iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42001

To Develop a Model for 4g LTE and Predictable 5G at 3500 Mhz that Would Predict the Path Loss for the Environment in Semi-Urban or Mixture of Urban and Rural Surroundings at Specific Geographical Locations

Suryashree Pandey[1], Abhinandan Sarkar[2]
[1, 2]*Department of Electronics and Telecomunication, Shree Ramakrishna Institute of Science and Technology, West Bengal- 700145 India*

***Abstract:** In wireless communication, a planned network is given by the path loss model. Link budgeting, coverage prediction, and system performance optimization are indispensable in developing an accurate, simple, and general path loss model. To predict path loss in a particular environment each type of path loss propagation model is designed, it may be inaccurate in another different environment. In this paper, we are trying to predict a path loss model of Durgapur considering a particular place with a mixture of high-rise buildings, sub-urban, open, and foliage environments. For this proposal, the model area has been divided into twelve sectors taking 30° sectoring of radii 5 km and applying the path loss model for the calculation of path loss.*

***Index Terms:** Path loss, Predicted model, Outdoor propagation model consideration, Cell site selection, results, and discussions.*

I. INTRODUCTION

The attenuation of an electromagnetic wave is described by path loss. As the distance between the transmitter & receiver increases the radio wave signal strength also diminishes. To forecast the received power level for a specified coverage area by propagation model [1]. Empirical models contribute a statistical description of the relationship between path loss & propagation parameters. The parameters are frequency, antenna separation distance, and antenna heights. However, parameters of the empirical model are delivered from measured data in a particular structure. Before fitting the propagation model, it is required to divide the area into cells; we have divided the total area into 12 sections taking 5 km radii with 30° of sectoring. This given cell area consists of a different environment, each of which consists of a different environment, each of which contributes to signal strength loss. These given cells may consist of any one or more of the following environments [2] the human-made structure in an open area, in a suburban area, in an urban & in a rural area, natural terrain, flat terrain, hilly area, forest, & grasslands. The results of path loss generated from the prediction will depend upon the combination of the above factors, which make the cell geography. After the path loss levels are obtained, they are plotted against various parameters like angle, distance, etc.

II. REVIEW OF PATH LOSS PREDICTION FORMULATION

In the field of path loss propagation models, several studies have been completed where good results are obtained. All these studies are very important and play a vital role in wireless network planning. In [3] authors gave a brief introduction to loss models, concluding that each model is suitable for a specific environment. While [4] has analyzed and compared the path loss values of the selected models in different environments.

A. COST-231/Walfisch-Ikegami Model,

A combination of the Walfisch-Bartoni model using the Ikegami model, an addition reflection down to the receiver. Provision for correction factor and simplicity. It is often used in medium, small cities and given by

$PL=46.3+33.9\log 10(f)-13.82\log10(h_b)-ah_m(44.9-6.55\log10(h_b))\log10(d)+C$

In urban area, $ah_m=3.2(\log10(11.75h_m))^2-4.97$, when $f>400$MHz. In open area, $ah_m=(1.1\log10(f-0.7)h_m)-(1.56\log10(f-0.8))$. The value of C=3 for urban and C=0 for semi-urban, h_m-Receiver antenna height(in meter), h_b-Base antenna height(in meter).

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

B. Two Ray Ground Reflection Model,

Friis propagation model considers the line-of-sight (LOS) path between the transmitter and the receiver. The expression for the received power becomes complicated if the effect of reflections from the earth's surface has to be incorporated in the modeling [5]. In addition to the line-of-sight path, a single reflected path is added in the two-ray ground reflection model**,** as illustrated in Figure 1.

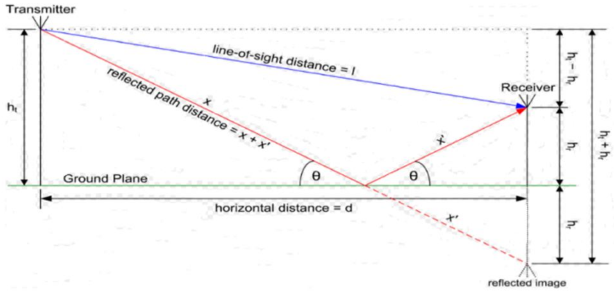


Figure 1: Two ray ground reflection model

The received signal consists of two components: an LOS ray that travels the free space from the transmitter and a reflected ray from the ground surface. The distances traveled by the LOS ray and the reflected ray are given by

$$d_{los} = \sqrt{d^2 + (ht - hr)^2}$$
$$d_{ref} = \sqrt{d^2 + (ht + hr)^2}$$

Foliage Loss,

In general, path loss due to through-vegetation can be well represented by the following expression,

Lfoliage (dB) = A X $f^B . d^C$.

