

# International Journal of Innovative Research in Science, Engineering and Technology

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## Simulative Investigations of Detrimental Effects of Channel Conditions on LTE-A

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**ABSTRACT:** Abundant operators worldwide have commercially flung Long Term Evolution (LTE) and LTE-Advanced (LTE-A) networks in latest few years. Now, further than release 10, the 3<sup>rd</sup> GPPP is deliberating additional evolution. By providing the greater bandwidth, steep peak data rate, advanced efficiency, future broadband services and countless more features attracts many users towards LTE and LTE-A. The main objective of this paper is to estimate and validate the performance of LTE-A mobile systems under diverse circumstances by taking different model types as well as correspondingly penetration losses i.e. in indoor, outdoor, incar, deep indoor. We have also considering the macroscopic pathloss model environment i.e. urban and rural. In particular, we describe our paper by elaborating crucial details of each of penetration losses and fluctuations in the results.

**KEYWORDS:** LTE-A, Indoor, Deep Indoor, Incar, Outdoor, Urban, Rural.

### I. INTRODUCTION

In command to augment the capability of contemporary cellular systems and fulfill the provision difficulties of future user submissions, mutually the mobile production and the investigation communal are functioning on the regularization of the fourth group of wireless technology mentioned as Long Term Evolution (LTE) [1]. Wireless data procedure is accumulative quicker now than even previously. The request for mobile data facilities has amplified by distinctive of 160% in the year alone, and around mobile importers have practiced growth even additional aggressive development figures. The worldwide mobile data movement is predictable to endure to dual every year over 2014, foremost to a global complex yearly development amount of 108% [2]. LTE is a novel radio technology which allows workers to attain great peak throughputs than 3G technologies [3]. The chief impartial of LTE technology is to deliver tremendously tall performance radio- access technology which offers great vehicular speed movement [4]. By using system level simulator, calculations are completed in a real- world environment. Moreover, we present an agenda by taking various penetration losses i.e. indoor, outdoor, deep indoor, incar and also macroscopic pathloss environment i.e. urban and rural and estimate the scenarios in terms of the influence of losses on customers. This is the simulator that helps in presenting the genuine state of numerous losses that happens in daily life. However, there are so many the loss factors takes place in an environment such as steep attenuation in an atmosphere, construction and wall penetration, deflection and physique/obstacle loss. Some losses are happened in the slighter distances or approximately at bigger values. When various losses are present in the real word scenario, then connection lost to some extent. Path losses into buildings are inclined by the structure of wall of building and indoor stuff planning. Due to the enlarged practice of cell phones, it is flattering extra important to confirm that mobile communication organizations wrapping more indoor zones [5]. Mostly the antennas of indoor base stations recognized the buildings of the indoor service zone. However, the indoor mobile communication is familiar by radio pathways from outside base locations. So, in this paper we focus on to the all penetration losses by using model type= Gamma and macroscopic pathloss environment i.e. urban and rural.

This paper is systematized in numerous divisions: first portion is exploratory part. Subsequent part is the background description that shows about brief introduction to penetration losses. The third section of this paper designates the simulation environment and simulation methodology. Further results and discussions describes and several fluctuations in various parameters.

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## II. BACKGROUND DESCRIPTION

In the previous few ages an aggregate number of wireless transmission as well as broadcast systems have been fixed up. Acclaim of attention is the usage of cell phone into a motor vehicle. In contrast with outdoor usage, the acknowledged in-vehicle signal level is considerably inferior. However, as long as consistent in-vehicle attention is inside the scope of numerous wireless service suppliers [6]. The network coverage is the main issue in today's situation. Therefore numerous losses happened, but in the simulation set up macroscopic pathloss is applied, in accumulation to the fixed maps.

Following is the strings which is used as inputs and are equivalent to the below values:

- outdoor= 0 dB
- Deep indoor= 23 dB
- Indoor= 17 dB
- Incar= 7 dB

This paper includes the model type= gamma, above four penetration losses, macroscopic pathloss model environment i.e. urban and rural.

