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Performance Analysis of BER and SNR Performance in High-QAM Modulations Using Advancements in MIMO Systems

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Abstract: **Wireless communications is one of the most active areas of technology development of our time. This development is being driven primarily by the transformation of what has been largely a medium for supporting voice telephony into a medium for supporting other services, such as the transmission of video, images, text, and data. Today, the widely deployed network type is based on a centralized approach that requires a network point of access, commonly called the Access Point (AP), to serves as a gateway between the mobile device and the Internet. The obtained results demonstrate that spatial diversity along with the power of STBC significantly improves the error performance in frequency selective wireless fading channels. The BER level is depend on the modulation type, SNR value and channel behavior. Modulation schemes that we have used in this paper are 4-QAM, 8-QAM, 16-QAM and 64-QAM which further improved using forward error correction codes (FEC). A comparison is made between the diversity gains of MIMO systems in terms of BER for high QAM modulation scheme. This work presents, a simulation toll MATLAB R2023a used for model implemented using Nakagami channel to study the performance analysis of Bit Error rate (BER) V/S Signal to Noise ratio (SNR).**

Keywords: AWGN, BER, Fading Channel, MIMO System, Nakagami, OFDM, QAM Modulation, SNR, STBC etc.

I. INTRODUCTION

The wireless communication history, every generation of computers get advanced with new frequency bands, high data rates and non-backwards compatible transmission technology. Here as we know 4G is a successor of 3G, i.e. 4G provides internet broadband in computer devices and other mobile devices .Some of the other features you use now are days are parts of it like High definition Mobile TV, Video conferencing, video calling, accessing mobile internet, IP Telephony (Voice Over Internet Protocol [VIOP] it is the group of technologies which is used to deliver the voice communication through the internet protocol) [1]. 4G can be categorized in two types –LTE (Long Term Evolution [first used in Norway, Oslo in 2009]), Mobile WiMAX (firstly used in South Korea in 2006) [2-3]. The WiMAX Forum develops system profiles, which define mandatory and optional capabilities for WiMAX products. The list of features tested in system profiles is more stringent than the underlying standards, but does not include any new feature that is not included in the standards [74]. Initially, the WiMAX Forum focused on the 10-66GHz frequencies in the Wireless MAN-SC physical layer specifications of IEEE Standard 802.16-2001. The OFDM frequency distribution and multiple user access are accomplished by means of assigning different users to different sub-channels. In order to better support mobile users, the technology also modulates the transmitted signal power based on the quality of the data transmission channel [5-8].

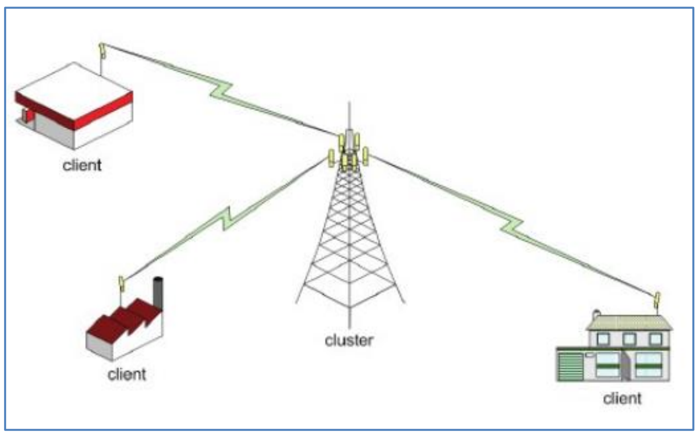

Fig. 1: The architecture of WiMAX

The standard for WiMAX is a standard for wireless metropolitan networks (WMAX) that has been developed by working group number 16 of IEEE 805, specializing in broadband wireless access. It is also supported by a wide number of industry companies [9]. WiMAX technology will support traffic based on transport technologies ranging for Ethernet, Internet protocol (IP), and asynchronous transfer mode (ATM), the forum will only certify the IP-related elements of the 805.16 products. The WiMAX has two important standards/usage models, a fixed usage model IEEE 805.16d for fixed wireless broadband access (FBWA) and a portable usage model IEEE 805.16e for mobile wireless

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broadband access (MBWA). The architecture of WiMAX is show Fig. 1.

A. Features of WiMAX

An important and very challenging function of the WiMAX system is the support of various advanced antenna techniques, which are essential to provide high spectral efficiency, capacity, system performance, and reliability,

a. Beam forming using smart antennas provides additional gain to bridge long distances or to increase indoor coverage; it reduces inter-cell interference and improves frequency reuse.

b. Transmit diversity and MIMO techniques using multiple antennas take advantage of multipath reflections to improve reliability and capacity [10].

