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LTE Downlink Transmission Scheme

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ABSTRACT

LTE(Long Term Evolution) it combines both radio and core network is the next generation standard by 3rd generation patnership project (3GPP).LTE is the new standard specified by 3GPP for fourth generation (4G) wireless communication.By using the physical layer LTE transceiver is analyzed in downlink transmission.simulation of physical layer LTE transceiver is obtained with the use of **keysight systemvue. keysight System vue** is a advanced library to generate various downlink(OFDMA).signal sources with MIMO and measure the closed loop throughput ,Bit Error Rate (BER),are obtained by different simulation configurations .

INDEX TERMS- **LTE ,PDSCH ,PHY, Simulations.**

1.INTRODUCTION

LTE(Long Term Evolution) is the combination of both (radio and core)network. Radio means radiation wireless transmission of electromagnetic energy through space.It carry the information such as sound by systematically (modulating)some property of the radiated waves.The radio equipment involved in communication system includes the transmitter and reciever.each antenna having appropriate terminal equipment such as microphone at the transmitter loud speaker in the case of voice communication system.Core network means is the central part of the telecommunication network that provides various services to customer who are connected by access network.Core is the backbone network provides paths for the exchange of information between different sub networks.LTE provides high Spectral Efficiency,high peak data rate ,short round trip time,frequency flexiliblity .lte follows the technologies such as Orthogonal frequency division multiplexing (OFDM),Multiple input and multiple output(MIMO), robust channel coding ,scheduling and link adaptation .LTE provides seamless service and multimode devices for the customers hence its technology evolved over the multiple releases which have led to improved data throughput,lower latencies and increasingly flexible configurations .

3GPP: Third generation patnership project it unites the telecommunication standard development organization known as “organizational patners”it provides the members in a stable environment its covers the cellular network ,network technologies including radio access. Work in 3GPP is organized around the concept of release which can be defined as a complete set of functionalities

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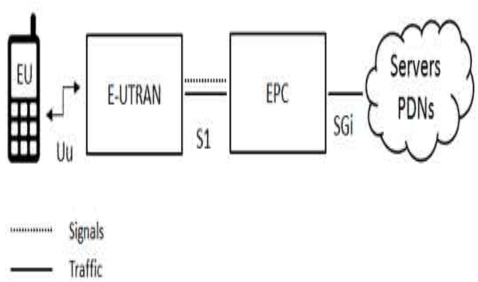
for a full cellular network allowing new set of services to be deployed by operators.After completing a long evolution of the Wideband CDMA radio technology, 3GPP decided to work on a new concept of radio technology to allow further evolution having in mind a long term evolution. LTE was born. But this does not stop completely parallel evolution of the WCDMA.

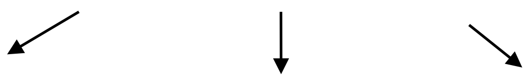
2.OVERVIEW OF LTE

The high level of network architecture comprised of 3 main components :

- User Equipment (UE)
- Evolved packet core(EPC)
- EUTRAN(Evolved Universal Terrestrial Radio Access Network)



User equipment: This is actually a mobile equipment (ME).



Mobile Termination Terminal Equipment UICC

Mobile termination: Which handles all the communication functions .

Terminal equipment : Terminates the data streams .

UICC: This is also known as the sim card of the LTE equipments its runs the application known as Universal Subscriber Identity Module(USIM) stores the user specific data very similar to the 3G sim card .This keeps the information about users phone number ,network identity,security keys etc..

Evolved packet core: This communicates the packet data network in the outside world such as Internet,private corporate network or the IP multimedia sub system.

The E-UTRAN (The access network)

The E-UTRAN handles the radio communications between the mobile and the evolved packet core and just has one component, the evolved base stations, called **eNodeB** or **eNB**.

3.OVERVIEW OF LTE DOWNLINK TRANSMISSION

The communication is going from a satellite to ground is called downlink (from tower to device). OFDM is an excellent choice of multiplexing scheme for the 3GPP LTE downlink . To fulfill all the requirements LTE uses a transmission scheme called orthogonal frequency division multiplexing (OFDM) for the downlink transmission.The high data rates of the LTE standard does not only need wider bandwidth but also a more advanced modulation technique.while OFDM is considered as a optimum modulation technique to fulfill the downlink transmission requirement. OFDM allocates the adjacent transmitters send the same signal simultaneously at the same frequency as the same signal from multiple distant may be combined constructively rather than interfering traditional system LTE uses OFDM for the downlink – that is, from the base station to the terminal. OFDM meets the LTE requirement for spectrum flexibility and enables cost-efficient solutions for very wide carriers with high peak rates. OFDM uses a large number of narrow sub-carriers for multi-carrier transmission.

