An Efficient QAM Communication to Reduce S/N Ratio and BER in 5G MIMO LTE Network

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Abstract - This In wireless network the wireless station is communication with each other in the air through unguided media. The micro wave signals are the signals having high wavelength for large bandwidth. The different signals having different frequency are required modulation to transmit data to destination. The same as destination end signals are demodulated. In this paper we proposed the technique to improve the performance of wires network. The proposed work is in Multiple Input and Multiple Output (MIMO) network with LTE and 5G. The 5G network having higher data rate and required more bandwidth for communication. The performance of proposed scheme is compare with pure 4 bit QAM, 8 bit QAM and 16 bit QAM. In QAM case combine the multiple signals in single channel to improve bandwidth utilization. In MIMO the wireless devices are communicate with each other through multiple antennas. The multiple antennas are requited more bandwidth and QAM technique with MIMO is handle efficiently with higher 5G data rate. The only QAM technique is provides is improvement in modulation of signals and the larger size of bits are able to handle more data but also the possibility of signal to noise ratio (SNR) is more. If the SNR ratio is increased it means the Bit Error Rate (BER) is also increased that shows the degradation in signal strength. The BER in pure QAM scheme with bit size of 4, 8 and 16 is more but after applying QAM technique in MIMO_LTE with 5G is reduces the BER ration that is also reduces the SNR ratio. In MIMO the devices have multiple antennas and through these antennas the signal device are receive and sends the signals in network. The performance metrics shows the performance of proposed technique of communication is provides better results and enhances channel utilization.

Keywords: - SNR, BER, MIMO, Bandwidth, 5G, QAM, Wireless Devices.

I. INTRODUCTION

Wireless communication systems are expected to meet the ever increasing demand for high data rates. The MIMO technique has been shown to significantly improve the capacity of wireless links without additional bandwidth or transmit power expenditure [1]. Antenna selection is a cost-effective solution for reducing the increased complexity and cost arising from the multiple radio frequency (RF) chains associated with multiple antennas [2]. In line with the need for high data rates, capacity has been the main criterion used in MIMO systems with antenna selection. The rapid evolution of wireless communications technologies, which has been fuelled by the need to meet the ever increasing requirements of wireless services and applications, has been accompanied by increased energy consumption. Multiple input multiple output technology for wireless communication system has been extensively investigated in recent research with many antennas increasing from tens to hundreds due to its potential support for greater efficiency in data rate and higher reliability than a conventional technology like single-input single-output (SISO) [3]. To address the new challenges that 5G networks are expected to solve, various types of modulation have been proposed, such as filtering, pulse shaping, and precoding to reduce the out-of band (OOB) leakage of OFDM signals. Filtering [4] is the most straightforward approach to reduce the OOB leakage and with a properly designed filter, the leakage over the stop-band can be greatly suppressed. Pulse shaping [5] can be regarded as a type of subcarrier-based filtering that reduces overlaps between subcarriers even inside the band of a single user, however, it usually has a long tail in time domain according to the Heisenberg-Gabor uncertainty principle [6]. Introducing proceeding [6] to transmit data before OFDM modulation is also an effective approach to reduce leakage. In addition to the aforementioned approaches to reduce the leakage of OFDM signals, some new types of modulations have also been proposed specifically for 5G networks. For example, to deal with high Doppler spread in eV2X scenarios, transmit data can be modulated in the delay-Doppler domain [7]. The above modulations can be used with orthogonal multiple access (OMA) in 5G networks. Considering the advantages of OFDM and MIMO transmission techniques, the combination of them unsurprisingly appears as a strong alternative for 5G and beyond wireless networks [8]. Recent technology constituent like high-speed packet access (HSPA) and long-term evolution (L E) will be launched as a segment of the advancement of current wireless based technologies. Nevertheless, auxiliary components may also constitute future new wireless based technologies, which may adjunct the evolved technologies. Specimen of these new technology components are different ways of accessing spectrum and considerably higher frequency ranges, the instigation of massive antenna configurations, direct device-to- device communication, and ultra-dense deployments [8]. An idea to shift towards 5G is based on current drifts, it is commonly assumed that 5G cellular networks must address six challenges that are not effectively addressed by 4G i.e. higher capacity, higher data rate, lower End to End latency, massive device connectivity, reduced cost and consistently.

