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Path Loss Analysis using AWAS Electromagnetic Code for WiMAX at 2300 MHz

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Abstract— **Propagation Modeling is required to provide a reliable and efficient planning of cellular network. In this Study, various propagation models like COST-231 Hata, ECC SUI are used to compute the path loss for WiMAX at 2.3 GHz in dense urban and sub urban environment. AWAS Numerical Method compares the path loss with these empirical models. The Path Loss by AWAS Code is appeared as very high because of the regular variations in Near Field Distribution at 2.3 GHz. It can be controlled by allowing the Near field distribution with a limited height of base stations.**

Keywords—— ***Path Loss Exponent, Propagation Models, WiMAX, , Near field distribution***

I. Introduction

WiMAX is a family of IEEE 802.16 is basically a result of accessing the broadband services in the wireless domain.. In India, WiMAX is operating at 2300 MHz frequency band which is tends to provide an access to operate the wireless devices at very high data rates over very long distance[1]. In this study, the variations in path loss of WiMAX is being estimated for different environments of India – dense urban , urban, sub urban or rural. This path loss is dependent on several factors – transmitted power, electric field distribution, environment of the base station, the diameter of the transmitting antenna, height of antenna etc. which is always concerned while developing the propagation models. This radio channel is linear, but time variant due to which there are rapid variations in the field strength which ultimately increase the path loss. These models are widely used to estimate the various parameters i.e. field strength, path loss etc. in different environments [2]. Propagation models are provided to telecommunication providers to improve their services for better signal coverage and capacity for mobile user satisfaction in the area. Propagation models are available to predict the path loss, but not the coverage area of a system[3]. An empirical propagation models used for estimating the channel parameters are a COST-231 Hata model, ECC-33 model [4], SUI Model [5], and ITU-R (P.1411-1) model[6] at 2300 MHz.

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To create antenna hardware or to enhance the quality of transmission or reception through an antenna, one must consider the propagation and radio transmission characteristics by these models. In this study, AWAS electromagnetic code, which is based on sommerfeld's approach for ground, is used to compute the path loss of propagation link & field strength. As it was reported by Prasad *et al*. that the advantage of AWAS Electromagnetic Code is that it did not require any building information and it was able to compete with other empirical methods[7]. It is compared with the measured data at 2300MHz and significant changes in height of transmitting antenna is identified to radiate efficient signal for WiMAX.

In Section II, the details of AWAS Electromagnetic code and Environmental details are provided. In section III, we have analyzed the data from AWAS electromagnetic code with existing prediction methods. Conclusions are presented in Section IV.

II. Experimental Details

A. *An AWAS Numerical Electromagnetic Code*

AWAS numerical electromagnetic code is a computer program which evaluates the current distribution of a conductor by analyzing the polynomial coefficients. This program is based on a two potential equation which is solved numerically using the method of moments with a polynomial approximation for the current distribution. The influence of the ground is taken into account using Sommerfeld's approach, with numerical integration algorithm developed for this program.

B. *Experimental and Environmental details*

The Experiment is performed in dense urban and suburban environments of Western India. AWAS Electromagnetic code is implemented to calculate the electric field density (V/m) and sustained path loss of the Base Stations in this environment. The Base Stations where experimental work was AAC, AHT, BTW, KTB, GRJ, JVD, and OLK are situated in the dense urban area of Mumbai, India, except AAC, JVD, and OLK, which are located in an urban area[8]. BTW and GRJ are fully surrounded by dense environment. They are surrounded by industrial environments at the eastern side of 0.7 km and at eastern side after 0.9 km respectively[8]. Dalela *et al* reported the parameters of these base stations which is shown in Table II is computed by the AWAS electromagnetic code. Other details like height of receiving antenna, transmitted power etc. is also used to calculate the numerical part of the computational parameters of the WiMAX. Fig 1(a) & (b) shows the clutter environmental site of the base stations listed in table I .

TABLE I
BASE STATION DETAILS

Sr. No.	Name of Base Stations	Height of Transmitting Antenna	Near Field Distance (in Km)
1.	Ajay-Amar (AAC)	37m	1.70
2.	Arihant (AHT)	32m	1.47
3.	Bootwala Bldg (BTW)	46m	2.11
4.	Khethan Bhabhan (KTB)	31m	1.42
5.	Giriraj (GRJ)	28m	1.28
6.	Jeevan Dhara (JVD)	27m	1.24
7.	Obelisk (OLK)	30m	1.38

TABLE III
OTHER DETAILS OF EXPERIMENTAL SITE

Sr. No.	Other Details	
1.	Height of Receiving Antenna	1.5m
2.	Transmitted Power	43.8 dBm
3.	Average Height of Building	25m
4.	Average Street Width	15m
5.	Average Separation Between Buildings	30m

III.