The basic LTE downlink physical resource can be seen as a time-frequency grid. In the frequency domain, the spacing between the subcarriers, Δf, is 15kHz. In addition, the OFDM symbol duration time is $1/\Delta f$ + cyclic prefix. The cyclic prefix is used to maintain orthogonality between the sub-carriers even for a time-dispersive radio channel.

One resource element carries QPSK, 16QAM or 64QAM. With 64QAM, each resource element carries six bits.The OFDM symbols are grouped into resource blocks. The resource blocks have a total size of 180kHz in the frequency domain and 0.5ms in the time domain. Each 1ms Transmission Time Interval (TTI) consists of two slots (Tslot).In E-UTRAN, downlink modulation schemes QPSK, 16QAM, and 64QAM are available.

3.1 Downlink Physical Layer Procedures

For E-UTRAN, the following downlink physical layer procedures are especially important:

- Cell search and synchronization:
- Scheduling:
- Link Adaptation:
- Hybrid ARQ (Automatic Repeat Request)

4. LTE GENERIC FRAME STRUCTURE

The LTE signal in time domain is based on frames, which are 10 ms long and consist of 10 subframes each of 1 ms duration. The subframes are divided further into two slots each 0.5 ms long. In each slot 7 or 6 OFDM symbols are contained depending on whether normal or short

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Cyclic Prefix is used. The time domain frame structure of the LTE downlink can be seen below,

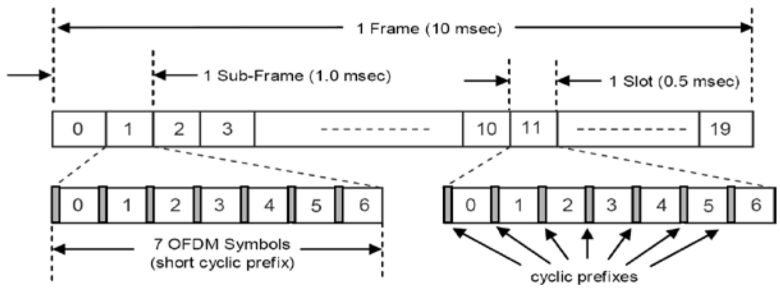

Figure: 4.a LTE downlink signal structure in time domain

4.1 Resource management in LTE downlink physical layer

LTE uses a three dimensional space to manage the resources time, frequency and space (antennas).In Fig:4.a only time and frequency dimensions are shown. The smallest unit is the so-called Resource Element (RE), which consists of a time interval of duration of one OFDM symbol and one subcarrier. Seven OFDM symbols (in case of normal CP length) or 6 symbols (in case of long CP length) build a time slot. The area consisting of 12 subcarriers (180 kHz) and one time slot is called Resource Block and contains 12x7=84 Resource Elements in case of normal Cyclic Prefix.

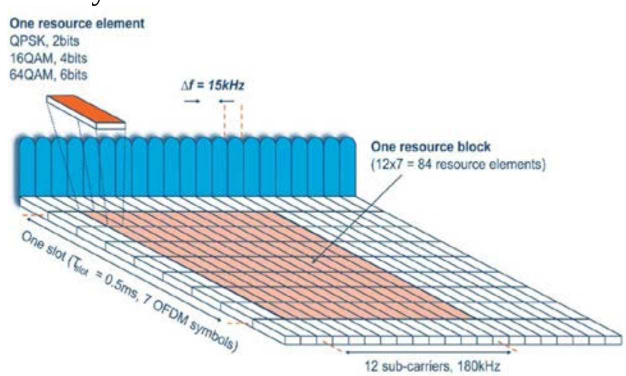

FIG: 4.b Resource management in LTE downlink.

5. PHYSICAL DOWNLINK CHANNEL:

Physical downlink shared channel (PDSCH) is the main data bearing downlink channel in TD-LTE .TD-LTE downlink,OFDM is selected as a air interface. PDSCH is mainly used for all user data also for paging messages and broadcast channel (PBCH).physical downlink shared channel is used to transmit the downlink shared channel.when employed for user data,one or at most two transport bocks can be transmitted by UE per subframe,depending on the transmission mode selected for the PDSCH.each transmission corresponds to an applied multi-antenna transmission technique.

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The transmitter in the physical layer starts with the grouped resource data which are in the form of transport blocks. The transmitter and receiver structure of PDSCH is shown in figure.

