PERFORMANCE ANALYSIS OF LTE PHYSICAL LAYER BASED ON RELEASE 8&9 THROUGH SIMULINK ENVIRONMENT

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Abstract

Despite their tremendous success over the years, the wireless technologies are still confronted with some of the critical challenges such as, fading, multipath, and interference and spectrum limitations. To fulfill this, wireless communication industry defined a new air interface for mobile communications i.e., LTE, Long Term Evolution is the evolution of the Universal Mobile Telecommunication System. It describes standardization work by the 3rd Generation Partnership Project, enhances the overall system performance by increasing the capacity of the system along with improving spectral efficiencies while reducing latencies. In order to achieve above requirements important changes have been required at the physical layer e.g. new modulation and coding schemes, reduced Transmission Time Interval (TTI) or advanced medium access techniques. In this project, the main objective is to investigate a downlink and uplink physical layer performance of Long Term Evolution system based on LTE Release 8, 9.

Introduction

LTE stands for "Long Term Evolution" is a new technology that suggests intensifications to prevailing mobile technologies. LTE is 4G (4th Generation) technology that focused to afford excelling features of service as compare to other technology. LTE is extensively called the adversary technology to WiMAX because of its wireless nature and mobile services. In the interim the period of 2009 most of the mobile phones and other mobile broadband avails are functioned on normal GSM (Global System for Mobile communication) and CDMA [7]. Now LTE affords lower cost for users of mobile wireless with high data speed and improved bandwidth for network service providers. LTE technology is under the phase of growth and advancements to afford network providers a definite elucidation to shift from 3G to 4G technology environment. For mobile wireless users LTE expedites the current applications to achieve on better speed as well as for the new mobile applications to get more by using LTE.

In Release 8, Long Term Evolution (LTE) was assimilated by 3GPP as the successor of the Universal Mobile Telecommunication System (UMTS). The objectives for downlink and uplink peak data rate necessity were set to 100Mbit/s and 50Mbit/s, respectively, when operating in a 20MHz spectrum allocation. A first performance evaluations manifestation that the throughput of the LTE physical layer and MIMO improved WCDMA is approximately the same [1]. However, LTE has many other benefits of which the most important are clarified in the following topics.

This paper analyzes the performance of the LTE physical Layer in the downlink and uplink direction. The main features introduced in the new 3GPP-LTE specifications are described and evaluated by means of simulations. The rest of the paper is structured as follows. In Section II a brief description of LTE physical (PHY) layer is presented. Obtained results are presented in Section III. Finally, Section IV gathers the main conclusions and future work.

LTE Physical Layer

The pattern of the LTE physical layer is abundantly influenced by necessity for high peak transmission rate (100 Mbps DL/50 Mbps UL), spectral efficiency, and multiple channel bandwidths (1.25-20 MHz) [2]. To fulfill these necessities, orthogonal frequency division multiplex (OFDM) and Multiple Input Multiple Output (MIMO) was selected to be in data transmission. In enlargement, the LTE physical layer utilizes Orthogonal Frequency Division Multiple Access (OFDMA) on the downlink (DL) and Single Carrier – Frequency Division Multiple Access (SC-FDMA) on the uplink (UL) [6].

Orthogonal Frequency Division Multiple Access

Data transmission in downlink is depending on OFDMA, which is an assured technique to give an efficient access over high-speed wireless networks. Moreover, it is acceptable for broadcasting even in Multiple-Input Multiple-Output (MIMO) scenarios [3]. OFDMA acquires high spectral efficiency in multiuser ambiance by dividing the total convenient bandwidth into confined sub-bands to be distributed by users in an efficient manner. Different bandwidths are reinforcement (from 1.25 to 20 MHz) holding subcarrier spacing unchanged and, as a result, the number of subcarriers changes accordingly. This technology will affords broadband wireless access at data rates of multiple Mbit/s to the end-user and within a range of several kilometers.

