LTE MODEL AND ITS OPERATION: A SURVEY

Showkat Ahmad Bhat, Amandeep Singh*

School of Electronics and Electrical Engineering Lovely Professional University Phagwara, Punjab
Email: amandeep.17403@lpu.co.in

Abstract:

The continuous plan and institutionalization of the fifth generation (5G) new radio (NR) will empower new utilize cases and applications, forcing all the more difficult necessities as far as portability execution. For instance, 5G portable systems should bolster consistent portability with zero information interference at every handover, even at high speeds. This thesis studies about the different techniques used for efficient image transmission over LTE network under different fading channels. By studying different techniques at each stage of image transmission, the intention is to find the optimum techniques which can enhance the implementation of image transmission over LTE system. Image segmentation is first stage in image transmission, in which the image is broken into segments. The second stage is encoding where different codes can be used. Interleaving is the third step where block interleave, chaotic inter-leaver are used. The fourth step is modulation where the interleaved data blocks are modulated with the carrier signal. The modulation schemes like QPSK, BPSK and QAM can be used for the image transmission over the LTE.

1. INTRODUCTION

Digital imaging is broadly employed in different field like medical, multimedia, biometric, and weather forecasting …etc. in several cases images are to be transmitted to receiver station through wireless communication to perform desired processing of the image. While image acquisition and transmission, there are several factors which degrades the image quality like channel interference, additive noise. Image de-noising method makes an attempt to cut back or eliminate the noise. De-noising could be a difficult process from an image corrupted with additive white Gaussian noise (AWGN). Certain parameters like noise variance and mean are useful to eliminate the noise efficiently from the received image or data. MIMO channels employ multipath propagation offers critical increment in data throughput and range of the communication is increased without any increase in bandwidth requirement and transmit power of signals. MIMO channels provide high data rates which make image transmission possible over LTE network with high unwavering quality[1]. Several image processing and channel coding techniques are used to maintain the quality of the transmitted image from transmitter to receiver

2. LTE Downlink and Uplink Channel Model

The series of information signal processing operations carried out on the downlink channel can be summed up in ordered sequence of transport layer and physical channel operations[2]. The operations are totally given and determined in 3GPP reports depicting the multiplexing techniques and the channel coding and physical channels and regulations. The series of operations carried out on the DLSCH and PDSCH can be represented by the channel model as shown below in Fig.1 and are summed up as follows :

o CRC (Transport block Cyclic Redundancy) code generator
o Code block – Turbo coding with code rate of one-third
o Bit level scrambling of coded bit stream
o Modulation of the scrambled data stream for transmission on the channel ports
o OSTBC Encoder is used for implementing the MIMO for improving the performance of the system

