Design and Performance of the 3GPP Long Term Evolution Transceiver Physical Layer in SUI Channels

Mohannad J. Mnati, Saleim Hachem Farhan, Maher Ibraheem Gamaj

Abstract — Third Generation Partnership Project Long Term Evolution (3GPP LTE), emerged with an aim of providing voice, data, video and multimedia services on mobile phones at high speeds and cheap rates. Long Term Evolution (LTE) is one of the 4th generation wireless communications. The major aim of this paper is to analyze the LTE radio frame. We designed and simulated the OFDM system with cyclic prefix. Its Bit Error Rate (BER) is verified by changing the Signal to Noise Ratio (SNR) value. We designed, simulated the QAM digital modulation in SUI channels its BER vs. SNR are verified using simulations on MATLAB.

Index Turbo Coder, LTE, 3GPP, OFDM, FFT, SUI.

I. INTRODUCTION

A current scheduler should differentiate between the Quality of Service (QoS) classes offered, optimize each service to its specific needs and maximize the use of the radio resources. It should also be easy to the operators to include new services into the network. The Long Term Evolution of UMTS has been introduced by the 3GPP. It has latest Physical layer thoughts and protocol architecture for UMTS. From the Ericsson analysis, by the year of 2016, there will be about 5 billion mobile broadband subscribers and these are supported by HSPA and LTE networks in majority [1].In the year of 1981, there was a big commercial growth in the mobile communication system that was famous as 'First Generation Systems'. The first analog mobile communication systems were introduced in the Nordic countries by the NMT (used in parts of Europe) and at the similar time in the North America by analog AMPS [2]. There were number of independently advanced systems worldwide, other analog systems in the world are TACS (used in parts of Europe) and J-TACS (used in Japan and Hong Kong) [3]. The Second Generation Systems advanced with the coming of digital communications. Global roaming was first introduced in this system, increase in the data rate, capacity and the constancy of the quality of the systems attracted the mobile communication subscribers. The second generation systems like GSM was initially the solution for voice traffic while the data capability was added later [4]. 2G based CDMA advanced by Qualcomm was the biggest competition for GSM. GPRS introduced in GSM, carried Packet data over cellular systems. This system was mentioned to as 2.5G. In Europe, RACE initiated the first phase of research about 3G and UMTS had been named as 3G in Europe. WCDMA was chosen as the technology for UMTS in the paired spectrum (FDD) and TD-CDMA for the unpaired spectrum (TDD) [5]. 3GPP is the standards- evolvement body of GSM, it is a partnership project formed by the standard bodies of ETSI, ARIB, TTC, CCSA and ATIS. 3GPP2 was too advanced in parallel and this standard body is for CDMA-2000 which is a 3G technology and it is advanced from 2G-CDMA which is of IS-95 standards. HSPA is the 'Third Generation System' which has support data usage incredibly. Approximately 90 percent of the global mobile subscribers are served by 3GPP technologies-GSM/GPRS/EDGE and WCDMA/HSPA [6]. 3GPP LTE is built on the large base of 3GPP technologies. First Generation Analog system was based on Frequency Division Multiple Access. GSM/GPRS/EDGE was based on Time and Frequency Division Multiple Access (TDMA/FDMA). IS-95, CDMA-2000/UMTS family of W-CDMA/HSPA was based on Code Division Multiple Access. UMTS-LTE, which is the latest multiple access technology used in the mobile radio standards [7-9].

