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Performance Analysis of physical layer in LTE

[1] Neha Narudkar, [2] Tejasvini Naik, [3]Vaishali S. Jadhav, [4] Uttam Kolekar
[1][2][3] Dept. of Electronics Engineering
[1][2] RAIT,[3] Ramrao Adik Institute Of Technology,Nerul, [4]A. P. Shah Institute of Technology,Thane

Abstract - **Long Term Evolution (LTE) is an advanced standard technology of the mobile communication systems. LTE has been developed by the 3rd Generation Partnership Project (3GPP). The new features exhibited by this technology is a direct impact of applying new modulation and coding techniques such as the Orthogonal Frequency Division Multiplexing (OFDM) for the Downlink and the Single Carrier Frequency Division Multiple Access (SC-FDMA) for the Uplink. It is observed that throughput is increased. Overall performance is improved, QoS is also improved.**

Index Terms— 3GPP, LTE, OFDMA, SC-FDMA, UMTS, GSM.

INTRODUCTION

LTE stands for Long Term Evolution and it was started as a project in 2004 by telecommunication body known as the Third Generation Partnership Project(3GPP). LTE evolved from an earlier 3GPP system known as the Universal mobile Telecommunication System(UMTS), which in turn evolved from the Global System for Mobile Communication(GSM)[1].

The rapid growth of cellphones, wireless LANs and recently the wireless internet, in short, wireless communications is driving the whole world towards integrity with wireless communications [2]. Mobile users have become much more mature and their satisfaction comes with higher capacity, better coverage and Quality of service (QoS) with cheaper rates. They are not satisfied with a voice call or text message, but they want to make video calls and run real time applications i.e. video streaming and playing online games etc [3].

The LTE PHY is a highly efficient means of conveying both data and control information between an enhanced base station (eNodeB) and mobile user equipment (UE). The LTE PHY employs some advanced technologies that are new to cellular applications. These include Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input Multiple Output (MIMO) data transmission [4].

A. Abbreviations and Acronyms

LTE- Long-Term Evolution

3GPP- 3rd Generation Partnership Project

OFDM- Orthogonal Frequency Division Multiplexing

SC-FDMA- Single Carrier Frequency Division Multiple Access

GSM- Global System for Mobile Communications

UMTS- Universal Mobile Telecommunications System

E-UTRAN- Evolved Universal Terrestrial Radio Access Networks

LTE PHY- Long Term Evolution Physical Layer

II. EVOLUTION OF MOBILE COMMUNICATION

The ability to provide wireless communications to an entire population was not even conceived until Bell Laboratories developed the cellular concept in the 1960s and 1970s[2]. The world saw its first successful mobile communication system in 1980s. After that many wireless communication systems and more generations have been developed throughout the world. In 1G, 2G, 3G, 4G systems G means generation of mobile network or telephone standard. More G means higher power and efficiency to send and receive more information [5].

Technology / Features	1G	2/2.5G	3G	4G	5G
Start/ Deployment	1970/ 1984	1980/ 1999	1990/ 2002	2000/ 2010	2010/ 2015
Data Bandwidth	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Standards	AMPS	2G: TDMA, CDMA, GSM 2.5G: GPRS, EDGE,1xRTT	WCDMA, CDMA-2000	Single unified standard	Single unified standard
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband, LAN/WAN/	Unified IP and seamless combination of broadband,

Figure 2.1. Difference between mobile generations [6][7].

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III. LTE CONCEPT

Long-Term Evolution (LTE) is a standard for high-speed wireless communication for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements [8].

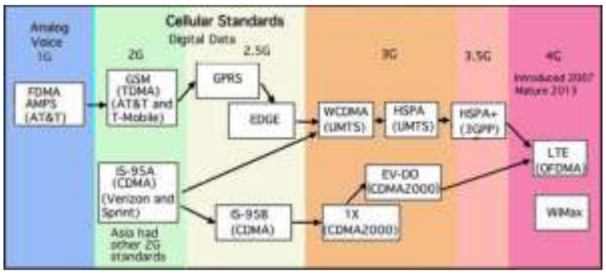

Figure 4.1. Evolution of LTE [6].

A. LTE Architecture

LTE network architecture is designed more to be flat and all IP based structure, which means LTE has been designed to support only packet switched services. Flat architecture helps to reduce delays in user plane and control plane which improves data rate.

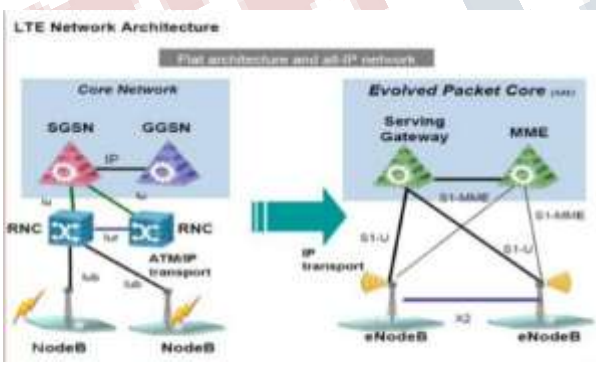

Figure 4.2. LTE architecture [6].

