ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: https://doi.org/10.29121/granthaalayah.v7.i7.2019.771

INTERNATIONAL JOURNAL OF RESEARCH – GRANTHAALAYAH
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Science

BIT ERROR RATE ANALYSIS IN DIFFERENT TERRAINS FOR LTE

Dilshad Mahjabeen [1], Moshiur Rahman Tarafder [1], T Saikat Ahmed [1]
[1] Electrical and Electronic Engineering, Stamford University Bangladesh, Bangladesh

Abstract

Focus of this paper is mainly evaluating the performance of Long Term Evolution (LTE) system in different terrains such as urban, suburban and rural area. The performance parameters such as, Bit Error Rate (BER) and the Data Throughput are reported in terms of Signal to Noise Ratio (SNR). The system parameters taken into consideration are signal to noise ratio (SNR), number of receiving antenna (RxAn), reference channel and duplex mode. All of the simulations were performed in MATLAB, version 2014a simulink. The results are presented in table and graph which gives clear idea of the effect of environment on signal and receiver sensitivity. Also bit-error-rate, an important parameter in case of receiving signal, is analyzed with respect to SNR values. A comparative analysis of bit-error-rate is performed between three areas for same conditions which proves that LTE signal is well suited in a rural area than that of a suburban and urban area.

Keywords: BER; SNR; Throughput; Different Component; Formatting; Style; Styling; Insert.

Cite This Article: Dilshad Mahjabeen, Moshiur Rahman Tarafder, and T Saikat Ahmed. (2019). “BIT ERROR RATE ANALYSIS IN DIFFERENT TERRAINS FOR LTE.” *International Journal of Research - Granthaalayah*, 7(7), 331-339.

1. Introduction

Long Term Evolution (LTE), the fourth generation of mobile technology, is a wonder for mobile communication. LTE delivers high speed transfer rates (up to 300Mbit per second), downloads the files faster, provides increased capacity, experiences low power consumption and smooth handover. Spectral efficiency, flexible bandwidth usage and cell breathing phenomena of LTE ensure reliable and enriched mobile communication. All IP network architecture, packet switched operations, use of MIMO antenna technology, use of SC-FDMA and OFDMA in uplink and downlink respectively, effective channel resource utilization, low handover latency features of LTE proves itself superior than other mobile technology. It supports data as well voice [1,2].

In the race of high speed for mobile subscriber, LTE offers fastest speed than other 4g wireless communication. Long Term Evolution (LTE) is the latest high speed 4G technology introduced in 2010 by AT & This standard is developed by 3GPP and is specified in its release 8 series. LTE is the best technology from 1G, 2G and 3G. First generation (1G) introduced in 1980 was based on

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: 10.5281/zenodo.3364435

analog technology. In it, signal is modulated to higher frequency, approximately 150 MHz and up. Its speed is so less.

To overcome the drawback of analog low speed 1G, 2G came into picture in 1991 based on digital technique.2G technologies can be divided into TDMA (Time Division Multiple Access) based and CDMA (Code Division Multiple Access) based depending upon the type of multiplexing used. The main 2G standards are GSM, IS-95, PDC, D-AMPS and IS-136.The main disadvantage was that some digital signals may be weaker enough to reach the cell tower. Its data rate is less. To increase its speed, 2.5G i.e. **GPRS** *(General Packet Radio Service)* came into existence. It has packet switched domain with circuit switched domain. After 2.5G, the technology moved to 3G in 2000 offering faster data transmission speeds, divergent data transfer rate, greater network capacity and more advanced network services. It uses packet switching for data transmission and turbo codes for error correction.3G technologies are CDMA2000, UMTS etc. The frequency band used in 3G is 1.5-2.8 GHz. In it, peak upload rate is 5 Mbps and download rate is 100 Mbps. In it, video conferencing and other high quality services can be used. But wider bandwidth was not available in it.