II. PROPOSED MODIFIED MODEL

The Block diagram in Fig (1) represents the whole system model for Proposed LTE Transceiver Design. In this section the system models that have been used in the LTE simulator will be presented. The used system model is outlined in Figure 1 In transmitter side the digital random data set is generated uniformly. CRC Insertion: A 24-bits CRC is calculated and appended at the end of every transport block. CRC allows receiver to detect residual errors from the decoded transport block. The block diagram for CRC insertion is shown in Figure 1. The current 3G systems use turbo coding scheme, but due to the high peak data rates supported by LTE [10], it becomes imperative to know if this same turbo coding scheme can scale to high data rates while maintaining reasonable decoding complexity. It is currently debated that turbo coding has a particular drawback that it is not amenable to parallel implementations which limit the achievable decoding speeds. The underlying reason behind this issue is the contention for memory resources among parallel processors which occurs as a result of the turbo code internal interleaver. On the other hand, it is argued that turbo codes can also employ parallel implementations if turbo internal interleavers can be made contention-free. These blocks of digital data set have been paralleled and mapped into complex data blocks using 16-QAM modulation technique.

Every complex data block referred to a symbol of data is attached to an individual

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Mohannad J Mnati , Electronic Technique Dept. Institute of Technology, Baghdad, Iraq.

Saleim Hachem Farhan, Electronic Technique Dept. Institute of Technology, Baghdad, Iraq.

Maher Ibraheem Gamaj, Electronic Technique Dept. Institute of Technology, Baghdad, Iraq.

sub-carrier. The Inverse Fast Fourier Transform (IFFT) is used in order to generate the time version of transmitted signal. The time domain signals corresponding to all subcarriers are orthogonal to each other. However, the frequency spectrum overlaps. After this, the data converted from the parallel to the serial form are fed to the SUI channels more information about SUI channels in [11]. The receiver performs the same operations as the transmitter, but in a reverse order. In addition, wavelet OFDM includes operations for synchronization and compensation for the destructive SUI channels.

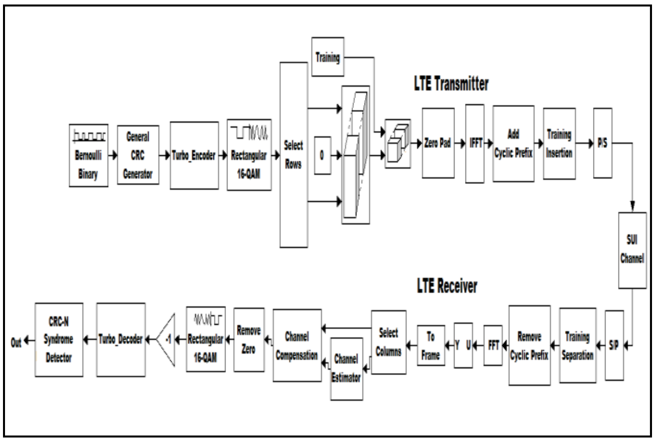

Fig .1.Block Diagram of LTE Transceiver Design

III. SIMULATION RESULTS OF THE PROPOSED DESIGN

The reference model specifies a number of parameters that can be found in Table (1).

Table (1) System parameters

Transmission Bandwidth	**2.5 MHz**
Sub-frame duration	**0.5ms**
Sub-carrier spacing	15KHz
Sampling Frequency	3.84MHz
FFT Size	256
OFDM symbol per slot (short/long CP	7/6
CP length (µsec/samples) SHORT	(4.69/18) x 6 (5.21/20) x 1
LONG	(16.67/64)
Modulation type	16QAM
Channel coding	Turbo
Channel type	SUI Channel
Channel estimation	Perfect
Receiver decoder type	Soft sphere detection (SSD)
Number of iterations	1000

In this part the simulation of the proposed LTE Transceiver system is achieved, beside the BER performance in Six SUI channel models

A. Performance of LTE Transceiver in SUI-1 Channel

In this scenario, the results in Figure 2 obtained were encouraging. it can be seen that for BER=〖 10〗 ^(-3) the SNR is required is about 13.13 dB.