As shown in figure EPCs communicate with each other and with E-UTRANs. EPC contains a Mobile Management Entity (MME), System Architecture Evolution Gateway (SGW), Packet Data Network Gateway (PDN GW). EUTRAN alone contains Evolved Universal Terrestrial Radio Access Network Base Stations (eNB) where the User Equipment (UE) communicates with eNB and eNBs communicate with each other and with the EPCs. There is one-to-one communication between UE and eNB but there is one-to-many communication among eNB, MME, and SGW [9].

B. Overall Structure

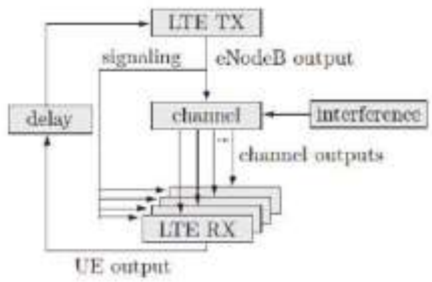

Figure 4.3. Overall simulator structure [10].

The LTE link level simulator consists of the following functional parts: one transmitting eNodeB, N receiver User Equipments (UEs), a downlink channel model over which only the Downlink Shared Channel (DL-SCH) is transmitted, signaling information, and an error-free uplink feedback channel with adjustable delay [10].

C. LTE Supporting Technologies

1) OFDM

In the downlink, orthogonal frequency-division multiplexing (OFDM) was selected as the air interface for LTE. OFDM is a particular form of multicarrier modulation (MCM). In general MCM is a parallel transmission method that divides a radio frequency channel into several, more narrow-bandwidth subcarriers and transmits data simultaneously on each subcarrier.

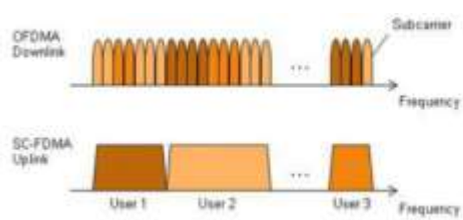

Figure 4.4. OFDM and SC-FDMA [6].

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2) SC-FDMA
SC-FDMA is used to reduced Peak to Average Ratio(PAR) and to maximize the coverage. SC-FDMA uses a cyclic prefix to allow high-performance and low-complexity receiver implementation in the eNodeB [13].

IV. LTE CHANNEL TYPES

- Physical channels: These are transmission channels that carry user data and control messages.

Physical channels including physical broadcast channel (PBCH), physical control format indicator channel (PCFICH), physical downlink control channel (PDDCH), physical hybrid indicator channel (PHICH), physical random access channel (PRACH), physical uplink shared channel (PUSCH), physical uplink control channel (PUCCH)
Physical signals including primary synchronization signal (PSS), secondary synchronization signal (SSS), cell-specific reference signals (RS), demodulation reference signal (DMRS), channel state information reference signals (CSI-RS), sounding reference signals (SRS).

- Transport channels: The physical layer transport channels offer information transfer to Medium Access Control (MAC) and higher layers. The LTE transport channels vary between the uplink and the downlink as each has different requirements and operates in a different manner.
- Logical channels: Provide services for the Medium Access Control (MAC) layer within the LTE protocol structure [11] [12].

V. LTE PHYSICAL LAYER PERFORMANCE RESULTS

A. LTE Modeling

1) Downlink lte modeling:
Figure 6.1 shows the measurement of physical downlink shared channel throughput of transmit/receive chain.

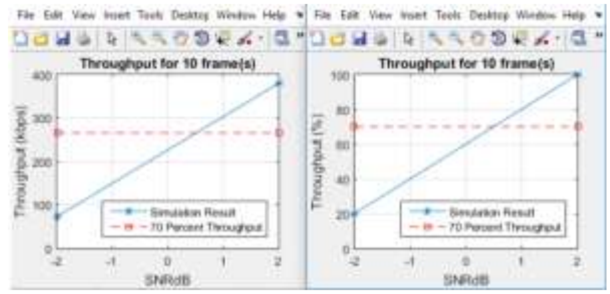

Figure 6.1. PDSCH Transmit Diversity Throughput Simulation.

2) Uplink lte modeling:
Figure 6.2 shows to configure User Equipment (UE) and cellspecific Sounding Reference Signals (SRS) transmission. Physical Uplink Control Channel (PUCCH) is also configured for transmission.

