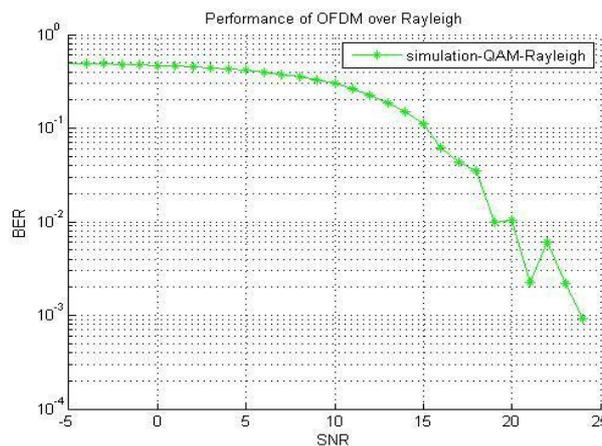


Fig- 6: Performance of Simulation Result QAM-OFDM using Rayleigh channel

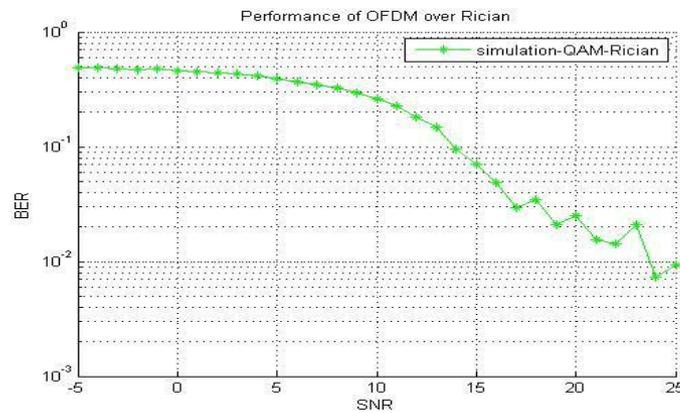


Fig- 7: Performance of Simulation Result QAM-OFDM using Rician channel

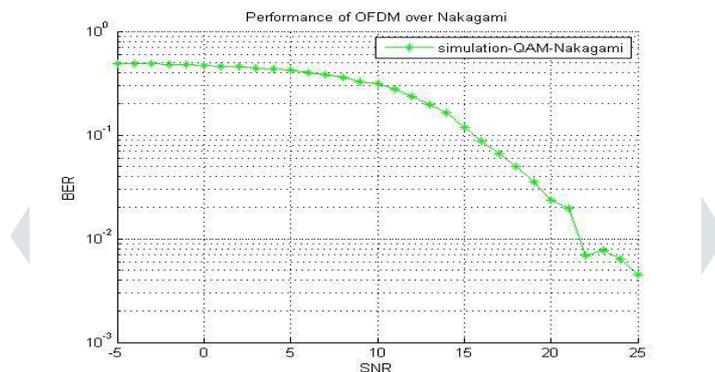


Fig-8: Performance of Simulation Result QAM-OFDM using Nakagami channel

## 6. CONCLUSIONS

MIMO-OFDM is a powerful modulation technique used for high data rate, and is able to eliminate ISI. It is computationally efficient due to the use of FFT techniques to implement modulation and demodulation functions. The performance of MIMO-OFDM is tested for modulation techniques namely QAM using MATLAB-2013a. The OFDM with higher M-ary modulation scheme is used for large capacity, long distance application at the cost of slight increase in Eb/No. The comparison of different channel with QAM-OFDM indicates that, BER is large in BPSK as compared to other. We conclude that QAM modulated MIMO - OFDM system achieves better SNR results for Rician channel is (24db SNR in  $10^{-2}$  BER). In other AWGN channel is (9db SNR in  $10^{-2}$  BER), Rayleigh channel is (20db SNR in  $10^{-2}$  BER) and Nakagami channel is (22db SNR in  $10^{-2}$  BER). In further new wavelet basis can be designed according to wireless channel conditions to improve the overall system performance.

## 7. REFERENCES

- [1]. 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.
- [2]. Surekha, T.P "Modeling and Performance Analysis of QAM-OFDM System with AWGN Channel" 978-1-4577 0855-8, 17-18 July 2011
- [3]. 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.
- [4]. Xu Zhang "Modeling & Performance Analysis of QAM-based COFDM System" University of Toledo August 2011.
- [5]. 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.
- [6]. U. D. Dalal and Y. P. Kosta "Adaptive Parameters Based Transmission Control and Optimization in Mobile WiMAX at Physical Layer" ISBN 978-953-7619-53-4, Published, December 1, 2009.
- [7]. Mukesh Patidar, Rupesh Dubey "Performance Analysis of WiMAX 802.16e Physical layer model" 978-1-4673-1989-8/12/2012 IEEE.