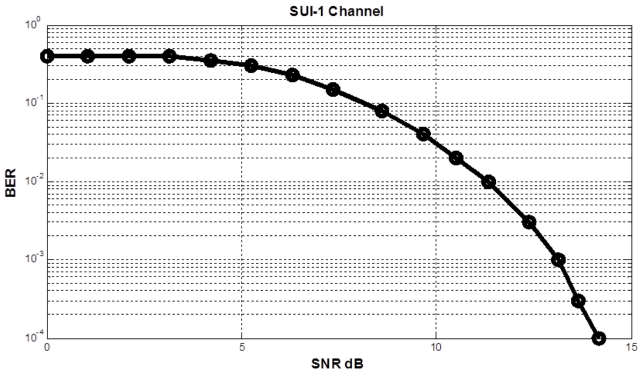

Fig..2. BER performance of LTE Transceiver in SUI-1 Channel

B. Performance of LTE Transceiver in SUI-2 Channel

In this simulation profile some influential results in Figure 3 were obtained. It can be seen that for BER=〖 10〗 ^(-3) the SNR required for is about 17.5 dB.

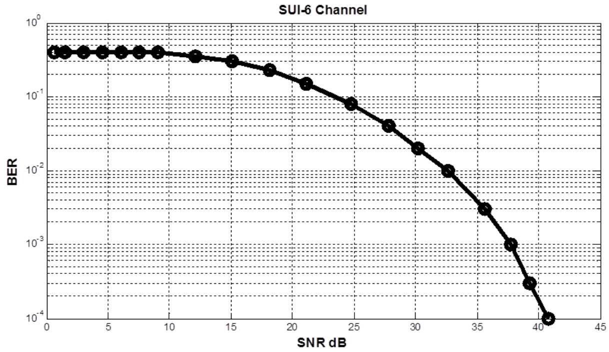

Fig .3. BER performance of LTE Transceiver in SUI-2 Channel

C. Performance of LTE Transceiver in SUI-3 Channel

In the SUI-3 channel, the results are depicted in Figure 4 it can be seen that for BER=〖 10〗 ^(-3) the SNR required is about 22.5 dB.

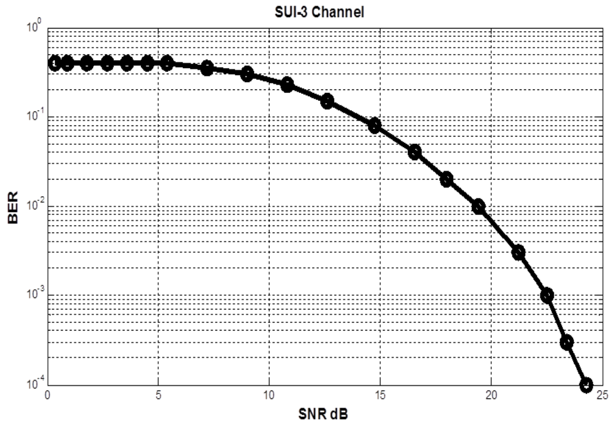

Fig .4. BER performance of LTE Transceiver in SUI-3 Channel

D. Performance of LTE Transceiver in SUI-4 Channel

Using similar methodology as in the previous section, simulations for SUI-4 channel .The result depicted in Figure 5 it can be seen that for BER=〖 10〗 ^(-3) the SNR required is about 27.5 dB .

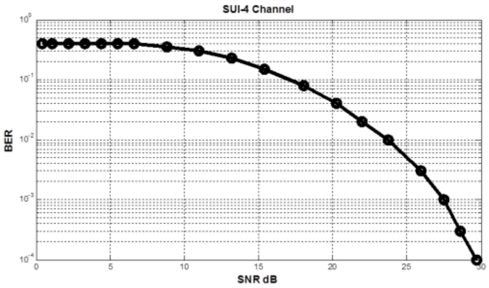

Fig .5. BER performance of LTE Transceiver in SUI-4 Channel

E. Performance of LTE Transceiver in SUI-5 Channel

In this model, the results obtained were encouraging. It can be seen that for BER=〖 10〗 ^(-3)the SNR required is about 32.5 dB.