II. QUADRATURE AMPLITUDE MODULATION

Quadrature Amplitude Modulation (QAM) [9] is both an analog and a digital modulation scheme. It conveys two analog message signals, or two digital bit streams, by changing (modulating) the amplitudes of two carrier waves, using the amplitude-shift keying (ASK) digital modulation scheme or amplitude modulation (AM) analog modulation scheme. The two carrier waves, usually sinusoids, are out of phase with each other by 90° and are thus called quadrature carriers or quadrature components hence the name of the scheme. The modulated waves are summed, and the resulting waveform is a combination of both Phase Shift Keying (PSK) and amplitude-shift keying (ASK), or (in the analog case) of phase modulation (PM) and amplitude modulation. In the digital QAM case, a finite number of at least two phases and at least two amplitudes are used. PSK modulators are often designed using the QAM principle, but are not considered as QAM since the amplitude of the modulated carrier signal is constant. QAM is used extensively as a modulation scheme for digital telecommunication systems arbitrarily high spectral efficiencies can be achieved with QAM by setting a suitable constellation size, limited only by the noise level and linearity of the communications channel. QAM is being used in optical fiber systems as bit rates increase; QAM16 and QAM64 can be optically emulated with a 3-path interferometer. .

III. LITERATURE SURVEY

The MIMO is provides the advanced communication technique of multiple antennas. The research work done in field of 5G with MIMO is mentioned in this section to reduce BER and S/N ratio.

In this paper [10] gives a clear thought of the error performance of 4QAM-OFDM, 8QAM-OFDM & 16QAM-OFDM system over AWGN channel & Rayleigh fading channel. It is observed from the simulation results that has the signal power is increases the error rate decreases in both AWGN & Rayleigh fading channel but error rate increases as the value of modulation scheme *M* increases. The error rate in Rayleigh fading channel is also higher than the AWGN channel for same signal. So to provide a reliable communication along with the high data rate, there should be a tradeoff between modulation order and signal power. Designing high performance wireless communication system basically depends on the effect of channel environment. Channel estimation is a method of characterizing the effect of the physical medium on the input data stream.

In this paper [11], we propose a new algorithm focusing on the lattice reduction (LR) to improve the bit error rate (BER) performance. LR can significantly improve the BER performance in MIMO linear decoding using LLL (Lenstra-Lenstra-lovasz) algorithm. However, LLL algorithm has two problems. One is non-orthogonal reduced basis and another is finding the feasible set of detected symbol with round operation. A new proposed algorithm focuses on finding the feasible set of detected symbol with unknown transformed symbol and uses maximum likelihood method on Lattice reduction (LR) aided MIMO detection techniques are recently adopted in MIMO systems. Lattice reduction (LR) aided linear detection (LD) techniques can give the same BER performance as ML detection with low complexity. In this part, our algorithm is the same as the previous LR-LD algorithm. In second part, the proposed algorithm extends the received signal point calculated in LD to neighborhood point. In this part, our algorithm is more complex than previous LR-LD algorithm because the number of calculation for returning to original basis increases depending on the number of points.

In this paper [12] proposes an iterative detector based on message passing de-quantization (MPDQ). The proposed MPDQ algorithm is capable of detecting high-order QAM signals for Massive MIMO with low-precision quantization, termed MPDQ-hl. In simulations, we take 256-QAM as an example, and the algorithm is feasible for other orders of QAM as well. MPDQ-hl is compared with unquantized MMSE and low-precision quantized MMSE (qMMSE). A low-precision quantization signal detection scheme for high-order QAM is introduced at the receivers. MPDQ-hl with 7 bits quantization could achieve better BER performance than MMSE with full precision system, thus saving 3 bits or more by comparison. MPDQ-hl can achieve identical performance to MMSE with low precision quantization.

In this paper [13], we extend the work in [14] to spatially correlated MIMO channels. The impact of spatial correlation on the energy efficiency and throughput of MIMO systems with cross-layer energy-efficient transmit antenna selection is investigated. Additionally, an iterative algorithm, which improves the performance of the reduced complexity algorithm proposed in [14], is developed. In [14], a cross-layer approach to energy-efficient transmit antenna selection was introduced. A throughput-based EE metric, defined as the ratio of the system throughput to the total power consumed, was proposed. Maximization of the throughput based EE takes into account information from the data link and physical layers, making it a cross-layer approach. Furthermore, cross layer energy efficient transmit antenna selection reduces the impact that spatial correlation has on the system performance.