The three parameters, *A*, *B*, and *C* in (4) can be empirically optimized through regression techniques based on specific measured data.

C. Consideration of Outdoor Propagation Model

The total path loss calculations are calculated by

1) Foliage loss
2) Plane earth loss
3) Walfish -Ikegami /COST-231 model.

A path loss model was made for every micro sector. Some portions may have buildings, some foliage, and some open area in a micro sector.

III. SELECTION OF CELL SITE

For path loss modeling, for example, a place was taken by Rajendranath College of the polytechnic, near Gopalpur, Durgapur-12.

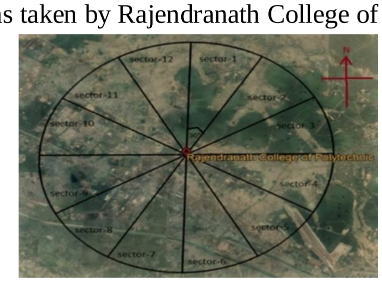


Fig.2. Sectional view

The longitude is from $23^\circ28'$ N to $23^\circ28'$ and the latitude from $87^\circ20'$ E to $87^\circ26'$ E for the given sectional view.

A circle with a radius of five kilo-meters was taken at the center of the place. Sections were taken at 30° and a total of 12 sections were grasped in this circle.Fig.2. Shows a sectional view of the area.

IV. RESULT AND DISCUSSION:

For example which place we have considered is a mixture environment (like some portion open, foliage, suburban, urban and high rise buildings).In Fig-3, we have taken 12 sectors of 30°, depicted in black color each. All sections are the combination of two or more environments. We use the red line for the foliage area, the blue line indicates the suburban area ,the yellow line for the open space area, and the green line indicates high rise building area.

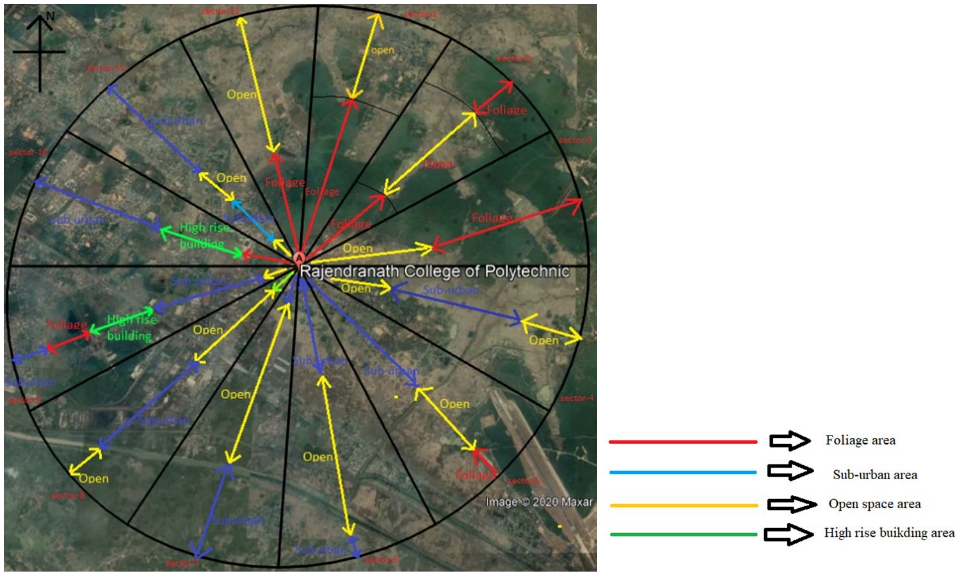


Fig.3. Categorized path loss environments

The different path loss predicted by the COST-231 model is simulated in MATLAB at the 3500 MHz frequency band. Transmitter antenna height 100 meters and receiver antenna height 3 meters and separation between transmitter & receiver are 5000 meters. The simulated results are plotted in Fig-4, Fig-5, and Fig-6 which are varied & predicted path loss versus separation between transmitters and receiver & each figure depicts 4 sectors' path loss value. Such-that, Fig 4 contains (0°<30°), (30°<60°) & (60°<90°) & (90°<120°) path loss values ; Fig 5 contains (120°<150°),(150°<180°),(180°<210°) &(210°<240°) path loss values ; Fig 6 contains (240°<270°),(270°<300°),(300°<330°) & (330°<360°) path loss values ;

