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Correction of the propagation model in digital terrestrial television networks in urban environments

Corrección del modelo de propagación en redes de televisión digital terrestre en entornos urbanos

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RESUMEN

Este artículo presenta un modelo de propagación idóneo para el diseño de redes Televisión Digital Terrestre (TDT) en la ciudad de Bogotá. En el desarrollo se encuentra la evaluación y comparación de tres modelos de propagación comúnmente usados para el diseño de este tipo de redes; estos son los métodos Stanford University Interim (SUI), Xia-Bertoni y Okumura-Hata, escogidos porque permiten calcular las pérdidas de propagación sobre la banda UHF y la información cartográfica que requieren para estimar las pérdidas por difracción no es de alta precisión. Aquí se determina que dos de los modelos escogidos son cercanos al modelo real en un rango de 10 – 15 dB. Dado esto, se ajustaron y se efectuó una corrección, por medio de Matlab, a los todos los modelos con el fin de obtener una acertada estimación de pérdidas en la propagación de la señal. Los modelos fueron evaluados con criterios estadísticos de significancia como lo son el coeficiente de correlación, error medio cuadrado, desviación estándar etc. [1] Como resultado se determinó que tanto el modelo Okumura-Hata como el Xia-Bertoni se ajustaban fácilmente al modelo real, sin embargo, el error del modelo Xia Bertoni es menor en comparación con Okumura.

ABSTRACT:

This article presents an ideal propagation model for the design of Digital Terrestrial Television (DTT) networks in Bogotá City. Here was developed, evaluated and compared three propagation models commonly used for the design of this type of networks; these are the methods Stanford University Interim (SUI), Xia-Bertoni and Okumura-Hata. Those were chosen because they allow to calculate the propagation losses over the UHF band and the cartographic information required to estimate the losses by diffraction is not high precision. Here, we found two of the selected models are close to the actual model in a range of 10-15 dB. So, all the models were adjusted and corrected by MATLAB in order to obtain an accurate estimate of signal propagation losses. The models were evaluated with statistical criteria of significance such as correlation coefficient, mean square error, standard deviation and so on [1]. As a result, both Okumura-Hata and Xia-Bertoni models were found to fit easily into the real model, however, the error of the Xia-Bertoni model is smaller compared to the Okumura model.

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1. Introduction

It is known for the date that Colombia since 2009 began a gradual process of migration of analogous TV to digital, looking for the "analogical blackout" for 2019. Therefore, since then multiple designs of network have taken place which offer coverage service to the national territory under the Digital Standard Video Broadcasting Second Generation Terrestrial DVB-T2. Being Bogota the capital city and one of the biggest cities of the country, it's with total coverage already provided by 5 stations: Suba y Santa Librada operated by CCNP (Consorcio Canales Nacionales Privados) and Calatrava, El Cable y Cruz Verde operated by RTVC (Radio Televisión Nacional de Colombia). [2-3]

The present article analyzes and compares the yields of three models of propagation with measures of field made in different points in Bogota. It is tried to complete a correction to the propagation model that better adjusts to the design of a network with an efficient coverage. [4] This means that when correcting and/or modeling to a radio link, considering the characteristics of trajectory between the transmitter and the receivers, it is possible to determine the implementation viability of the network as far as capacity and costs of the systems [5-6]. The document is divided in the following sections: Section 2 the state of art, Section 3 looks for explaining the propagation process and to describe the models to study: Stanford University Interim (SUI), Xia-Bertoni and Okumura-Hata. Section 4 describes the treatment of the coverage data in the city. Section 5 shows the comparation and correction of the best model of propagation for an accurate design of network DTT in the city. Finally, section 6 with the main conclusions of this article.