II. MIMO SYSTEM

Wireless MIMO channels have been recently attracting a great interest since they provide significant improvements in terms of spectral efficiency and reliability with respect to single input single-output (SISO) channels. The gains obtained by the deployment of multiple antennas at both sides of the link are the array gain, the diversity gain, and the multiplexing gain. The array gain is the improvement in signal-to-noise ratio (SNR) obtained by coherently combining the signals on multiple-transmit or multiple-receive dimensions while the diversity gain is the improvement in link reliability obtained by receiving replicas of the information signal through independently fading dimensions [11]. The multiple antennas can be used at the transmitter and receiver, arrangement called a Multiple Input Multiple Output technique. The multiple input multiple output (MIMO) system takes advantage of the spatial diversity that is obtained by spatially separated antennas in a dense multipath scattering environment. The multiple input and multiple output schemes may be implemented in a number of different ways to obtain either a diversity gain to combat signal fading or to obtain a capacity gain [12-13]. A multiple input multiple output techniques are three categories.

A. Spatial Diversity

When a channel is rich in multipath signal components, it is possible to simulate independent virtual paths which can then be used to transmit signal copies for redundancy. The ability to transmit redundant data through independently faded channel is called Diversity. Diversity techniques like space, time and frequency are well known techniques used to improve reliability of wireless communication systems [14]. Among them, spatial diversity technique is the most promising one, because it does not require any additional bandwidth and does not introduce additional delays in signal transmission. Space–Time Block Codes (STBCs) are the simplest types of spatial temporal codes that exploit the diversity offered in systems with several transmit antennas. It was designed to achieve maximum diversity order for the given number of transmit and receive antennas subject to the constraint of having a simple decoding algorithm. In addition, space-time block coding provides full diversity advantage. Alamouti designed a simple transmission diversity technique for systems having two transmit antennas [15]. This method provides full diversity and requires simple linear operations at both transmission and reception side. The encoding and decoding processes are performed with blocks of transmission symbols. Detail analysis of 2X2 Alamouti space time coding is given below.

B. Alamouti space-time coding scheme (2×2)

The Alamouti space-time coding scheme for the system with two transmission antennas and two reception antennas in a memory less channel, as proposed in is shown in Figure 2. The transmission scheme is the same as with the 2×1 system. **Received signals at receive antenna 1 are**:

$$R_0(t) = h_{11}(t)X_1(t) + h_{21}(t)X_2(t) + n_0(t) \quad (1)$$

and

$$R_1(t) = -h_{11}(t)X^*{}_2(t) + h_{21}(t)X^*{}_1(t) + n_0(t + T \quad (2)$$

Where n_0 represents noise at receive antenna 1.

At receive antenna 2 the received signals are:

$$R_2(t) = h_{12}(t)X_1(t) + h_{22}(t)X_2(t) + n_1(t) \quad (3)$$

and

$$R_5(t) = -h_{21}(t)X^*{}_2(t) + h_{22}(t)X^*{}_1(t) + n_1(t + T) \quad (4)$$

At time instances t and $t + T$, respectively, where n_1 represents noise at receive antenna 2. Again, the estimates of the signals in the decoder/combiner are given as in equation 5 and 6.

$$\widehat{X_1} = h^*{}_{11}(t)R_0(t) + h_{21}(t)R^*{}_1(t) + h^*{}_{12}(t)R_2(t) + h_{22}(t)R_5(t) \quad (5)$$

$$\widehat{X_2} = h^*{}_{11}(t)R_0(t) - h_{21}(t)R^*{}_1(t) + h^*{}_{12}(t)R_2(t) - h_{22}(t)R_5(t) \quad (6)$$

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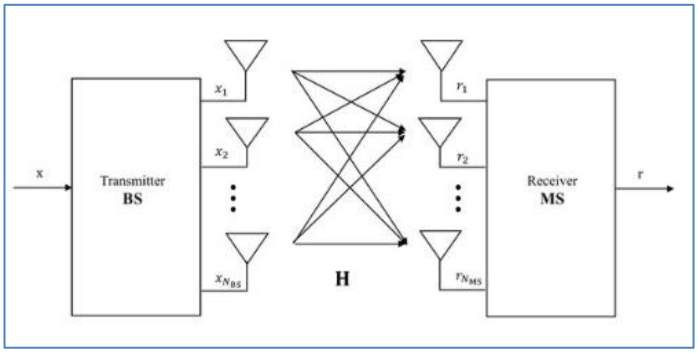

Fig.2 MIMO System

Decoded symbol blocks are obtained using a maximum likelihood (ML) detector. A maximum likihood detector maps the estimated symbols $\widehat{X_1}$ and $\widehat{X_2}$ to the most probable reference symbols from the phase shift keying modulation (PSK) or quadrature amplitude modulation (QAM) constellation being used. The measure used for mapping is the two dimensional distance between the estimated and the reference symbol on the constellation grid.