OFDMA at the physical layer, in combination with a Medium Access Control (MAC) layer, supports an optimized artifice allocation and Quality of Service (QoS) support for distinct types of services [8].

The OFDM signal used in LTE consist of a maximum of 2048 different sub-carriers having a spacing of 15 kHz. Although it is necessary for the mobiles to have capability to be able to draws all 2048 sub-carriers, not all need to be transmitted by the base station which only needs to be endowing to support the transmission of 72 sub-carriers. In this way all mobiles will be endowing to talk to any base station.

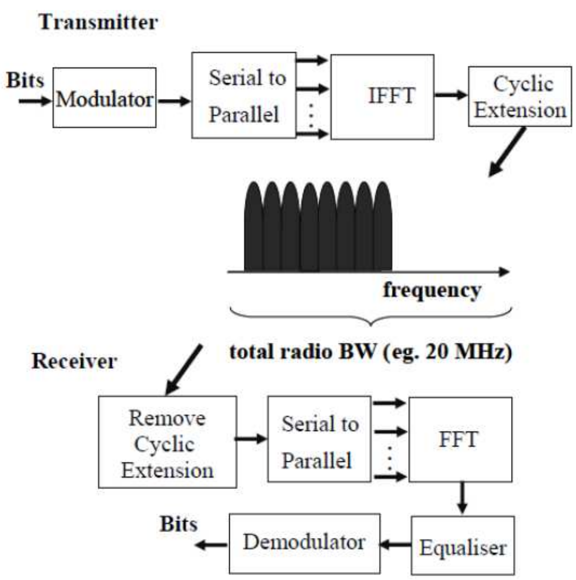

Figure 1Transmitter-Receiver block diagram for OFDMA

Within the OFDM signal it is attainable to choose between three types of modulation:

1. QPSK (4QAM) = 2 bits per symbol
2. 16QAM= 4 bits per symbol
3. 64QAM= 6 bits per symbol

Single Carrier Frequency Division Multiple Access

Single Carrier Frequency Division Multiple Access (SC-FDMA) is a new technology utilizes for uplink physical layer in LTE. SC-FDMA is the multiple access adaptation of Single Carrier Frequency Domain Equalization (SC-FDE), which is similar to OFDM, in that they both accomplish channel estimation and equalization in the frequency domain. Multiple accesses are acquired in frequency domain in SC- FDMA. Thus to changeover from SC-FDE to SC-FDMA requires division frequency amongst frequencies. The use of SC-FDMA in LTE is confined to the uplink because the raised time-domain processing would be an abundant burden on the base station, which has to carryover the movements of multi-user transmission. SC- FDMA can content all of the benefits mentioned for OFDM in addition to low Peak Average Power Ratio (PAPR). Similar to OFDM, the bandwidth is divided into multiple parallel subcarriers with cyclic prefix within order to stay orthogonal to each other and annihilate Inter Symbol Interference (ISI). In SC-FDMA, the undisturbed combination of all data symbols that are transmitted at the identical time is modulated to a given subcarrier [5]. In a given symbol period, all transmitted subcarriers of a SC-FDMA signal are sustaining a component of each modulated data symbol. This is known as a single carrier scheme of SC- FDMA.

The basic transmitter and receiver architecture is very coincident (nearly identical) to OFDMA, and it affords the same degree of multipath protection. The SC- FDMA transmitter belongs of function blocks similar to OFDMA. The block diagram of SC-FDMA is shown in Figure 2. The input data groups are first modulated to single carrier symbols by using QPSK, 16-QAM or 64-QAM. The accumulated modulated symbols become the inputs of the functional blocks of SC-FDMA. The description of every functional block is described below:

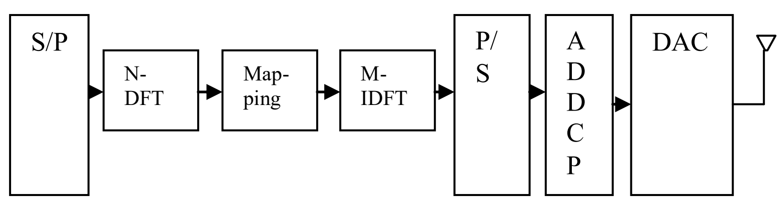

Figure 3SC-FDMA transmitter structure [4]