2. State of the art

The wild growing of new technology applications had had an important impact in the way we communicate each other. Telecommunications had been increasing their hardware and software to make the message process optimal. So, old technologies had opened the space to new protocols which improves bit rates, bandwidth, modulation systems and so on. Improvements like 4G/5G technologies had modified mobile communications and the increasing of the speediest switching technologies had putting aside analogic systems. Digital TV is just one of those applications who had changed the quality of an important communication service. The designing of a DTT network is an actual challenge to solve. [7] There are many communication networks working already, that's why the designer must take in count probably interferences with other services working near to their operational frequencies. United Kingdom was one of the early developers DTT countries. In fact, in 1999 a coverage analysis was made by the BBC in UK. Using a helicopter, measurement system was designed to sense field strength [8]. Each country in the world choose a standard which defines transmission and reception parameters to consider when designing those networks. For example, in USA their standard ATSC 3.0 had been analyzed in the designing process to offer coverage [9], same as in Indonesia however their standard changes to DVB-T and DVB-T2 [10]. As we said in the introduction, the standard chosen to Colombia DTT networks is DVB-T2 and all the designs must use it. Many studies had been made because of our topology and our Andean Country condition [11]. For example, to develop the service in urban areas, [12] analyzes the feasibility of providing mobile DTT DVB-T2 service over the coverage of the RTVC DTT Network in Bogota. They found it will be possible to provide mobile DVB-T2 mobile services due to the fact that the DTT networks have been designed to provide portable indoor receptions in those kinds of areas. Also, is so important to identify the possible co-channel interferences due to those scenarios of 700 MHz frequency band, where DTT DVB-T2 and 4G/5G systems exists. The analysis made by [13] found permissible interfering field strength levels for the co-channel operations so it seems to be an analysis to keep in mind when the designing process. Moreover, the coexistence scenarios on the frontier's country zones with the convergence of services as DVB-T2 (Colombia) and SBTVD (Brazil) and LTE/LTE-A has to be studied [14]. As we can see next-generation DTT standards are called to provide increased capacity within the reduced spectrum [15]. Multipath is an accentuated condition in the region we are. However, the DVB-T2 standard was designed to take advantage of this condition because of the modulation system. [16] A fundamental topic on designing DTT networks is the prediction method for estimating signal scattering from many obstacles in the coverage area [17-18]. We realize there is not enough methods for estimating all types of signal scattering, for example [19] study the way that losing estimations of signal scattering from wind turbines is made and found a lack of accuracy. Also taking in account the terrain characteristics: which DTT tuner should be chosen? [20]. Studying models is a way to fit the best of all to our designing process, [21] proposes a model as a tool to investigate the potential network planning gains of time-frequency slicing in Sweden. An important analysis is the path loss. Propagation models should be studied. For example, [22-24] compared three propagation models, Free-Space, Lee, Hata and Extended Cost-231. Other propagation model's performance was studied as long-distance, Okumura-Hata, Okumura-Hata-Deygout, ITU-R P. 1546, ITU-R P. 1812-3 where statistical parameters as Root Mean Square Error was evaluated to choose the model better fits [25-27]. The studies were made in South America Countries like Uruguay and Perú [28-30]. Also, some other propagation models had been studied for mobile propagation and reception, Longley-Rice, ITU R-P. 1546 [31]. Some of those models uses different methods to fit or correct those evaluated models in order to improve the accuracy of propagation results, [32] uses the square method fitting to adjust the equation once Okumura-Hata was evaluated and compared.

