International Journal of Computer Applications (0975 – 8887)
Volume 57– No.4, November 2012

Model Selection for Radio Propagation in Suburban Niche with Low Roof Residential Scenario

Sumit Joshi
M-IAENG, ISOC
Assistant Professor-GRD-IMT
Dehradun

Vishal Gupta, PhD.
AMIETE, NSBE, ISTE
H.O.D-GRD-IMT
Dehradun

Sandeep Vijay, PhD.
M-IEEE, M-IAENG
H.O.D-D.I.T
Dehradun

ABSTRACT

In the recent times the study of signal propagation models are under continuous reviewand currently a lot of work is being done on prediction of path losses associated with different kinds of environments, but the exactness of each model deployed is valid only for a small frame of fixed parameters which are the fundamentals of it. An exact radio propagation model is important for coping up with new challenges of the field of communication like: appropriate design, deployment, and service management strategies for any wireless network. It thereby becomes important for the purpose of signal coverage prediction, data reception, performance parameters, reception schemes, analysis of signal attenuation under different environments and in determination of the optimum location for the purpose of installation of base stations. Therefore the majorpurpose of this work is to survey various residential path loss prediction models along with few other models and to probe the accuracy of some widely used outdoor propagation models which are applicable for900MHz and 1800 MHz band such as Free space model, Egli model, Okumura model and COST 231 Hata model, ECC model, Bertoni's model on the interfacial regions of Dehradun. Probing studies requires field measurement which is done in the sub-urbanized zone of the concerned region. Some base stations operating at GSM 1800 MHz band were selected for the measurement in the particular area. Finally the models were verified against the field measurement in order to find out most suitable model for the region.

General Terms

Radio propagation, Comparative analysis, Model selection.

Keywords

Radio, TEMS, Bertoni's model, Fitting, Residential scenario.

1. INTRODUCTION

Radio system planning can be seen as a process that defines the stages required to provide a desired radio network plan for a given geographical area. To achieve a desired radio network, it is important to capture critical factors that influence the choice of base transceiver station locations. It is important to note that the parameters that affect radio system planning also define the radio propagation environment that specifies the characteristics of the radio propagation which furthermore has a significant effect on the coverage and capacity of radio network. This paper presents a brief description on data collection along with the model selection methodology from field measurements collection.

2. METHODOLOGY FOR DATA FETCH

The concerned methodology deals with drive test tools which contains both software and hardware devices.Here we have deployed TEMS 10.0 for drive test measurments.The complete process of data collection via, TEMS-10.0 or any other advanced version is not a simplistic task. It 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 car's battery for non-interrupted battery charge up during the drive test. Secondly, 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 following connect the software loaded in the system thereafter. The chosen region is surveyed with the help of this mobile vehicle along with the accessories as mentioned. An HASP (dongle) security key is used for secure access to the TEMS investigation software and readings appear on the map of concerned scenario as the vehicle starts moving, it should be kept in mind that readings will be clear only if regional base-station vectors and regional map vectors are already loaded in to the system. Normally, propagation model measurements are carried out if planning is done for a new network and, if there is an area with changes in the propagation environment such as new buildings, new roads, or else a new frequency band is taken into consideration.

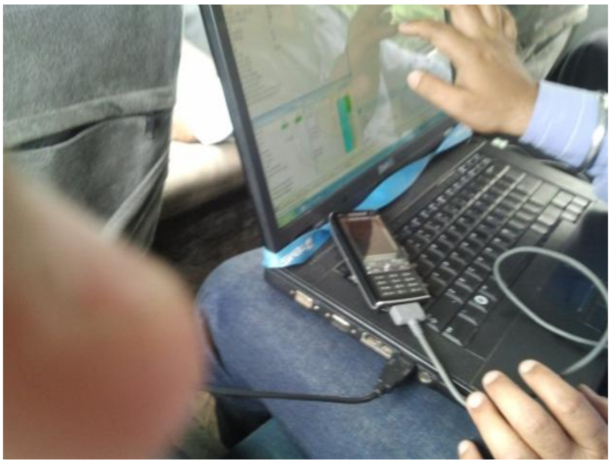

Figure.1. Process of data collection depicted using real-time drive test pictures.

