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EVALAUTION OF PATH LOSS MODELS OF WIMAX IN SUB URBAN ENVIRONMENT

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Abstract

It is a challenge to the wireless and networking engineer to decide upon the path loss model applicable to the different environments. Estimation of path loss is very important in initial deployment of wireless network and cell planning. Our main concentration in this paper is to find out a suitable model for sub urban environment to provide guidelines for cell planning of WiMAX at cellular frequency of 3.4 GHz

1. Introduction

After successful implementation of wireless broadband communication in small area coverage (Wi-Fi), researchers move forward for the wireless metropolitan area network (WMAN). To find the solution, in 1998, the IEEE 802.16 working group decided to focus their attention to gaze on new technology. In December 2001, the 802.16 standard was approved to use 10 GHz to 66 GHz for broadband wireless for point to multipoint transmission in LOS condition. It employs a single career physical (PHY) layer standard with burst Time Division Multiplexing (TDM) on Medium Access Control (MAC) layer [1].

Worldwide Interoperability for Microwave Access (WiMAX) is the latest broadband wireless technology for terrestrial broadcast services in Metropolitan Area Networks (MANs). It was introduced by the IEEE 802.16 working group to facilitate broadband services on areas where cable infrastructure is inadequate. It is easy to install and cheap [2]. It provides triple play applications i.e. voice, data and video for fixed, mobile and nomadic applications. The key features of WiMAX including higher bandwidth, wider range and area coverage, its robust flexibility on application and Quality of Services (QoS) attract the investors for the business scenarios [2]. Now the millions of dollar are going to be invested all over the world for deploying this technology.

This BWA technology is based on Orthogonal Frequency Division Multiplex (OFDM) technology and considers the radio frequency range up to 2-11 GHz and 10-66 GHz. Propagation condition under NLOS is possible by using OFDM, which opens the possibility of reliable and successful communication for wireless broadband. An important feature is an adaptive modulation technique, which depends on Signal to Noise Ratio (SNR) [4]. It ensures transmission during difficult condition in propagation or finding weak signal in the receiver-end by choosing a more vigorous modulation technique.

In an ideal condition, WiMAX recommends up to 75 Mbps of bit rate and range within 50 km in the line of sight between transmitter and receiver. But in the real field, measurements show far differences from ideal condition i.e. bit rate up to 7 Mbps and coverage area between 5 and 8 km. To reach the optimal goal, researchers identified the following becomes that impair the transmission from transmitter to receiver. [4]

. Estimation of path loss is very important in initial deployment of wireless network and cell planning. Numerous path losses (PL) models (e.g. Okumura Model, Hata Model) are available to predict the propagation loss. In this paper we compare and analyze five path loss models (i.e. COST 231 Hata model, ECC-33 model, SUI model, Ericsson model in different receiver antenna heights in suburban environment in NLOS condition. As our city of consideration (Amritsar) falls in sub urban area so we will be concentrating on the path loss models parameters conforming to the sub urban area.

So we compare and analyze path loss behaviour for 3-3.5 GHz frequency band for sub urban environment (Amritsar)

2. THEORY

BASIC PROPAGATION MODELS

Free space model-Path loss in free space defines how much strength of the signal is lost during propagation from transmitter to receiver. FSPL is diverse on frequency and distance. The calculation is done by using the following equation:

$$PL_{FSPL} = 32.45 + 20\,log_{10}(d) + 20\,log_{10}(f)$$

Cost 231 Hata model-COST 231 Hata model is initiated as an extension of Hata model. It is used to calculate path loss in three different environments like urban, suburban and rural (flat). This model provides simple and easy ways to calculate the path loss(PL) [2]:

$$PL = 46.3 + 33.9log_{10}(f) - 13.82log_{10}(h_b) - ah_m + (44.9 - 6.55log_{10}(h_b))log_{10}d + c_m$$

where

d:	Distance between transmitter and receiver antenna	[km]
f:	Frequency	[MHz]
h_b:	Transmitter antenna height	[m]

SUI model-The basic path loss expression of The SUI model with correction factors is presented as

$$PL = A + 10\gamma log_{10}\left(\frac{d}{d_0}\right) + X_f + X_h + s \qquad for\ d > d_0$$

d:	Distance between BS and receiving antenna	[m]
d_0:	100	[m]
λ:	Wavelength	[m]
X_f:	Correction for frequency above 2 GHz	[MHz]
X_h:	Correction for receiving antenna height	[m]
s:	Correction for shadowing	[dB]
γ:	Path loss exponent	

Ericsson model-To predict the path loss, the network planning engineers are used a software provided by Ericsson company is called Ericsson model [2]. This model also stands on the modified Okumura-Hata model

$$PL = a_0 + a_1.log_{10}(d) + a_2.log_{10}(h_b) + a_3.log_{10}(h_b).log_{10}(d) - 3.2(log_{10}(11.75h_r)^2)$$