As we been talking about the efficient use of the radio spectrum, there is a broadcast network call SFN or single frequency network, where diverse transmitters simultaneously send the same signal over the same frequency. This sort of network is the one chose to DTT network design, for example [33] examines the way to maximize an SFN coverage for DTT based on ISDB-T standard. They use the ITU-R P.1546 propagation model to determinate path loses and uses a digital terrain map with high levels of resolution as a tool to determinate the expected power values. Simulations are an important instrument to take as a reference and depending on the resolution could be taken as equal as a measure campaign. As we can read in [34-35] were using XIRIO and ICS Telecom simulation software, and evaluating Hata+Deygout66, ITU-R P.1546, Longley Rice and de deterministic model ITU-R 525/526, got mean error values of 0.8 dB, 6.2 dB of standard deviation and 0.72 of global correlation. Simulations in [35] were made around the Bucharest city and the best propagation model to design was Hata-Davidson empirical model. Different situation for [36] where there is a comparation between the measurements taken by a spectrum analyzer on field and simulations using Irregular Terrain Model (NTIA-ITS Longley-Rice), Hata-Davidson and ITU-R 1546. They found that using the DVB-T standard the Longley-Rice model gives satisfactory results in comparison to the measurements. However, any of those models were fitted or adjusted. Another topic to be evaluated is the convergence of DTT and WSD (White space devices). For a high-quality network, the WSD emission limits are quite sensitive to the constraint on Location Probability degradation says [37]. A propagation model based on building penetration for TV withe spaces systems has been proposed in [38]. The model is based on free space loss with additional building penetration losses. Also, in [39] has been studied a particular case of a low occupancy time and locations on the DTT band. There frequency band and area between LTE-A and DVB-T2 is sharing. They found the need of spectrum from International Mobile Communications-Advanced technologies, so spectrum sharing is proposed as a solution. In addition, they demonstrated, based on measurements in real scenarios, the feasibility of using TV-White-Spaces in the DTT band for spectrum sharing between indoor LTE-A femtocells and DVB-T2 networks with fixed rooftop reception.

As we've seen the DTT network is currently in construction, propagation models are just one of the components on designing DTT SFN either rural or urban. This article proposes an urban scenario were instead just a comparation there is a fitting and correction of the most suitable model to design.

3. Propagation Models

When evaluating a process of network design for a certain coverage area, is mandatory to consider the existence of reflection parameters, diffraction and dispersion that the transmitted signal in tis way to the receiver undergoes. When modeling the propagation of this signal is necessary to keep in mind the surroundings (urban, rural, suburban etc.), height of transmitters and propagation frequency and so on. The propagation models can be classified in determinists, empiricists and semi-determinists. [40]

The Xia-Bertoni model describes the propagation of signals located in the UHF band (300 MHz to 3 GHz) in big cities. That model considers the profile of the land and buildings for the losses. In each point of calculation, this model adds a term of losses for diffraction which depends on the measurement height of the obstacles located between transmitter and receiver [41]. The propagation model identifies two factors of diffraction in urban surroundings: diffraction Lrts tile-street and diffraction multiscreen Lmsd due to the buildings of the study surroundings.

The basic loss of the model is expressed like the sum of the losses in conditions of free space, the losses Lrts tile-street and the losses due to diffraction multiscreen Lmsd. The calculation of diffraction tile-street los, is carried out from the Geometric Theory of Diffraction [42]; the equation based on the frequency is as it follows:

$$L_{rts}(dB) = 27.78 + 10\ log\ r + 10\ log\ f + 20\ log\ [\varphi(2\pi + \varphi)] \quad (1)$$

here r corresponds to the distance from the diffraction point to the measurement point and φ is the angle formed by the diffraction.

In order to determine the losses by multiscreen diffraction, there are three parameters to consider: if the height of the station antenna is over the tile roofs level, if the height of the station antenna is close to the tile roofs level and if the height of the station antenna is below to tile roofs level. In this study case and according to planning in Bogotá [43] we use the first condition, being the losses as it follows:

$$L_{msd}(dB) = 14.9 - 18\ log\ \Delta h_b - 9\ log\ b - 9\ log\ f + 20\ (1 - 4 \cdot 10^{-3} \Delta h_b)(3 + \ log\ d) \quad (2)$$

here b corresponds to a medium range between Δhb buildings height of the transmitting antenna and d is the distance from transmission point to reception.