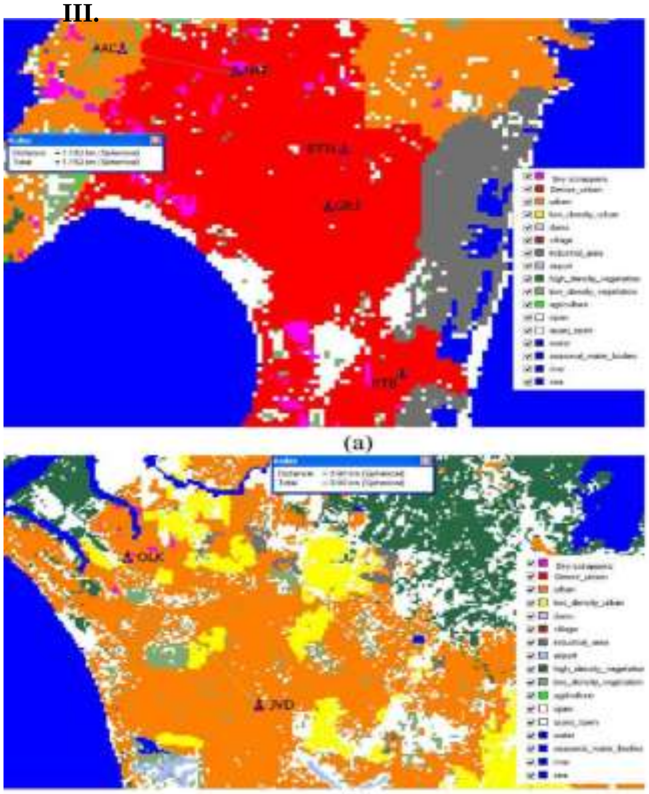

Fig. 1(a) & 1(b) Clutter Environment for experimental site (a)AAC, AHT, KTB, BTW (b)OLK and JVD

Analysis of Measured data

A. *Electric Field Distribution Analysis*

Electric Field is an important factor in analyzing the path loss and its effects in WiMAX. AWAS Electromagnetic code is implemented to calculate the electric field density (V/m) and then further sustained path loss of the Base Stations in this environment can be calculated. The Near Field distribution of base stations is determined for near field distance (in Km) (Table I) for various base stations and are substituted in AWAS Electromagnetic Code in order to estimate the Electric Field Distribution.

As WiMAX is operating at a higher frequency as compared to cellular communication, the variation in field strength is greater. At 2.3GHz, the regular variations in the field strength is shown by Fig 2(a) and Fig. 2(b) respectively.

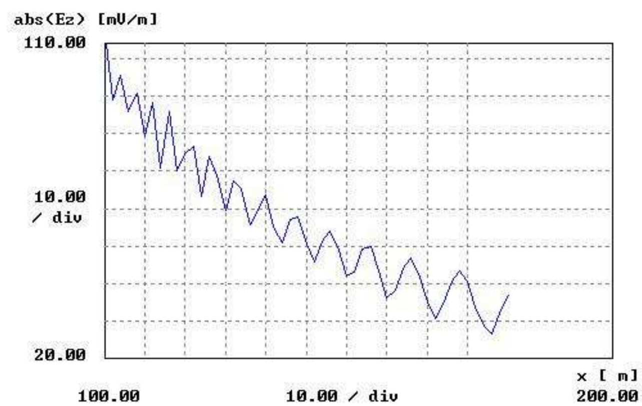

Fig 2(a) : Rapid Variation in Near Field Distribution of GRJ Base Station at 2.3 GHz from 100m to 200m by AWAS Electromagnetic Code

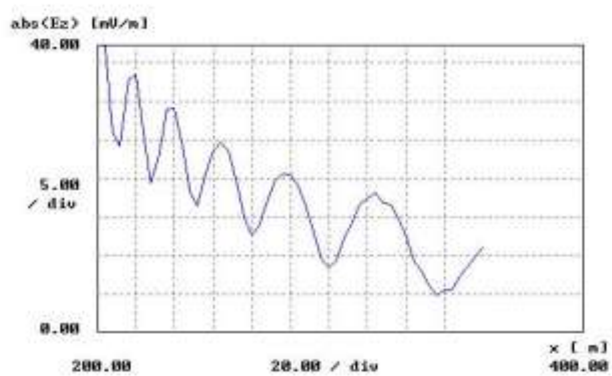

Fig 2(b) : Rapid Variation in Near Field Distribution of GRJ Base Station at 2.3 GHz from 200m to 400m by AWAS Electromagnetic Code