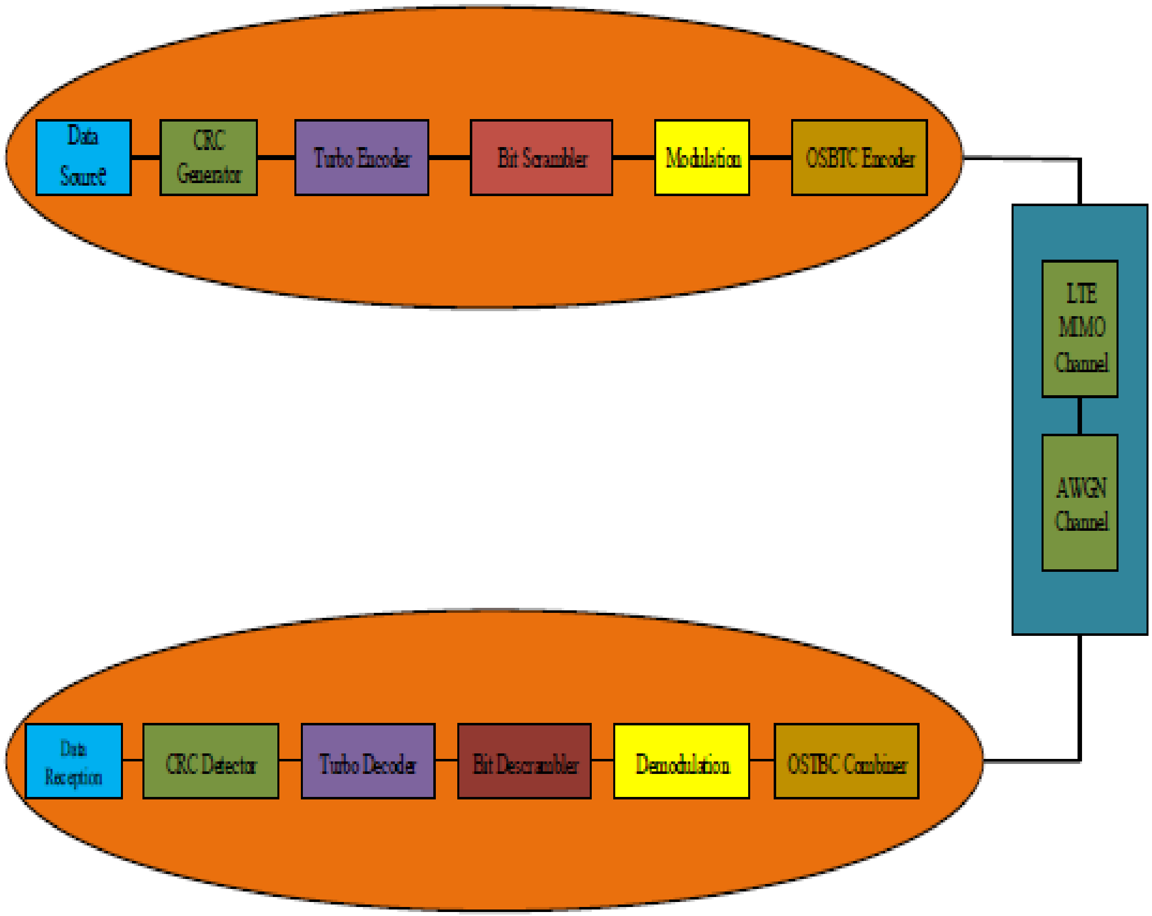

Fig.1 DLSCH AND PDSCH Channel Model

2. Air Interface

In LTE the utilization of OFDM gives critical focal points over option different access advances and flags a sharp takeoff from the past[3]. LTE permits better channel estimation to be performed in the versatile, permitting auspicious inputs vital for connecting adjustments to be given to the base station. Some propelled types of transmission multiplexing join recurrence and time division approaches like OFDM or CDMA. It is typically utilized with a radio transmitter or radio recipient.As flown in figure below.