### A. Indoor and Outdoor

The indoor situation comprises open and closed workplaces, for example: halls inside workplace and shops. Due to numerous reflections as of walls, ground contributes to a waveguide such as effect of propagation. There are so many situations in which propagation loss exists; the free space path loss is given as: [7]

$$FSPL = (4\pi d / \lambda)^2 \text{ or } (4\pi d f / c)^2$$

Where, FSPL is the free space path loss, d is the distance between transmitter and receiver which is in meters,  $\lambda$  is the wavelength of signal in meters, f is the frequency of signal in hertz and c is the speed of light in vacuum in meters per second ( $3 \times 10^8$  m/s). When there will be a high frequency, the propagation losses increase correspondingly. These losses happen because of many consequences, like loss of free space, reflection, refraction, diffraction, pairing loss, and absorption. Path loss is too prejudiced by ground curves, atmosphere (urban or rural), and propagation standard (waterless or humid air). Alternative issue also depends upon the outdoor to indoor arrangement; it is promising that dissimilar ray pathways among the transmitter and receiver can assign to the whole ground [8]. Meanwhile in a scenario of cell phones users, the consumer is anticipated to go into constructions, that are irradiated under dissimilar incident viewpoints, the influence of incidence angle is roughly that requires to be reported for. Definite replicas [9-10] comprise in their formulation the result of this angle, wherever an additional loss feature adds up to the harm below standard incidence for an incidence angles that are non-zero.

### B. Penetration loss

In LTE, penetration loss designates the radio signals of fading that comes from an indoor to a base station because of hindrance through a building. To conserve the standard transmission between transmitter and receiver, the signal must be adequately durable. The LTE values are contingent on the coverage situation. That is why the coverage zones are divided into the areas which are more populated i.e. urban, rural zones.

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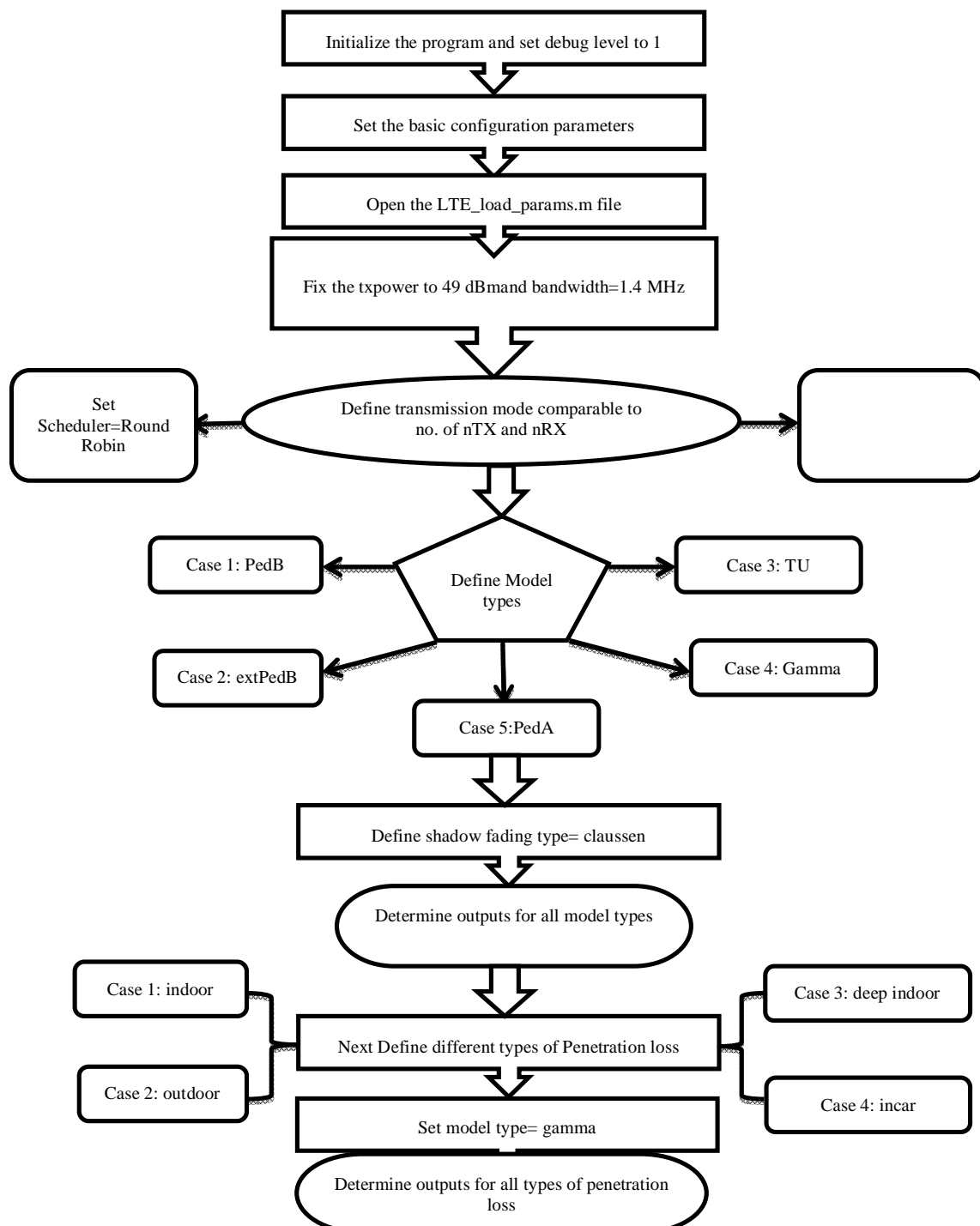
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## III. SIMULATION METHODOLOGY AND ENVIRONMENT