$+g(f)$

$$g(f) = 44.49log_{10}(f) - 4.78(log_{10}(f))^2$$

and parameters

f:	Frequency	[MHz]
h_b:	Transmission antenna height	[m]
h_r:	Receiver antenna height	[m]

3. SIMULATION

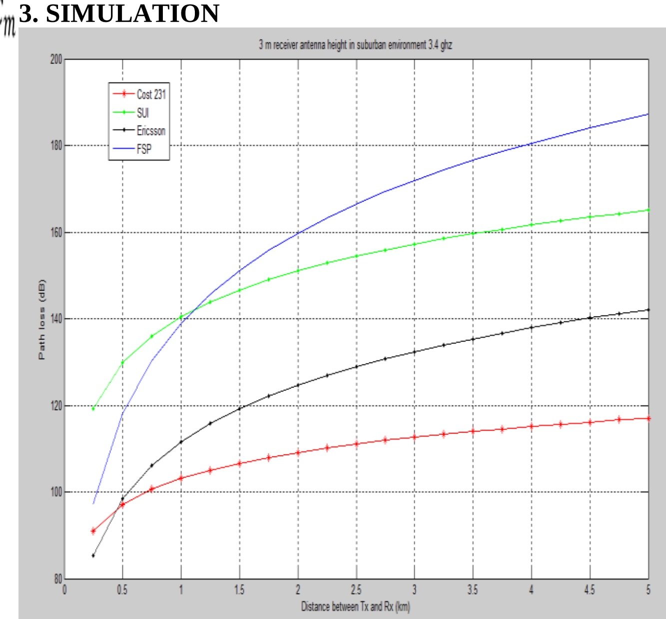

Fig 1: Path loss in Sub urban environment at 3m receiver height

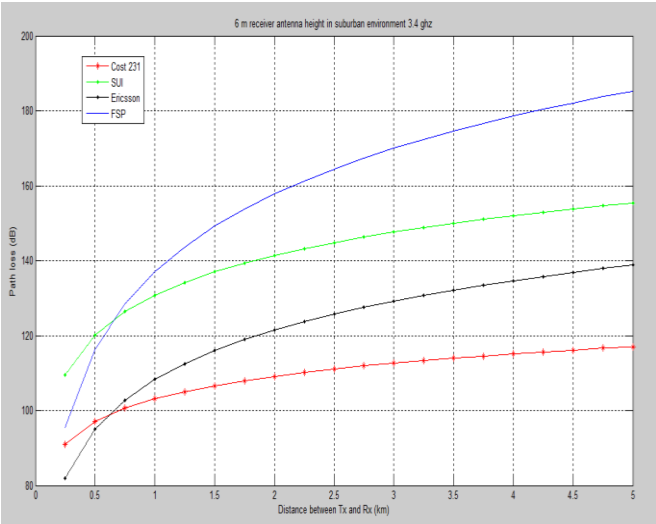

Fig 2:Path loss in Sub urban environment at 6m receiver height

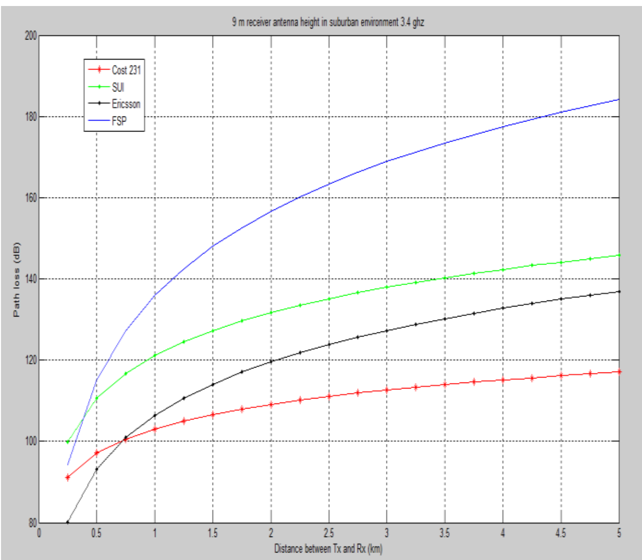

Fig 3: Path loss in Sub urban environment at 9m receiver height

CONCULSION:

It is showed that the SUI model predict the lowest path loss in this terrain with little bit flections at changes of receiver antenna heights. Ericsson model showed the heights path loss prediction especially at 6 m and 9 m receiver antenna height. The COST-Hata model showed the moderate result with remarkable fluctuations of path loss with-respect-to antenna heights changes. Maximum coverage can be served by using more transmission power, but it will increase the probability of interference and if we consider less path loss model for deploying a cellular region, it may be inadequate to serve the whole coverage area. So, we have to trade-off between transmission power and adjacent frequency blocks interference while choosing a path loss model for initial deployment.

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