In this paper, [14] proposed an Energy Efficiency (EE) metric that is defined as the ratio of the system throughput to the total power consumed by the system, i.e. the number of successfully received information bits per unit energy. We refer to this metric as TB-EE. Using TB-EE as an antenna selection criterion is considered a cross layer approach, this is because characteristics from the data link and physical layer are taken into account when calculating throughput. Analytical expressions for CB-EE and TB-EE are derived for a Spatial Multiplexing (SM) MIMO system that uses N-SAW ARQ retransmission protocol and is equipped with a Zero Forcing (ZF) linear receiver. Optimal energy efficient transmit antenna selection algorithms based on exhaustive search are then developed. The algorithms optimize Capacity Based (CB-EE) and Throughput Based (TB-EE) separately, and adapt the number of active transmit antennas and transmit power, under a spectral efficiency constraint. Reduced complexity sub-optimal algorithms are also developed.

In this paper [15] we represents the performance analysis of OFDM system in MIMO downlink system and achieve high data rate, getting low bit error rate (BER) with respect to the SNR (signal to noise ratio). The modulation technique QPSK, 16QAM, 64QAM is used. The SNR and guard interval in OFDM signal improves the system performance for transmission. Here we have transmit our data with the help of OFDM technique in which large numbers of closely-spaced orthogonal sub-carriers are used and they carry data and performance is plotted by bit error rate verses signal to noise ratio.

IV. PROBLEM STATEMENT

In MIMO network the number of multiple antenna are access the medium or communicate with other nodes and utilizes the bandwidth of wireless channel. The only QAM is provides the technique of combined multiple signals in one channel and the problem is that if we work with multiple antennas then we required the more space for communication because in wireless communication the antennas are receive the signals for particular devices. The possibility of noise is longer communication is more and we required the higher data rate for communication and only QAM with normal 3G equivalent technique it is not possible and also the Bit Error Rate (BER) is enhanced. The main problems are discussed below:-

1. The QAM in fast communication required more bandwidth capacity.
2. The problem of single antenna notable receives the higher data rate efficiently.
3. The level of noise needed to move signals to different decision point.
4. The level of noise is also enhance the BER of signals received at destination.

V. PROPOSED SCHEME TO MINIMIZES S/N AND BER

The MIMO is the Multiple Input Multiple Output network in which combinations of more than one transmitters / receivers or antennas at both sides of digital communication systems. It can be expressed as facsimile of smart antennas array group. In wireless communications MIMO techniques is growing technology that offers substantial increase in data bandwidth devoid of any extra transmission power. In research work we work on two modules:-

1. The bandwidth utilization is improve with applying QAM technique to reduce S/N ration and enhance signal strength that is reduces the BER (Bit Error Rate).
2. In second module we will work on 5G and LTE. The MIMO technique with QAM is applied to improve wireless network performance. The performance of both the protocols is measure through performance metrics S/N ratio and signal strength. The 5G having higher data rate and this rate is provides more better output then QAM.

Working Scheme of LTE (long term evaluation)

Long term evaluation is a combination of MIMO-OFDM technique that improves the data rate. It also detects the error or noisy signal through cyclic redundancy check (CRC) and reduces the Bit Error Rate (BER).

Representation:

t_n: transmitter nodes

$A=\sum a_n$ where k=1 to4: Antenna

cw_i: code word or data

n_{cw}: mixed code word

s_{mb}: set of symbols

CRC: cyclic redundancy check

Output: SNR, BER, PDR, delay, throughput

Transmitter:

t_n generate cw_n where n = 1 to m

for all t_n send cw_n scramble module

$n_{cw} = \sum cw_n$ where i=1 to n

map ($n_{cw,}$ s_{mb})

Bitwise n_{cw} symbol send 2 MIMO modules

(ns_{mb}) map with linear array

Pre-code the (ns_{mb})

Send to OFDM modulator

Insert CRC bit in pre-coded symbol

$(bit\_data)_n$ transmitted by A

Receiver:

