Path Loss Model Tuning at GSM 900 for a Single Cell Base Station

Allam Mousa, Department of Electrical Engineering, An-Najah National University, Nablus, Palestine

Mahmoud Najjar, Department of Electrical Engineering, An-Najah National University, Nablus, Palestine

Bashar Alsayeh, Department of Electrical Engineering, An-Najah National University, Nablus, Palestine

ABSTRACT

Mobile communications has become an everyday commodity. In the last decades, it has evolved from being an expensive technology for a few selected individuals to today’s ubiquitous systems used by a majority of the world’s population. Imprecise propagation models lead to networks with high co-channel interference, as well as power waste. This study aims to adapt a propagation model in the city of Nablus (Palestine) for a GSM frequency band. This study helps to design better GSM networks for the city in spite of the geographical and frequency limitations. The modification is accomplished by investigating the variation in path loss between the measured and predicted values, according to the propagation model for a specific cell. The results from a simulation model and measured data was compared and analyzed. Bertoni-Walfisch model, without tuning, gave the best results with a mean error of 1.426 dB, which is much less than the mean error obtained by the Standard Macrocell model, 10.91 dB, which is used by a local mobile operator. The two models have been tuned to fit measured data for GSM-900 in the city of Nablus. This is a vital step in cell planning and rollout of wireless networks. To confirm the superiority of Bertoni-Walfisch, a comparison between Bertoni-Walfisch and Standard Macrocell model in terms of Standard Deviation and Mean Error (RMSE).

Keywords: Bertoni-Walfisch Model, Global System for Mobile Communication (GSM) Frequency, Least Mean Square Error Tuning, Propagation Measurements, Standard Macrocell Model

1. INTRODUCTION

In spite of the development of numerous empirical path loss prediction models, the generalization of these models to any environment is still questionable. They are suitable for a variety of geographical settings (urban, suburban, rural, etc.), or specific cell radius (Macrocell, Microcell, Picocell), depending on the mobile communications environment. There is a relationship between these models and the types of environments for which they are suitable. To overcome this drawback, the empirical models’ parameters can be adjusted or tuned according to a specific environment. The propagation model tuning must optimize the model parameters in order to achieve minimal error between predicted and measured signal

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strength. This will make the model more precise in receiving wireless signal predictions (Yang, Shi, 2008).

Operators utilize special planning software to undertake propagation model tuning, such as ASSET and ATOLL (Mingjing, Wenxiao, 2008), (Yang, Fang, Yongyu, Dacheng, 2007). The local cellular communication operator uses ASSET software (AIRCOM International Ltd., 2007) which is based on modified Hata model.

1.1. Terrestrial Description of Nablus City

The city of Nablus cast narrow streets and moderately high buildings, the buildings heights vary between 9 and 12 m within the old city and city center. Most of the buildings are mass of concrete, rock-like blocks, and bricks. Furthermore, in terms of landscape, Nablus has a particular characteristic of having a large number of squares (small open areas).

Extensive experimental tests were performed in the geographic area of Nablus and especially in the city center to investigate the channel propagation behavior in different directions relative to the streets. The results of those measurements were used to define the standard deviation, mean error and RMSE to enhance our understanding of wave propagation in the city.

1.2. Frequency Reuse Problem in Drive Test

Frequency reuse is a technique where frequencies and channels within a communication system is reused to improve capacity and spectral efficiency. Frequency reuse in mobile cellular systems requires each cell to maintain a frequency that is enough far away from the frequency in the adjacent cell to eliminate the interference problems. A local operator requires frequency reuse for many sites. For example, Nablus has around seventy sites with each site containing two to three cells while the operator has twenty-four channels from GSM-900 band.

The first twelve channels are BCCH (Broadcast Control Channel), and the last twelve are traffic channels due to certain agreements. Therefore, frequency reuse is an urgent need in Nablus cellular networks.

The paper is organized such that Section 2 presents the measurement environment. Section 3 reviews some propagation models and the path loss concept. Section 4 discusses the standard macrocell model tuning. Section 5 describes Bertoni-Walfisch model tuning and Section 6 concludes the findings.

2. MEASUREMENTS

The measured data was collected using a test drive where an average of several measurements was taken for each rout. The test software, TEMS Investigation (Ericsson, 2009), was installed on a laptop which was connected to a mobile phone, also a GPS (Global Positioning System) was used to get an accurate locations (Jalel, Ali, Rafiqul Islam, Al-Hareth, 2011).

According to the requirement of radio network planning, a single Macrocell base station located in the downtown (city center) was chose. The drive test was performed through a specified rout to cover the area from the Northern Mountain, through the city center, to the Southern Mountain for both ways. Unfortunately, the test failed because the frequency of the selected cell had many frequencies reuse. Thus, we received a signal at a maximum distance of 200 meters due to interference with other neighbor cells at the same frequency. This was insufficient to conduct a useful analysis. Therefore, a clear relationship between the distance and the path loss slope per decade cannot be concluded. Furthermore, in order to reassess the goal of this paper, an empirical data can’t be collected for a large landmass though tests drive (Jianhui & Dongfeng, 1998).

Due to aforementioned conclusion, the test was repeated after the neighboring six cells which shares the same frequency was turned
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