One of the most well-known and applied propagation models for the estimation of urban atmosphere losses is the described one in the compiled Okumura-Hata. It represents the urban loss by propagation based on the operation frequency (f) (150 to 1500 MHz), distance between transmitter and receiver, antennas height and a correction factor (hre) of the receiving antenna height that will depend on the size of area at issue [44]. For a large city as Bogota applies as it follows:

$$a(h_{re}) = 32.2\ (\log 11.75\ h_{re})^2 - 4.97 \quad f \geq 400\ MHz \quad (3)$$

The propagation model developed by IEEE altogether with the University of Stanford, proposes three different types of land: [45]

Type A: Mountainous land, with moderate or abundant presence of vegetation, related to the greater amount of losses.

Type B: Flat or mountainous land with little vegetation.

Type C: Flat land with little vegetation, associated to low losses.

Considering this information, the model determines the following expression to find the losses:

here:

$$L(dB) = A + 10\,\gamma\ log\ [\tfrac{d}{d_0}] + S \quad (4)$$

$$\gamma = a - bh_b + \frac{c}{h_b} \quad (5)$$

hb, is transmitter height, s is a shaded factor of and γ is the exponent of losses due to trajectory, whose constants a,b and c depend on the type of land to study; for the present article case of study, Type C corresponds to the terrain.

Parameter	Terrain Type C
a	3.6
b	0.005
c	20
S	8.2

Table 1. Parameters for Stanford Model. [46]

4. Coverage Data

The propagation analysis in this article takes as transmission reference the stations Calatrava and Cruz Verde placed in a hill in Suba and the Eastern hills respectively, the study takes place on channels 16 and 17 assigned to RTVC [47].

Next, the transmission parameter of the mentioned stations is described in Table 2.

Description	Value	Unit
PIRE BTS	24013.14194	W
PTx BTS	73.8044	dBm
Gain Tx Antenna	12.45	dBi
Gain Rx Antenna	5	dB
Central Frequency Channel 16	485	Mhz
Central Frequency Channel 17	491	Mhz

System Loss Rx	3.5	dBm
System Loss Tx	2.42	dB
BTS Height	58	m
Measurement Height	10	m

Table 2. Parameters Calatrava station. [11]

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PIRE BTS	24013.14194	W
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Gain Rx Antenna	5	dB
Central Frequency Channel 16	485	Mhz
Central Frequency Channel 17	491	Mhz
System Loss Rx	3.5	dBm
System Loss Tx	2.42	dB
BTS Height	38	m
Measurement Height	10	m

Table 3. Parameters Calatrava station. [11]

Initially for the acquisition of the data we looked for making measurements by our own with equipment pertaining to Distrital University. Nevertheless, from investigations was found that the function "Transmitter Signature" provided by standard DVB-T2 like a method which transmits a specific signal transporting identification information from the transmitter [48]; it is not implemented in the same one, thus requiring also expensive equipment to carry out an empirical measurement with a directional antenna. Therefore, the exact identification of the station becomes difficult due to the others BTS which offer coverage in the city. However, the National Authority of Television in Colombia (ANTV), on its official web site in the section Terrestrial Digital Television, publishes information of coverage study over each station that offers the DTT service in Bogota [49]; information elaborated by the TELEMEDICIONES S.A company. The points selected for the study on Calatrava and Cruz Verde can be identified respectively in Figures 1 and 2.

Figure 1. Points of measurement with respect to the Calatrava station 4°44'36.88 " N, 74° 4 ' 29,38 " W. Source: Software Google Earth.

Figure 2. Points of measurement with respect to the station Verde Cross 4°37'53.13 " N, 74°03'04.1 " W. Source: Software Google Earth.

Next, power reception versus distance graphs are showed in Figures 3, 4, 5 and 6.

Figure 3. Relation received power versus distances for Calatrava on channel 16. Source: own.