$(bit\_data)_n$ receives by A

SNR = 20 $\log_{10}$ (vs/vn) …..………(1)

Where SNR signal to noise ratio

vs : Incoming signal strength in micro volts

vn : Noise level in micro volts

Separate signal & noise level

BER(t) = b_{err} / bt_x ………..(2)

Where BER bit error rate at time t

b_{err} : Number of error bit

bt_x : Number of transferred bit

b_{err} Detected by CRC than correct it

Pass the receives bit to MIMO

Process receives bit

ns_{mb} mapping and separation n_{cw}

De-scramble n_{cw}

Generate cw_n

Receive cw_i

End

The proposed scheme is reduces the S/N ratio that means the error possibility in signals is reduces that also reduces the BER. The signals are actually flow in wireless medium and the number of sender and receiver are using the higher data rate of communication i.e. 5G. In MIMO network the multiple antennas in single device is uses for fast communication. In this scheme the number of devices are uses the QAM technique with MIMO in 5G and reliability of communication is better.

VI. PERFORMANCE PARAMETERS

The simulation of QAM and QAM with MIMO_LTE is is based on the following performance metrics mentioned in table1. The performance of both the scheme is evaluated on mentioned parameters.

Simulator version	NS - 2.31
Traffic Type	UDP
QAM (in bits)	4, 8, 16
Radio Propagation	TwoRayGround, OFDMA
Number of Stations	20
Network Interface Type	MIMO
Antenna	Omni Directional
Number of Antenna	4
Traffic Type	CBR
Cellular Communication	5G LTE
Communication range (meters)	550
Network Grid area (meters)	800m*800m

VII. RESULT DESCRIPTION

In this section the results description are mentioned that compare the performance of QAM and QAM signals with 5G in MIMO network. The LTE is maintained the signaling properly with higher data rate to improve performance.

Packets Receiving Analysis in QAM and MIMO-LTE

The proper communication in network is shows the better data receiving. In this graph the performance of 4-QAM (4 point constellation), 8QAM and 16 QAM with QAM with MIMO_LTE is measured and observe that the MIMO performance is better than the pure QAM techniue of sinalling. The signal data in MIMO network is counted in packets and due to multiple antennas are provides the proper signalling of data and also maintained the proper connectivity between the numbers of communication devices. The digital signalling or bits at receiver end is shows the less noise in channel.

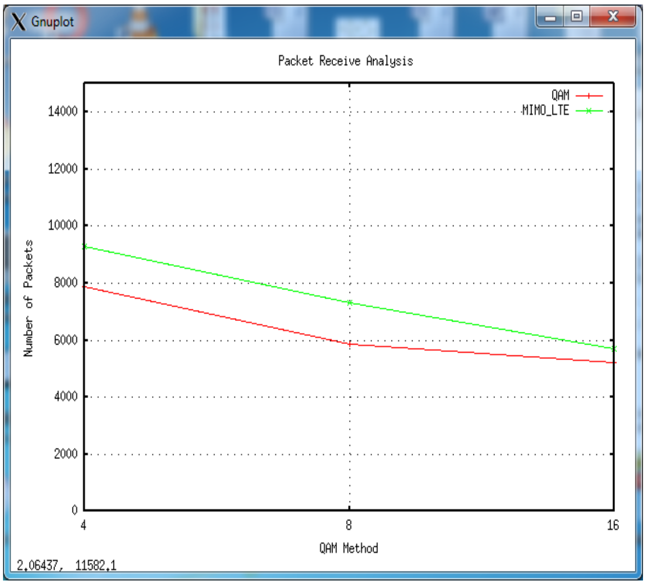

Fig.1 Packets Receiving Analysis

Throughput Analysis in QAM and MIMO-LTE

The number of data bits is counted in per unit of time in network is evaluated by throughput performance metrics. The number of senders having multiple antennas in MIMO and LTE is maintained the proper signal strength and the only QAM technique is provides the reliable digital communication because of that the number of bits interval in unit time is improves but in MIMO each device ahs multiple antennas and these antennas are able to handle the data rate of 5G network with LTE. The noise is created in only QAM based communication but in proposed scheme it reduces. The QAM with digital communication is provides better throughput but the proposed MIMO communication with LTE and 5G is provides better performance in higher data rate. The percentage of throughput in case of proposed MIMO_LTE with 5G is provides better results.