### A. Flow chart of the program

The procedure of sequence of the program depicted below:

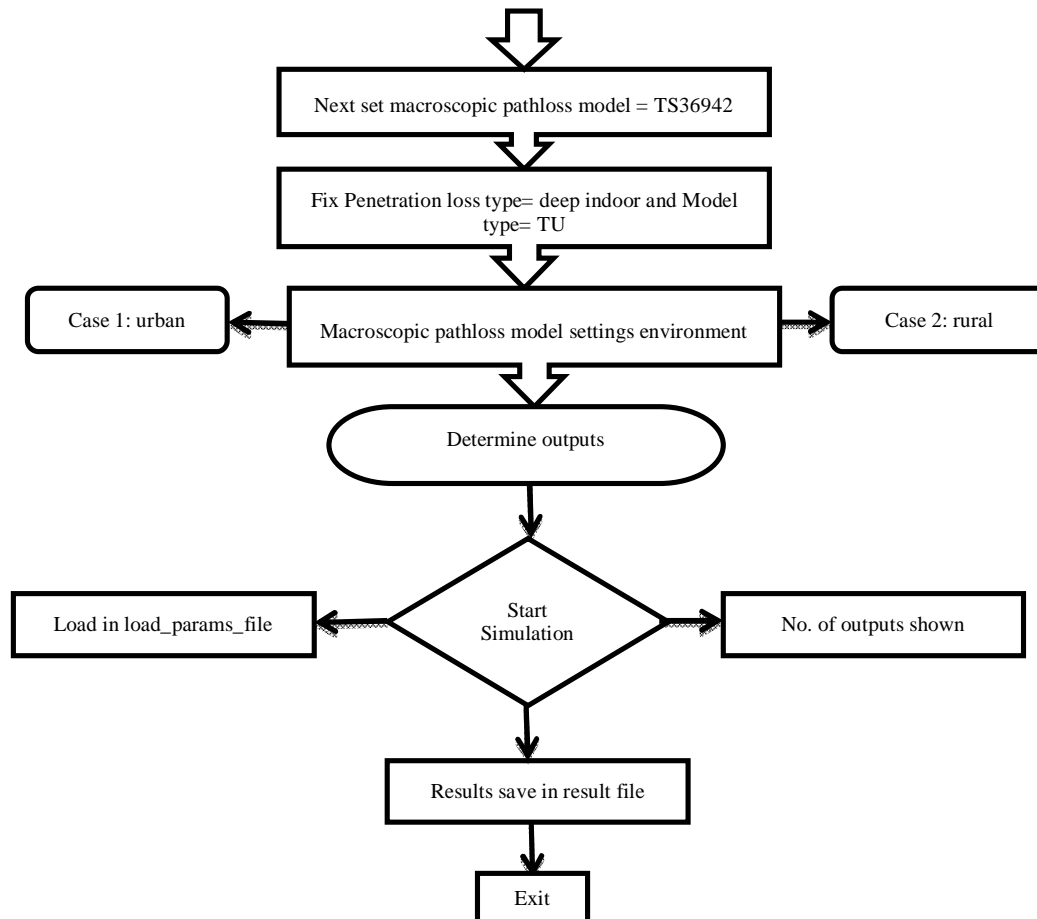


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## B. Simulation Environment

The Simulation considerations as per the PHY and MAC layer provisions that used in the models have been tabularized below:

Below are the values which are used in the program in the course of simulation:

Table 1 Simulation Environment

Sr. no.	Parameters	Values
1.	Bandwidth	1.4 MHz
2.	Transmitted power	49 dBm
3.	Carrier Frequency	2.14 GHz
4.	Simulation configuration type	Tri_sector_tilted_4*4 and Tri_sector_tilted_4*2
5.	Scheduler	Round Robin
6.	Simulation tti	10
7.	Network Source	generated
8.	Transmission mode	CLSM
9.	No. of transmitters	2
10.	No. of receivers	2
11.	Power allocation	Homogeneous
12.	Channel model types	PedB, extPedB, TU, Gamma, PedA