Generally, statistical models are based on measurement data and have high computational efficiency as opposed to deterministic models[6]. Practically, the accuracy of statistical models depends not only on the accuracy of the measurements, but also on the similarities between the propagation environments of the area where the measurement campaign is performed and the environment that the calibrated model is to be applied. To obtain such data, radio frequency (RF) measurements campaigns were performed in sub-urban region of Dehradun for various sites that contained buildings and vegetation.

2.1 Site and Scenario Selection

Since the measurement campaign was required to establish the effect of vegetation and buildings on radio signal propagation, the sites for measurement were selected to ensure that the sites were representative of the clutter types being considered. At first, built areas were considered. The sites chosen were initially analyzed using MATLAB code based on Bertoni's model and some other important models. The cell characteristics were analyzed to verify that the cell contained over 80% of built clutter.

Figure.2. Building topology of area studied

One of the typical built-type clutters in the area studied is shown in Figure.2. For the vegetation type clutter, the same procedure was considered. However, only trees in a straight line were considered as it was evident that in such areas, trees were almost always along streets except for those in parks and a few in individual compounds.

2.2 Data collection and setup features

The TEMS Investigator handset and software versions 5.0, 8.1, 10.1& 13.1[1][4] were used to collect samples of the measured signal. The handset was used with precaution as it is known to have a typical accuracy of ± 4 dBm. The calibrated power was -100≤ - <-40dBm. The device used was TEMS handset[4] given time to settle on a particular range of values. The readouts were made on software in pre-definedformat. A geographical positioning system (GPS) receiver was used to collect the location information. The data captured included: logical channel 1 with information on BCCH, serving cell BCCH ARFCN, Base station identity code, received signal strength (RxLev)[1], Traffic channel, Timeslot number, Transmit power-graphic, carrier-to-interference ratio in dB, Timing advance, cell identity and the neighbor list. The GPS had an accuracy of ± 15m. This accuracy is much better compared to previous values of ±200-300m. This is due to the fact that selectivevariability was switched off in the recent past which improved the accuracy of the GPS dramatically. The network cells within the area being studied were measured for model selection since all relevant parameters such as effective isotropic radiated power (EIRP), antenna type, direction and height were known. The drive routes were selected for the sites that had over 80% of the clutter type under consideration. The data was recorded manually as there was no available interface to the computer. An average value of the range within which the handset settled was recorded. The data is available after slight modification as a CSV (Comma Separated Values) file which can also be modified to KML (Google earth map file) via. csv to kml converter tool. Each measurement run was analyzed for trends and errors to satisfy that the available data correctly maps the targeted area.

2.3 Measurement and drive test

It took almost 6 months of time for visiting different locations within and outside the Dehradun region for GSM data fetch up. The region of concern was the sub-urban region of Indira Nagar, Dehradun and Garhi Cantonment exteriors at 1800 MHz of operating frequency[5]. The data samples taken are for a base station transmitted signal value of 43dBm. The major objective is to measure path loss on the basis of readings taken, the values were obtained using TEMS navigation tool.

These values were taken only for few kilometers in the radial-arc because of small free areal-coverage in all the three sectors i.e. only a little portion provides continuum terrain and building features for study. The variability in scenario is observed even at short distances beyond the specified working distance chosen for measurement. The most important fact pertaining to the mentioned cause is the valley type hilly terrain in mix with flat terrain at places. Moreover the entire region is a combination of sub-urban and rural profile features as observed. The results obtained via, measurements undertaken during the entire 6 months slot are used to obtain path loss values and thereafter these values are compared with respect to Walfisch-Bertoni model and some other suitable models, as per believe that empirical results generally supersede the modeling based results[6]. Here on the basis of comparative analysis, we obtain an error factor which facilitates model choice for the region of concern.

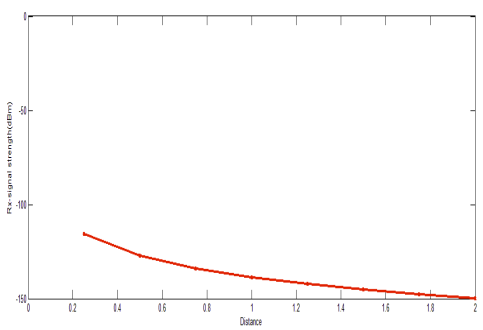

Figure.3. Received signal strength with respect to distance from BTS.