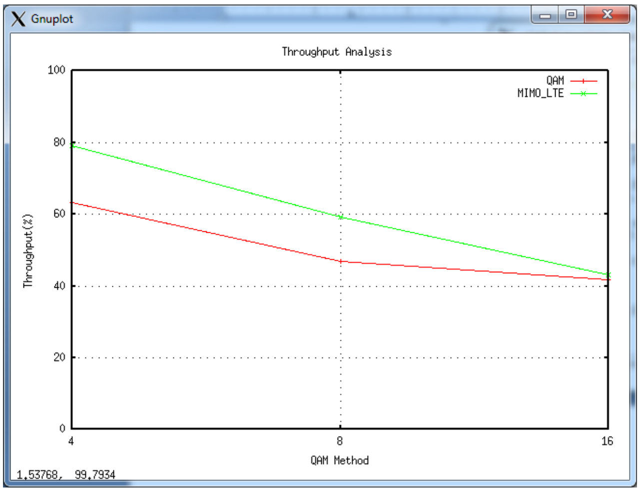

Fig.1 Throughput Analysis

PDR Analysis in QAM and MIMO-LTE

The percentage of successful data receiving is evaluated through PDR performance metrics. MIMO is a practical technique for sending and receiving more than one data signal on the same channel at the same time by using more than one antenna and QAM is a higher order modulation technique, which allows one and only radio wave to signify n bits of data by manipulating the amplitude and phase of the radio wave into one of 2^n different discrete and computable states.

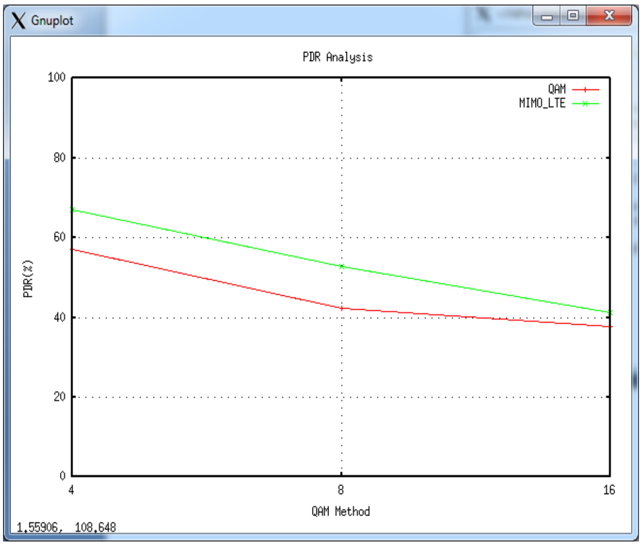

Fig.1 PDR Analysis

The PDR performance of QAM is showing up to 38% in 16-QAM but the performance of MIMO is showing better results to handle the available bandwidth and rate of data efficiently. The better PDR is shows less BER due to less noise ratio. The MIMO is handle the higher data rate with 5G communication and QAM performance is also enhanced.

Delay Analysis in QAM and MIMO-LTE

The delay is the signals receiving is counted in mille seconds in network. In this graph the delay in digital signal is more in only QAM technique but after applying in MIMO_LTE the performance is improves and the available channel capacity is utilized efficiently. The signal quality is better if the data is received at destination in certain time period. But if the numbers of bits are not reach that means the noise is more and BER is also high. In this graph the delay in normal QAM communication is more but in MIMO_LTE the multiple antennas is improve the efficiency of communication. The channel bandwidth utilization is improved and the noise ratio is decreased by that BER is also reduced.