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13.	UE_Speed	5 Km/hr
14.	Shadow fading type	Claussen
15.	Penetration loss	Indoor, outdoor, deep indoor, incar
16.	Macroscopic pathloss model	TS36942
17.	Macroscopic pathloss model settings environment	Urban, rural
18.	UE per eNodeB	2,25
19.	Network geometry	Regular Hexagonal grid

## IV. RESULTS AND DISCUSSION

Based on the wide-ranging simulations in that have being approved out as each the particulars declared in the preceding segment, the below results have been achieved:

### A. Model types

In this section we will discuss about the different model types i.e. PedB, extPedB, TU, Gamma, PedA. Below are the results presented for individually of model types for UE average throughput, average spectral efficiency, Wideband SINR, Wideband SINR-to- throughput mapping and wideband SINR- to-spectral efficiency mapping:

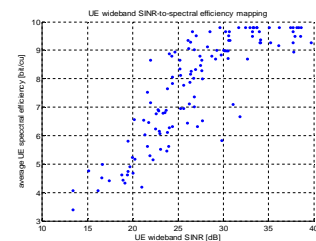
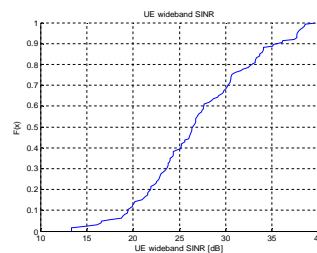
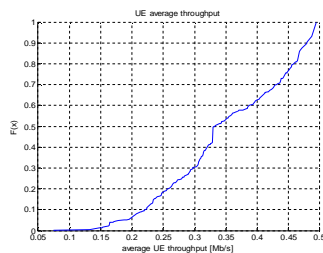
#### PedB

Fig.1 UE average throughput

Fig.2 UE Wideband SINR

Fig.3 UE Wideband SINR-to-spectral eff.

As perceived from the fig.1 UE average throughput CDF plot, the average throughput up to 0.25 Mbps is attained for about 19% of UE's and other than 52% of the nodes attains the average UE throughput of 0.35 Mbps. As perceived as



of the fig.2 UE wideband SINR CDF plot, the wideband SINR up to 25 dB is attained for about 39% of UE's and other than 69% of the nodes attain the UE wideband SINR of 30 dB. The fig.3 shows the UE wideband SINR-to spectral efficiency mapping. It shows the scattering plot which shows plot between average UE spectral efficiency and UE wideband SINR.

#### extPedB

#### TU

#### Gamma

Next, below in fig.4 the UE average spectral efficiency CDF plot is shown, the spectral efficiency up to 5 bit/cu be achieved about 18% of UE's and other than 87% of the nodes attain the average UE spectral efficiency of 9 bit/cu. In fig.5 the UE average spectral efficiency CDF plot is shown, the spectral efficiency up to 7 bits/cu be achieved about 51% of UE's and other than 78% of the nodes attain the average UE average spectral efficiency of 9 bit/cu.

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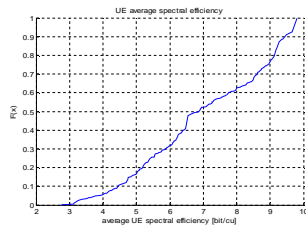


Fig.4 UE average spectral eff.

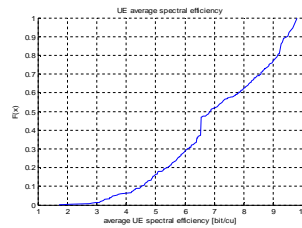


Fig.5 UE average spectral eff.

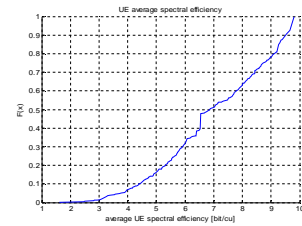


Fig.6 UE average spectral eff

In fig.6 shows CDF plot of the UE average spectral efficiency, the spectral efficiency up to 8 bit/cu be accomplished about 62% of UE's and other than 32% of the nodes reach the average UE average spectral efficiency of 6 bit/cu.