Now data transmission is becoming more and more popular than voice calls. After 3G, 4G is specially designed for data transmission rather than voice. LTE is 4G technology with WiMAX introduced in 2010. LTE is termed as “MAGIC-Mobile multimedia, anytime anywhere, Global mobility support, and customized personal service”. LTE supports peak download rate of 1 Gbps and upload rate of 500 Mbps. It uses packet switching and message switching. It uses concatenated codes for error correction. Its frequency band is 2-8 GHz. For wider bandwidth to get access to multimedia, video conferencing, full motion video, uninterrupted global roaming and easy access to all the services, it is needed. We can easily watch streaming videos, games, location services, chat, online stores, information, entertainment etc. using LTE. So, it was the need of LTE [3]

One of the magic stick behind the high speed and quality data and signal transmission by LTE is the reduced possibility of error launched in the medium. During the transmission of data over a data link, there is every possibility of being corrupted by errors introduced into the system. In consequence, the integrity of the system may be compromised. To maintain the quality of the signal, it is necessary to assess the performance of the system, and bit into the system. In consequence, the integrity of the system may be compromised. To maintain the quality of the signal, it is necessary to assess the performance of the system, and bit error rate (BER), provides an ideal way in which this can be achieved. BER is defined as the rate at which errors occur in a transmission system. It is the number of bit errors per unit time. The bit error ratio is the number of bit errors divided by the total number of transferred bits during a prescribed time interval. This key parameter is used to

1) Assess systems that transmit digital data from one location to another.
2) Assess the full end to end performance of a system including the transmitter, receiver and the in between medium.
3) Help in enabling the actual performance of a system in operation.

For better medium between the transmitter and receiver, the signal to noise ratio is high, then the bit error rate will be very small and insignificant [4]. On the other hand, in presence of noise, the bit error rate will need to be considered. In this paper, bit error rate analysis is performed for LTE

4G network in urban, suburban and rural area by simulation MATLAB simulink. In this paper section II highlights some related works done previously very much linked with this work, their considerations and their observed inferences. Section III, IV and V mention the system model, mathematical model and system set up. Various simulation criteria are described in section VI. Section VI also analyzes the results and comparative study of BER for three different areas.

2. Related Works

This section discusses about the recent research techniques that were published in different reputed journals. Elfatihi et al. [5] have simulated the Bit Error Rate (BER) For LTE 4G network Reena et al. [6] have investigated the performance analysis of LTE-A networks in different transmission modes using 16-QAM, under different fading channels with different antenna correlation conditions. Poornima et al. [7] have analyzed a numerical evaluation of the performance of MIMO radio systems in the LTE network environment. Pranay et al. [8] have evaluated the performance of Long-Term Evolution (LTE) Downlink system under Urban Microcell Scenario for different MIMO transmission schemes.

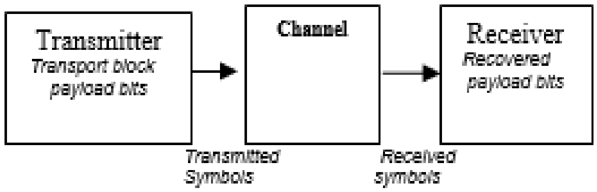
Table 1: Contribution of Recent Works

Authors	Considerations	Inferences
Elfatihi et al [5]	Parameters are AWGN, Fading, Bandwidth, cycle prefix and Maximum Doppler shift key.	the bit error rate decrease as the signal to noise, band width and cycle prefix increased while the bit error rate increase was Doppler frequency increased and signal. bit error rate decrease of AWGN only compared
Reena et al [6]	Single Input Multiple Output (SIMO), Transmit diversity, Open and Closed Loop Spatial Multiplexing and it is carried out for 2×2 and 4×4 antenna configuration.	the bit error rate decrease as the signal to noise
Poornima et al [7]	two OSTBC diversity MIMO schemes; namely the 2 × 1 SFBC-OFDM and the 4 × 2 FSTD-OFDM in the 3GPP 5 MHz Long Term Evolution (LTE) system over a ayleigh flat fading channel by the LTE norm as a function of the signal to noise ratio.	throughput almost reaches to the capacity limit
Pranay et al [8]	A 2X2 MIMO LTE Downlink is developed using various building Blocks using Agilent's System Vue and its Channel Builder tools.	Error rate of is generally better at low SNRs (<8dB).

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: 10.5281/zenodo.3364435

3. System Model

The system model is composed of a transmitter, a channel model, and a receiver shown in figure 1.



The processing chain in the transmitter is specified in detail by the standard. The standard also specifies various channel models for performance evaluations. The receiver operation provides the opportunity for various system designers to distinguish their implementation with distinct performance profiles.