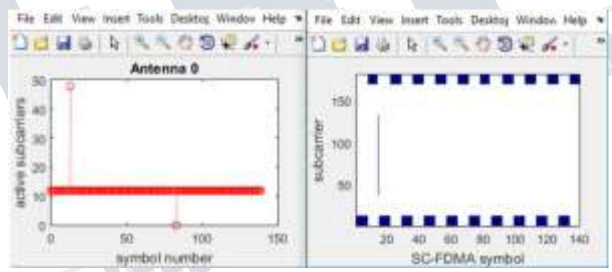

Figure 6.2. Uplink waveform modeling using SRS and PUCCH.

B. End to End Simulation

1) Downlink lte end to end simulation: Figure below i.e. 6.3 shows the achieved throughput for a UE in the serving cell is measured and plotted, hence analyzing the effect of inter-cell interference on performance.

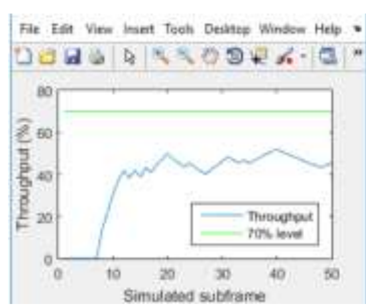

Figure 6.3.Effect of inter-cell interference on PDSCH Throughput.

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2) Uplink lte end to end simulation:
The probability of correct detection of the Physical Random Access Channel (PRACH) preamble is measured when the preamble signal is present as seen in figure 6.4.

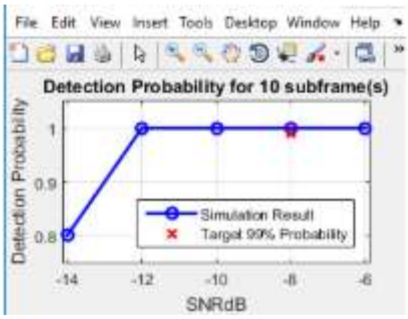

Figure 6.4. PRACH detection conformance test.

C. Waveform generation and analysis
1) Downlink Waveform generation and analysis:
Figure 6.5 shows to generate a test model using LTE System Toolbox.

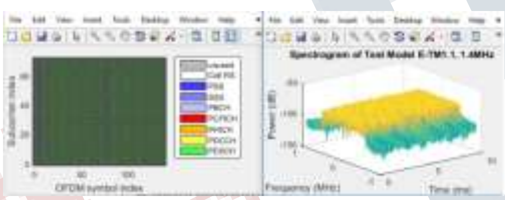

Figure 6.5. LTE downlink test model(E-TM) waveform generation.

2) Uplink Waveform generation and analysis:
As shown in figure 6.6, the LTE System Toolbox can be used to perform Error Vector Magnitude (EVM) and in-band emissions measurements on an uplink signal as per TS 36.101

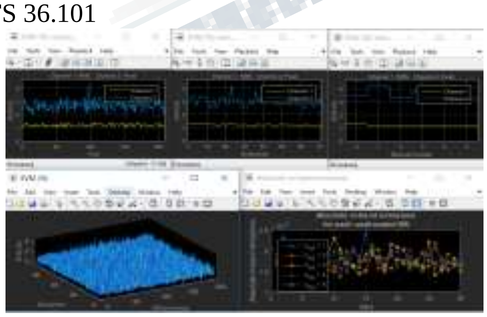

Figure 6.6. LTE uplink EVM and in-band emissions measurements.

CONCLUSION

In this paper we have studied LTE concepts, its architecture and channel types. The results are obtained using the physical layer implementation of LTE in Matlab 16. From the results it is seen that throughput is increased. Overall performance is improved, QoS is also improved.

REFERENCES

[1] https://www.tutorialspoint.com/lte/lte_overview.htm

[2] Wireless Communications-Principles and Practice by Theodore S. Rappaport 2nd edition Pearson publication.

[3] Call Admission Control in LTE by prof. vaishali jadhav.

[4] Overview of the 3GPP Long Term Evolution Physical Layer

[5] Wireless Communications by T L Singal Mc Graw Hill publication.

[6] https://www.google.co.in/search

[7] Computer Communication Networks by J.S.Katre, Sumit Khandelwal, Ashwini Ab-hale

[8] https: // en . Wikipedia . org / wiki / LTE _ (telecommunication)

[9] A Review of 3GPP-LTE System by Prof. Vaishali Jadhav And Dr. Uttam Kolekar.

[10] SIMULATING THE LONG TERM EVOLUTION PHYSICAL LAYER by Christian Mehlfuhrer, Martin Wrulich, Josep Colom Ikuno, Dagmar Bosanska, Markus Rupp (Institute of Communications and Radio-Frequency Engineering Vienna University of Technology) published in 17th European Signal Processing Conference (EUSIPCO 2009 (http :// www . nt . tuwien.ac.at/ ltesimulator