## PedA

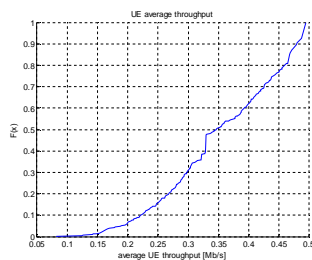


Fig.7 UE average throughput

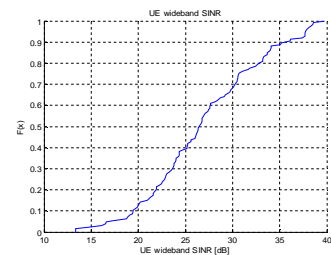


Fig.8 UE Wideband SINR

As observed from the fig.7 UE average throughput CDF plot, the average throughput up to 0.25 Mbps is attained for about 16% of UE's and other than 78% of the nodes attains the average UE throughput of 0.45 Mbps. As perceived as of the fig.8 UE wideband SINR CDF plot, the wideband SINR up to 30 dB is attained for about 69% of UE's and other than 89% of the nodes attain the UE wideband SINR of 35 dB.

Following is the values that are tabularized of different model types i.e. PedB, extPedB, TU, Gamma, PedA. As the values are shows for fairness index value is higher for TU model type than others i.e. 0.933361 and average spectral efficiency i.e. 7.08 bit/cu. The value of fairness index is same for model type gamma and PedA i.e. 0.93071 and average spectral efficiency is also same for gamma and PedA model type. The values for PedB model type is less than other model types.

Table 2: Model Types

S.No.	Model type	Fairness index	Average UE spectral efficiency(bits/cu)	Rank indicators
1.	<b>PedB</b>	0.927452	6.98	R1-75.45% R2-24.55%
2.	<b>extPedB</b>	0.931226	7.04	R1-75.60% R2-24.40%
3.	<b>TU</b>	0.933361	7.08	R1-75.21% R2-24.79%
4.	<b>Gamma</b>	0.930731	7.04	R1: 75.36% R2: 24.64%
5.	<b>PedA</b>	0.930731	7.04	R1: 75.36% R2: 24.64%

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## B. Penetration loss

In this segment we will describe out the different penetration losses i.e. indoor, deep indoor, incar, outdoor. We have taken the model type= gamma, this is model type which we discussed in the previous section A. Following are the results shown regarding the penetration losses:

### Indoor

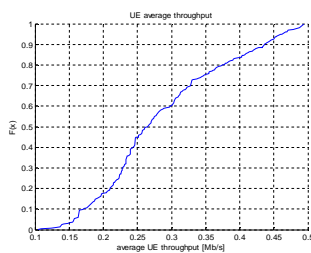


Fig.9 UE average throughput

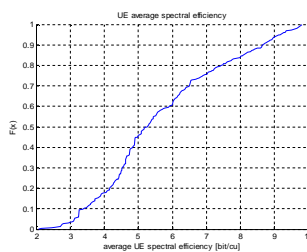


Fig.10 UE average spectral eff.

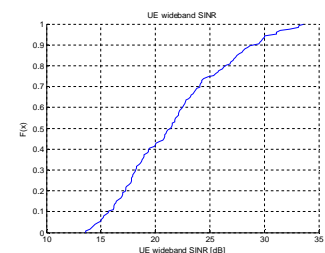


Fig.11 UE Wideband SINR

The fig.9 shows the UE average throughput CDF plot, the average throughput up to 0.25 Mbps is attained for about 43% of UE's and other than 82% of the nodes attain the average UE throughput of 0.4Mbps. Next, in fig.10 the UE average spectral efficiency CDF plot is shown, the spectral efficiency up to 5 bit/cu be achieved about 46% of UE's and other than 70% of the nodes attain the average UE spectral efficiency of 6.5 bit/cu. As perceived as of the fig.11 UE wideband SINR CDF plot, the wideband SINR up to 30 dB is attained for about 92% of UE's and other than 41% of the nodes attain the UE wideband SINR of 20 dB.

### Deep indoor

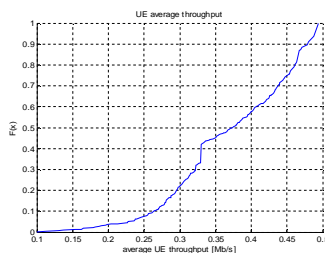


Fig.12 UE average throughput

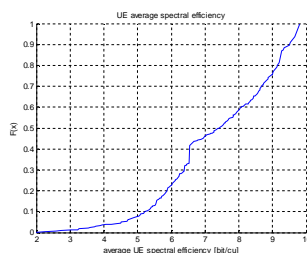


Fig.13 UE average spectral eff.