4. Mathematical Expression

The basic equation for signal power and bit rate [9] is

$$\frac{S}{R_b} = E_b \qquad (1)$$

Where,
R_b= bit rate in bits/second
E_b = Energy per bit in Joules/bit
S = Total Signal power in Watts
Introducing the noise power N_0 in equation (1)

$$\frac{E_b}{N_o} = \frac{S}{R_b N_o}$$

$$SNR = \frac{R_b E_b}{N_o} \qquad (2)$$

This equation implies that the SNR will be more than E_b/N_0 by a factor of R_b (if $R_b > 1$ bit/second).Increasing the data rate will increase the SNR, however , increasing R_b will also cause more noise and noise term also increases (due to ISI – inter symbol interference , since more bits are packed closer and sent through the channel).

5. System Set Up

The simulations were carried out in TS36.101. Three different test modules were established by considering various parameters. To analyze performance, test modules are divided into urban area, sub Urban area and rural area on the basis of following considerations:

- Signal to Noise Ratio (SNR)
- Number of receiving Antenna ((RxAn)

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- Reference Channels
- Duplex Mode

All of the simulations were performed in MATLAB, version 2014a simulink.

6. Simulation Parameters

The key system parameters are tabulated below in TABLE II.

Table 2: Simulation Parameters

Parameters	**Values**
Reference Channel	R.11
Duplex Mode (variable)	FDD
Transmission scheme	Tx Diversity
PDSCH RHO (Resource power allocation)	-3
Propagation model (Delay profile)	EPA
Doppler (Hz)	5
Antenna Correlation	Low
No. of receiving antennas	2/4
SNR (dB)	0-18 dB
Simulation Length (Frame)	5
No. of HARQ process	8/7
Perfect Channel Estimation	Yes
PMI Mode	Wideband
Simulation Result	Sim Result

7. Results and Discussion

In this paper throughput and bit error analyses are performed for three different terrains such as
1) Urban area
2) Suburban area
3) Rural area

Table III contains the result of throughput analysis and Bit-Error-Rate with different parameters of urban, suburban and rural area.

Result of Throughput Analysis and Bit-Error Rate of Urban, Suburban and Rural Area with RxAn-2

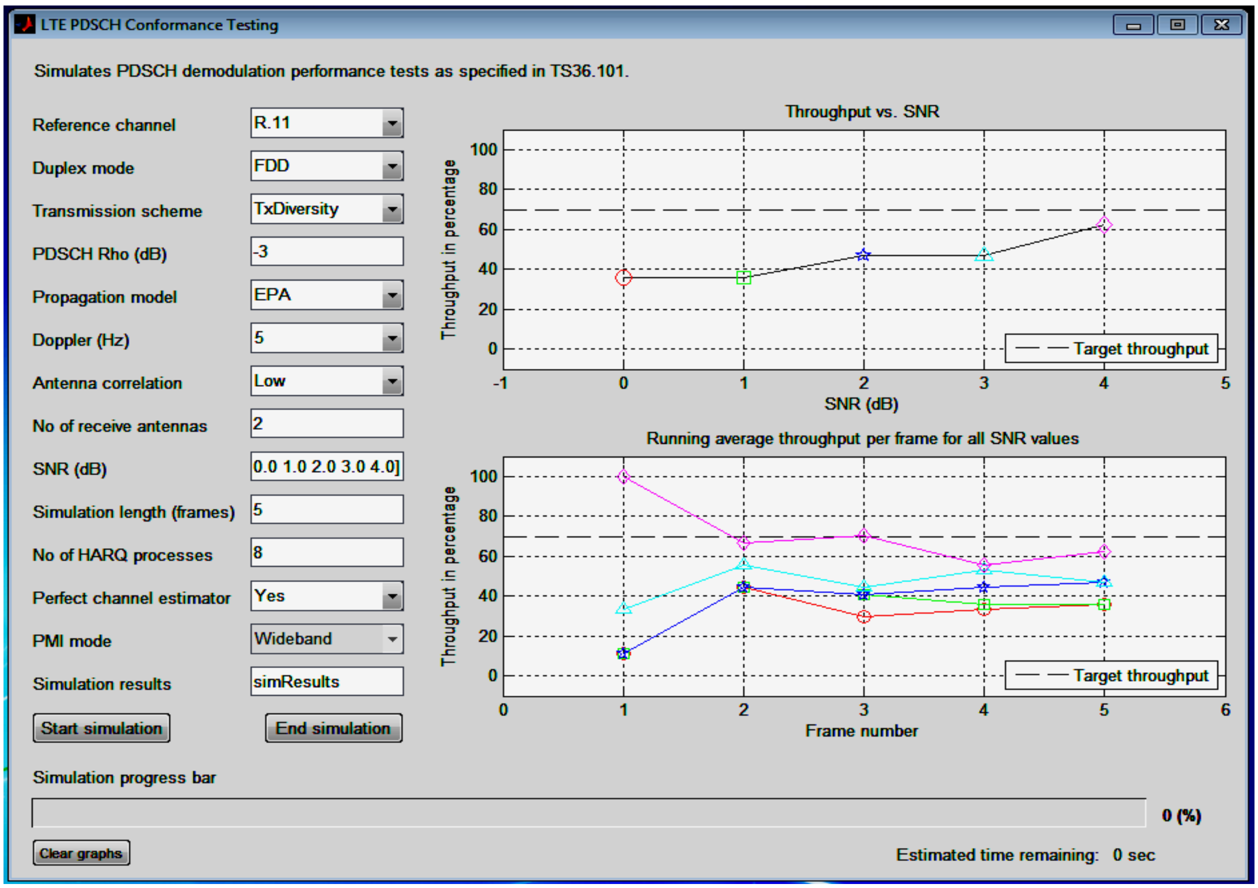
Terrains	**Duplex Mode**	**SNR**	**Receiving Antenna- 2**	
			Throughput (%)	**BER**
Urban	FDD	0.0	17.78	0.2321
		1.0	28.89	0.2079
		2.0	28.89	0.1842
		3.0	46.67	0.1610

