High Performance 5G Communication Design Using Intelligent Modulation Choice

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Abstract: The use of Multiple-Input Multiple-Output (MIMO) techniques has revolutionized wireless communications systems with potential gains in capacity when using multiple antennas at both transmitter and receiver ends of a communications system. New techniques, which account for the extra spatial dimension, have been adopted to realize these gains in new and previously existing systems. MIMO technology has been adopted in multiple wireless systems, including Wi-Fi, WiMAX, LTE, and is proposed for future standards (such as LTE-Advanced and IMT-Advanced). The goal of this paper is to implement and OFDM Physical layer specification by following IEEE 802.16e-2005[1] Using Adaptive decision control techniques we analyze the performance of OFDM physical layer in mobile 5G LTE based on the simulation results of Bit-Error-Rate (BER), Signal to Noise Ratio (SNR) and Probability of Error (Pe). The performance analysis of OFDMA- is done in MATLAB under reference channel model with channel equalizer.

Keywords: 5G, Dense networks, MIMO, LTE

1. Introduction:

5G LTE is an emerging global broadband wireless system based on IEEE 802.16 standard. It is a new wireless OFDM-based technology that provides high quality broadband services long distances based on IEEE.802.16 wireless (Metropolitan Area Network) MAN air interface standard to fixed, portable and mobile users[1,2]. 5G LTE promises to combine high data rate services with wide area coverage (in frequency range of 10 – 66 GHz (Line of sight) and 2 -11 GHz (Non-Line of Sight)) and large user densities with a variety of Quality of Service (QoS) requirements. 5G LTE can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed station and 3 to 10 miles (5-15 km) for mobile stations with theoretical data rates between 1.5 and 75 Mbps per channel. The new standards for 5G LTE are being developed for expanding the mobility further with enhanced coverage, performance and higher data rates (of the order of 100 Mb/s) in a 5G LTE Network. The 5G LTE standard air interface incorporates the meaning of both the medium access control (MAC) and the physical (PHY) layers for the endorser station and base station while the entrance system operability is characterized by the 5G LTE Forum, an association comprising of administrators and part and gear producers. As the essential capacity of 5G LTE PHY layer is the genuine physical transportation of information. The primary execution turns out to be all the more difficult when portable situations are experienced in remote channel. Keeping in mind the end goal to accomplish most extreme execution at low BER, high information rate transmission (both in settled and versatile situations) and high ghastly productivity with assortment of QoS needs IEEE 802.16d/e standard backings assortment of PHY layer instruments with an assortment of components. The adaptability of the PHY empowers the framework planners to tailor their framework as per their prerequisites.

5G LTE is cutting edge broadband remote innovation it gives fast, secure, sophisticate broadband administrations .The advancement of 5G LTE started with the necessity of having a remote Internet access and other broadband administrations which can function admirably in rustic ranges or in regions where it is difficult to set up wired base and financially not possible. IEEE 802.16, otherwise called IEEE Wireless-MAN is standard of altered remote broadband and included portable broadband application. 5G LTE discussion, set up in 2001 to arrange the segments and add to the gear those will be perfect and bury operable. In 2007, Mobile 5G LTE hardware created with the standard IEEE 802 16e [5] got the affirmation and discharged theitem in 2008, giving versatility and traveling access. The IEEE 802.16e depended on Orthogonal Frequency Division Multiple Access (OFDMA) can give better execution in non-observable pathway situations. IEEE 802.16e acquainted versatile channel transfer speed up with 20 MHz, Multiple Input Multiple Output (MIMO) and AMC empowered 802.16e innovation to bolster crest Downlink (DL) information rates up to 63 Mbps in a 20 MHz channel through Scalable OFDMA (S-OFDMA) framework [2]. It has solid security engineering as it uses Extensible Authentication Protocol (EAP) for common verification, a progression of solid encryption calculations, CMAC or HMAC based message insurance and lessened key lifetime [4].