These on further approximations clearly indicate that the field strength reduction depends not only on distance between the transmitting and receiving entity but also on the objects lying between the two & their geometry along with its outlook. In detailed view it was found that Bertoni also mentioned impact of base station height on signal strength and justified it using ray-trace techniques[9]. Still, there are certain degrees of improvement required in the approach of the model being discussed for the region of our interest and thus pertaining to actual measurements made via, drive test need to be compared with theoretical approximations for better network planning and QoS provisioning[8].

2.4 Measured data results in contrast to persisting models

This context under covers a comparative outlook on different Propagation models for path loss measurement[7]. It also compares pre-existing theoretical profiles with empirical measurement[3] (depicted Measured values vs. d) with different theoretical models singularly and in a cumulative fashion too. Thereafter we select the closest proximity theoretical models to our measured values taken in sub-urban region of Patel Nagar in Dehradun, Uttarakhand as shown below:

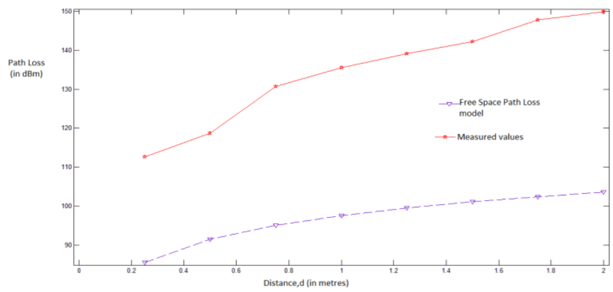

Figure.4. Measured path loss versus free space path loss

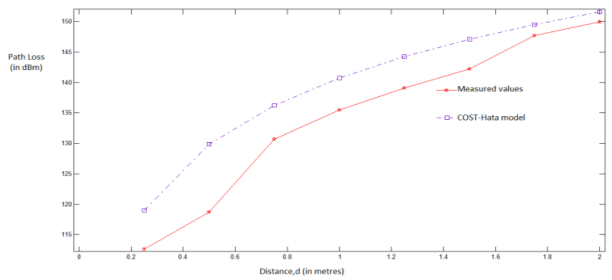

Figure.5. Measured path loss versus COST-Hata path loss

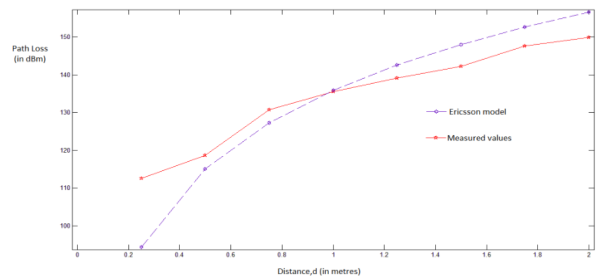

Figure.6. Measured path loss versus Ericsson path loss

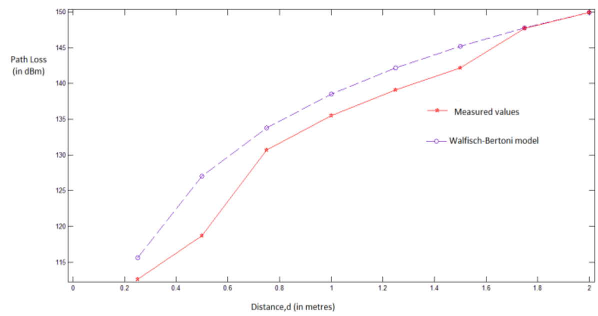

Figure.7. Measured path loss versus Bertoni's path loss

3. FITTING APPROXIMATION FOR MODEL SELECTION

On the basis of fitting analysis studies followed by comparison for different models as shown in Curve fitting layout below, we can easily decide appropriate model for the region. More over from general comparative observations based on path loss[7], it was found only three of the models best approximate measurement results namely: COST-Hata, Ericsson and Bertoni's model[2][9]. Therefore task is more simplified and now we need to carry out analysis for only three such models.