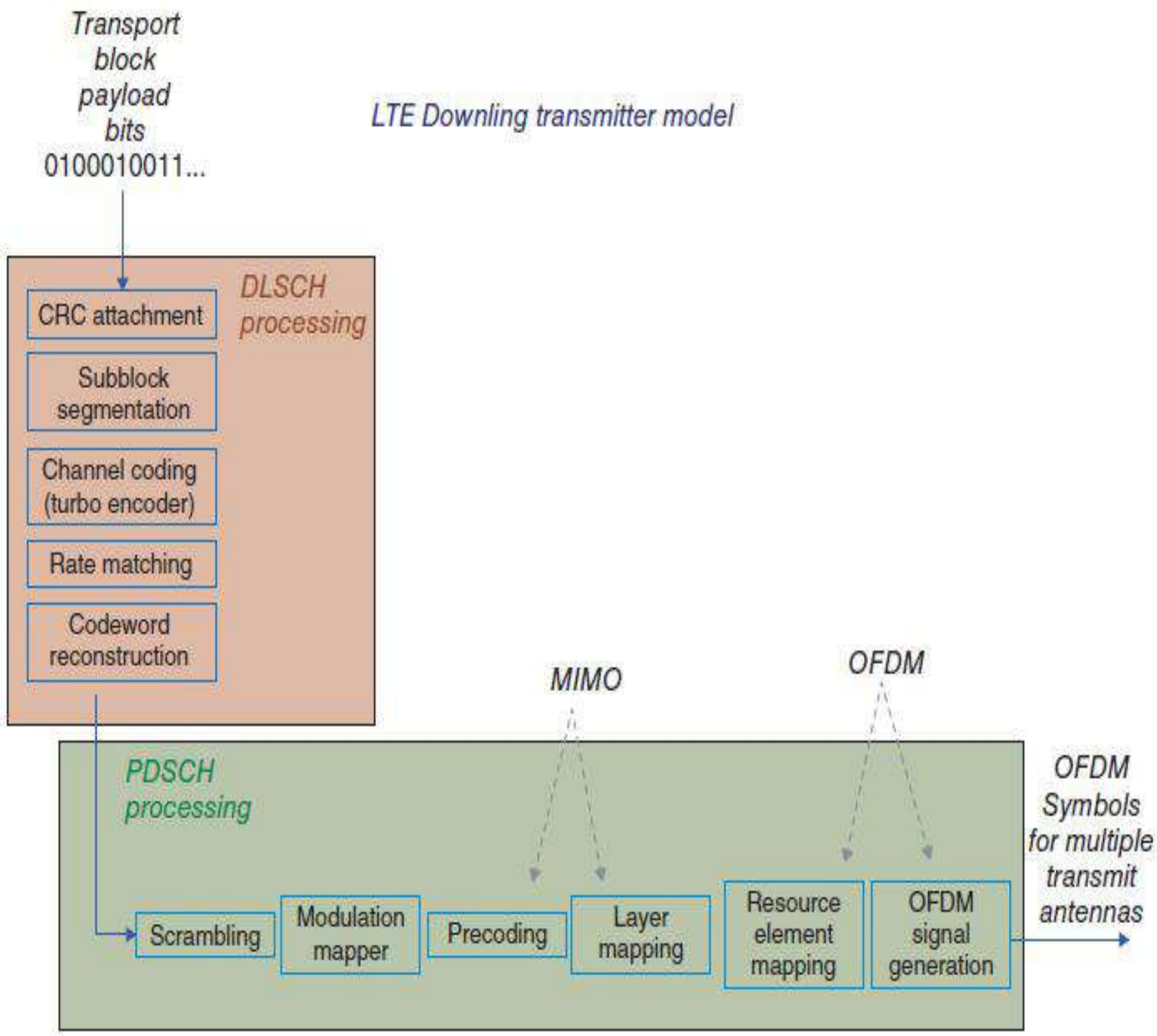

Fig. 2 Physical Layer Specifications in LTE

3. Frequency Bands

The LTE gauges indicate the accessible radio spectra in various recurrence groups. One of the objectives of the LTE benchmarks is consistent joining with past portable frameworks. In that capacity, the recurrence groups effectively characterized for past 3GPP gauges are accessible for LTE sending[4-5].

Notwithstanding these normal groups, a couple of new recurrence groups are likewise presented without precedent for the LTE detail. The controls overseeing these recurrence groups change between various nations. Thusly, it is possible that not only one but rather a significant number of the recurrence groups could be sent by any given specialist organization to make the worldwide meandering instrument substantially simpler to oversee. Discharge 11 of the 3GPP details for LTE demonstrates the farreaching rundown of ITU IMT Advanced (International Telecommunications Union International Mobile Telecommunication) recurrence groups.

Table 1 Paired frequency bands defined for E-UTRA

Operating Band Index	Uplink (UL) operating band frequency range(MHz)	Downlink (DL) Operating band frequency range(MHz)	Duplex Mode
1	1920–1980	2110–2170	FDD
2	1850-1910	1930-1990	FDD
3	1710-1785	1805-1880	FDD
4	1710-1755	2110-2155	FDD
5	824-849	869-894	FDD
6	830-840	875-885	FDD
7	2500-2570	2620-2690	FDD
8	880-915	925-960	FDD
9	1749.9–1784.9	1844.9–1879.9	FDD
10	1710–1770	2110–2170	FDD
11	1427.9–1447.9	1475.9–1495.9	FDD
12	699–716	729–746	FDD
13	777–787	746–756	FDD
14	788–798	758–768	FDD
15	Reserved	Reserved	FDD
16	Reserved	Reserved	FDD
17	704–716	734–746	FDD
18	815–830	860–875	FDD
19	830–845	875–890	FDD
20	832–862	791–821	FDD
21	1447.9–1462.9	1495.9–1510.9	FDD
22	3410–3490	3510–3590	FDD
23	2000–2020	2180–2200	FDD
24	1626.5–1660.5	1525–1559	FDD
25	1850–1915	1930–1995	FDD