2. Literature review:

In 2012 Nitin Sharma et al, "On the use of particle swarm optimization for adaptive resource allocation in orthogonal frequency division multiple access systems with proportional rate constraints" presented his work on the use of particle swarm optimization for adaptive resource allocation in orthogonal frequency division multiple access systems with proportional rate constraints. In this work they proposed that orthogonal frequency division multiple access (OFDMA) was a promising technique, which could provide high downlink capacity for future wireless systems. The total capacity of OFDMA could be maximized by adaptively assigning subchannels to the user with the best gain for that subchannel, with power subsequently distributed by water-filling algorithm. In this work they had proposed the use of a customized particle swarm optimization (PSO) aided algorithm to allocate the subchannels. The PSO algorithm is population-based: a set of potential solutions evolves to approach a near-optimal solution for the problem under study. The customized algorithm worked for discrete particle positions unlike the classical PSO algorithm which was valid for only continuous particle positions. It was showed that the proposed method obtains higher sum capacities as compared to that obtained by previous works, with comparable computational complexity. In his work, they had proposed the use of PSO, a stochastic optimization technique, for sub-channel allocation in downlink of OFDMA systems followed by power allocation using water-filling algorithm. The results produced by the simulations indicate that the algorithm performs better in terms of sum capacities as compared. The sum capacity increases with the increase number of users. The sum capacity also increases initially with the increase in number of iterations and population size but rapidly saturates to a near optimal value. This result suggests that PSO aided subchannel allocation could provide significant gain in capacity even with very small population size and number of iterations. Moreover in PSO aided subchannel allocation the search and subchannel allocation was performed simultaneously as compared to traditional methods where the subchannels were first sorted in accordance of their gains and then allocation was performed. This significantly reduces the complexity of PSO aided allocation. The complexity of our algorithm was assessed to be O(N) as compared to O(KNlog2N) for that of method in . Hence it might be concluded that the proposed algorithm was order of magnitude faster as compared to the method in This fact makes PSO aided subchannel allocation a suitable choice for practical wireless systems like WiMAX (802.16e) where the convergence rate plays a very important role as the wireless channel changes rapidly. The fact that the channel is assumed to be constant during allocation makes convergence rate a very important parameter for wireless systems. The future scope of this paper could be to use multiple antennas on both transmitter and receiver site, which can provide further gain in capacity because of spatial multiplexing.

In 2012 Nelly M. Shafik"Wavelet Transform Effect on MIMO-OFDMSystem Performance"presented his work and proposed that many reasons cause multi- carrier CDMA to be the best technology in the latest mobile generations known by fourth generation for mobile. As well known, the greatest enemy for any wireless communication is multi- path fading which usually result in distortion in time- domain, or in frequency domain or even in both. Therefore any new technique applied into mobile communication system was concerning with mitigating multi-path fading distortion which appears in form of reducing BER level. In this work three techniques had been combined in order to enhance mobile system performance in the presence of multipath fading channel. These techniques were, orthogonal frequency division multiplexing (OFDM), code division multiple access (CDMA), and modified space shift keying (SSK). The last technique was considered special case for MIMO technology. By the aid of MATLAB code, proposes system was simulated in order to display BER performance versus variation in the SNR at many various system conditions.

Fourth generation of mobile has introduced many different families one of those families uses both OFDM and CDMA techniques together in order to join benefits of frequency and time diversity. But in spite of the efficient performance of all families of the 4G, it faces great challenge because of required services. Modern applications for digital communication systems such as video calls, internet services, mobile live entertainments . . .etc all those applications need higher transmission data rates and high quality of services. They had recommended in this paper, novel technique for MIMO technology denoted by modified SSK had been inserted into OFDM- CDMA system. This modified algorithm provided efficient selection for transmitting antennas instead of using all transmitting antennas as in case of traditional MIMO technology. Simulation results for proposed system showed acceptable BER level at small value of SNR and also at bad fading channel condition. For example at only SNR = 4dB, BER is order of 10^-6 using 7 transmitting antennas and 2 receiving antennas in presence of multi- path Rayleigh fading channel.

2008YueHongGao et al presented his work on "**Performance Evaluation of Mobile 5G LTE withDynamic Overhead"**. In this work they proposed that Mobile WiMAX had become one of the 3rd Generation communication systems and its performance has been widely evaluated. The physical overhead is a critical factor that may affect the overall performance significantly. But almost no attention has been paid to the impact of overhead on system performance yet. In this paper, we first analyze main signaling resources needed in physical layer, which consist of the physical overhead. Then the dynamic overhead model for downlink and uplink are proposed respectively and simplified, while maintaining the simulation accuracy. Average overhead amount was obtained through system level simulation using dynamic overhead calculation. Finally, it was proved that the model was reasonable and the average overhead size may be used instead of dynamic calculation for the sake of reducing simulation complexity as well as keeping evaluation results precise.

In his work, they analyze each signaling component needed in mobile 5G LTE physical layer on the downlink and the uplink, respectively. Then the dynamic overhead calculation model is presented and simplified by using the average value. It was proved that the model was reasonable and the average overhead size may be used instead of dynamic calculation for the sake of reducing simulation complexity as well as keeping evaluation precision.

