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Investigation of Radio Wave Propagation Model for Sublime Region between Haridwar and Rishikesh

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Abstract: The present paper aims to adapt a propagation model for the area between Haridwar and Rishikesh, Uttararkhand, India. The study is in continuation to the works by several authors which was carried out for the urban, sub-urban and rural regions on the basis of the data collected from the local operator. In this paper we compare the field measured data with various path loss models like Free space path model, Stanford Interim University (SUI model),Ericsson 9999 model, Cost Hata Model and Walfisch Bertoni Model to find the most suitable model for the concerned region based on RMSE value.

Keywords: Radio Waves, Propagation Model, Path-Loss, Model Selection, TEMS

I. INTRODUCTION

Radio systems and related technology is undergoing a vital and radical change every day with a rapid rate. Thus need for high quality and high capacity network is the order of the day. The effective design, assessment and installation of a radio network require accurate estimation of propagation loss. By knowing the propagation loss it becomes convenient to compute the coverage area, signal to noise ratio, carrier to interference ratio etc. The accurate prediction the field strength is very difficult and complex task. The cellular concept was a major breakthrough in solving the problem of spectral congestion and hence increases the user capacity. The cellular concept is a system level idea in which a large cell is replaced with several small cells **[1]**. A cell denotes the coverage area of a single base station transmitter. The loss in the signal strength as it travels from a base station (BS) to a mobile station (MS) is termed as the path loss and depends mainly on the operating frequency, antenna height and the distance. Base station close to one another is assigned separate group of channels to minimise interference between the base stations or to minimise interference between the adjacent cells. As the demand for service increases, the number of base stations can be increase and hence providing additional capacity without increase in radio spectrum. The Basic idea of cellular system is that it is possible to serve unlimited number of subscribers distributed among a wide area by using only limited number of channels by efficient channel reuse **[2].**This article discusses the comparison between the theoretical and empirical propagation model and concludes that Ericsson 9999 model is the best suitable model for the sublime area between Haridwar And Rishikesh.

II. METHODOLOGY OF DATA FETCH

The concerned methodology deals with the drive test tools which contain hardware and software. Here we have used TEMS 9.1 for drive test measurements. The complete process of data collection using TEMS 9.1 or any other advanced version involves careful setting up of GPS and TEMs enabled hand-set for the purpose of data collection. The first step is to connect the laptop with the cars battery for non-interrupt power supply. Next a GPS device is connected to the laptop via USB-2.0 interface and GPS device is placed over the car's roof. Next we connect the TEMS help enabled hand-set via USB-2.0 and thereafter connect the software loaded in the system. A HASP (Dongle) security key is used to secure access to the TEMS investigation software and reading appears on the map of the concerned scenario as the vehicle starts moving in the area to be surveyed at an average speed of 30 km/hr. Data collection was done starting at a distance of 200m from the base station. The process was repeated for all the three sectors. For the clear reading it is desirable that the regional base station vectors and the regional map vectors are already loaded in the system.

Generally the statistical models are based on field measurement data and have higher computational efficiency compared as compared to deterministic model [3]. Practically the accuracy of the statistical model depends not only on the accuracy of the measurement but also on the similarities between the area's propagation model where the measurement is performed and the environment to which the calibrated model is to be applied [4] The TEMS Investigator handset and software versions 5.0, 8.1 and 9.1[5] [6] were used for the data collection. The handset was used with the precaution as it has an accuracy of ±4dB. The power calibration was done in the range of -100< -<-40dBM.The TEMS handset was given time to settle on a particular range of values. The readouts were made on software in a pre-determined format. A GPS receiver was used to collected location information. The accuracy of the GPS used was ±15m.The data was recorded manually as the interface to the computer was not available.

Field Measurement Results:

Table1: Received signal level as a function of distance.