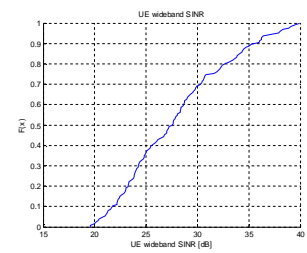


Fig.14 UE Wideband SINR

The fig.12 shows the UE average throughput CDF plot, the average throughput up to 0.35 Mbps is attained for about 46% of UE's and other than 21% of the nodes attain the average UE throughput of 0.3 Mbps. Next, in fig.13 the UE average spectral efficiency CDF plot is shown, the spectral efficiency up to 6 bit/cu be achieved about 21% of UE's and other than 77% of the nodes attain the average UE spectral efficiency of 9 bit/cu. As perceived as of the fig.14 UE wideband SINR CDF plot, the wideband SINR up to 30 dB is attained for about 69% of UE's and other than 50% of the nodes attain the UE wideband SINR of 27 dB.

### Incar

The fig.15 shows the CDF plot of UE average throughput, the average throughput up to 0.3 Mbps is attained for about 98% of UE's and other than 60% of the nodes attain the average UE throughput of 0.17 Mbps.



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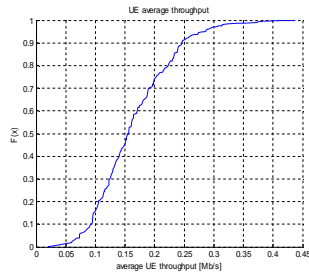


Fig.15 UE average throughput

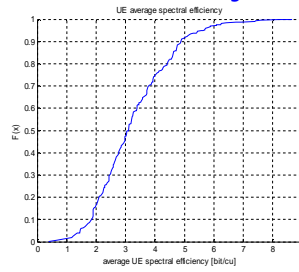


Fig.16 UE average spectral eff.

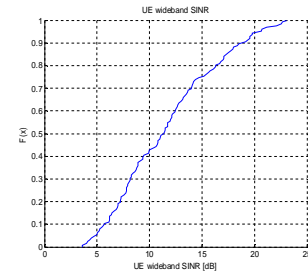


Fig.17 UE Wideband SINR

Next, in fig.16 the UE average spectral efficiency CDF plot shows, the spectral efficiency up to 5 bit/cu be achieved about 91% of UE's and other than 60% of the nodes attain the average UE spectral efficiency of 3.3 bit/cu. As observed as of the fig.17 UE wideband SINR CDF plot, the wideband SINR up to 20 dB is attained for about 93% of UE's and other than 50% of the nodes attain the UE wideband SINR of 11 dB.

## Outdoor

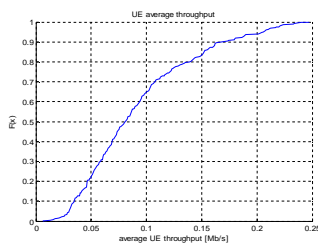


Fig.18 UE average throughput

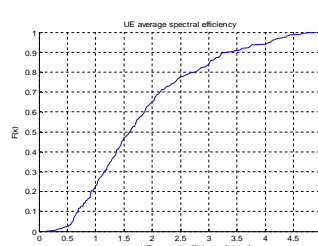


Fig.19 UE average spectral eff.

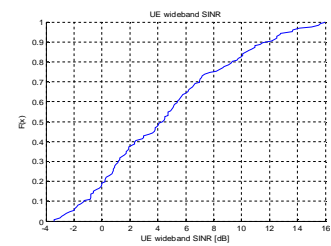


Fig.20 UE Wideband SINR

The fig.18 shows the CDF plot of UE average throughput, the average throughput up to 0.05 Mbps is attained for about 21% of UE's and other than 85% of the nodes reaches the average UE throughput of 0.15 Mbps. Next, in fig.19 the UE average spectral efficiency CDF plot shows, the spectral efficiency up to 2.5 bit/cu be achieved about 79% of UE's and other than 99% of the nodes attain the average UE spectral efficiency of 4.5 bit/cu. As detected as of the fig.20 UE wideband SINR CDF plot, the wideband SINR up to 6 dB is attained for about 63% of UE's and other than 81% of the nodes achieve the UE wideband SINR of 10 dB.