B. *Path Loss Analysis*

The path loss is calculated by using the values of near and far field distribution. Due to the decreasing nature of electric field distribution, the path loss can be even extended up to 200 db at 5 km for the WiMAX base stations having optimum height.

In case of COST-231 Hata Model and ECC Model, the path loss is evaluated by detected path loss exponent n, which is given by [9]

$$PL = PL(n_o) + 10n\log_{10}(d/d_o) + s \quad d>d_o \qquad (1)$$

where n denotes the path loss exponent, d is T-R separation distance,d_o is reference distance point at 100m, s is shadow fading term and $PL(d_o)$ is path loss at range d_o.

The far field is in polar coordinates which is being converted into cartesian coordinates by using classical electromagnetic methods in the AWAS EM code. The gain of the transmitter (G_t) is 8dBi and the gain of the receiver is 2dbi and for 2300mhz frequency, the path loss is given by an equation as :

$$Path\ Loss\ (dB) = 107 + ERP - 20\log(d\ in\ kms) \qquad (2)$$

Substituting distance from the Friss Equation, above equation can be easily reduced to :

$$Path\ Loss(dB) = 107+ERP+20\log(f\ in\ MHz)-E(in\ dB)-29 \qquad (3)$$

where ERP is effective isotropic radiated power which is product of transmitted power and gain of the transmitter.

$$ERP = 20\log_{10}(P_t.G_t)$$

And the path loss for 2.3 GHz becomes

$$PL\ (dB) = 195.45 - E(dB) \qquad (4)$$

where the path loss and electric field is in dB.

The base stations parameters are substituted in the path loss equations, and ultimately the path loss value using AWAS electromagnetic code is been calculated and compared with the graphs of several empirical path loss models. Fig 3(a) , 3(b), 3(c) gives the path loss variation of AAC, KTB and GRJ base stations respectively.

WiMAX signal strength is appeared fluctuating with distance. It is investigated that by decrease in height of a Base Station Antenna and by the usage of repeaters, this problem can be eliminated