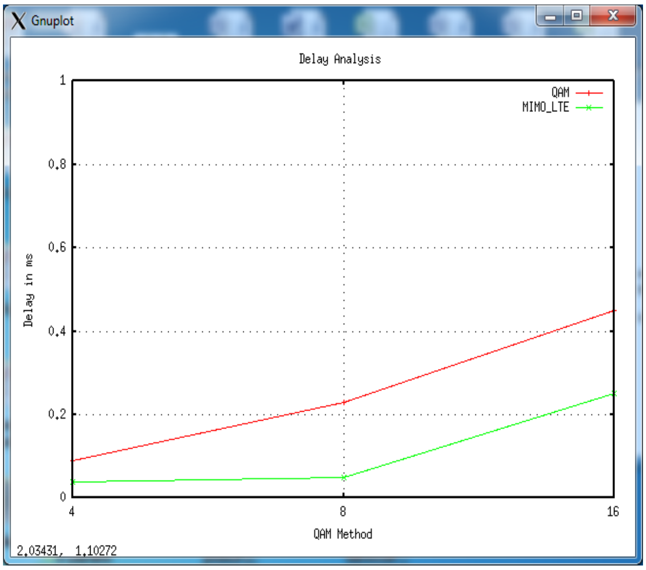

Fig.1 End to End Delay Analysis

Packets Dropping Analysis in QAM and MIMO-LTE

The number of data bits drops in network due to heavy load data, link failure, or any security reason. In this graph the performance of normal WiFi network is compare with MIMO in same technique of modulation of signals. The more number of bits in QAM is also store number of bits per word. Here the loss data is measure in only in pure QAM and QAM with MIMO_LTE and surly again the performance of proposed scheme is better. The data packets are dropped due to single antenna and due to unavailable of channel for micro wave signals. The multiple antenna of MIMO network is provides more than one antenna and LTE is provides carrier aggregation to improve bandwidth utilization that reduces the BER.

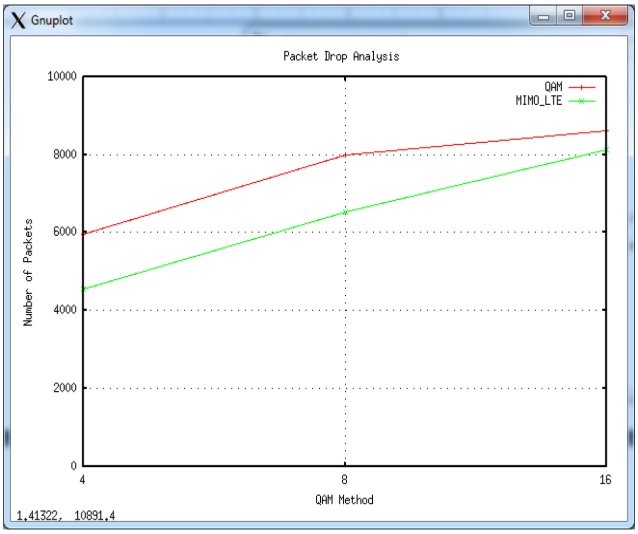

Fig.1 Packet Dropping Analysis

VIII. CONCLUSION & FUTURE WORK

The bandwidth of digital signals is measured in bits per seconds (bps) and analog signals are measured in Hertz (Hz). The analog signals are modulated and converted in to one to another form. The signals are required sufficient bandwidth for transmission in between sender to receiver. If the sufficient amount of bandwidth is not available then signals are properly flow and produced noise in the channel. The QAM in communication technique combined the two different messages and provides the same available bandwidth to both of the messages. That means tow different signals are pass through available bandwidth in network. In this dissertation we proposed the efficient communication in MIMO network to improve performance and reduce SNR ratio. The performance of QAM in network with different symbol per bit is compare with proposed QAM with MIMO_LTE in 5G network. The performance comparison is reduces the BER and SNR of network and also the multiple antenna of devices is reliable of communication between the different wireless devices. The bandwidth utilization is improves that shows the better throughput performance. The channel utilization is improves because of that SNR ratio of proposed scheme provides better results of packets receiving and minims drop in network. The Bit Error Rate of digital signals are minimizes in high data rate of 5G. The 5G network having data rate more than 100 Mbps and for this rate handling sufficient amount of bandwidth is required. MIMO with LTE is the right choice to deliver different data through same bandwidth channel. The multiple antennas are carry multiple signals and also the each antenna is contain own bandwidth capacity to sending and receiving signals in MIMO. Due to that proposed scheme is provides better performance than pure QAM.

The QAM technique is improves the bandwidth utilization and this is also possible in any network where QAM technique is exist. Now in network the attackers are also improves the noise ratio or drop the number of data bits in network. The jamming attacker is blocks the signals of data and generates unwanted signals to consume available network bandwidth. In future we proposed the security scheme against jamming attack to improve signal strength and bandwidth utilization.

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