3. Methodology:

3.1 Physical layer model with fading:

After justifying the 5G LTE model performance in AWGN noise we have tested our model in the presence of fading channel along with AWGN noise. The model is shown in figure 1

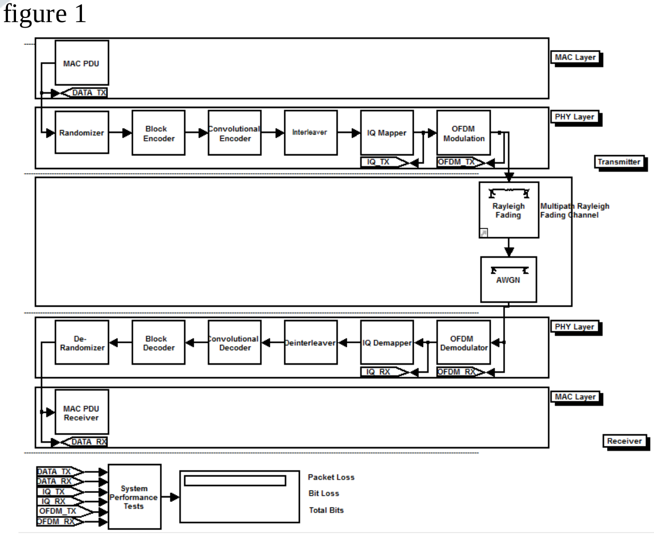

Fig. 1.Model for 5G LTE Physical layer in presence of Rayleigh flat fading

A. Multipath Rayleigh Fading Channel:

The Multipath Rayleigh Fading Channel block implements a baseband simulation of a multipath Rayleigh fading propagation channel. You can use this block to model mobile wireless communication systems. This block accepts a scalar value or column vector input signal. The block inherits sample time from the input signal. The input signal must have a discrete sample time greater than 0.

Parameters:
Maximum Doppler shift (Hz): 40
Doppler spectrum type: Jakes
Discrete path delay vector (s): [0 2e-6]
Average path gain vector (dB): [0 -3]
Initial seed: 73

4. Channel Estimation:

For eliminating the effect of channel fading we apply channel estimation on 7 different modulation schemes and it is found that the estimated gain and phase delay when adjusted with the received data we get a lower value of BER.
To minimize the multipath fading effect we have designed 5G LTE models with different IQ mapping schemes. The preferred IQ mapping schemes are BPSK1/2, QPSK1/2, QPSK3/4 and QAM 16.For each IQ mapping simulink models are designed along with channel estimation subsystem.
The channel estimation subsystem extracts the pilot data inserted before transmission and compare with original pilot data. In course of comparison the estimator calculates the change in gain and phase.

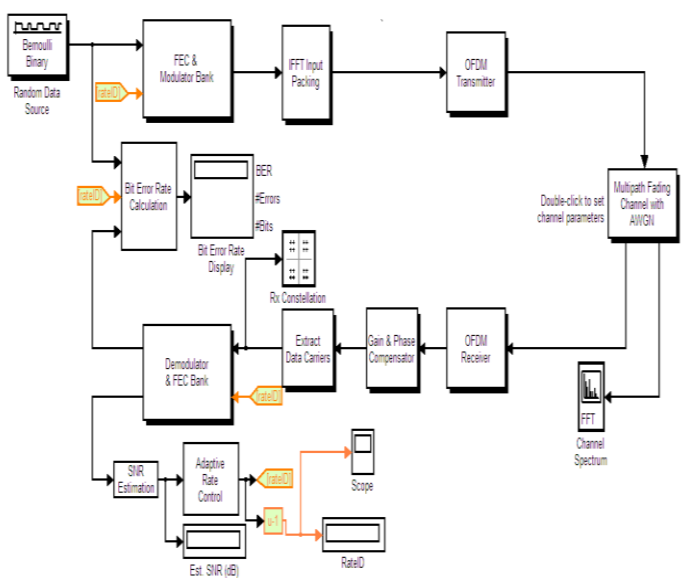

Fig. 2. 5G LTE Model Adaptive rate control in Flat fading channel

5. Transmit Diversity vs. Receive Diversity:

Using diversity reception is a well-known technique to mitigate the effects of fading over a communications link. However, it has mostly been related to the receiver end. In [1], Alamouti proposes a transmit diversity scheme that offers similar diversity gains, using multiple antennas at the transmitter. This was conceived to be more practical as, for example, it would only require multiple antennas at the base station in comparison to multiple antennas for every mobile in a cellular communications system.

This section highlights this comparison of transmit vs. receive diversity by simulating coherent binary phase-shift keying (BPSK) modulation over flat-fading Rayleigh channels. For transmit diversity, we use two transmit antennas and one receive antenna (2x1 notationally), while for receive diversity we employ one transmit antenna and two receive antennas (1x2 notationally).
The MIMO OFDM configuration that has been used is:
Choice for modulation scheme is from 1 to 5 each choice represents:
1:Adaptive Modulation
2:BPSK
3:QPSK
4:16QAM
5:64QAM

Random binary data is generated for Mt transmitters and pilot data is inserted thereafter the cyclix prefix is added.Initially a random data stream is generated having size of Nsym*Nfft= 6144 samples with 6 (Nsym) OFDM blocks with 1024(Nfft) size of each block. The transmitted signal is has length extra then the generated block due to addition of cyclic prefix block. Since CP length is 128 thus the transmitted signal block will have length as Nfft+CP. Thus a Tx array is initialized to store transmitted data with size Nsym*(Nfft+CP)= 6912.

