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Performance Analysis of Modulation Techniques for Long Term Evolution

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ABSTRACT

Wireless communication has become on most essential and prominent part of our daily life. It is one of the important active areas of discussion. Accurate simulation of wireless channels as well as performance-based evaluation of wireless components and wireless communication plays an important role. We analyzed and evaluated the act of available transmission modes in LTE. However, overall performance analysis can be done by using evaluation of LTE. By calculating probability of Bit Error Rate (BER) versus Signal to Noise Ratio (SNR) under most frequently used wireless channel model (AWGN) the performance of transmission modes are evaluated. The data rate and data modulation are considered to analyze BER vs. SNR performance. With analysis, BER with QAM from Fig 5.4.8 with modulation order 4 and Eb/N0 =2 shows acceptable result. Hence QAM can be used as better modulation technique for LTE.

KEYWORD: LTE, AWGN, PSK, QAM, DPSK, OQPSK, PAM, BER.

INTRODUCTION

In telecommunications, modulation is the technique of various one or greater properties of a waveform that's called 'carrier signal' along with a modulating signal which includes data to transmit. A carrier signal is a periodic signal with consistent amplitude and frequency (Hz), wherein data may be brought to the carrier with the aid of using varying its amplitude, frequency or phase. Analog modulation and Digital modulation are the two types of modulation techniques. We use analog modulation when the modulating signal is analog likewise modulating signal is digital then we use digital modulation. PSK, QAM, PAM, DPSK, OQPSK, FSK modulation are popularly used in digital modulation.

1.1. Motivation

In mobile communication, LTE is the latest technology to provide connectivity and advanced services. LTE achieves higher peak data rates up to 50 Mbps in uplink and 100Mbps in downlink with scalable bandwidth and better spectral efficiency. As a result of rapid adoption and growth, operators upgrade their hardware with every generation of wireless communication. In many cases, these upgrades require complete modification of the existing devices. This is costly and constraints researchers, service providers and end-users. In modern days most of the standard wireless communications are almost primarily based totally on Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input Multiple Output (MIMO). The maximumvitalissue that comes up with wireless communication is 'Mobility'. The multipliedperformance and functionality in wireless in addition to wireline presentedsmooth connectivity and served the customer's needs.

2.Literature Survey

In general communications is the medium of data transmission from one location to give up uses. And the, Wireless communication refers to a method where data is transmitted through wireless medium. The wirelesscommunicationideabecame first delivered by Guglielmo Marconi in 1897. In the past due 1970, the primary two-way communicationbecamedelivered.

2.1. Existing System

The 1st generation of cell telephones 1G became primarily based totally on analogue communications and the use of FDMA. The 2nd cell technology 2G became primarily based totally on virtual conversation because it became the use of virtual modulation to supply voice and records. This cell technology became delivered in past due 1980 and covered the worldwide cell gadget GSM which remains relevant in many countries. As compared to 1G, extra a couple of access strategies have been delivered in 2G. They have been Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA). Frequency band allotted for 2G is 890- 960(MHz) and 1710-1880(MHz). After second technology, General Packet Radio Service (GPRS) became delivered which became taken into consideration as 2.5G. Then Enhanced Data Rates for GSM Evolution (EDGE) became introduced which became 2.75G. The 3rd technology became delivered which became essentially Universal Mobile Telecommunications System. The 4th technology follows on from 3G (0.33 technology). It is 5 to seven instances quicker than 3G and gives all what 3G do with more services. That equates to most capability speeds of round 80Mbps with inside the actual world.

2.2. Disadvantages of Existing System

The disadvantages of existing system are, it is unable to estimate high throughput with low latency of high parallelism with less BER performance. Unable to compute throughput at the physical layer but recommended for future research direction.

2.3. Proposed Method

Here we propose to analyze various Modulation types at different Modulation orders to find the best Modulation technique for LTE. The analysis is based on measuring bit error rate (BER) vs. signal to noise ratio. Table 2.3.1. provides the comparison of various works for literature survey.