Distance (Km)	0.2	0.6	0.8	1.2	1.6	2.0	2.4	2.6	3.0	3.4
Rx Level(dB)	-60	-69	-72	-82	-85	-90	-97	-99	-102	-104

III. MEASURED DATA RESULT IN CONTRAST TO PERSISTING MODELS

The below context covers a comparison of propagation models for path loss propagation[7]It also compares the pre-existing profiles with empirical measurements[8] with different theoretical models singularly and in cumulative manner. Thereafter we select the most appropriate theoretical model for our measured data.

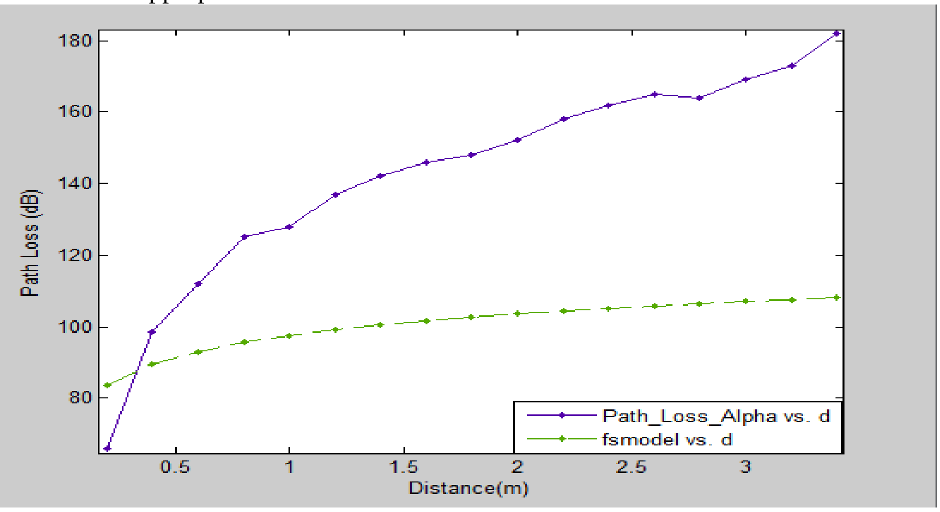

Figure1: Comparison of measured with free space path loss model

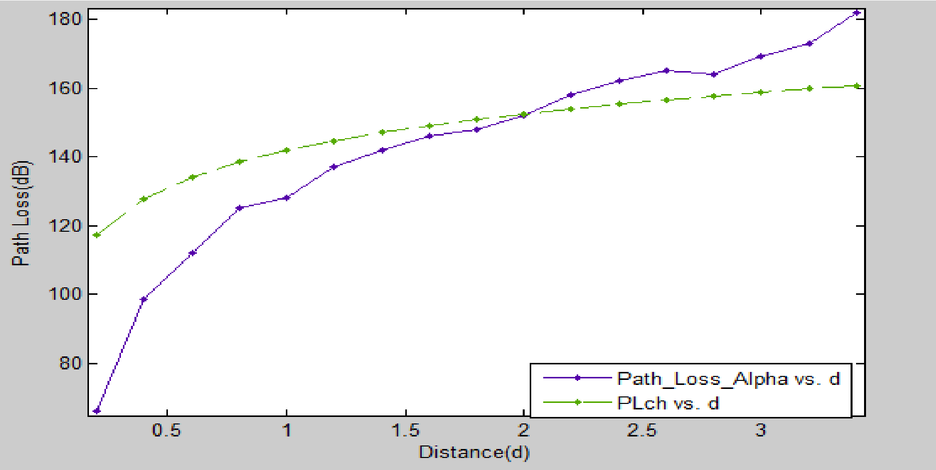

Figure2: Comparison of measured path loss with theoretical COST-Hata model

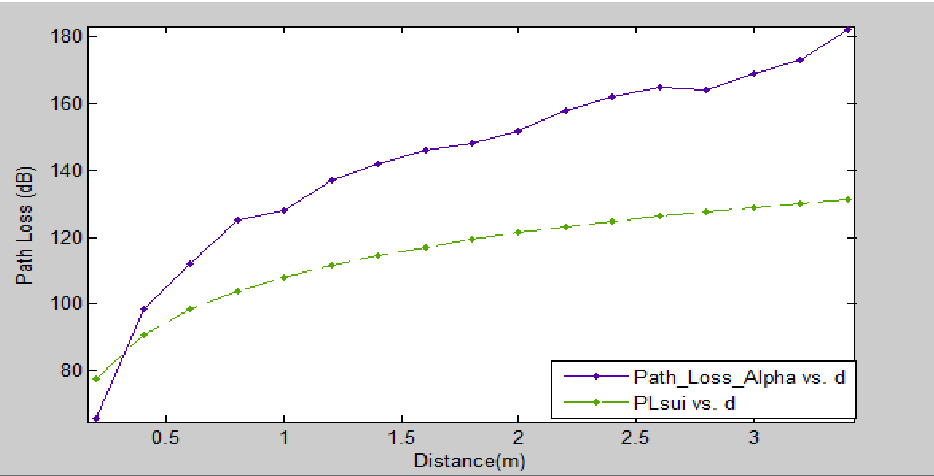