Table 2 Unpaired frequency bands

Operating band index	UL and DL operating band freq. range (MHZ)	Duplex Mode
33	1900-2000	TDD
34	2010–2025	TDD
35	1850–1910	TDD
36	1930–1990	TDD
37	1910–1930	TDD
38	2570–2620	TDD
39	1880–1920	TDD
40	2300–2400	TDD
41	2496–2690	TDD
42	3400–3600	TDD
43	3600–3800	TDD

4 OFDM Multicarrier Transmission

UMTS suffers from the problem of multipath fading; to solve this problem in LTE OFDM is used for downlink. OFDM increases the band width efficiency of the system by multiplexing large number of 180 KHZ narrow sub-carriers for data transmission from multiple users on the same channel from eNodeB to the terminal[6]. OFDM is employed as a digital modulation scheme in LTE. OFDM having features like spectrum flexibility, efficient bandwidth utilization and cost efficiency makes it the best multiplexing technique to be used in LTE. The symbols used in OFDM have been categorized into resource blocks of 180 KHZ size in frequency domain and 0.5ms in time domain. There are two slots used for each 1ms interval.

OFDM depends on the outstanding procedure of FDM. FDM has diverse surges of data are mapped onto isolate parallel recurrence channels. Every FDM channel is isolated from the others by a recurrence watch band to decrease impedance between neighboring channels. The OFDM conspire varies from conventional FDM in the accompanying interrelated ways:

1. Multiple transporters (called subcarriers) convey the data stream,
2. A watch interim is added to every image to limit the channel postpone spread and intersymbol impedance.
3. The subcarriers are orthogonal to each other

5. Bandwidth Allocation

The IMT-Advanced rules needs range adaptability in LTE standard. That prompts versatility in the recurrence space, which is showed by a rundown of range portions running from 1.4 to 20MHz. The recurrence spectra in LTE are framed as links of asset squares comprising of 12 subcarriers. As these carriers are isolated by 15 kHz, the aggregate transfer speed of an asset square is 180 kHz. This empowers transmission transfer speed arrangements of from 6 - 110 asset obstructs over a solitary recurrence transporter, that clarifies how the multicarrier transmission character of the LTE standard takes into account channel data transmissions going from 1.4 - 20.0 MHz in ventures of 180 kHz, enabling the required range adaptability to be accomplished. Table 4.3 shows the connection between the channel data transmission and the power transmitted over an LTE RF bearer. For transfer speeds of 3– 20 MHz, the totality of asset hinders in the transmission data transfer capacity involves around 90% of the channel transmission capacity. On account of 1.4 kHz, the rate drops to around 77%.

Table 3 Channel bandwidths specified in LTE

Channel Bandwidth (MHz)	Number of Resource Blocks
1.4	6
3	15
5	25
10	50
15	75
20	100

Under the LTE standard, the DL transmission depends on OFDM plot and the UL transmission depends on a firmly related philosophy called SC-FDM. OFDM is a multicarrier transmission approach which speaks to the broadband transmission transfer speed as an accumulation of numerous narrowband subchannels. There are numerous means engaged with OFDM flag age. To begin with, regulated information is mapped on to the asset framework, where they are sorted out and adjusted in the recurrence space. Each balanced image ak is doled out to a solitary subcarrier on the recurrence hub.

6. Multiple Input Multiple Output (MIMO)

MIMO wireless channels state explicitly the relation between information signals transmitted through numerous transmit antennas and information signals received at multiple antennas[7]. The number of multiple paths depends upon the number of transmitter (numTx) and receiver (numRx) antennas given by (numTx * numRx). For any given combination of receiver and transmitter antennas, the relation is expressed by scalar gain value called channel path gain. The different values of channel gains form a channel matrix H, with dimensions of (numTx, numRx). Linear equations describe the relationship between transmitted signal, received signal and the channel matrix. Consider a corresponding communication system, where from N transmitters we have to send N signals all the while. For instance, in a communication system, at every time slot t, signal Ct,n, n = 1,2

,3, … N are transmitted at the same time from N transmit antennas. The transmitted data signals travels through different channel to the every of the M receivers. Output from every channel is linear superposition of faded input signals by noise in the channel.