Table 2.3.1. Literature Analysis

S.No	Year	Work done	Simulation tool used	Result	Conclusion
1	2012	Performance Evaluation of Precoding in Spatial Modulation OFDM on a LTE Channel	Bit error rate Analysis (MATLAB)	ZFCI, MMSECI and BD pre-coding in SM-MU-MIMO-OFDM systems over EPA LTE channel was analyzed.	SM-MU-MIMO OFDM is optimum. Higher QAM constellation is avoided.
2	2015	Comparative Analysis of Different Modulation Techniques of LTE Network	Agilent spectrum Analysis	Study between QPSK, 16QAM and 64QAM for LTE network.	QPSK is better than 16,64-QAM from perspective of average power But, 64QAM gives the best result
3	2019	Evaluation of BER in LTE system using various modulation techniques over different modulation schemes	Bit error rate Analysis (MATLAB)	Transmission modes are evaluated by calculating probability of BER vs. SNR under the three wireless channel models.	Confirm increase in the coverage area of the physical layer in the LTE devices. Describe fading environment Receiving end, signal is error free.
4	2021	Performance Analysis of LTE Codes System Using Various Modulation Techniques	Bit error rate Analysis (MATLAB)	Performance of Viterbi decoder is analyzed by measuring BER vs. SNR (8dB).	16-QAM gives better BER result than 64-BER BPSK and QPSK are outperform both 16-QAM and 64-QAM.
5	2013	Performance analysis on throughput in 4G network in digital environment with SISO tech	MATLAB	The higher type of modulation is used, the throughput delivered is of high data rate.	The performance delivered by the RF is almost the same as delivered by the digital one.
6	2011	Technology & performance analysis	BER (MATLAB)	The values of the PAPR in SC-FDME are much lower than the ones in OFDMA, and that is why it has been adopted for uplink transmission in LTE system.	SC-FDME is more power efficient
7	2017	Performance analysis of Downlink and uplink transmission schemes in 4G LTE using various modulation techniques	LTE (MATLAB)	The uplink and downlink transmission modes utilized in LTE framework expanding of the BER is noticed for fixes worth of SNR for higher request tweak techniques (16-QAM and 64-QAM).	To embrace low request balance plot for example BPSK, QPSK and 16-QAM for uplink to have less PAPR at client end. In nutshell, SC-FDMA is more power efiicient.
8	2014	Comparative performance Analysis of different modulation techniques for PAPR reduction of OFDM signal	MATLAB	In case of higher CR value, QAM is more appropriate than PSK. In case of lower CR value, PSK is better suited than QAM.	The rational amount of BER is quite more than rational amount of PAPR reduction in case of all higher modulations. Lower modulation is better than higher modulation.
9	2020	Evaluation of BER in LTE systems using various modulation techniques over different modulation schemes	MATLAB	QAM modulation scheme, BER is measured for AGWN Rayleigh &radian channel for different SNR	The performance of transmission modulation evaluation by calculating probability of SNR results SNR under frequency used three wireless channel models.
10	2019	Performance analysis and comparison of different modulation schemes with channel estimation method for MIMO-OFDM system.	MATLAB (R2018b)	MMSE-SIC performs best in all scenarios as well as with different modulation like BPSK and QAM. MMSE-SIC also promises us low BER as compared to other algorithms.	MMSE-SIC delivers low BER there as well as it is in the current 4G networks. MIMO and OFDM will be used in the 5G networks.
11	2013	Performance Evaluation of differential modulation in LTE downlink	MATLAB	The utilized cognizant recognition in the LTE downlink out performs differential balances with non reasonable location, regardless of whether MSDSD is applied.	The higher offered most extreme throughput must be accomplished for exceptionally high SNR upsides of around 33dB, which isn't reasonable for a remote framework.

S.No	Year	Work done	Simulation tool used	Result	Conclusion
12	2019	Physical layer performance modelling of modern multicarrier module techniques	MATLAB	OFTS is the best suited multicarrier modulating for time varying channels.	The received SINR do these multicarrier techniques derived for the frequency domain MMSE equalization and fading specific PLA is proposed.
13	2015	Reliability checking for digital modulation schemes in 4G-5G communication system.	MATLAB	If QPSK modulation scheme can be applied for the whole system the BER will be minimized in a noticeable amount.	QPSK showed better performance compared to QAM. So a combination of QAM and QPSK can be better solution for implementation of 5G.
14	2013	Performance analysis of essential modulation techniques	MATLAB	For BPSK balancing procedure the image mistake rate is lower than any remaining technique in this regard BPSK is ideal despite the fact that it has many burdens moreover.	Critical upgrades as far as BER and throughput can be accomplished exhibiting the prevalence of the BPSK balance plans contrasted with other transmission plans.
15	2007	Physical Layer Performance of Long Term Evolution Cellular Technology	LTE (MATLAB)	Complete offered load is near framework's ability (≈ 60 Mbps), viable throughput declines steadily.	Greatest LTE limit around 60 Mbps (for 20MHz framework transfer speed), which might be even copied when 2x2 radio wire setup is applied.
16	2006	Technical Solutions for the 3G Long-Term Evolution	LTE	By applying MIMO and cutting edge beneficiaries to WCDMA, comparable execution is accomplished with respect to the advanced RAN	Advanced interface layer idea, and an OFDM-based actual layer supporting multi-radio wire arrangements, which together help high piece rates, limit, and inclusion
17	2015	Performance Analysis of Adaptive Modulation and Coding Schemes on OFDMA Physical Layer	MATLAB Simulink, (BER)	BER execution of transmission over non-blurring AWGN channels improves with expanding SNR values when contrasted with that of the blurring channels	Effective usage of data transmission and sign power as well as upgrading limit and generally speaking throughput.
18	2013	Comparison between scheduling techniques in long term evolution	MATLAB (LTE)	The best CQI calculation beats different calculations as far as throughput levels	The covetous best CQI gives the best outcome in throughput LER among the other two.
19	2015	A Comprehensive Review of Modulation Techniques used in Long Term Evolution	MATLAB	Likelihood of mistake refrains SNR for both the uplink (SC-FDMA) and downlink (OFDMA) conspire. In both method SNR esteem increments for higher adjustment	The framework execution is worked on regarding BER and SNR for low request regulation methods
20	2008	Performance Evaluation of 6-Sector-Site Deployment for Downlink UTRAN Long Term Evolution	MATLAB	The 6-area sending in the blended organization geography can be a feasible choice to satisfy high traffic needs in a confined region, for example, problem areas, yielding a limit gain in the 6-area locales in the request for 95 % to 110 %	Relative limit gain for 6-area site when contrasted with 3-area site is in the request for 88% for a homogenous organization.
21	2014	BER analysis of conventional and wavelet based OFDM in LTE using different modulation techniques	MATLAB	Broke down the exhibition of wavelet based OFDM framework and contrasted it and the presentation of DFT based OFDM framework	Daubechies2 and haar wavelets both give their best exhibitions at various timespans.
22	2020	Performance Analysis of LTE Based Transceiver Design Using different modulation schemes	LTE (MATLAB)	BER and SNR execution appraisals on planned handset structures are broke down	The channel productivity is assessed utilizing boundaries like data transmission and conveying power as limitations.
23	2020	Performance Evaluation of LTE System in Different Channels with Different Retransmissions	MATLAB	The AWGN channel model performed better than other channels	TxD 4x2 technique achieved a considerable gain compare to the OLSM 4x2 techniques in terms of BLER
24	2011	Performance Evaluation of Link to System Interface for Long	MATLAB	The MIESM model enjoys an upper hand over EESM model	The EESM and MIESM models have a high precision execution,