According to the processing steps of transmitting downlink data in PDSCH are given below.

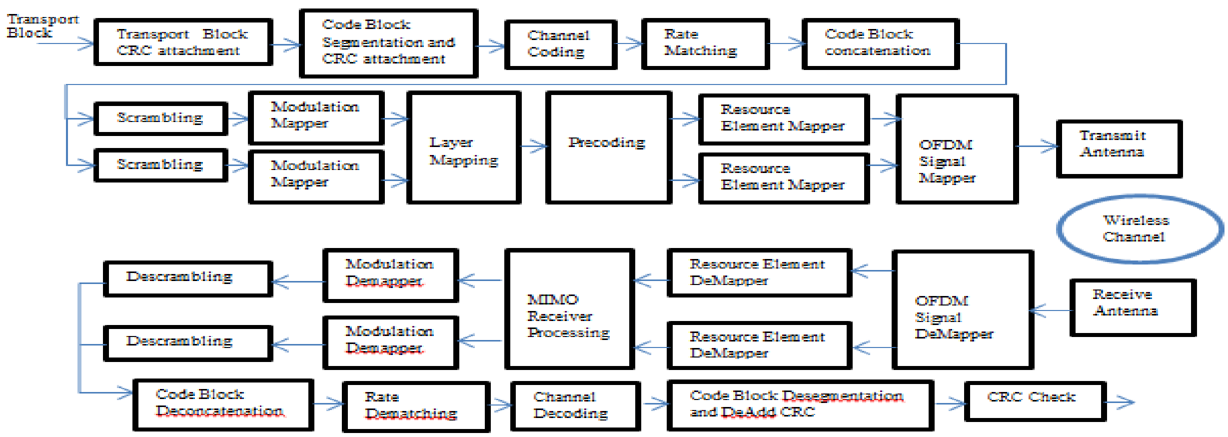


FIG: 5.1 Block diagram of PDSCH Transceiver

Transport block CRC attachment:

A cyclic redundancy check (CRC) is used for error detection in transport block. The entire transport block is used to calculate the CRC parity bits and these parity bits are then appended to the end of transport block.

Code block segmentation and CRC attachment:

In LTE, a minimum and maximum code block size these block sizes supported by the turbo interleaver. Minimum code block size is 40 bits and maximum code block size is 6144 bits. The input block is segmented when the input block is greater than the maximum code block size.

Channel coding:

The channel coding scheme for PDSCH adopts Turbo coding, which is a robust channel coding. The coding rate of turbo encoder is 1/3.The code blocks undergo turbo coding which is a form of forward error correction that improves the channel capacity by adding redundant information. The turbo encoder scheme uses a Parallel Concatenated Convolutional Code (PCCC) with two recursive convolutional coders and a contention-free Quadratic Permutation Polynomial (QPP) interleaver.

Rate Matching:

The main task of the rate matching block is to create an output bit stream to be transmitted with a desired code rate. The Hybrid Automatic Repeat Request (HARQ) error correction scheme is incorporated into the rate-matching algorithm of LTE.

Code Block Concatenation:

In this stage, the rate matched code blocks are concatenated back together. This task is done by sequentially concatenating the rate-matched blocks together to create the output of the channel coding.

Scrambling:

The codewords are bit-wise multiplied with an orthogonal sequence and a UE-specific scrambling sequence to create the following sequence of symbols for each codeword.

Modulation:

The scrambled codewords undergo modulation using one of the PDSCH modulation schemes QPSK, 16 QAM, 64 QAM, resulting in a block of modulation symbols.

Layer Mapping:

The modulation symbols are mapped to one, two, or four layers depending on the number of transmit antennas used. There are mainly two kinds of layer mapping, one for transmit diversity and the other for spatial multiplexing. If transmit diversity is used, the input symbols are mapped to layers based on the number of layers. In the case of spatial multiplexing, the number of layers used is always less or equal to the number of antenna ports used for transmission of the physical channel.

Precoding:

Symbols on each layer will be pre-coded for transmission on the antenna ports according to different modes of transmission, which are spatial multiplexing, transmit diversity, and single antenna port transmission.