In Fig-4(b), (0°<30°), (30°<60°) & (60°<90°) sectors are a mixture of foliage and open environments. (90°<120°) the sector is a combination of open and suburban environments. As we can see in figure-1path loss varies according to the environment.

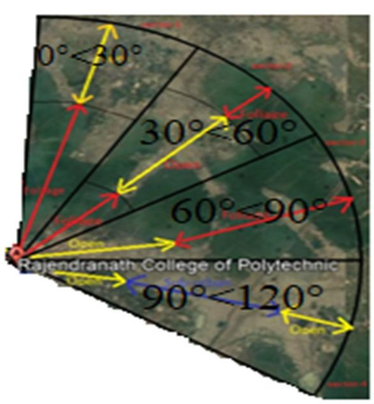


Fig.4.(a) 1st 4 sectors

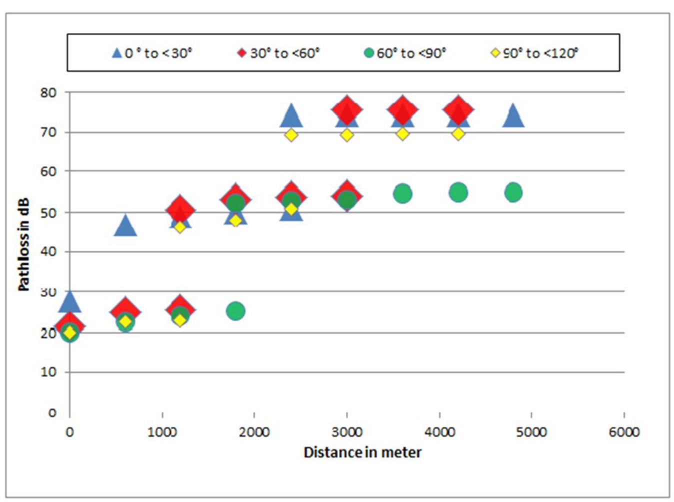
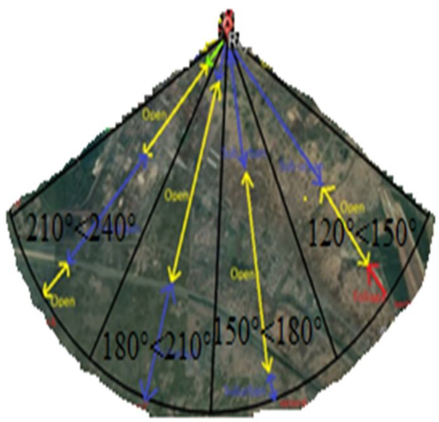


Fig.4. (b)Plotting of (0°-30°), (30°-60°), (60°-90°) and (90°-120°) sectors

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Here, in the plotting fig-4(b), we used different shapes and also different color to indicates different pathloss in different sectors. Path loss are presented in a blue triangle shape for the sector (0°<30°), in red diamond shape for the sector (30°<60°), in green circle shape for the sector (60°<90°) & lastly in yellow diamond shape for the sector (90°<120°) .

In Fig-5 (120°<150°) sector is mixture of suburban, open and foliage environments. (150°<180°) & (180°<210°) sectors are mixture of suburban and open environments. Under (210°<240°) sector some portion occupies 7th floor high rise buildings and rest portion is the combination of open & suburban area. Based upon the environments for every sections path loss changes accordingly.