S.No	Year	Work done	Simulation tool used	Result	Conclusion
		Term Evolution System		since it is doesn't require alignment for little data transmission plans and low MCS plans	specifically, when low MCS plans are applied
25	2010	Performance Evaluation of Uplink Multiple Access Techniques in LTE Mobile Communication System	MATLAB	Mixture procedure accomplishes better start to finish connect execution when contrasted with the unadulterated SC-FDMA method and keeps up with a similar PAPR esteem in access connect.	Lower PAPR is accomplished contrasted with OFDMA case, which is a significant legitimacy in the uplink transmission because of the UE's power assets limitations
26	2021	Performance Evaluation of 5G Modulation Techniques	MATLAB	UFMC further develops BER execution contrasted with ordinary OFDM and different plans referenced	UFMC with PAPR decrease is viewed as in up and coming age of remote correspondence framework
27	2019	BER Evaluation in LTE SC-FDMA under Multipath Channels	MATLAB framework	BER execution for SC-FDMA under four different channel evening out like AWGN, Rayleigh, Pedestrian An and Vehicular A channels	By applying ZFE and MMSE on SC-FDMA the presentation of the got signal has fundamentally improved.
28	2012	Long Term Evolution Downlink Physical Layer Simulation in Matlab and Simulink	MATLAB	Matlab and Simulink-based LTE downlink physical-layer test system as indicated by 3GPP details and related recommendations.	Brief presentation of each and every part is given alongside actual ideas and examination for bit blunder rate and throughput
29	2017	Performance Analysis of OFDM Signal Using BPSK and QPSK Modulation Techniques	MATLAB	The information pace of OFDM signal is extremely high with lower necessities of data transmission	The information pace of BPSK is lower than the QPSK signal yet in addition bit mistake rate is lower than QPSK
30	2014	Simulating the Long Term Evolution (LTE) Downlink Physical Layer	MATLAB	Recieving wires number and transmission capacity decision are key variables in accomplishing hypothetical paces publicized with a wide choice MIMO and satisfactory transfer speed	With LTE framework utilizing MIMO and OFDMA because of cyclic prefix permits beat traffic among eNodeB and UE, causing parcel misfortune and a drop in speed

ANALYSIS

By the utilization of MATLAB in general execution capacity of DFT essentially based absolutely OFDM is obtained for one of kind tweaks which can be utilized for the LTE, as demonstrated in figures. Tweaks that may be utilized for LTE are QPSK, 16 QAM and 64 QAM. QPSK truly does now never again convey data at exceptionally over the top speed. At the point when motion toward commotion proportion is of precise remarkable then best better adjustment systems might be utilized.

Lower kinds of regulation (QPSK) do now never again require exorbitant sign to commotion proportion. For the reason for reproduction, sign to commotion proportion (SNR) of different qualities are conveyed through AWGN channel. Information of 9600 pieces is dispatched with inside the state of 100 images, so one picture is of 96 pieces. Averaging for a particular expense of SNR for the images is all finished and BER is procured and indistinguishable procedure is rehashed for each of the upsides of SNR and last BERs are gained.

DESIGN

LTE has been extended to meet the need of this age and to grasp the point of Accomplishing worldwide broadband versatile interchanges. The expectation of this advanced framework incorporates higher radio access information rates, further developed framework limit, inclusion, adaptable transmission capacity activities, worked on ghostly productivity, low dormancy, diminished working expenses and impeccable joining with the Internet and existing portable correspondence frameworks.

It relies upon the advances like Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input and Multiple-Output (MIMO), hearty channel coding and connection change methods. LTE conveys both time division duplex plans as well as recurrence division duplex plans (TDD/FDD). Regulation plans like QPSK, 16-QAMand 64-QAM are upheld by LTE. Fig 4.1 is the engineering of the LTE.