In Serial to Parallel Convertor (S-to-P), the modulated symbols are converted into parallel symbols and organized into blocks, the N Point DFT (Discrete Fourier Transform) Converts time domain single carrier blocks into N discrete frequency tones, then Subcarrier Mapping, It Controls the frequency allocation, and maps N-discrete frequency tones to subcarriers for transmission. The mapping can be localized or distributed. In localized mapping, N-discrete frequency tones are mapped on N consecutive subcarriers where as in distributed mapping; N-discrete frequency tones are mapped on uniformly spaced subcarriers-Point IDFT (Inverse Discrete Fourier Transform), Converts the mapped subcarriers to time domain then Parallel to Serial Convertor (P-to-S) the time domain subcarriers are converted back from parallel to serial, Cyclic Prefix (CP) is added to avoid ISI. The length of CP is larger than the channel delay spread in order to avoid ISI at the receiver. Finally Digital to Analogue Convertor (DAC) converts the digital signal to analogue signal and up convert (convert set of values to higher set of values) to RF for transmission over the channel.

Moreover, the SC-FDMA receiver does the inverse of SC-FDMA transmitter. The block diagram of receiver is shown in Figure 4

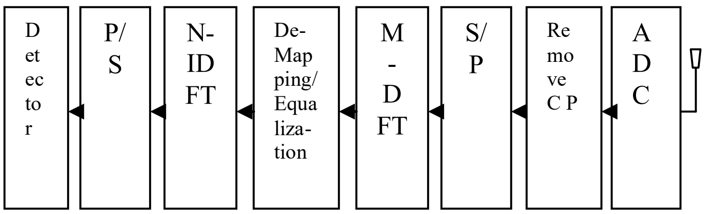

Figure 4SC-FDMA receiver structure

Simulation Environment

The main focus of our study is to measure the performance of LTE uplink and downlink physical layer based on Release 8 & 9. First and foremost, studies made on issues related to LTE and the fundamental of LTE need to understand. Next, the related simulator need to find to running the simulation and the suitable simulator use to obtain the result is MATLAB. The purpose of choosing MATLAB simulator is because it is widely used in data analysis. Furthermore, the result can be obtained by running a program and setting the parameter in the simulator and the comparison of OFDM performance can be measured and analyzed with different modulation techniques and different channel models.

Simulink is a graphical extension to MATLAB for the modeling and simulation of systems. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available (such as transfer functions, summing junctions, etc.), as well as virtual input devices and output devices. Simulink is integrated with MATLAB and data can be easily transferred between the programs [9] Figure shows OFDM_4QAM AWGN Simulink model.

Working Principle

Simulink model consists of transmitter and receiver side. Transmitter section first block is Data source, its Contains random integer input and integer to binary bit converter, this integer is converted into binary bits then its gives input as a IQ Mapper, this IQ Mapper block contains binary bit into integer converter, QAM modulation, Math function ,here IQ mapper performs modulation for given inputs then its followed to OFDM Modulation its converts given input as 24 subcarrier then follows perform FFT and Add cyclic prefix after its goes to receiver section its perform operation of transmitter side. After that each block output are taken from use of Go to tag then it's give to input of error rate calculation use of from tag. Similarly between transmitter and receiver use different channel model and analyze the performance