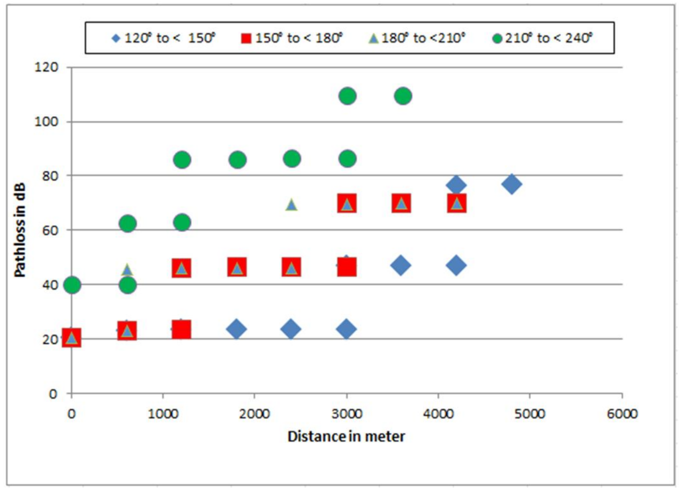
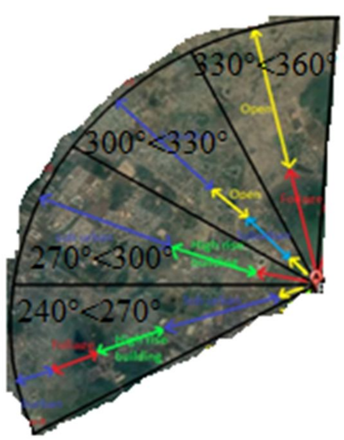


Fig.5.(a) 2nd 4 sectors

Fig.5.(b) Plotting of (120°-150°), (150°-180°), (180°-210°) and (210°-240°) sectors

Here, in the plotting fig-5(b), we used different shapes and also different colors to indicate different path losses in different sectors. Path loss is presented in a blue diamond shape for the sector (120°<150°), in a red square shape for the sector (150°<180°), in a green triangle shape for the sector (180°<210°) & lastly in green circle shape for the sector (210°<240°) .

In Fig-6.(b) four sectors cover different environments. The sector (240°<270°) is a mixture of the open, suburban, area with high-rise buildings and foliage environments. Next, 2nd sector (270°<300°) is the combination of areas with high-rise buildings, foliage, and some suburban area. For 3rd section (300°<330°) is a mixture of open & suburban environments. Now the 4th one (330°<360°) is the combination of foliage and open , from the figure-3 we can see varied path loss.



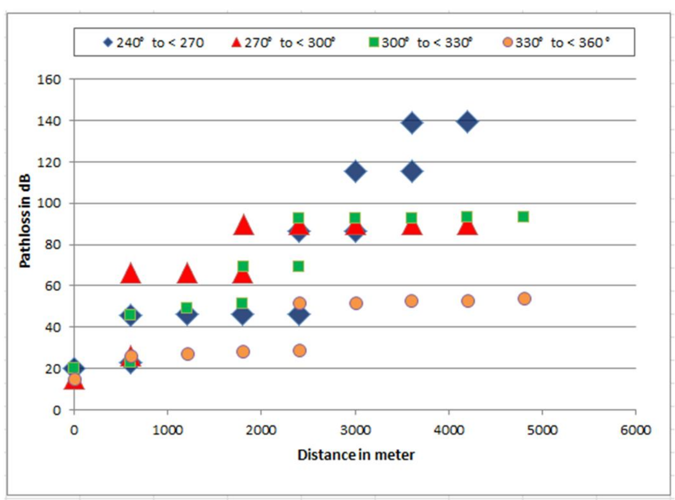


Fig.6.(a) 3rd 4 sectors

Fig.6.(b) Plotting of (240°-270°), (270°-300°), (300°-330°) and (330°-360°) sectors

Here, in the plotting fig-6(b), we used different shape and also different color to indicates different pathloss in different sectors. Path loss are presented in blue diamond shape for the sector (240°<270°), in red triangle shape for the sector (270°<300°), in green square shape for the sector (300°<330°) & lastly in peach circle shape for the sector (330°<360°) .

V. CONCLUSION

We have predicted a path loss propagation model for a mixture of semi-urban, open & foliage areas in and around Durgapur. We observed different path loss values coming depending on various environment areas. Path loss prediction has a considerable impact on the planning and deployment of the wireless network. We hope this paper is going to serve as a reference for existing service providers.

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