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: 10.5281/zenodo.3364435

		4.0	46.67	0.1310
Suburban	FDD	5.0	68.89	0.1164
		6.0	100.00	0.0953
		7.0	100.00	0.0758
		8.0	100.00	0.0580
		9.0	100.00	0.0425
Rural	FDD	10.0	100.00	0.0287
		11.0	100.00	0.0157
		12.0	100.00	0.0145
		13.0	100.00	0.0053
		14.0	100.00	0.0037

Urban Area

The following figures refer to the simulation of throughput analysis on urban areas.



Simulation of throughput analysis of LTE PDSCH on Urban area at RxAn-2

The two graphs in Fig.1. represent SNR vs. Throughput and Average Throughput per frame respectively where SNR limit is set to 0 dB to 5 dB.

ISSN- 2350-0530(O), ISSN- 2394-3629(P)
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Suburban Area

The following figures represent simulation of throughput analysis of LTE in suburban areas.

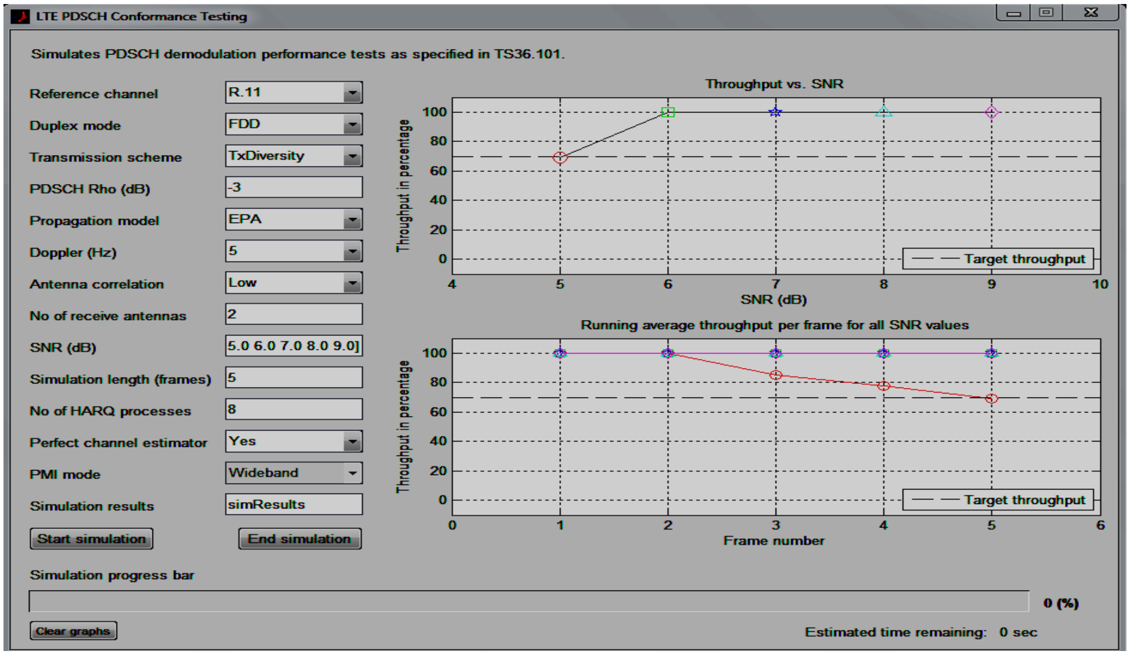

Figure 2: Simulation of throughput analysis of LTE in a suburban area

Suburban Area

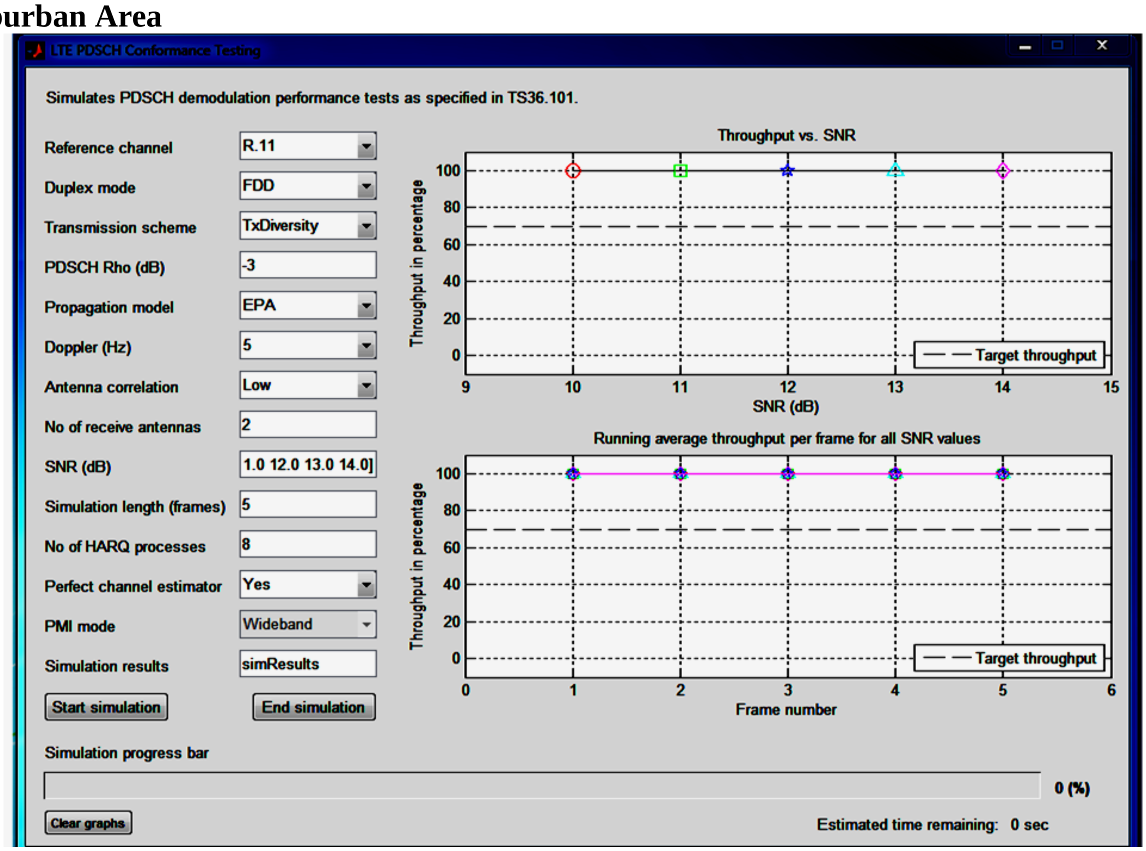

Figure 3: Simulation of throughput analysis of LTE in a rural area.

