A New Empirical-Physical Method for Calculation of Path Loss for Fixed Wireless Access in Suburban Areas

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Abstract— **In this paper a new empirical-physical method for calculation of path loss in the fixed wireless access in suburban areas is proposed. It is shown that this method has a relatively good accuracy for high transmitter antennas. Since in fixed wireless access, high transmitter antennas are used, we can use this method for this kind of communications and in special case for systems based on IEEE 802.16a. In this method a new empirical model for calculation of path loss exponent is used which is based on measurements reported in various papers and in contrast to other models, the effect of receiver antenna height in the path loss exponent is considered. The first step of this method is the calculation of path loss for a 2D scenario by using GO[1] and UTD[2] methods with respect to transmitter-receiver distance. Then using new empirical model, path loss exponent is corrected and in this manner, the final path loss is obtained.**

Keywords- fixed wireless access, GO, IEEE 802.16a, path loss, path loss exponent, UTD.

I. INTRODUCTION

Study of various papers ([1]–[3]) has shown that up to now there isn't a reliable model for fixed wireless access in 3.5 GHz (one of the frequency bands in systems based on IEEE 802.16a). In fact, most of the known path loss models are for frequencies below 2 GHz [1] (frequency bands for cellular communications) and thus there is a need for development of current models or establishment of a new model for higher frequencies. On the other hand these models are basically for mobile communications and their effectiveness for fixed wireless communications is not verified ([2], [3]). One of the main differences between mobile communications and fixed wireless communications, from the viewpoint of channel modeling, is the receiver and transmitter antenna heights. In fixed wireless communications, receiver antenna height is considered between 3^m and up to the buildings height. Whereas in mobile communications this height is considered about 1^m to 3^m [4]. In addition, in fixed wireless communications, transmitter antenna height is generally higher than average buildings heights, whereas in mobile communications this height can be lower than average buildings heights [4].

At present the most applicable models for fixed wireless communications at 3.5 GHz are: SUI [5], COST 231 Hata [6], and COST 231 Walfish-Ikegemi [7]. These models are generally for frequencies below 2 GHz. In addition, in some of these models there are limitations for receiver antenna height. In SUI model there is a correction for higher frequencies and higher receiver antenna heights, but correctness of this improved model at 3.5 GHz needs more in depth studies.

In this paper, the path loss in suburban areas is calculated with a new empirical-physical method which can be used for various frequencies and various antenna heights. In this method a new empirical model for calculation of path loss exponent in suburban areas is used. The first step of this method is the calculation of path loss for a simple 2D scenario, using GO and UTD methods. After that, using new empirical model, path loss exponent is corrected and in this manner, final path loss is given.

It is shown that this method has a good accuracy for high transmitter antennas which is one of the fixed wireless communications specifications.

Section 2 of this paper is about a new empirical model for path loss exponent. In section 3 calculation of path loss using GO and UTD is explained. Finally in section 4 the results of correction of path loss exponent and comparison of these results with measurements and well-known models are presented.

II. NEW MODEL FOR PATH LOSS EXPONENT IN SUBURBAN AREAS

Study of papers which have measurement results of path loss for various receiver antenna heights, shows that path loss exponent has a reverse relationship with respect to receiver antenna height ([4], [8] and [9]). In known path loss models like SUI, COST 231 Hata, COST 231 Walfisch-Ikegemi, the relationship between path loss exponent and receiver antenna height is not considered. Since in mobile communications, receiver antenna height is considered to be about 1^m to 3^m, consideration of this relationship is not important. But in fixed

[1] Geometrical Optics
[2] Uniform Theory of Diffraction