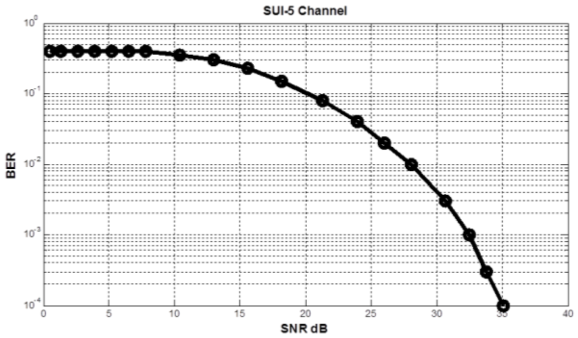

Fig .6. BER performance of LTE Transceiver in SUI-5 Channel

F. Performance of LTE Transceiver in SUI-6 Channel

In this state, the results obtained were hopeful. It can be seen that for BER=〖 10〗 ^(-3) the SNR required is about 37.75 dB.

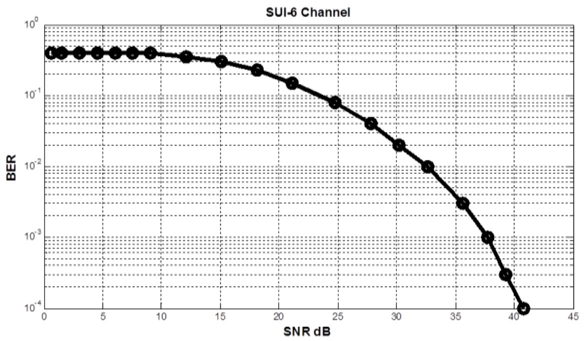

Fig .7. BER performance of LTE Transceiver in SUI-6 Channel

Table (2) Simulation results

Channel for BER= 10^{-3}	SUI-1 dB	SUI-2 dB	SUI-3 dB	SUI-4 dB	SUI-5 dB	SUI-6 dB
LTE Transceiver	13.13	17.5	22.5	27.5	32.5	37.75

In this section the simulation of the proposed LTE Transceiver system in MATLAB version 13 are achieved, and the BER performance of the OFDM system considered in different SUI channel models, the, SUI-1, SUI-2, SUI-3,-SUI4, SUI-5 and SUI-6 .The simulation results shown in Table (2).

IV. CONCLUSION

To maintain its competitive edge in the world of mobile transceiver in the future, 3GPP has initiated work on LTE. LTE is a packet optimized radio access technology with low latency and large bandwidths. This paper work is based on the explain of LTE Transceiver structures. During this research paper the SUI channel models and tools for LTE Transceiver demonstration have been done.

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AUTHRS PROFILE

Assist Lecturer Eng.Mohannad J Mnati Received his B.Sc. in Electrical and Electronics from the Faculty of Electrical Engineering, University of Technology Baghdad, Iraq in 2000, and received the M.Sc. degree in Electronic engineering from Faculty of Electrical Engineering, University of Technology Baghdad, Iraq in 2005. Currently he is Assist Lecturer, Researcher and training supervisor, Dep. of Electronic in Institute of Technology Baghdad. His research interests include Micro strip antenna, Electronic circuit design, Wired& Wireless Network Administration.

Assist Lecturer Eng Saleim Hachem Farhan Received his B.Sc. Academy of Engineering - Sarajevo - Bosnia's Republic in 1982, and received the M.Sc. degree in Electrical Engineering - University of Belgrade in 1984. Currently he is Assist Lecturer, Researcher and training supervisor, Dep. of Electronic in Institute of Technology Baghdad.

Assist Lecturer Eng Maher Ibraheem Gamaj Received his B.Sc. Academy of Engineering - Sarajevo - Bosnia's Republic in 1983, and received the M.Sc. degree in Electrical Engineering - University of Belgrade in 1985. Currently he is Assist Lecturer, Researcher and training supervisor, Dep. of Electronic in Institute of Technology Baghdad.