Below are the values that are tabulated of different Penetration losses i.e. indoor, deep indoor, incar, outdoor. The table clearly shows that the fairness index value of deep indoor is higher than that of other penetration losses i.e. 0.948276. The dissimilar types of throughput values of deep indoor are higher than others. The fairness index is lower in incar i.e. 0.863676. The average UE throughput is lower in outdoor i.e. 0.09 Mbps. There is lot of difference between the deep indoor and outdoor values in terms of the throughput, the peak throughput of the deep indoor is 0.49 Mbps and for outdoor the value is 0.21 Mbps. There is slight difference between deep indoor and indoor the peak throughput of the indoor is 0.46 Mbps and for deep indoor the value is 0.49 Mbps. But there is a great change in average UE throughput among indoor and deep indoor.



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Table 3: Penetration Loss

## C. Macroscopic Pathloss Model Settings environment

S.No	Penetration loss	Fairness index	Peak throughput (Mbps)	Average throughput (Mbps)	Edge UE throughput (Mbps)	Average cell throughput (Mbps)	Average UE throughput (Mbps)	Average UE spectral efficiency (bits/cu)	RI
1.	indoor	0.903556	0.46	0.29	0.16	5.73	0.29	5.69	R1: 82.19% R2: 17.81%
2.	Deep indoor	0.948276	0.49	0.37	0.23	7.42	0.37	7.36	R1: 73.71% R2: 26.29%
3.	incar	0.863676	0.28	0.16	0.07	3.30	0.16	3.27	R1: 97.02% R2: 2.98%
4.	outdoor	0.760686	0.21	0.09	0.03	1.86	0.09	1.84	R1: 99.60% R2: 0.40%

In this section we will define the dissimilar Macroscopic Pathloss Model Settings environment i.e. urban and rural. This segment includes the macroscopic pathloss model i.e. TS36942, macroscopic pathloss model settings environment will be urban and rural. We choose the additional penetration loss= deep indoor as discussed in previous section B. We have taken the channel model type= TU which is also discussed in section A. The trace length of the channel model type is 10. Following are the results shown concerning the Macroscopic Pathloss Model Settings environment:

## Urban

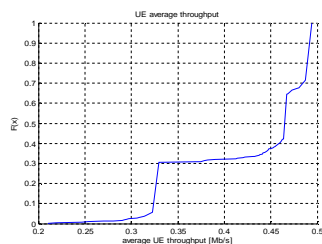


Fig.21 UE average throughput

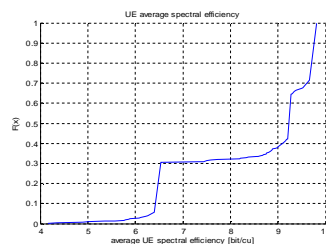


Fig.22 UE average spectral eff.

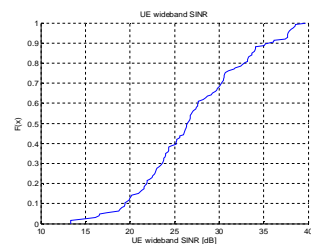


Fig.23 UE Wideband SINR

The fig.21 shows the CDF plot of UE average throughput, it shows like steps and it is not linear, the average throughput up to 0.35 Mbps is attained for about 31% of UE's and other than 60% of the nodes reaches the average UE throughput of 0.47 Mbps. Next, in fig.22 the UE average spectral efficiency CDF plot shows, the spectral efficiency up to 7 bit/cu be achieved about 31% of UE's and other than 80% of the nodes attain the average UE spectral efficiency of 9.7 bit/cu. As detected as of the fig.23 UE wideband SINR CDF plot, the wideband SINR up to 30 dB is attained for about 69% of UE's and other than 50% of the nodes achieve the UE wideband SINR of 27 dB.

## Rural

In fig.26 the CDF plot of UE average throughput displayed, it shows like an irregular pattern, the average throughput up to 0.45 Mbps is attained for about 41% of UE's and other than 10% of the nodes reaches the average UE throughput of 0.33 Mbps. Next, in fig.27 the UE average spectral efficiency CDF plot shows, the spectral efficiency up to 8 bit/cu be achieved about 32% of UE's and other than 50% of the nodes attain the average UE spectral efficiency of 9.1 bit/cu.

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As detected as of the fig.28 UE wideband SINR CDF plot, the wideband SINR up to 24 dB is attained for about 78% of UE's and other than 55% of the nodes achieve the UE wideband SINR of 22 dB.