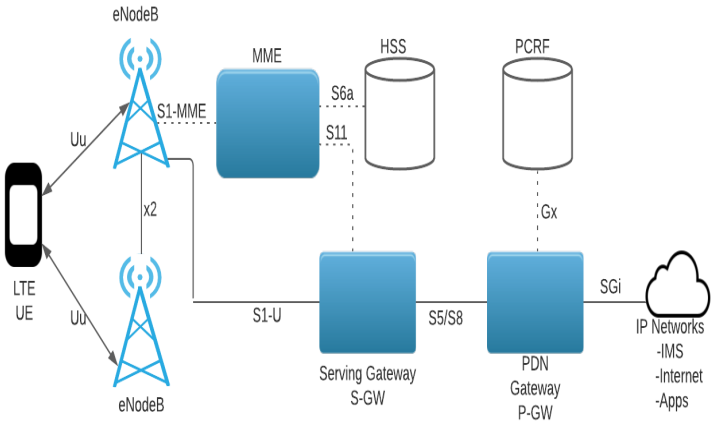


Fig.4.1.LTE Architecture

4.1 Design parameters

Parameters used to generate the data for analyzing modulation techniques for LTE are mentioned in the Table 4.1.1.

Table 4.1.1. Design parameters

Parameter Name	Values
E_b/N_0 range	0.18Db
Channel type	AWGN
Modulation types	PSK,DPSK,OQPSK,PAM,QAM,FSK
Modulation order	2,4,8
Channel coding	None
Perfect synchronization	Perfect synchronization

IMPLEMENTATION AND RESULTS

5.1 Introduction

Matlab:
MATLAB is one among the superior languages that's generally used for the aim of technical computing. By integrating the visualization, and programming, MATLAB creates an easy-to-use environment wherever perceivable mathematical notations are accustomed specific the issues and solutions. This language is mostly utilized in the event of algorithms, and computation and maths.

5.2 Implementation of key functions

Bit Error Rate:
The Bit Error Rate (BER) is characterized as the quantity of piece Errors reliable with unit time. The Bit Error Ratio (furthermore BER) is the quantity of Bit Errors partitioned through the general number of sent bits at some stage in a concentrated on time stretch. Bit Error proportion is a unit less by and large execution measure, oftentimes communicated as a rate.

E_b/N_0(db):
E_b/N_0 is depicted in light of the fact that the standardized sign to commotion proportion, or motion toward clamor per bit. E_b/N_0 is uniquely gainful while looking at the Bit Error Rate (BER) generally execution of different regulation strategies.

AWGN:
AWGN represents Additive White Gaussian Noise. This channel gives white Gaussian commotion to the sign that passes through it. You can make an AWGN direct in a form the utilization of the correspondence AWGN Channel System object, the AWGN work.

Modulation Type:

Modulation schemes are classified into 4 types: Analog modulation, Digital modulation, Pulse modulation and Spread spectrum method. Analog modulation is usually used for AM, FM radio, and short-wave broadcasting. Digital modulation includes transmission of binary signals (0 and 1).

PSK:
Short form of Phase shift keying, a modulation method utilized by modems wherein unique phase angles with inside the carrier signal are used to symbolize the binary numbers 0 and 1.

DPSK:
DPSK is the short form of Differential Phase Shift Keying. A usual form of phase modulation utilized in analog modems. DPSK does now no longer need complicated demodulation circuitry and is much less prone to random phase modifications with inside the transmitted waveform.

QPSK:
Quadrature Phase Shift Keying (QPSK) could be a sort of Phase Shift Keying inside which 2 pieces are balanced immediately, picking one among four potential transporter stage shifts (0, 90, 180, or 270 degrees). QPSK grants the sign to hold doubly the most extreme sum information as standard PSK exploiting steady data transmission. QPSK is for the most part utilized for satellite transmission of MPEG2 video, link modems, videoconferencing, cell frameworks, and elective kinds of advanced correspondence over a RF transporter.

PAM:
Pulse amplitude modulation is described as the information transmitted via way of means of changing the amplitudes (power or voltage) of each pulse in a regular time series of electromagnetic pulses. The viable wide variety of amplitudes may be infinite, however in most cases it is some power of two in order that the output signal may be digital.

QAM:
QAM (Quadrature Amplitude Modulation) is described as the modulation method that's the aggregate of phase and amplitude modulation of a carrier wave right into a channel. QAM transmits data through converting both the amplitude and phase of a carrier wave, thereby doubling the powerful bandwidth.

FSK:
Frequency Shift Keying is the full form of FSK. It is the digital modulation method wherein the frequency of the carrier signal differs in line with the digital signal changes. FSK is a scheme of frequency modulation. The output of a FSK modulated wave is very high in frequency for a binary High input and is low in frequency for a binary Low input. The binary 1s and 0s are known as Mark and Space frequencies.

Modulation Order:
The modulation order of a digital modulation theme is decided by the number of the various symbols which will be transferred by using it. Modulation order can solely be outlined for digital modulations.

5.3 Method of Implementation
In the technology of wireless communication, the evaluation of Bit Error Rate overall performance of various modulation schemes can be calculated with appreciate to unique Signal to Noise Ratio. For this reason, in this examine to plot the Bit Error Rate (BER) simulation outcomes of various modulation schemes we taken into consideration the Bit Error Rate and Signal to Noise Ratio (SNR) values at y-axis and x-axis respectively in addition to taken into consideration the SNR tiers from - 4 to 30dB. In this observation, we additionally took into consideration a logarithmic characteristic to calculate the price of the Bit Error Rate in decibel units. The Bit Error Rate (BER) overall performance changed into simulated the usage of MATLAB framework and the simulation outcomes of PSK,FSK, PAM, DPSK, OQPSK and QAM modulation schemes are depicted.