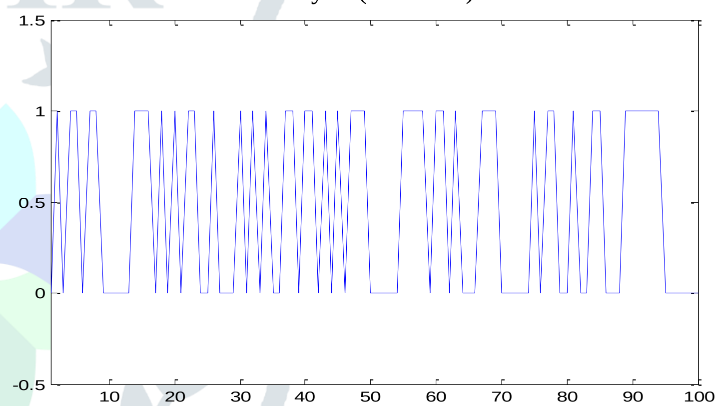

Fig 4. Initial 100 samples of generated binary data.

After generating the binary data modulation is applied on the data for example if we apply BPSK then we will get two values of same magnitude but opposite phases as shown in figure2.

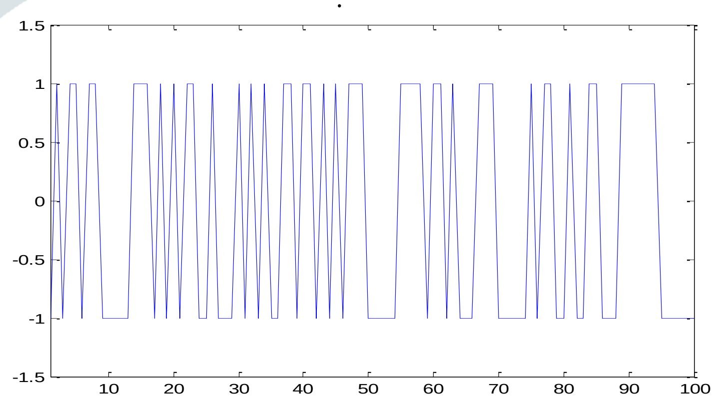

Fig. 5. Initial 100 samples of BPSK modulated binary data.

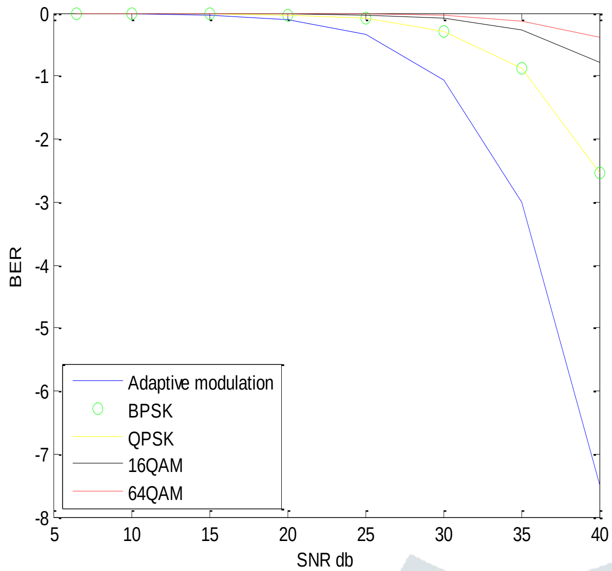

Fig. 6. Performance evaluation of CP based channel estimation and correction in terms of BER at different modulation for MIMO OFDM systems.

6.Conclusion:

This work discuss and implements the issue that has helped to improve the channel distortion estimation accuracy due to the channel effect for enhancing the standard a reliable transmission for different modulation technique including adaptive channel modulation in presence of channel fading, noise and distortions. To this end in the thesis work we have develop an highly accurate and simple algorithm which can jointly estimate channel state prior to data decoding for a wireless communication system. In the future numerous algorithms can be applied to deal channel estimation for MIMO-OFDM systems. The results are generated at different modulation schemes at different SNR values and then we have tabulated the estimated carrier frequency offset values to observe the average estimated offset frequency and its error to the ideal offset value as defined in the algorithm. The average error is found to be very small.

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