III. Additive White Gaussian Noise (AWGN) Channel

The simplest radio environment in which a wireless communications system or a local positioning system or proximity detector based on Time of-m flight will have to operate is the Additive-White Gaussian Noise (AWGN) environment. Additive white Gaussian noise (AWGN) is the commonly used to transmit signal while signals travel from the channel and simulate background noise of channel. The mathematical expression in received signal [16]:

$$r(t) = s(t) + n(t) \quad (7)$$

That passed through the AWGN channel where $s(t)$ is transmitted signal and n(t) is background noise. In AWGN channel adds white Gaussian noise to the signal that passes through it. It is the basic communication channel model and used as a standard channel model. The transmitted signal gets disturbed by a simple additive white Gaussian noise process [17-18].

IV. RESULT ANALYSIS

The different modulation scheme are consider like (4-QAM, 16-QAM and 64-QAM), Channel like AWGN, Nakagami and fading. The Carrier rate is ½ with FFT size 256 consider. The project work done by using simulation tool MATLAB R2013a Used.

Result Analysis: In this performance, we have used communication Nakagami channel with different QAM modulation techniques. The performance is displayed in figure 3 in terms of the BER verses SNR logarithmic plot. In this plot we analysis the 32-QAM, SNR is increased 1.7 dB on BER at 10^{-2} as compared to 16-QAM and Modulation Techniques at a constant signal power.

In this performance, we have used the Alamouti scheme with communication Rician channel and different modulation techniques. The performance is displayed in figure 4 in terms of the BER verses SNR logarithmic plot.

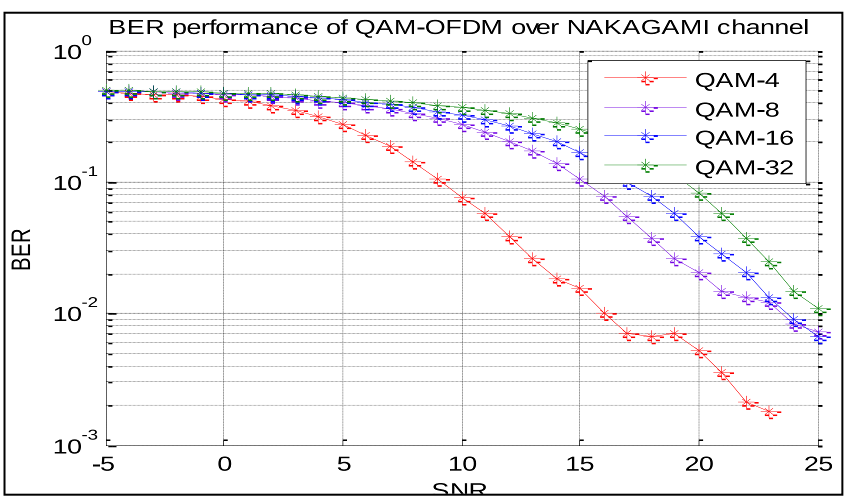

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Fig: 3 BER performance of QAM-OFDM over NAKAGAMI