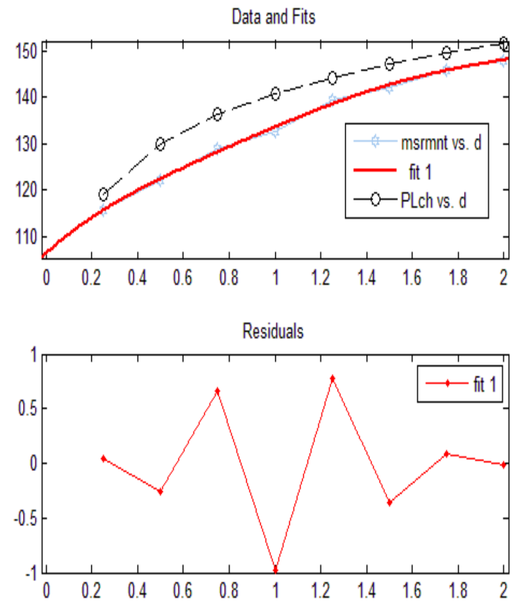

Figure.8. Fitted measured values in fair proximity to COST-Hata model

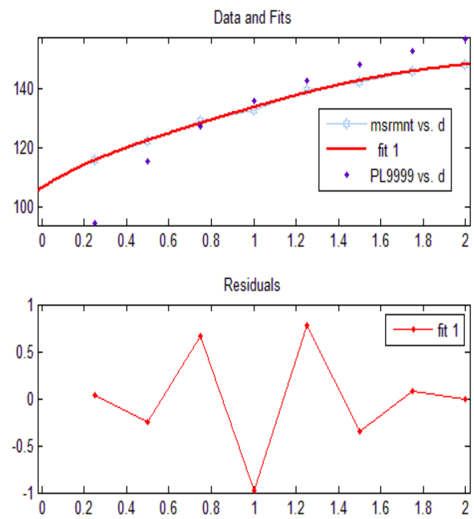

Figure.9. Fitted measured values in fair proximity with Ericsson model

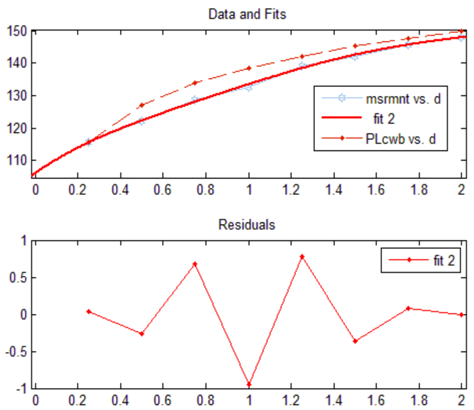

Figure.10. Fitted measured values in closest proximity to Bertoni's model.

4. CONCLUSION

On the basis of results obtained during curve fitting (using 5th order polynomial approximation and confidence bound of 95%) for each of the three chosen models, it was found that 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.

The most important feature of conclusion is that the analysis is also justifiable on theoretical basis as mentioned in works of Bertoni(specifically for low roof-top residential profile).

Still, the measured values show an appreciable deviation from actual Bertoni's theoretical results thus providing scope for further improvement in the model for regions similar to our region of interest.

5. ACKNOWLEDGMENTS

We would like to thanks BSNL (Bharat Sanchar Nigam ltd.), Dehradun and Vodafone for their support in patiently guiding us throughout the process of data collection. We would also like to thanks Departmental Research Committee, D.I.T-Dehradun for their guidance & support.

6. REFERENCES

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

[2] Hemant Kumar Sharma, Santosh Sahu and Sanjeev Sharma, Enhanced COST-231 W.I. model in wireless network, IJCA,ISSN: 0975-8887, vol.19, No.6, April, 2011.

[3] Josip Milanovic, Snjezana Rimac-Drlje and Ivo Majerski, Radio wave propagation mechanisms and empirical models for fixed wireless access systems, Tehnickivjesnik17,UDC/UDK621.391.8:004.733(497.13 Osijek), ISSN: 1330-3651, 2010.

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

[5] Sami Celik, Yonus Emre Yoruk, Murat Bitirgan, Osman Kurnaz, Bahadir Basyigit, Selcuk Helhel and Sukru Ozen, Indoor to outdoor propagation model improvement for GSM-900/GSM-1800/CDMA-2100, IEEE, 2011.

[6] 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.

[7] Vishal Gupta, Sandip Vijay and S.C.Sharma, "Efficient Path Loss Prediction in Mobile Wireless Communication Network", ISN2008, Feb. 22-24, 2008, Pg-271.

[8] Mr. Sumit Joshi, Outdoor propagation models: Aliterature Review, IJCSE, Vol.12, Issue.2, 2012.

[9] H.L Bertoni, Radio propagation for modern wireless systems, Prentice hall-PTR, 2000.