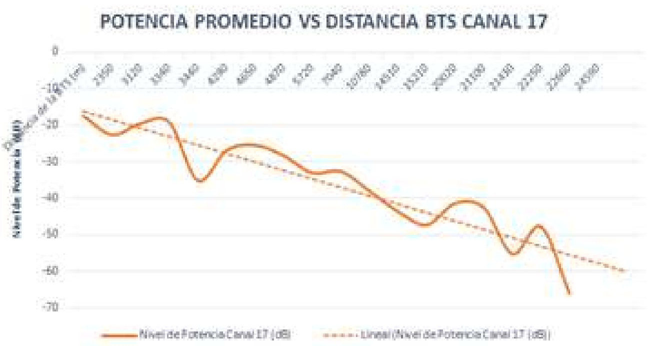

Figure 4. Relation received power versus distances for Calatrava on channel 17. Source: own

Figure 7. Relation power waited for from the model of free space. Source: own.

As we can observe in the figure 7, exists a difference of 10 dB at first and will be increasing in comparison with the measured real power.

4.2. Propagation by Okumura-Hata

Based on the explained empirical formula in section 1, it is possible to be demonstrated that it offers a unique pattern of correction in the analysis of those losses. This is the correction antenna factor established using (3):

$$a(h_{re}) = 32.2 (\log 11.75 * 10)^{2} - 4.97 = 8,7421$$

The correction factor depends on *hre* the height to which the measurements were done. To clarify, as much for Calatrava as Cruz Verde, a height of 10m was used.

Next, its shown the data obtained when applying the measurement trajectories using Okumura-Hata model and its corresponding Friis equation. Also, in figure 8 and 9 we can compare the behavior of the expected power in Okumura-Hata model with the real measurements taken point to point in reference to the Calatrava and Cruz Verde stations.

Figure 8. Relation power waited for from the model of Okumura-Hata for Calatrava Canal 16. Source: own.

From the graphical analysis of the power expected behavior using Okumura-Hata estimation losses model, it's evident a difference between the real data and the theorical data of 15 dB for channel 16 on Calatrava and a difference close to 10 dB for channel 16 on Cruz Verde.

Figure 9. Relation power waited for from the model of Okumura-Hata for Green Cross Canal 16. Source: own.

Comparing the data collected with Okumura-Hata and the free space model, a difference between 10 and 15 dB stays in reference to real data and obtained slopes are agreed with real data. With the purpose of evaluating the performance of estimation losses models, some statistical criteria of significance are analyzed, as they are:

Statistical Criteria for Okumura-Hata		
Criterion	**Vlr. Ch 16**	**Vlr. Ch 17**
Coefficient of Correlation	0.904	0.904
Average Quadratic error	243.14	243.145
Covariance	145.28	145.280
Variance	166.27	166.270
Standard deviation	12.894	12.894
Index of structural Similarity	0.4507	0.451

Table 4. Statistical criteria for Okumura-Hata Calatrava Canal 16 and 17. Source: own.

4.3. Propagation by Stanford University

The Interim University of Stanford model, defines three different scenarios to calculate the basic path loss. The scene which adjust to the conditions in which the present investigation was made, corresponds to category C: Level Zones with very low vegetation density. With the constants provided by the Stanford Study that corresponds to the land type C, we obtain according to the equation (4):

$$L(dB) = A + 10\,\gamma\,log\left[\frac{d}{d_0}\right] + S$$

$$A = 3.6$$

$$S = 8.2$$

Here, *d* is the distance between the transmitter and the receiving antenna, *d0 =100m₂ s* correspond to shaded effect and *r* is the trajectory losses exponent that depends on the constants *a*, *b* and *c* related in Table 1.

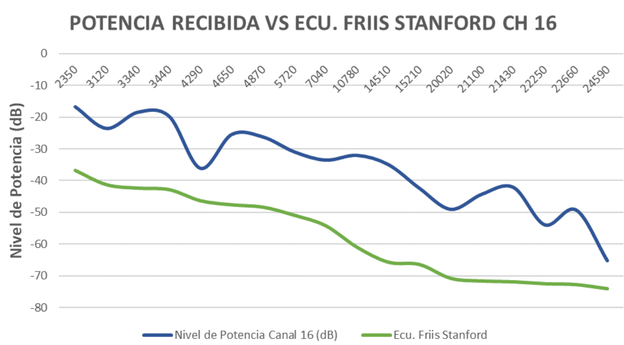

Figure 10. Relation power waited for from the model of (SUI) for Calatrava Canal 16.
Source: own.