Mapping to Resource Elements:

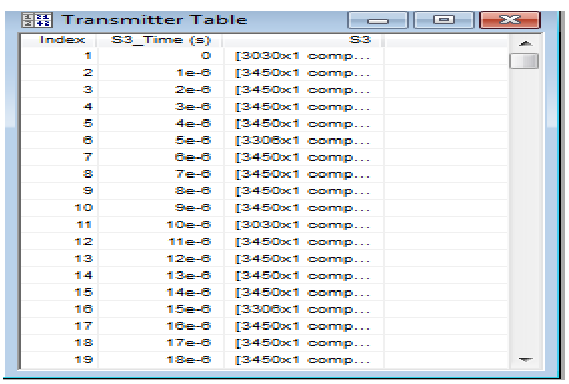
The block of complex valued symbols, are mapped in sequence to resource elements not occupied by the other physical downlink channels except PDSCH, or synchronization and reference signals.The number of resource elements are mapped together to the resource block which is allocated to PDSCH.

TABLE I
PDSCH TRANSMIT DIVERSITY THROUGHPUT SIMULATION CONFIGURATION

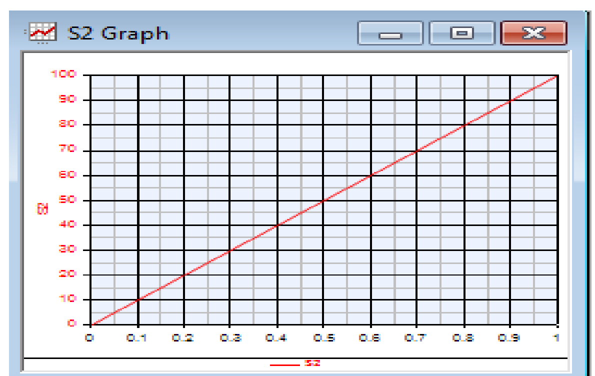
Code word	Single
Transmission Scheme	Transmit Diversity
Number of Transmitters	4
HARQ	8 HARQ retransmission processes
Reference Measurement Channel (RMC)	R12
Number of Frames	10 (first simulation) and 20 (second simulation)
Number of Receivers	2
Multi-antenna Correlation	Medium
Propagation Channel	Extended Pedestrian A (EPA 5)
Signal to Noise Ratio (SNR) Range	[-5.8, -4.6, -3.4, -2.2, -1.2, 0.2, 1.2, 2.2, 3.4, 4.6]

6.RESULT ANALYSIS :

SYSTEM VUE DESIGN : DOWNLINK TRANSMITTER (FLOW TABLE)


Transmitter Table

Index	S3_Time (s)	S3
1	0	[3030x1 comp...
2	1e-6	[3450x1 comp...
3	2e-6	[3450x1 comp...
4	3e-6	[3450x1 comp...
5	4e-6	[3450x1 comp...
6	5e-6	[3306x1 comp...
7	6e-6	[3450x1 comp...
8	7e-6	[3450x1 comp...
9	8e-6	[3450x1 comp...
10	9e-6	[3450x1 comp...
11	10e-6	[3030x1 comp...
12	11e-6	[3450x1 comp...
13	12e-6	[3450x1 comp...
14	13e-6	[3450x1 comp...
15	14e-6	[3450x1 comp...
16	15e-6	[3306x1 comp...
17	16e-6	[3450x1 comp...
18	17e-6	[3450x1 comp...
19	18e-6	[3450x1 comp...



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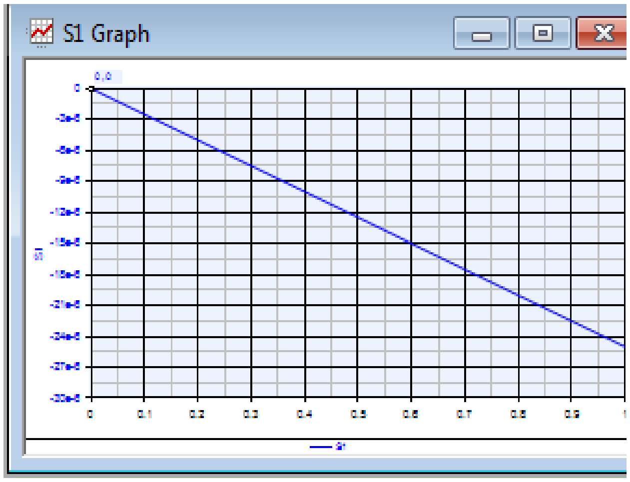

S1graph->BER

S2graph->THROUGHPUT

SIMULATION RESULTS AND ANALYSIS :

Simulations are performed by using KEYSIGHT SYSTEM VUE and Throughput and Bit Error Rate can be performance results are analysed by downlink transceiver .

CONCLUSION :

Thus simulations results are obtained by using KEYSIGHT SYSTEM VUE .further analyzed the performance of Throughput, Bit Error Rate, Spectrum Efficiency,are measured .further work can be done by carrying out a various downlink LTE transceiver by using different SNR values.

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