© 2018 IJSRST | Volume 4 | Issue 3 | Print ISSN : 2395-6011 | Online ISSN: 2395-602X

National Conference on Advances in Engineering and Applied Science (NCAEAS)
29th January 2018
Organized by : Anjuman College of Engineering and Technology (ACET) Nagpur, Maharashtra, India, In association with
International Journal of Scientific Research in Science and Technology

Implementation various Modulation techniques for MIMO OFDM Systems

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ABSTRACT

Due to the escalation in number of users, the wireless systems require tremendously high data rates and high reliability to meet the expectation. MIMO – OFDM (Multiple input and Multiple Output-Orthogonal Frequency Division Multiplexing) is being considered as an optimum solution, considering the ability to serve large number of users with a high speed communication, utilizing the bandwidth proficiently. The Multi carrier modulation provides an advantage of reduction in inter symbol interference. The efficiency of this system is subjected to vary with the channel and modulation techniques. This project is used to obtain the efficiency in terms of the Bit Error Rate performance versus Signal to Noise Ratio. In addition it includes variations based on different channels i.e. AWGN (Additive white Gaussian Noise various modulation techniques i.e. BPSK, QPSK, M-PSK, D-BPSK, DQPSK, DPSK, QAM.

Keywords: OFDM, MIMO, BPSK, QAM

I. INTRODUCTION

An overview of the basics of MIMO-OFDM technology and focuses on the BER Analysis of MIMO-OFDM systems. 3G popularly known as third generation mobile communication systems cannot meet the requirements of a variety of business types because of its low data rates. Secondly, voice transportation in 3G is conversant to second-generation (2G) communication systems because they both use circuit switching technology rather than Internet Protocol approach. Because of these limitations many countries have introduced the revolutionary,(4G) communication systems that provides a far-reaching and secure IP solution where data, voice and multimedia can be provided to users with increased data rates than previous technologies. Communication in the wireless medium takes place through electromagnetic waves which carry the signals over the communication path. This term is mainly used in the telecommunications industry in order to refer to telecommunications systems (e.g. receivers, radio transmitters, remote controls etc.) which use energy to transfer information without the use of wires. This means the transfer of data between two or more points that are not physically connected by an electrical conductor. It can be divided into-Wireless at fixed location, portable locations and wireless in mobile applications. Cellular telephones and personal digital assistants are included under fixed and portable communication. Modulation is one of the most important process in wireless

communication, it involves varying some features of a carrier signal with the message signal which contains information to be transmitted. Fading is the change in attenuation that affects a signal over certain propagation media. Different signal copy's will experience different fading and hence will be attenuated in a different manner. Delay and phase profoundly affect the transmitted signal. This results in either constructive or destructive interference, which amplifies or attenuates the signal power seen at the receiver. Destructive interference may result in temporary failure of communication due to a severe drop in the channel's signal-to- noise ratio. OFDM is a special form of multicarrier modulation, where a single data stream is transmitted over a large number of lower rate sub-carriers.

II. MIMO OFDM

Various schemes that employ multiple antennas at the transmitter and receiver are being considered to improve the range and performance of communication systems. By far the most promising multiple antenna technology today happens to be the so called multiple-input multiple-output (MIMO) system. MIMO systems employ multiple antennas at both the transmitter and receiver

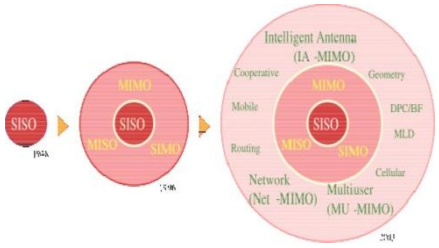

Figure 1. A sample line graph using colours which contrast well both on screen and on a black-and-white hardcopy

a. OFDM

OFDM is a multi-carrier transmission technology in which the frequency band is discrete into a number of sub channels. Usual multiplexing techniques involve a number of filters to prevent interference among the sub-carriers and the non – overlapping must be preserved with a minimum frequency separation. On the other hand, OFDM uses signal processing techniques which thus eliminates this issue moreover, the sub- carriers are orthogonal in nature eliminating the need of many filters.

An OFDM system consists of a transmitter and a receiver. The signal is mapped in to a suitable constellation by the different modulation techniques. This serial data is then converted into parallel data stream, to which ofdm is performed. It consists of N sub carriers which carries the symbols. An OFDM transmitter involves an IFFT block

$$f(n) = \sum_{k=0}^{N-1} F(k) exp\left(\frac{j2\pi kn}{N}\right)$$

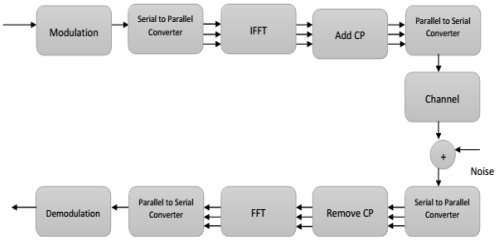

Figure 2. Ofdm Model

Cyclic prefix is added to the output to reduce ISI. This is then processed to a serial output which is passed through the corresponding channel.