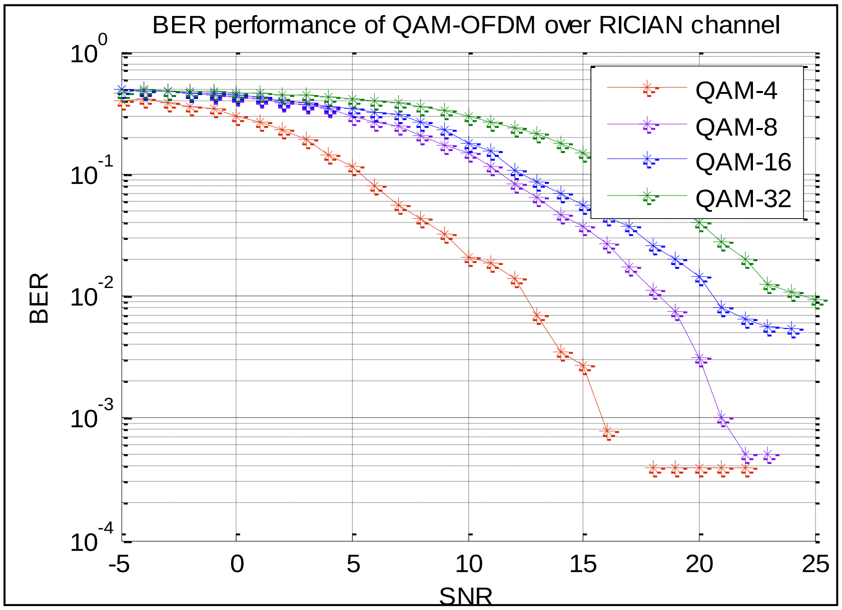

Fig: 4 BER performance of different QAM-OFDM over RICIAN

V. CONCLUSION

In conclusion, wireless communications globally is something that people can expect as technology advances. Wireless communications has a lot of benefits and can make the world a lot more efficient. It does have concerns though as with every other new advancement that is made in today's world. Orthogonal Frequency Division Multiplexing–Multiple Input Multiple output system simulation setup with STBC Alamouti scheme has been developed. The comparison of different channel with QAM-OFDM indicates that, bit error ratio is large in BPSK as compared to other. We conclude that QAM modulated MIMO - OFDM system achieves better SNR results for Rician channel. In other AWGN channel, Rayleigh channel, and Nakagami channel. It is found that with increase of modulation order the capacity enhancement is compare to BER and SNR.

REFERENCES

1 Chen, S.; Zhang, J.; Zhang, J.; Björnson, E.; Ai, B. A survey on user-centric cell-free massive MIMO systems. Digit. Commun. Netw. 2021.

2 Mokhtari, Z.; Sabbaghian, M.; Dinis, R. A Survey on Massive MIMO Systems in Presence of Channel and Hardware Impairments. Sensors 2019, 19, 164.

3 Ijiga, O.E.; Ogundile, O.O.; Familua, A.D.; Versfeld, D.J. Review of channel estimation for candidate waveforms of next generation networks. Electronics 2019, 8, 956.

4 Wen, F.; Wymeersch, H.; Peng, B.; Tay, W.P.; So, H.C.; Yang, D. A survey on 5G massive MIMO localization. Digit. Signal Process. 2019, 94, 21–28.

5 Zheng, K.; Zhao, L.; Mei, J.; Shao, B.; Xiang, W.; Hanzo, L. Survey of Large-Scale MIMO Systems. IEEE Commun. Surv. Tutor. 2015, 17, 1738–1760.

6 Yang, S.; Hanzo, L. Fifty Years of MIMO Detection: The Road to Large-Scale MIMOs. IEEE Commun. Surv. Tutor. 2015, 17, 1941–1988.

7 Paul, B.S.; Bhattacharjee, R. MIMO channel modeling: A review. IETE Tech. Rev. 2008, 25, 315–319.

8 Yu, K.; Ottersten, B. Models for MIMO propagation channels: A review. Wirel. Commun. Mob. Comput. 2002, 2, 653–666.

9 Fatema, N.; Hua, G.; Xiang, Y.; Peng, D.; Natgunanathan, I. Massive MIMO Linear Precoding: A Survey. IEEE Syst. J. 2018, 12, 3920–3931

10 Qiao, G.; Babar, Z.; Ma, L.; Ahmed, N. Channel Estimation and Equalization of Underwater Acoustic MIMO-OFDM Systems: A Review Estimation du canal et l'égalisation des systèmes MEMS-MROF acoustiques sous-marins: Une revue. Can. J. Electr. Comput. Eng. 2019, 42, 199–208.

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11 Fette, B. Introducing Adaptive, Aware, and Cognitive Radios. In Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems; Arslan, H., Ed.; Springer: Dordrecht, The Netherlands, 2007; pp. 1–16.

12 Luther, E. 5G massive MIMO testbed: From theory to reality. White Paper. 2014. Available online: https://www.ni.com/en-rs/innovations/white-papers/14/5g-massive-mimo-testbed--from-theory-to-reality--.html (accessed on 4 May 2022).

13 Hasan, W.B.; Harris, P.; Doufexi, A.; Beach, M. Real-Time Maximum Spectral Efficiency for Massive MIMO and its Limits. IEEE Access 2018, 6, 46122–46133.

14 Zhang, C.; Qiu, R.C. Massive MIMO testbed-implementation and initial results in system model validation. arXiv 2014, arXiv:1501.00035.

15 Salah Talha Babiker (2017). New Wavelet Transform Smart Processor for Massive MIMO System, American Journal of Engineering Research (AJER) 6(1), pp. 179-183.

16 Banhijit Bhattacharyya and Somdutta Bhattacharya (2013). Emerging Fields in 4G Technology, it's Applications & Beyond-An Overview, International Journal of Information and Computation Technology, 3(4), pp. 251-260.

17 Sweta Rawat & Prabhat Sharma (2016). Review Paper on MIMO-OFDM System for WiMAX (IEEE 802.16) based on Cognitive Radio Networks, International Journal of Innovative Research in Computer and Communication Engineering, 4(10).