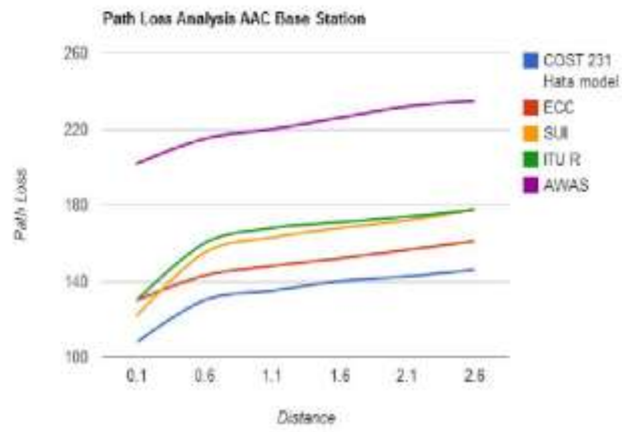

Fig 3(a) Path Loss Analysis of AAC Base Station

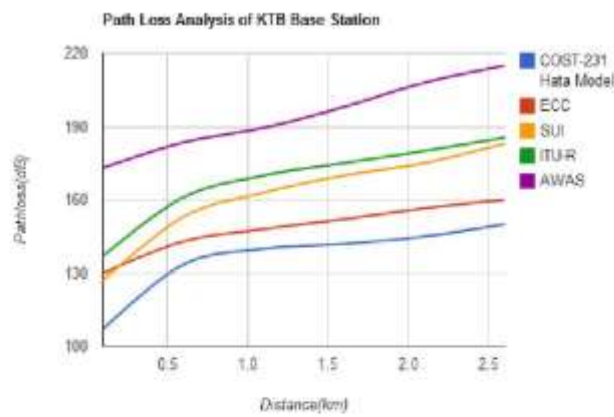

Fig 3(b) Path Loss Analysis of KTB Base Station

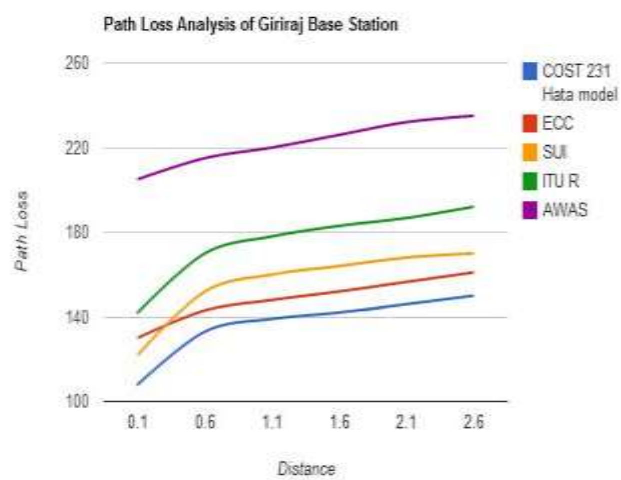

Fig 3(c) Path Loss Analysis of GRJ Base Station

These path curves shows how the path loss varies for AWAS electromagnetic code with respect to distance. These data of the path loss is due to the rapid variation in the near field distribution which is shown by Fig.2(a) and Fig 2(b).

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IV. Conclusion

The process of path loss analysis and estimation of the electric field is processed in WiMAX transmission using 2300 MHz to several base stations by AWAS electromagnetic code. The results are compared with empirical propagation models as COST-231 Hata model, ECC-33 model, model of SUI and ITU-R. It has been found that in the near field region, signal fluctuations are very high, and as the height of transmitting antenna increases, near field distance will be larger whereas the signal remain stable in the far field. Hence, it is advisable to keep the antenna closed to the ground and employee more repeater stations. Thus, with reduced transmitting antenna height will ultimately reduces the variations in near field distribution and is achieved to produce efficient radiated signal. AWAS Numerical Electromagnetic code predicts all the variations of path loss irrespective of environment, whether it is urban, suburban or rural whereas statistical models do not capture the fundamental physics and separate models for urban, suburban or rural environment.

References

[1] "FCC 16th Mobile Competition Report",pp.242-248,March,2013

[2] V Abhayawardhana, I. Wassell, D. Corsby, M. Sellars, and M. Brown, "Comparison of empirical propagation pathloss models for fixed wireless access systems," in *Proc. IEEE Veh. Technol. Conf.*, Stockholm, Sweden, Jun 2005, vol 1,pp 73-77.

[3] Isabona Joseph, Konyeha C.C., and I. G. Peter, "Radio Field Strength Propagation Data and Path loss calculation Methods in UMTS Networks," *Advances in physics Theories and Applications, IISTE*, vol. 21, pp. 54–68, 2013.

[4] CEPT ECC Report 172 ," Broadband Syatem Wireless usage in 2300-2400 MHz",p.11 March,2012.

[5] V. Erceg *et al.*,"Channel models for fixed wireless applications," IEEE 802.16 Broadband Wireless Access working Group, Jan 2001.

[6] "Propagation data and prediction methods for the planning of short range outdoor radio communication system and radio local area networks in the frequency range 300 MHz to 100 GHz," Internation Telecommunication Union, Geneva, Switzerland, Recommendation ITU-R P.1411-1,2001

[7] M.V.S.N. Prasad, Saurabh Gupta, M.M. Gupta, "Comparison of 1.8GHz Cellular Outdoor measurement with AWAS Electromagnetic Code and Conventional models over Urban and SubUrban regions of Northern India", Antenna and Propagation Magazine IEEE, 53(2011),76-85.

[8] Chhaya Dalela,M.V.S.N. Prasad, Pankaj Kumar Dalela & Rajeev Saraf,"Analysis of WiMAX Radio Measurements and Comparison with some models over Dense urban Western Indiaat 2.3 GHz*",IEEE Antenna and Wireless Propagation*, 10,2011.

[9] V. Erceg, I J Greenstein, YJ Tjandra, S R Parkoff, A Gupta, B Kulic, A.A. Julius and R Bianchi," An empiraqcally based path loss model for wireless channel in suburban environments," *IEEE J. Sel Areas Commun.* , vol 17,no.7,pp 1205-1211, Jul 1999.

[10] Y. Yamada, K. Kagoshima and K Tsunekawa, "Diversity Antennas for Base and Mobile Communication Systems", *IECICE Transactions*, vol. E74, no. 10,pp. 3202-3209,1991.

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