Figure3: Comparison of measured with free SUI model

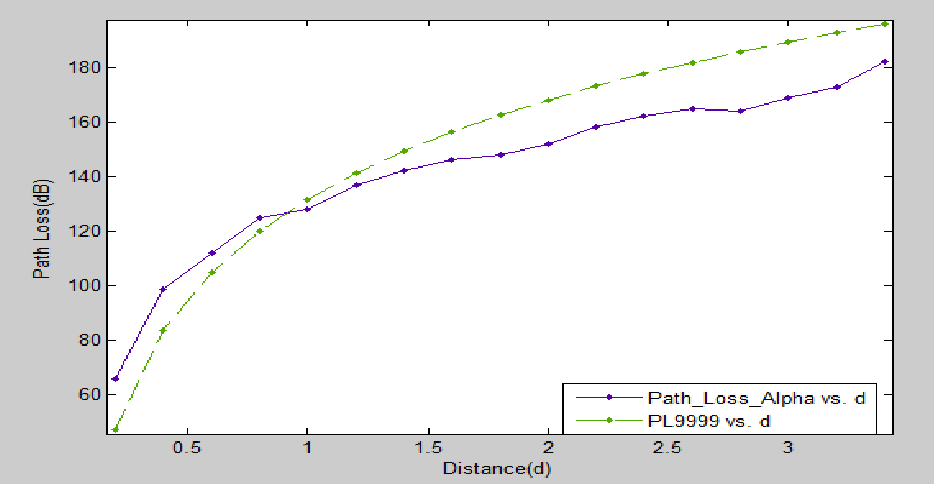

Figure4: Comparison of measured with Ericsson 9999 model

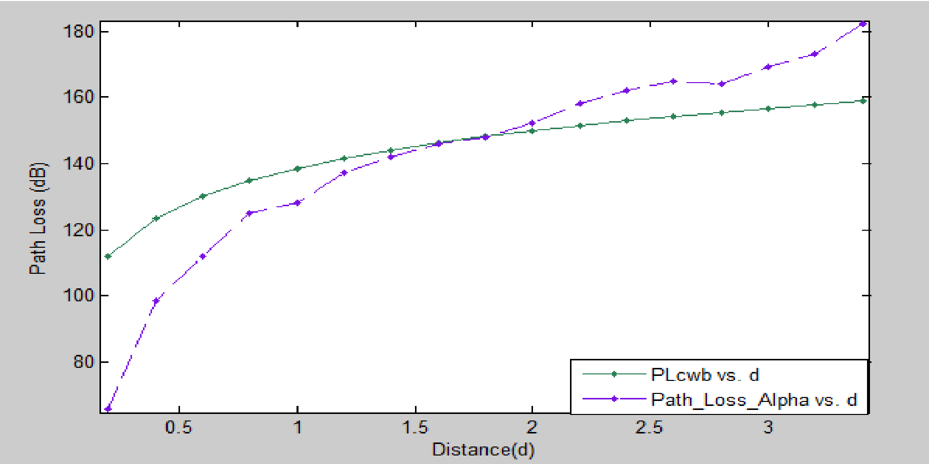

Figure5: Comparison of measured with Walfisch Bertoni's model

IV. RESULT AND ANALYSIS

On the basis of fitting analysis followed by the comparison with various models, we can easily deduce the most appropriate model for the region. Moreover from general comparative observations based on path loss models [7], it was found that only two models best approximate field measured data. We now carry analysis for relevant models on the basis of MSE and RMSE values. Mean squared error is the average of the squared error between the actual and the estimated sample in a data sample. MSE is generally calculated by:

$$MSE = \frac{\sum_{i=1}^{i=n}(X_{obs,i} - X_{model,i})^2}{n} \qquad (1)$$

where,
$X_{obs,i}$ denotes the i[th] observation of the estimated data set
$X_{model,i}$ denotes the i[th] observation of the actually measured data set
n in the number of observations.
Root Mean squared error (RMSE) is the root of MSE and is given by the equation:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{i=n}(X_{obs,i} - X_{model,i})^2}{n}} \qquad (2)$$

The MSE and RMSE for the theoretical curve and the actual measurement is as shown in the table below:

Table2: Comparison of various model on MSE and RMSE Values.

Model	MSE	RMSE
Free Space Path Loss Model	2.65	1.6279
Cost Hata Model	2.2635	1.5045
Cost Walfisch Bertoni Model	2.06	1.4354
SUI Model	2.196	1.482
Ericsson 9999 model	0.653672	0.8085

On the Basis of the MSE and the RMSE it is clear that the best fit model for the area under concern is Ericsson 9999 model followed by the Cost Walfisch Bertoni model.

V. CONCLUSION

It was revealed during the comparative study of different models along with interpolated measured field data values that out of different models studied only three specific models closely approximate the actual measurement characteristics namely: SUI model, Ericsson model and COST-Walfisch-Bertoni or Bertoni's model. Apart from these three models all other models showed huge deviation from the measured field data value, which clearly indicates inefficiency of all other models to be deployed for network planning in the concerned region at 1.8 GHz of operational frequency band. On the basis of results obtained during curve fitting (using Spline approximation and confidence bound of 95%) for each of the three chosen models, it was found that Ericsson model along with Walfisch-Bertoni model is in most closest proximity to measured data values and thus can be selected as a model to study radio signal strength distribution and network planning for the region concerned at 1800 MHz. Still, the measured values show an appreciable deviation from actual Ericsson theoretical results thus providing scope for further improvement in the model for region like the one discussed here.

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REFERENCES

[1] Gordon L. Stuber, "Principles of Mobile Communications, 3rd Edition, Pearson New Delhi, ISBN: 978-81-317-3186-4, 2012.

[2] V.H. MacDonald, "The Cellular Concept", The Bell System Technical Journal,Vol.58,No.1,PP:15-43, January 1979.

[3] V.S. Abhayawardhana, I.J. Wassel, D. Crosby, M.P. Sellers, M.G. Brown, "Comparison of empirical propagation path loss models for fixed wireless access systems," 61th IEEE Technology Conference, Stockholm, pp. 73-77, 2005.

[4] Joshi Sumit, Gupta Vishal, Sandeep Vijay "Model Selection for Radio Propagation in Sub-Urban Niche with Low Roof Residential Scenario" International Journal of Computer Application, ISSN: 0975-8887 Vol-56 No: 4,Nov. 2012

[5] Shoewu, O and F.O. Edeko, "Analysis of radio wave propagation in Lagos environs", AJSIR, ISSN: 2153-649X, 2011

[6] TEMS Investigation release notes, ASCOM, Document: NT11-21089, www.ascom.com/networktesting, 2011

[7] Vishal Gupta, Sandip Vijay and S.C.Sharma, "Efficient Path Loss Prediction in Mobile Wireless Communication Network", ISN2008, Feb. 2008.

[8] Josip M. Snjezana Rimac D. "Radio Wave Propagation Mechanism & Empirical models for Fixed Wireless Access System" Technical Gazette 17,ISSN: 1330.3651, 2010.

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