7. Space-Time Block Coding (STBC)

Space-time block coding procedure has been actualized in current situation of wireless communication system[8],[9]. STBC joins modulation, coding and uses multiple antennas at both terminals. The fading which occurs in wireless communication channels can be reduced by using MIMO system. MIMO system increases the capacity of the system. Data rates can be improved by utilizing higher order modulation schemes. By expanding the quantity of transmitter and receiver antennas yield more performance improvement and gives diverse advantages to MIMO system with reduced complexity. Therefore, Orthogonal Space- Time Space Time Block Coding (OSTBC) scheme is utilized in that principle of orthogonality has to be used among the signals by every transmitter antenna, which made signal detection linear and also signals are decoded independently and thus makes encoding less complex. OSTBC increases data rates and reduces the complexity of the decoder.

8. LTE MIMO behavior with 4QPSK

The BER and SNR analysis of LTEMIMO system model is performed for 4QPSK Modulation technique with Turbo coding over AWGN and MIMO fading channels using Orthogonal Space Time Block Coding (OSTBC) structure. Signal quality analysis after reconstructed at the receiver is done for signal types: Audio and image signals by adding noises like Salt and Pepper noise and AWGN noise in increasing amounts at different EbNo values. The plots drawn represent the BER and SNR and energy per (EbNo) bit got from the LTEMIMO channel with the theoretical calculated results of the LTE MIMO channel. This LTE gives equivalent performance for both the signal types.

9. Conclusion

MIMO channels provide high data rates which make image transmission possible over LTE network with high unwavering quality. Several image processing and channel coding techniques can be used to maintain the quality of the transmitted image from transmitter to receiver. In this thesis we will perform the transmission of different kind of digital images over LTE MIMO channel by using different image and data processing techniques at both transmitter and the receiver side to reconstruct the original image transmitted from transmitter. An image can be imported in the transmitter and different types of noises can be added to the image and then converted into binary data stream. Then the various signal processing operations are performed on the bit stream like CRC attachment, turbo coding, and 4QPSK modulation and then spatially multiplexed into parallel data streams to be transmitted over LTEMIMO channels. The amount of power transmitted by each antenna depends upon the data to be transmitted by the antenna.

[1] J. Zyren, "Overview of the 3GPP Long Term Evolution Physical Layer," Evolution (N. Y)., 2007.
[2] B. L. McNaughton and R. G. M. Morris, "Hippocampal synaptic enhancement and information storage within a distributed memory system," Trends in Neurosciences. 1987.
[3] E. Dahlman, S. Parkvall, and J. Skold, 4G: LTE/LTE-Advanced for Mobile Broadband. 2013.
[4] A. Ghosh, R. Ratasuk, B. Mondal, N. Mangalvedhe, and T. Thomas, "LTE-advanced: Next-generation wireless broadband technology," IEEE Wirel. Commun., 2010.
[5] S. Sesia, I. Toufik, and M. Baker, LTE - The UMTS Long Term Evolution: From Theory to Practice. 2009.
[6] D. Astély, E. Dahlman, A. Furuskär, Y. Jading, M. Lindström, and S. Parkvall, "LTE: The evolution of mobile broadband," IEEE Communications Magazine. 2009.
[7] H. Holma and A. Toskala, LTE for UMTS - OFDMA and SC-FDMA based radio access. 2009.
[8] K. Doppler, M. Rinne, C. Wijting, C. B. Ribeiro, and K. Hug, "Device-to-device communication as an underlay to LTE-advanced networks," IEEE Commun. Mag., 2009.
[9] G. Araniti, C. Campolo, M. Condoluci, A. Iera, and A. Molinaro, "LTE for vehicular networking: A survey," IEEE Commun. Mag., 2013.