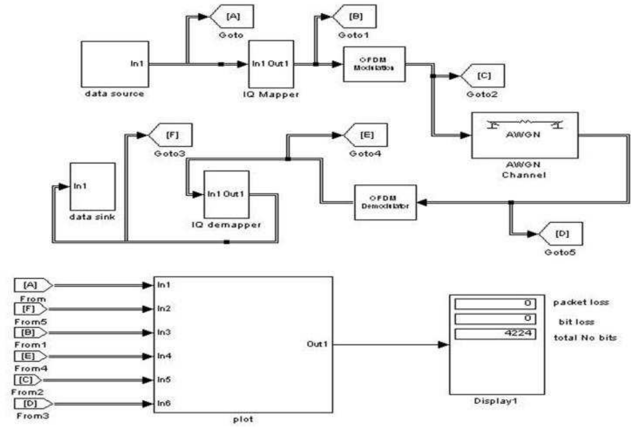

Figure 5 OFDM_4QAM AWGN

Table 1 System Parameter

FFT Size	1024
Window Type	Hann
Maximum Doppler phase shift Frequency	35Hz
Modulation Scheme	4-QAM,16-QAM,64-QAM
Channel Models	AWGN, Rayleigh, Rician
Simulation Time	10ms

The result shows at 10ms, AWGN channel transmit 4224 bits with zero packet loss and zero bit loss. Below result shows the scatter plot of 4QAM and spectrum scope of OFDM.

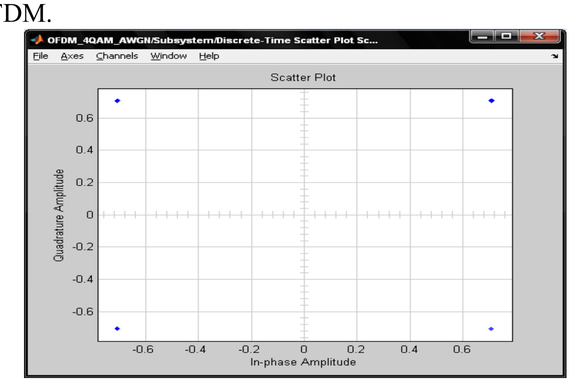

Figure 6 Scatter plot of OFDM in 4QAM

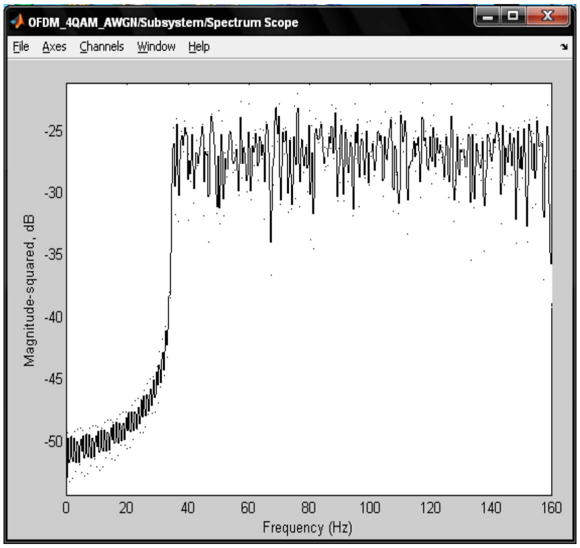

Figure 7 Spectrum scope of OFDM in 4QAM

Similarly with increasing order of modulation, transmitted number of bits also increased. By using 16 QAM and 64 QAM modulation AWGN channel transmit 8448 bit and 12672 bit respectively. For different modulation Simulink model and Simulink results are shown below