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
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Figure 3 shows the throughput of LTE in the rural condition. In a rural area, there is almost no obstacle, as a result the chances of reflection of the signal is about zero. So the throughput is 100% and the received signal is almost same as the transmitting signal.

In the above figures it is found that for a particular value of SNR, goes higher, throughput increases exponentially. In other words, As SNR decreases, the throughput will decrease exponentially. After certain values of SNR, throughput becomes maximum. Highest throughput means higher quality performance without noise. Throughput analysis also gives a clear view of Bit-Error-Rate within different atmospherical condition.

BER vs SNR for Three different terrains

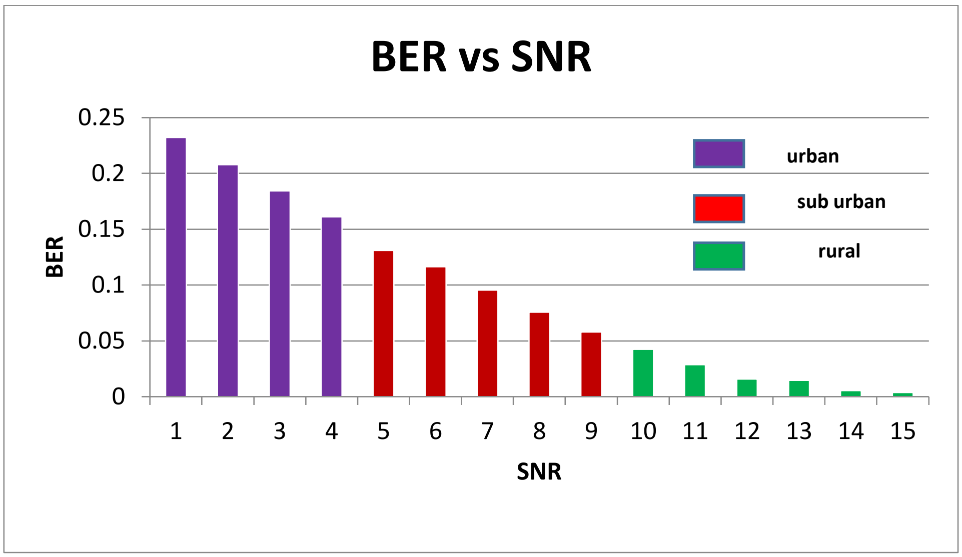

Figure 4: Graphical representation SNR vs. BER of a rural area

Figure 4 shows the inverse proportionality of Bit-Error-Rate (BER) with SNR for urban, suburban and rural area i.e. with increasing value of SNR, BER is being decreased which is very similar to ideal condition [Ref. Proakis}. In Figure 4, for urban area , when SNR is minimum (0 dB), BER is maximum (0.23), again at the maximum point of SNR the BER is reduced to 0.13, giving a reduction of 0.10, yet it's very high for a good quality of signal and cause an weak signal in the receiver. For sub urban area, the lowest error rate is 0.0425 at SNR 9 dB . Here, in suburban area the signal quality is better than urban area with only two receiving antennas whereas for urban with two receiving antennas the throughput and BER were 46.67% and 0.1380 respectively at SNR 5 dB. Again in rural area condition, bit-error-rate is less than 0.005, which is theoretically equal to 0. As a result, an ideal state can be obtained from this simulation. From the above observation it is clear that, the effect of environment on signal and receiver sensitivity play an important role on transmitting signal. Bit-Error-Rate, is very lower rate in rural areas. Lower BER gives an excellent indication of the performance of a wireless system. After comparing all of the conditions, LTE signal is well suited in a rural area than that of a suburban and urban area because of the less congestion and obstacles.

 ISSN- 2350-0530(O), ISSN- 2394-3629(P)
DOI: 10.5281/zenodo.3364435

8. Conclusion

The bit error rate and throughput analysis of LTE network for different simulator parameters have been done in terms of tables and graphs using MATLAB software against signal to noise ratio in different terrains. The result shows that bit-error-rate is very lower in rural areas than other two areas.

The signal quality of other areas can be improved by increasing the sensitivity of receiver, hence by increasing the number of receivers. Further work will focus on bit-error-rate analysis based on different modulations schemes in different terrains.

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*Corresponding author.
E-mail address: dmahjabeen.1978@ gmail.com/ tarafder_ece@ yahoo.com/ shaikatsrabon33@ gmail.com