5.4 Result Analysis

PSK:

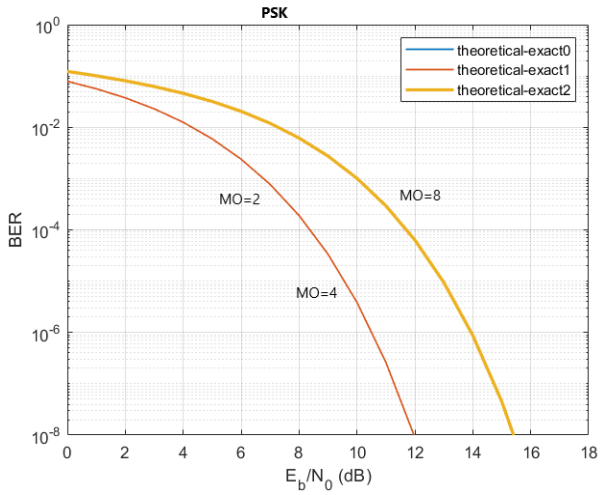


Fig.5.4.1 Relation between BER and SNR for PSK Modulation

In fig 5.4.1, the performance of PSK modulation has been shown under AWGN channel mode. From the figure without any channel coding, it has been analyzed that modulation orders 2 and 4 are best while modulation order 8 is worst. For 8 dB E_b/N_0, BER of Modulation order 2 and 4 lies between 10^{-3} and 10^{-4}, for Modulation order 8 BER lies between 10^{-2} and 10^{-3}.

Table 5.4.1 PSK Modulation

PSK			
E_b/N_0(dB)	**BER**		
	Modulation Order		
	2	**4**	**8**
0	$10^{-1.1}$	$10^{-1.1}$	$10^{-0.9}$
2	$10^{-1.5}$	$10^{-1.5}$	10^{-1}
4	10^{-2}	10^{-2}	$10^{-1.1}$
6	$10^{-2.9}$	$10^{-2.9}$	$10^{-1.8}$
8	10^{-4}	10^{-4}	$10^{-2.2}$
10	$10^{-5.8}$	$10^{-5.8}$	10^{-3}
12	10^{-8}	10^{-8}	$10^{-4.2}$
14	-	-	10^{-6}

DPSK:

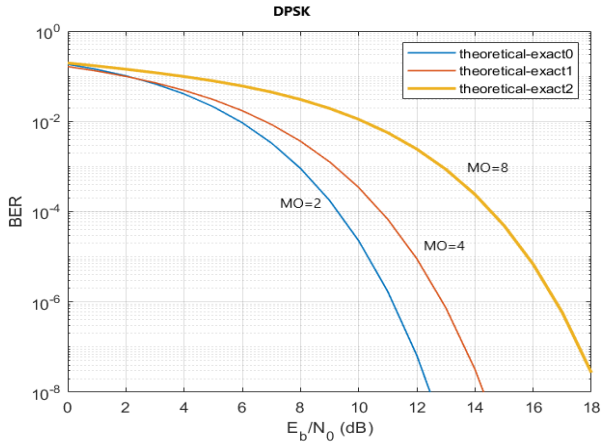


Fig.5.4.2 Relation between BER and SNR for DPSK Modulation

In fig 5.4.2, the performance of DPSK modulation has been shown under AWGN channel mode. From the figure without any channel coding, it has been analyzed that modulation order 2 is best while modulation order 8 is worst. For 8 dB E_b/N_0, BER of Modulation order 2 is near to 10^{-3}, for Modulation order 4 BER is near to $10^{-2.5}$ and for Modulation order 8 BER value is nearer to $10^{-1.5}$.

Table 5.4.2 DPSK Modulation

DPSK			
E_b/N_0(dB)	**BER**		
	Modulation Order		
	2	**4**	**8**
0	$10^{-0.9}$	$10^{-0.9}$	$10^{-0.9}$
2	10^{-1}	10^{-1}	$10^{-0.95}$
4	$10^{-1.5}$	$10^{-1.4}$	$10^{-1.2}$
6	10^{-2}	$10^{-1.8}$	$10^{-1.6}$
8	10^{-3}	$10^{-2.6}$	$10^{-1.8}$
10	10^{-5}	$10^{-3.7}$	10^{-2}
12	$10^{-7.2}$	10^{-5}	10^{-3}
14	-	$10^{-7.8}$	$10^{-3.8}$
16	-	-	10^{-5}
18	-	-	$10^{-7.8}$

OQPSK:

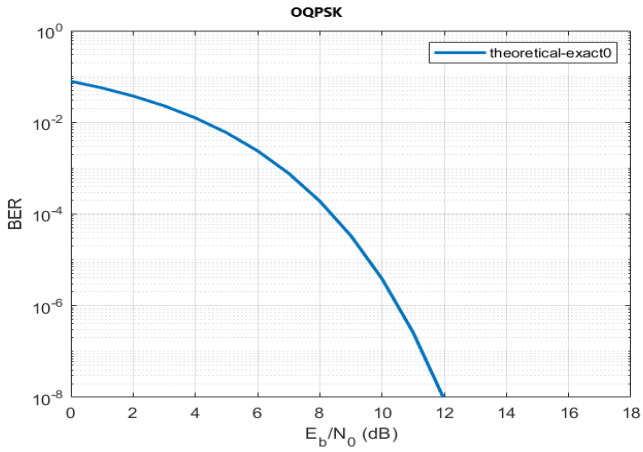


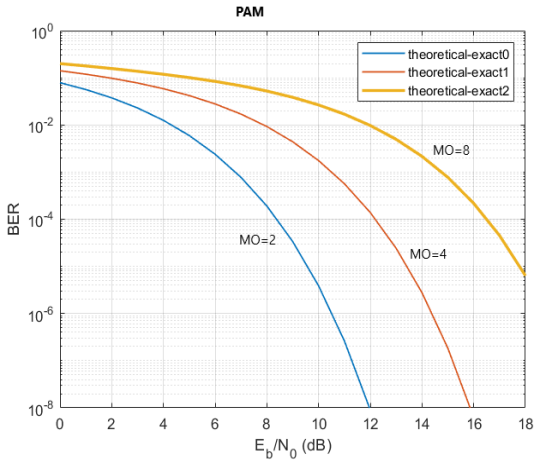
Fig 5.4.3 Relation between BER and SNR for OQPSK Modulation

In fig 5.4.3, the performance of OQPSK modulation has been shown under AWGN channel mode. For OQPSK only modulation order 8 exits. For 8 dB E_b/N_0, BER of Modulation order 8 lies between 10^{-3} and 10^{-4}.

Table 5.4.3 OQPSK Modulation

OQPSK	
E_b/N_0(dB)	**BER**
	Modulation Order
	8
0	10^{-1}
2	$10^{-1.7}$
4	10^{-2}
6	10^{-3}
8	$10^{-3.9}$
10	$10^{-5.7}$
12	10^{-8}

PAM:



5.4.4 Relation between BER and SNR for PAM Modulation

In fig 5.4.4, the performance of PAM modulation has been shown under AWGN channel mode. From the figure without any channel coding, it has been analyzed that modulation order 2 is best while modulation order 8 is worst. For 8 dB E_b/N_0, BER of Modulation order 2 is near to 10^{-4}, for Modulation order 4 BER is 10^{-2} and for Modulation order 8 BER value is nearer to 10^{-1}.

Table 5.4.4 PAM Modulation

PAM			
E_b/N_0(dB)	**BER**		
	Modulation Order		
	2	**4**	**8**
0	10^{-1}	$10^{-0.9}$	$10^{-0.5}$
2	$10^{-1.4}$	10^{-1}	$10^{-0.8}$
4	10^{-2}	$10^{-1.2}$	$10^{-0.9}$
6	$10^{-2.8}$	$10^{-1.8}$	10^{-1}
8	$10^{-3.9}$	10^{-2}	$10^{-1.5}$
10	$10^{-5.6}$	10^{-3}	$10^{-1.7}$
12	10^{-8}	10^{-4}	10^{-2}
14	-	$10^{-5.8}$	10^{-3}
16	-	-	$10^{-3.9}$
18	-	-	10^{-5}

QAM:

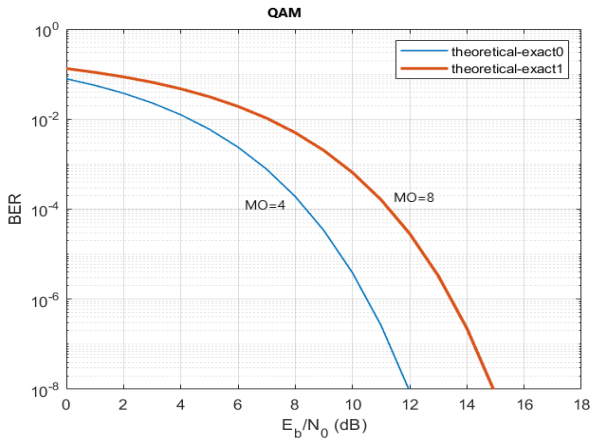


Fig 5.4.5. Relation between BER and SNR for QAM Modulation

In fig 5.4.5, the performance of QAM modulation has been shown under AWGN channel mode. From the figure without any channel coding, it has been analyzed that modulation order 4 is best while modulation order 8 is worst. For 8 dB E_b/N_0, BER of Modulation order 4 is closer to 10^{-4} while for Modulation order 8 BER is near to $10^{-2.5}$.

Table 5.4.5 QAM Modulation

QAM		
E_b/N_0(dB)	**BER**	
	Modulation Order	
	4	**8**
0	$10^{-1.1}$	$10^{-0.9}$
2	$10^{-1.7}$	10^{-1}
4	10^{-2}	$10^{-1.5}$
6	$10^{-2.9}$	$10^{-1.9}$
8	$10^{-3.8}$	$10^{-2.4}$
10	$10^{-5.8}$	$10^{-3.2}$
12	10^{-8}	$10^{-4.8}$
14	-	10^{-5}

FSK:

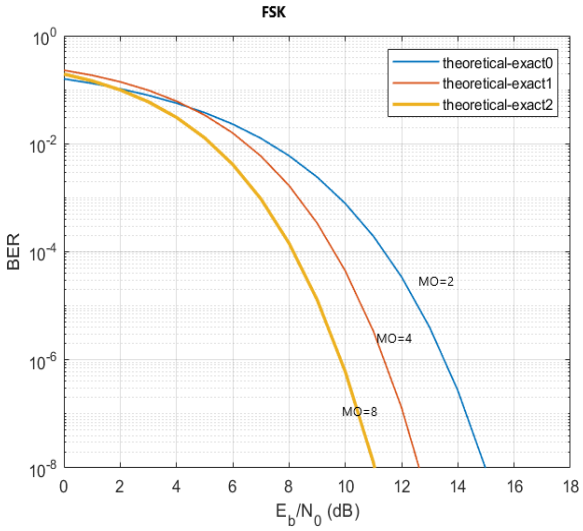


Fig 5.4.6 Relation between BER and SNR for FSK Modulation

In fig 5.4.6, the performance of FSK modulation has been shown under AWGN channel mode. From the figure is has been analyzed that modulation order 8 is best while modulation order 2 is worst. For 8 dB E_b/N_0, BER of Modulation order 8 is near to 10^{-4}, for Modulation order 4 BER is close to 10^{-3} and for Modulation order 2 BER value lies between 10^{-2} and 10^{-3}.

Table 5.4.6 FSK Modulation

FSK			
E_b/N_0(dB)	**BER**		
	Modulation Order		
	2	**4**	**8**
0	$10^{-0.9}$	$10^{-0.8}$	$10^{-0.9}$
2	10^{-1}	$10^{-0.9}$	10^{-1}
4	$10^{-1.5}$	$10^{-1.5}$	$10^{-1.8}$
6	$10^{-1.8}$	$10^{-1.9}$	$10^{-2.8}$
8	$10^{-2.2}$	10^{-3}	10^{-4}
10	10^{-3}	$10^{-4.1}$	10^{-6}
12	$10^{-4.8}$	$10^{-7.8}$	-
14	$10^{-6.8}$	-	-

Modulation Order= 2

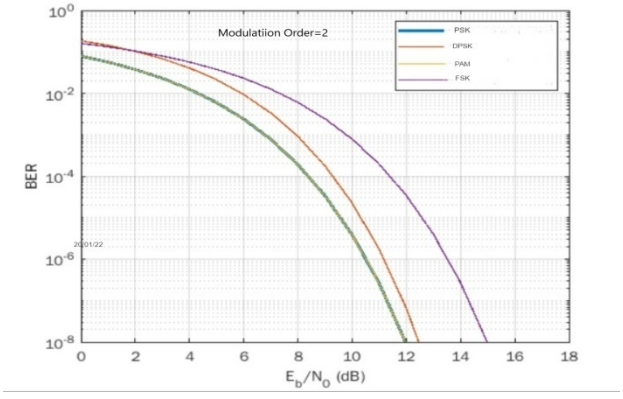


Fig 5.4.7 Various modulation techniques at Modulation Order 2

In fig 5.4.7, the performance of various modulation techniques at modulation order 2 is shown. From the figure without any channel coding it has been analyzed that PSK and PAM are overlapped and are the best modulation techniques. Whereas FSK is the worst modulation technique. At 8dB E_d/N_0, the BER value of PSK and PAM lies between 10^{-3} and 10^{-4}, and for DPSK the value of BER is approximately 10^{-3} and for FSK the BER is near to 10^{-2}.

Table 5.4.7 Comparison of Various Modulation Techniques at Modulation Order 2

Modulation Order=2						
E_b/N_0(dB)	**BER**					
	PAM	**PSK**	**DPSK**	**FSK**	**OQPSK**	**QAM**
0	10^{-1}	$10^{-1.1}$	$10^{-0.9}$	$10^{-0.9}$	-	-
2	$10^{-1.4}$	$10^{-1.5}$	10^{-1}	10^{-1}	-	-
4	10^{-2}	10^{-2}	$10^{-1.5}$	$10^{-1.5}$	-	-
6	$10^{-2.8}$	$10^{-2.9}$	10^{-2}	$10^{-1.8}$	-	-
8	$10^{-3.9}$	10^{-4}	10^{-3}	$10^{-2.2}$	-	-
10	$10^{-5.6}$	$10^{-5.8}$	10^{-5}	10^{-3}	-	-
12	10^{-8}	10^{-8}	$10^{-7.2}$	$10^{-4.8}$	-	-
14	-	-	-	$10^{-6.8}$	-	-

Modulation order= 4

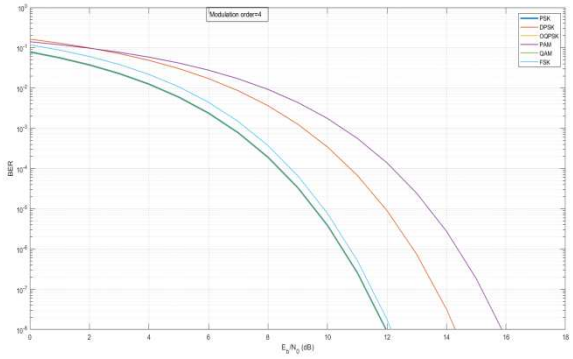


Fig 5.4.8 Various Modulation Techniques at Modulation Order 4

In fig 5.4.8, the performance of various modulation techniques at modulation order 4 is shown. From the figure without any channel coding it has been analyzed that QAM and PSK Modulation techniques are overlapped and are the best modulation techniques where as PAM is the worst modulation technique. At 8dB E_b/N_0, BER value of QAM and PSK is nearer to 10^{-4}, for FSK the BER lies between 10^{-3} and 10^{-4}, the BER of DPSK lies between 10^{-2} and 10^{-3} and for PAM, BER is approximately 10^{-2}.

