Dominant Path Model Fitted to Signal Measurements of Digital TV in Non-Line of Sight Propagation

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***Abstract*—Broadcast television is one of the most important telecommunication systems in Brazil. Such relevance requires that an assessment of the coverage and quality of the Digital TV signal must be extensively performed in the pursuit of technical excellence. The study of coverage prediction models would allow broadcasters to project their stations in a way to distribute their respective signals harmoniously. The aim of this paper is to evaluate measurements of Digital TV signal collected in the field and to compare them with numerical results obtained from computer simulation using the Dominant Path Model. The results indicate potential blocking zones and a low accumulated probability index above the signal reception threshold. Also, it characterizes the gain level of the receiving antenna that would avoid signal blocking.**

I. INTRODUCTION

The Brazilian System of Digital Terrestrial Television was instituted and implemented by federal decrees published in 2003 and 2006 respectively [1]. In the early days of its implementation led by government agencies, efforts were focused on the research and development of a high-performance system for the processing, transmission, and reception of digital audio and video signals. This system should have the ability to coexist with the Analogue TV system during the transition period between these two technologies [2]-[3].

The official kickoff for the transmission of Digital TV signals in Brazil occurred in 2007, in the city of São Paulo, and since then, other cities across the country have been following a schedule defined by the Ministry of Communications for new deployments [1]. An important characteristic of the digital system is the reception power because there are considerable losses in the quality of services when comparing it with the analog system [4].

With the objective of defining parameters related to coverage and interference, several prediction models are implemented as well as field measurements are performed [1]-[2]. Those measurements are essential in order to validate the prediction and to identify areas with a difficult reception [1].

In [2], a study is conducted in the main Brazilian capitals where a comparison is made between field intensity measurements and numerical results from the implementation of ITU-R P.526, Deygout-Assis, ITU-R P.1546 and CRC Predict models. A similar study is performed in [1] where 223 measurement points were distributed along the metropolitan region of the city of Curitiba.

This paper aims to evaluate field measurements of Digital TV signal collected in the coastline of the city of João Pessoa and compare them with numerical results obtained from the implementation of the Dominant Path prediction model using the *WinProp® Software Suite*.

II. OVERVIEW OF THE DOMINANT PATH MODEL

The Dominant Path Model (DPM) is based on the fact that not all power rays between the transmitter and the receiver contribute with similar energy to the total power received. In fact, only a few propagation paths are dominant in terms of energy input [5].

The DPM can be applied in indoor, urban and rural scenarios. It focuses on only the dominant paths and does not calculate the paths with small energy contribution. Also, it does not consider all the details of the database and, thus, requires less time to pre-process it [3].

The DPM model can be subdivided into two steps:

1) Determination of the dominant paths (geometry);
2) Loss prediction along the paths.

In the case of mountainous urban scenarios, the topography of the area should be considered along with the height of the buildings for taking into consideration the visibility factor [6].

III. MATERIALS AND METHODS

The applied methodology was based on the comparative analysis of field measurements and numerical results obtained from computer simulation using the Dominant Path Model.

A. Field Measurements

It was performed, in the city of João Pessoa, a survey on the reception intensity of Digital TV signal in several points on the coastline of Cabo Branco beach and adjacent streets.

On the 9th of February of 2017, 66 measurements were collected *in loco* and divided into three routes: blue (first), green (second) and red (third) routes. The red route is 30 m higher than

the other ones and the green route is right at the bottom of that 30-meter hill. Fig. 1 shows how those points were distributed along the routes.

Fig. 1. Measurement points (numbered from left to right).

The studied TV station was *TV Manaíra* which serves as the João Pessoa city affiliate station of the *Rede Bandeirantes* and operates in the frequency range between 482 MHz and 488 MHz.

B. *Study of the Coverage Prediction Model*

The coverage prediction was executed through the implementation of the Dominant Path Model using the *WinProp® Software Suite.*

With the objective of collecting results with maximum possible precision, the simulation scenario was prepared by building the blocks that represent the city buildings and houses along the region of interest, and by inserting its topographic information.

Also, the antenna pattern and its azimuth were taken into consideration as well as transmission power and tower height. Specifications regarding the TV station can be found in details at the Brazilian National Telecommunications Agency system.

IV. RESULTS

The data collected in the field and through computational simulation were organized and assessed by each route. The green route had the lowest reception power (Fig. 2).

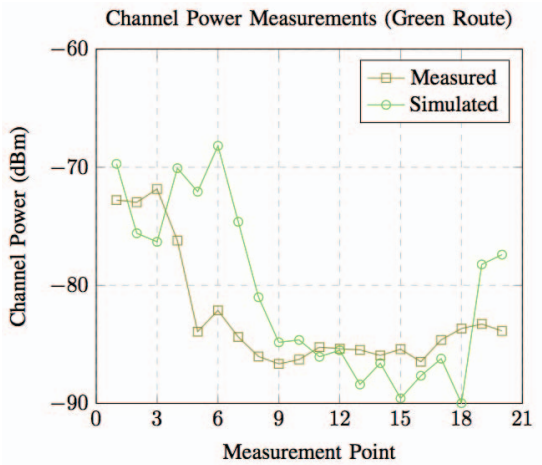

Fig. 2. Comparative analysis of the reception power.

Besides the comparative analysis, the numerical results also calculated the accumulated probability index. It shows the probability in which a channel power might be below a certain reception power.

As long as we are dealing with Digital TV signal, the reception threshold is -77 dBm, and the index showed that the probability of it to be below -77 dBm is 20%.

V. CONCLUSION

In order to verify the accuracy of this work, line graphs were plotted. In the example of Fig. 2, it is presented the worst scenario in which most of the measured and simulated points are below the reception threshold.

The accumulated probability index also shows us that only 80% of the region of interest has a coverage above the threshold of -77 dBm. This is a very low percentage since it is essential to get as close as possible to 100% coverage.

Based on this results, the Dominant Path Model showed itself not only as a reliable and accurate tool but also as a model that requires a low computational effort.

For future works, it would be important to evaluate the same region of interest through the use of other coverage prediction models.

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