At the receiver the data is converted into parallel input and the cyclic prefix is removed. This is then subjected to FFT. The frequency domain signal in kth receiving subcarrier is expressed as

$$F(K) = \sum_{n=0}^{N-1} f(n) exp\left(\frac{-j2\pi kn}{N}\right)$$

b. MIMO system model

Multiple antennas are present in both the transmitting and receiving end, thus ensures

increased channel capacity. However, the capacity is limited to the correlation of the sub channels in non-scattering environments. A path / channel is established between each transmitting antenna and receiving antenna. The signal with highest efficiency at any receiver is taken. The MIMO is used in wireless networks, cellular networks, WiMAX. The proposed system is a combination of

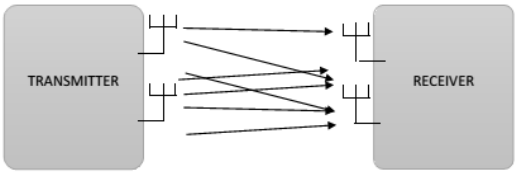

Figure 3. MIMO MODEL

c. MIMO-OFDM.

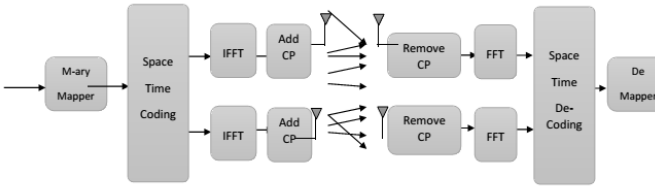

Figure 4. Mimo Model

The implemented involves MIMO-OFDM and a comparison in of different modulation schemes in various wireless channels. MIMO-OFDM is a combination of MIMO and OFDM.

Thus multiple inputs and outputs are added to the orthogonal frequency division multiplexing. Here the elimination of ISI due to signal processing , apart from eliminating the inter-symbol interference also increases the spectral efficiency enabling more number of users to share the available bandwidth. The implementation is performed using MATLAB.

III. RESULTS AND DISCUSSION

Wireless environments provides a challenging platform for maintaining good communication. The performance is mostly affected by fading (Multipath fading and motion induced fading).In a wireless communication channel, the signal can travel in more than one path in between the transmitter and receiver. The presence of multipath components in a transmission may have variant causes including atmospheric reflection or refraction, or due to reflections from other Interfering Objects (IO) like buildings, sub channels, etc. Generally, the multipath propagation, which involves a radio channel with several IOs and a moving receiver need to resort to statistical methods rather than a deterministic description of the radio channel which is proven to be less efficient. The statistical description of the radio channels is essential for wireless communication applications. The project features the characteristics of MIMO-OFDM over AWGN.

a. AWGN CHANNEL

Additive white Gaussian noise (AWGN) channel is widely used in analysis of different modulation schemes. The channel adds a white noise to the signal passing through it. The advantage of using this channel is the absence of Fading.

The received signal is expressed as:

$$R(t) = s(t) + n(t)$$

Where s (t) is transmitted signal and n (t) is additive white Gaussian noise.

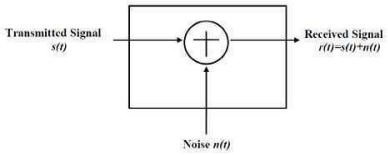

Figure 5. Awgn Channel

On applying different modulation schemes to the AWGN channel under MIMO- OFDM we observe the efficiency of the system. The simulation produces the plot of Bit Error Rate vs Signal to Noise ratio. The system with minimum bit error rate under even under low signal to ratio is considered to be efficiency. From the result it is shown that at any

instant if SNR (eg. 10 dB) the bit error rate is minimum for 256 QAM and is maximum for DQPSK. On repeating the procedure for more modulation schemes, shall produce a clear idea on the efficiency, thus enabling to choose the most optimum scheme based on the requirement.

IV. CONCLUSION

The goal of the project to obtain a performance analysis of different modulation schemes in AWGN channel for a MIMO-OFDM system is satisfied. This helped in obtaining the efficiency of the modulation techniques in terms of accuracy or reliability by plotting Bit Error Rate against Signal to Noise for a modulation scheme. This could further be enhanced by applying more modulation schemes across different wireless communication channels on a MIMO- OFDM system.

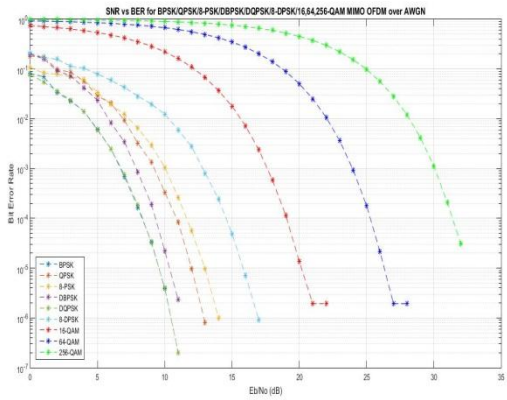

Figure 6. SNR vs BER for different modulation over AWGN

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