Table 5.4.8 Comparison of Various Modulation techniques at Modulation Order 4

Modulation Order=4						
E_b/N_0(dB)	**BER**					
	PAM	**PSK**	**DPSK**	**FSK**	**QPSK**	**QAM**
0	$10^{-0.9}$	$10^{-1.1}$	$10^{-0.9}$	$10^{-0.8}$	-	$10^{-1.1}$
2	10^{-1}	$10^{-1.5}$	10^{-1}	$10^{-0.9}$	-	$10^{-1.7}$
4	$10^{-1.2}$	10^{-2}	$10^{-1.4}$	$10^{-1.5}$	-	10^{-2}
6	$10^{-1.8}$	$10^{-2.9}$	$10^{-1.8}$	$10^{-1.9}$	-	$10^{-2.9}$
8	10^{-2}	10^{-4}	$10^{-2.6}$	10^{-3}	-	$10^{-3.8}$
10	10^{-3}	$10^{-5.8}$	$10^{-3.7}$	$10^{-4.1}$	-	$10^{-5.8}$
12	10^{-4}	10^{-8}	10^{-5}	$10^{-7.8}$	-	10^{-8}
14	$10^{-5.8}$	-	$10^{-7.8}$	-	-	-

Modulation Order= 8

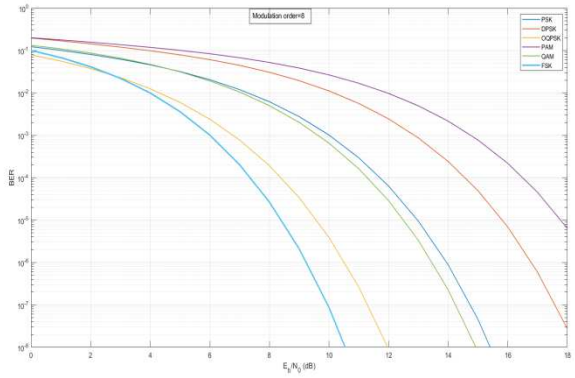


Fig 5.4.9 Various Modulation Techniques at Modulation Order 8

In fig 5.4.9, the performance of various modulation techniques at modulation order 8 is shown. From the figure without any channel coding it has been analyzed that FSK is the best and PAM is the worst. At 8dB E_b/N_0, FSK has BER value lies between 10^{-4} and 10^{-5}, for OQPSK the BER is near to 10^{-4}, the BER of QAM lies between 10^{-2} and 10^{-3}, for FSK the BER is near to 10^{-2}, the BER of DPSK lies between 10^{-1} and 10^{-2} and BER of PAM is also between 10^{-1} and 10^{-2}.

Table 5.4.9 Comparison of Various Modulation techniques at Modulation Order 8

Modulation Order=8						
E_b/N_0(dB)	**BER**					
	PAM	**PSK**	**DPSK**	**FSK**	**QPSK**	**QAM**
0	$10^{-0.5}$	$10^{-0.9}$	$10^{-0.9}$	$10^{-0.9}$	10^{-1}	$10^{-0.9}$
2	$10^{-0.8}$	10^{-1}	$10^{-0.95}$	$10^{-1.5}$	$10^{-1.7}$	10^{-1}
4	$10^{-0.9}$	$10^{-1.1}$	$10^{-1.2}$	10^{-2}	10^{-2}	$10^{-1.5}$
6	10^{-1}	$10^{-1.8}$	$10^{-1.6}$	10^{-3}	10^{-3}	$10^{-1.9}$
8	$10^{-1.5}$	$10^{-2.2}$	$10^{-1.8}$	$10^{-4.5}$	$10^{-3.9}$	$10^{-2.4}$
10	$10^{-1.7}$	10^{-3}	10^{-2}	10^{-7}	$10^{-5.7}$	$10^{-3.2}$
12	10^{-2}	$10^{-4.2}$	10^{-3}	-	10^{-8}	$10^{-4.8}$
14	10^{-3}	10^{-6}	$10^{-3.8}$	-	-	10^{-5}
16	$10^{-3.9}$	-	10^{-5}	-	-	-
18	10^{-5}	-	$10^{-7.8}$	-	-	-

RESULT

The above graphical outputs show the BER vs. SNR for various modulation orders. The observations are taken for various modulation techniques like PAM, QAM, QPSK, PSK, FSK and DPSK at various Modulation Orders (2,4,8). Here graphs are plotted with Signal to Noise Ratio (SNR) on X-axis and Bit Error Rate (BER) on Y-axis. The unit of SNR is dB and BER was expressed in E_b/N_0 (dB).

CONCLUSIONS

In this study, we evaluated the act of transmitting modes in LTE. However, overall performance evaluation may be done by using evaluation of LTE. The overall performance of transmission modes are evaluated through calculating the Bit Error Rate (BER) as opposed to Signal Noise Ratio (SNR) below the regularly used wireless channel model (AWGN). We will consider the data modulation and data rate to analyze overall performance this is BER vs. SNR. The analysis of overall performance of all Modulation Techniques concludes that QAM has low Bit Error Rate when compared to other modulation techniques.From Fig 5.4.8, with modulation order 4 and E_b/N_0=2, it was found that QAM is the better option for LTE. Thus QAM is best modulation technique for LTE.

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