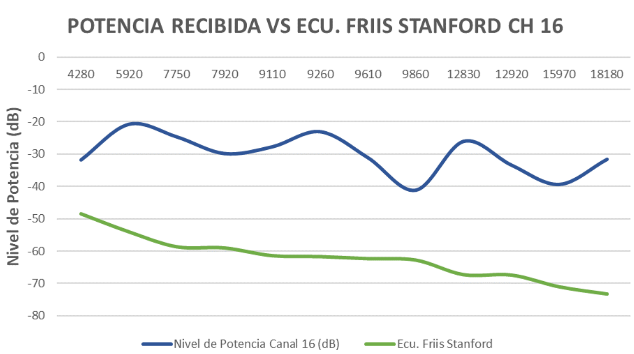

Figure 11. Relation power waited for from the model of (SUI) for Green Cross Canal 16.
Source: own.

Now, comparing the model Okumura-Hata and Stanford, it is observed that an 8dB margin exists and at first it separates them, nevertheless, maintain a slope similar. In table 5 the statistical criteria for this model can be analyzed:

Statistical Criteria for Stanford model		
Criterion	**Vlr. Ch 16**	**Vlr. Ch 17**
Coefficient of Correlation	0,904	0,906
Average Quadratic error	511,637	511,064
Covariance	159,222	159,005
Variance	166,650	166,434
Standard deviation	12,909	12,901
Index of structural Similarity	0,440	0,462

Table 5. Statistical criteria for SUI Calatrava Canal 16 and 17. Source: own.

4.4. Propagation by Xia-Bertoni

This propagation model requires urban cartography with buildings information; in the model the heights take part, wide of the streets and the separation between buildings. The basic los of propagation is synthesized as it follows:

$$L_b(dB) = 79.6 - 0.24\Delta h_b(m) - 18log\Delta h_b - 9\log b + 21\log f + 10\log r + 20\log[2\pi + \varphi)] + 40[1 - 2\cdot 10^{-3}\Delta h_b]\log\ d] \quad (5)$$

Using (5), which includes the partial losses that take part in the calculation of the basic loss of propagation. In figure 12 and 13 we can compare the behavior of the expected power using Xia-Bertoni model with the real measurements taken point to point in reference to the Calatrava and Cruz Verde stations:

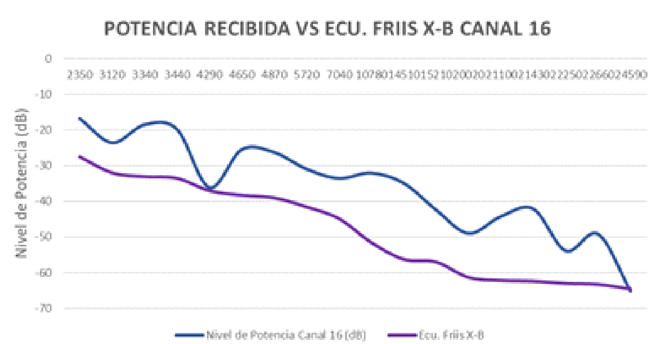

Figure 12. Relation power waited for from the model of Xia-Bertoni for Calatrava Canal 16.
Source: own.

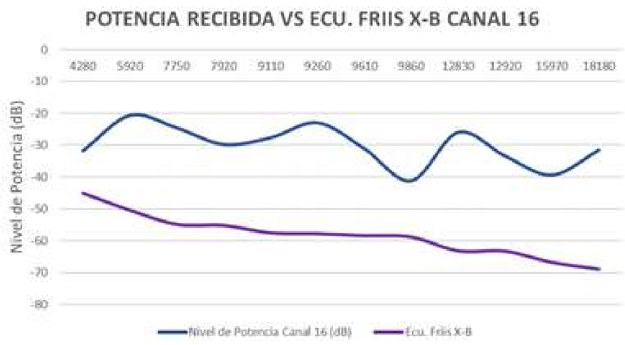

Figure 13. Relation power waited for from the model of Xia-Bertoni for Green Cross Canal 16. Source: own.