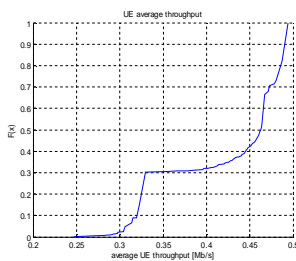


Fig.26 UE average throughput

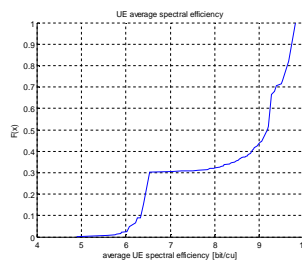


Fig.27 UE average spectral eff.

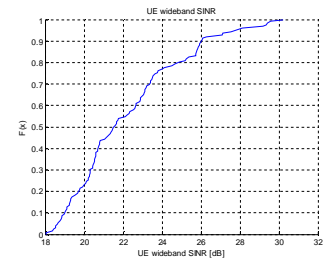


Fig.28 UE Wideband SINR

Below are the values that are organized of different Macroscopic Pathloss Model Settings environment i.e. urban, rural. The table clearly displays that the fairness index value of rural is higher than that of urban i.e. 0.972197. The peak throughput is same for urban and rural environment. The average throughput, edge UE throughput, average cell throughput, average UE throughput, average UE spectral efficiency is higher for urban environment as shown in table.

Table 4 Macroscopic Pathloss Model Settings environment

S.N o.	Environment type	Fairness index	Peak throughput (Mbps)	Average throughput (Mbps)	Edge UE throughput (Mbps)	Average cell throughput (Mbps)	Average UE throughput (Mbps)	Average UE spectral efficiency (bit/cu)
1.	urban	0.971628	0.49	0.43	0.32	8.57	0.43	8.51
2.	rural	0.972197	0.49	0.42	0.31	8.49	0.42	8.42

## V. CONCLUSION

In this catalogwe have considered the different channel model types i.e. PedB, extPedB, TU, Gamma, PedA. The values for TU channel model are much higher than that of the rest model types. Next, we choose the channel model type= gamma for different penetration losses i.e. in indoor, incar, deep indoor, outdoor. The fairness index and dissimilar types of the throughput is much higher for deep indoor than other penetration losses. Further, the channel model type TU is considered for the macroscopic pathloss settings environment i.e. urban and rural. The fairness index is higher in the rural environment than that of the urban environment. The distinct types of throughput's values higher in the urban environment than that of the environment of rural. The main motive of this paper is to show the whole scenario of penetration losses, macroscopic pathloss settings environment by considering different channel model types.

## ACKNOWLEDGMENT

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## REFERENCES

[1] David Lopez Perez, et.al, "Optimization Method for the Joint Allocation of Modulation Schemes, Coding Rates, Resource Blocks and Power in Self- Organizing LTE Networks", 30<sup>th</sup> IEEE International Conference on Computer Communications mini- conf., China, April 2011.

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Vol. 6, Issue 7, July 2017

- [2] Cisco VNI Forecast, "Cisco Visual Networking Index: Global Mobile data Traffic Forecast Update 2009–2014," Cisco Public Information, February 2010.
- [3] Willie Lu, et.al, "Technologies on Fourth- generation mobile communications," IEEE Wireless Communications, Vol. 9, no. 2, April 2002.
- [4] Munir Sayyad, et.al, "Determination of Vehicle Limit and Safe Tractive Velocity using LTE Network in Vehicle Telemetry", IJEST, Vol.3, no. 4, pp. 2707- 2719, April 2011.
- [5] M. Hata, "Fourth Generation Mobile Communication Systems beyond IMT-2000", IEEE Proc. APCC/OECC, pp. 765-767, 1999.
- [6] EmmericTanghe, et.al, "Evaluation of Vehicle Penetration Loss at Wireless Communication Frequencies", IEEE Transactions on Vehicular Technology, Vol. 57, no. 4, pp. 2036-2041, July 2008.
- [7]Jolly Parikh1, "Effect of Operating Frequency on Performance of LTE and LTE-Advanced Systems", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 3, Issue 6, pp.9890-9895, June 2014.
- [8] Honcharenko, et.al, 'Mechanisms governing propagation between different floors in buildings', IEEE Trans. Antennas Propagation, Vol.41, no.6, pp. 787-790, 1993.
- [9] COST 231 Final Report, 'Digital Mobile Radio: COST 231 View on the Evolution Towards 3<sup>rd</sup> Generation Systems', European Commission – COST Telecommunications, Brussels, Belgium,1998.
- [10] Horikoshi, J., Tanaka, K., Morinaga, T., "1.2 GHz Band wave propagation measurements in concrete Buildings for indoor Radio communications", IEEE Transactions on Vehicular Technology, Vol.35, no.4, pp. 146 152,1986