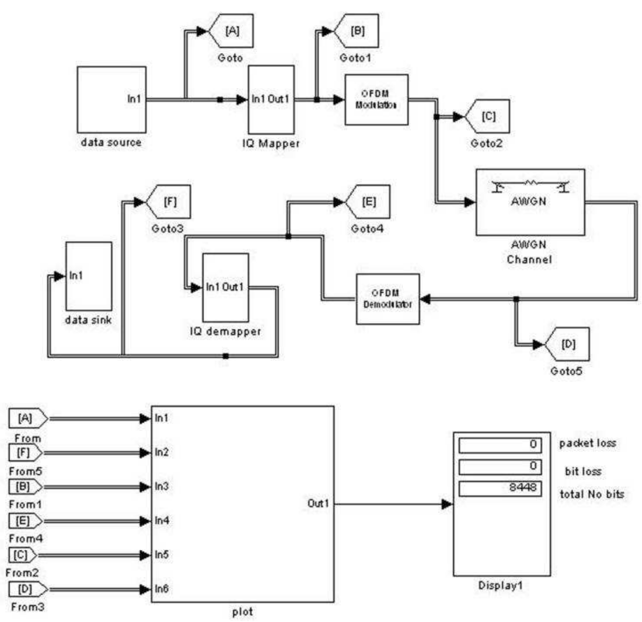

Figure 8 OFDM_ 16- QAM, AWGN

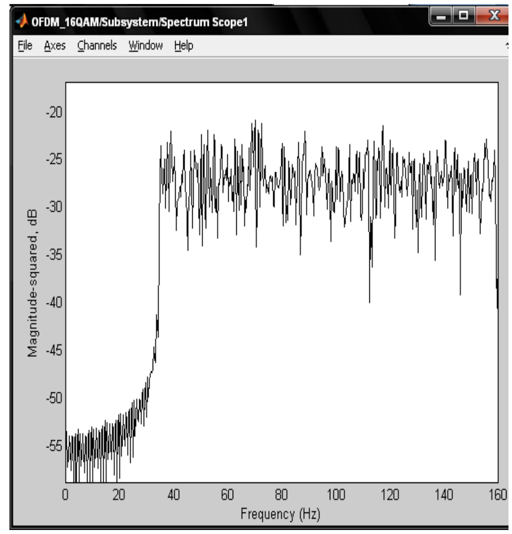

Figure 9Spectrum Scope of OFDM in 16-QAM

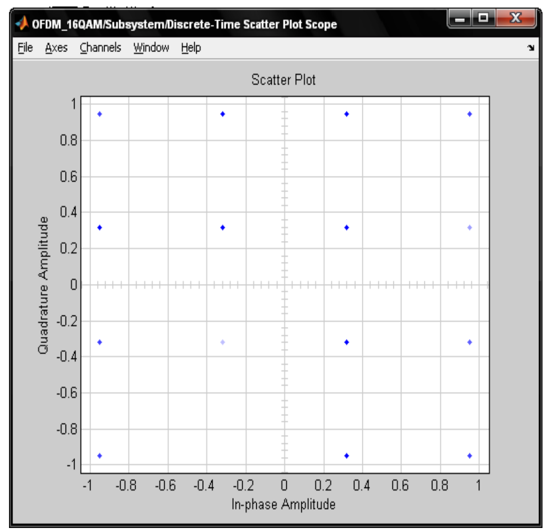

Figure 10Scatter plot of OFDM in 16-QAM

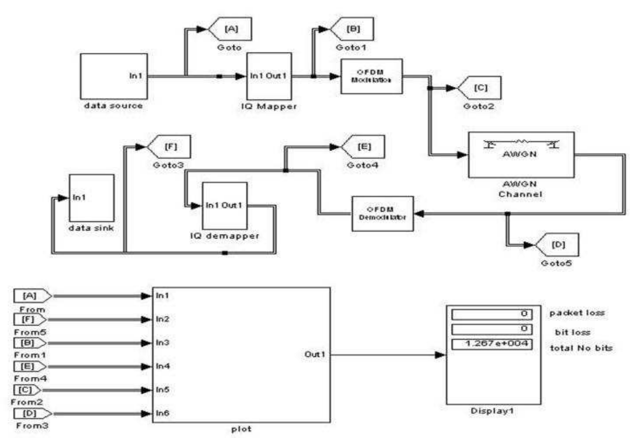

Figure 11.OFDM_64-QAM AWGN

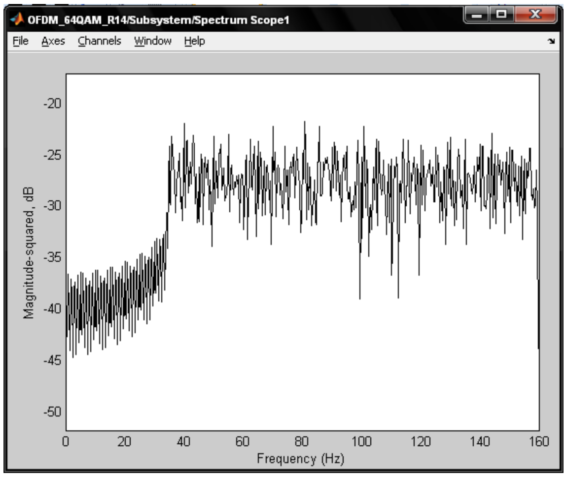

Figure 12 Spectrum Scope of OFDM in 64-QAM

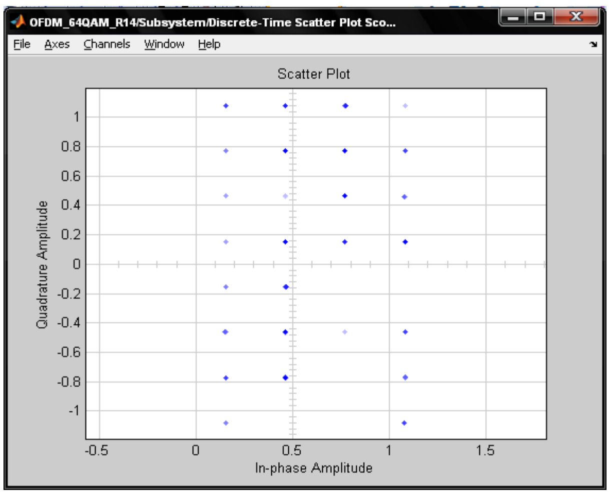

Figure 13.Scatter plot of OFDM in 64-QAM

By changing the channel models for the above Simulink models and different modulations are used. While changing channel model total number of bits are not changed.If Rayleigh and Rician channel considered its non-line of sight so there is present bit loss and packet loss. Table shows the Simulink result for AWGN, Rayleigh, and Ricianchannel with different modulation.

Table 2. BER in AWGN, Rayleigh and Rician channels in 4 - Q AM modulation scheme

Channel	Total No of Bit	Bit loss	Packet loss
AWGN	4224	0	0
Rayleigh	4224	2013	0.4766
Rician	4224	610	0.1444

Table 3 BER in AWGN, Rayleigh and Rician channels in 16- Q AM modulation scheme

Channel	Total No of Bit	Bit loss	Packet loss
AWGN	8448	0	0
Rayleigh	8448	3700	0.438
Rician	8448	1808	0.214

Table 4 B ER in A WGN, Rayleigh and Rician channels in 64- Q AM modulation scheme

Channel	Total No of Bit	Bit loss	Packet loss
AWGN	12672	0	0
Rayleigh	12672	6149	0.4852
Rician	12672	3907	0.308

Conclusion

From the Simulink results, the packet loss and bit loss is zero for AWGN channel but its line of sight. By using Non line of sight channel Rayleigh and Rician there is some packet loss and bit loss. When compared to Rayleigh channel, Rician channel performs better because it gives only 0.2618 for 16-QAM modulation.

Future Work

The enhancement can be done with the LTE Release 10, 11&12 Specifications. The Performance can be analyzed along with Single Input Single Output (SISO),Single Input Multiple Output (SIMO), Multiple Input Single Output (MISO), Multiple Input Multiple Output (MIMO); Antennas placing it at Transmitter and receivers of LTE Physical layer Structures.

Acknowledgments

The authors are thankful to IJATER Journal for the support to develop this document.

Thanks to Dr. Swarna RavindraBabu, Principle Engineer, Samsung India Pvt Ltd Bangalore for the immense support and the measureless encouragement for the successful completion of this paper work.

Thanks to Management, Staff of Arunai College of Engineering for their Wonderful Support towards this paper submission.

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Biographies

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