When analyzing the results obtained, in matter of expected power using Xia-Bertoni, can be affirmed that it is the model which better has come close to the reception power real data, we corroborate it from the statistical data represented in table 6.

Statistical Criteria for the Xia-Bertoni model		
Criterion	**Vlr. Ch 16**	**Vlr. Ch 17**
Coefficient of Correlation	0,904	0,906
Average Quadratic error	506,971	190,966
Covariance	159,222	158,012
Variance	166,635	164,895
Standard deviation	12,909	12,841
Index of structural Similarity	0,437	0,501

Table 6. Statistical criteria for Xia-Bertoni Calatrava Canal 16 and 17. Source: own.

5. Models Comparison and Correction

In figures 14 and 15, there are compiled the three studied models and the measures taken for channel 16 over Calatrava and Cruz Verde stations.

Figure 14. Compilation models Okumura-Hata, Stanford, Xia-Bertoni versus data measured for Calatrava Canal 16. Source: own.

Figure 15. Compilation models Okumura-Hata, Stanford, Xia-Bertoni versus data measured for Green Cross Canal 16. Source: own.

The correction of the propagation models takes place through Matlab Sofware, where changes were made in the constants of the model in such a way those new values adjusts closest to the awaited power levels. [50]

5.1 Okumura-Hata Correction

For this model, the constants were corrected appear stood out. From the new propagation equation new power levels are obtained referenced in figure 16.

$$L_{OH} = \mathbf{55} + (26{,}16 * \log(485)) - (13{,}82 * \log(58)) - 8{,}7421 + (\mathbf{44{,}88} - (6{,}55 * \log(58))) * \log(d/1000) \quad (6)$$

The new model adjusts to the real power curve as it is demonstrated in Figure 16.

Figure 16. Comparison of power received with equation of Okumura-Hata corrected on Calatrava Canal 16. Source: own.

With the purpose of evaluating the new corrected model precision level, again are evaluated the statistical criteria of significance characteristics, as it is possible to be observed in table 7.

Statistical Criteria for Corrected O-H model		
Criterion	**Vlr. Ch 16**	**Vlr. Ch 17**
Coefficient of Correlation	0,904	0,906
Average Quadratic error	30,788	30,014
Covariance	145,213	144,785
Variance	161,350	161,611
Standard deviation	12,702	12,713
Index of structural Similarity	0,489	0,522

Table 7. Statistical criteria for Okumura-Hata Corrected on Calatrava Canal 16 and 17. Source: own.

5.2 Correction Stanford University Model

Continuing with the procedure, correction to the model takes place obtaining the following results:

$$L(dB) = A + 3,96 * B * \log\left(\frac{x}{100}\right) + C + 15,54 \quad (7)$$

In figure 17 the result of the correction to the curve of expected power can be appreciated due to corrected Stanford model.

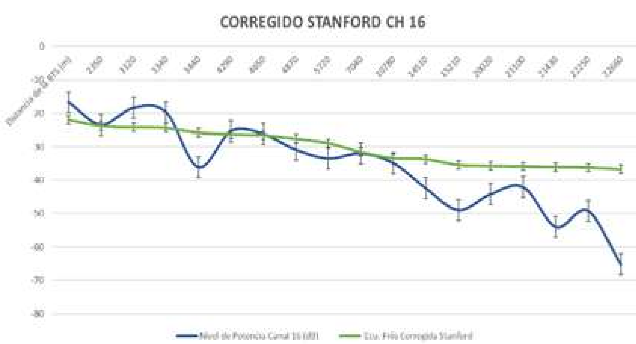

Figure 17. Comparison of power received with equation of Corrected Okumura-Hata Calatrava Canal 16. Source: own.

5.3 Correction Xia-Bertoni Model

Finally, the correction of Xia-Bertoni equation is made as it follows:

$$L(dB) = 69,89 - (0,24 * A) - (18 * \log(A)) - (9 * \log(B)) + (21 * \log(485)) + 10 * \log(C)) + (20 * \log(D * (2\pi + D))) + ((36,71) * (1 - (0,002 * A)) * \log(d/1000) \quad (8)$$

The new model adjusts to the real curve of expected power as it is demonstrated in figure 18. (8)

Figure 18. Comparison of power received with equation of Corrected Xia-Bertoni Calatrava Canal 16. Source: own.

Again, the statistical criteria corresponding to the corrected model of Xia-Bertoni, is related in table 8.

Statistical Criteria for Corrected O-H model		
Criterion	**Vlr. Ch 16**	**Vlr. Ch 17**
Coefficient of Correlation	0,904	0,906
Average Quadratic error	30,788	30,025
Covariance	145,213	144,818
Variance	161,350	161,548
Standard deviation	12,702	12,710
Index of structural Similarity	0,489	0,522

Table 8. Statistical criteria for Corrected Xia-Bertoni Calatrava Canal 16 and 17. Source: own.

For the elaboration of the present study the average quadratic error measures the average of the errors to the square, which means, it measures the difference between the estimator and what it estimates. Next, it is shown a compendium of the corrected models and its respective graphs in comparison with real power values received by each point. It is for channel 16 on Calatrava Station.

Figure 19. Comparison of power received with models of propagation Corrected Okumura-Hata, Xia-Bertoni and Stanford, Calatrava Canal 16. Source: own.

Statistical criteria	Corrected O H Ch 16	Corrected X-B Ch 16	Corrected Stanford Ch16
Coef. Correlation	0.904	0.904	0.904
Average Quadratic error	30.788	30.788	105.190
Covariance	145.213	145.213	63.052
Variance	161.350	161.350	168.219
Standard deviation	12.702	12.702	12.970
Index of Structural Similarity	0.489	0.489	0.305

Table 9. Statistical criteria for Corrected Okumura-Hata, Xia-Bertoni and Stanford, Calatrava Canal 16 and 17. Source: own.

6. Conclusions

The yield of the selected propagation models was analyzed using the results of two campaigns of measurements on the stations Calatrava and Cruz Verde in Bogotá city, whose scenes displays different characteristics like the height from transmitters, frequency (2 different channels were analyzed), surroundings and profile of the terrain and so on. The results shown in this article show the suitable election of the propagation model is due to considering the scene from unfolding, the cartographic information available, height of transmitters and terrain profile on which it is going be developed the coverage analysis. With the purpose of making the model the most precise it is necessary to take it to be a semiempirical model, which implies the taking of measurements to make a better adjustment.

From the statistical analysis of each model before and after its respective correction, we can determine two of those three model selected could be fit to the necessity of propagation in the investigation. Nevertheless, the Xia-Bertoni model before being corrected was the model better adjusted to the power data measured, this is because it takes a greater number of variables in account. Thanks to the correction and adjustment of the curves quadratic error could be reduced to 30 % average.

The propagation models allow to obtain a considered approach of the power level received according to the radius of transmitter BTS; where all the models do not react equal because the conditions are not 100 percent the same adding or diminishing variables to consider. Therefore, when managing coverage projects is necessary to consider that the model has a margin of error and it can be seen affected, moreover when we ignore interference parameters due to the atmosphere or the environment. When the correction of the propagation models takes place, those models are transformed from empirical to semiempirical. Working with semiempirical models in the design of our network or coverage study, provides more tools to get an exact determination of the basic parameters in the link or the broadcast transmission. Those parameters are the selection of power transmission, tilt of antenna, estimation of looses in the atmosphere, loses by diffraction, fading, refraction and so on.

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