IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 10, Issue 1 Ver. III (Jan – Feb. 2015), PP 48-59
www.iosrjournals.org

New Approach for Determination of Propagation Model Adapted To an Environment Based On Genetic Algorithms: Application to the City Of Yaoundé, Cameroon

Deussom Djomadji Eric Michel [1], Tonye Emmanuel [2].
[1&2] *(Department of Electrical and Telecommunications Engineering; Polytechnic National Advanced School of Engineering of Yaoundé ; University of Yaoundé I, CAMEROON)*

Abstract: *Propagation models are essential tools for planning and optimization in mobile radio networks. They enable the evaluation of the signal strength received by a mobile terminal with respect to a distance of a given base station. And through a link budget, it is possible to calculate the coverage radius of the cell and plan the number of cells required to cover a given area. This paper takes into account the standard model K factor then uses a genetic algorithm to develop a propagation model adapted to the physical environment of the city of Yaoundé, Cameroon. Radio measurements were made on the CDMA2000 1X-EVDO network of the operator CAMTEL. Calculating the root mean squared error (RMSE) between the actual measurement data and radio data from the prediction model developed allows validation of the results. A comparative study is made between the value of the RMSE obtained by the new model and those obtained by the standard model of OKUMURA HATA. We can conclude that the new model is better and more representative of our local environment than that of OKUMURA HATA. The new model obtained can be used for radio planning in the city of Yaoundé, Cameroon.*
Keywords: *Drive test, genetic algorithm, propagation models, root mean square error.*

I. Introduction

A propagation model suitable for a given environment is an essential element in the planning and optimization of a mobile network. The key points of the radio planning are: coverage, capacity and quality of service. To enable users to access different mobile services, particular emphasis must be made on the size of the radio coverage. Propagation models are widely used in the network planning, in particular for the completion of feasibility studies and initial deployment of the network, or when some new extensions are needed especially in the new metropolises. To determine the characteristics of radio propagation channel, tests of the real propagation models and calibration of the existing models are required to obtain a propagation model that accurately reflects the characteristics of radio propagation in a given environment. There are several softwares used for planning that include calibration of models on the market namely: ASSET of the firm AIRCOM in England, PLANET of the MARCONI Company, and ATTOL of the French company FORK etc.

Several authors were interested in the calibration of the propagation models, we have for example: Chhaya Dalela, and all [1] who worked on 'tuning of Cost231 Hata model for radio wave propagation prediction'; Medeisis and Kajackas [2] presented "the tuned Okumura Hata model in urban and rural areas at Lituania at 160, 450, 900 and 1800 MHz bands; Prasad et al. [3] worked on "tuning of COST-231.
"Hata model based on various data sets generated over various regions of India ', Mardeni & Priya [4] presented optimized COST - 231 Hata model to predict path loss for suburban and open urban environments in the 2360-2390 MHz, some authors are particularly interested in using the method of least squares to calibrate or determine the propagation models we have for example : MingjingYang; et al. [5] in China have presented "A Linear Least Square Method of Propagation Model Tuning for 3G Radio Network Planning", Chen, Y.H. and Hsieh, K.L [6] Taiwan presented "has Dual Least - Square Approach of Tuning Optimal Propagation Model for existing 3G Radio Network", Simi I.S. and all [7] in Serbia presented "Minimax LS algorithm for automatic propagation model tuning., Allam Mousa, Yousef Dama and Al [8] in Palestine presented "Optimizing Outdoor Propagation Model based on Measurements for Multiple RF Cell.

In our study, we use the data collected through drive test in CAMTEL CDMA1X EVDO RevB network in the city of Yaoundé. To do this we use 6 BTS distributed all around the city.
We propose an approach for the determination of the model based on genetic algorithms.

This article will be articulated as follows: in section 2, the experimental details will be presented, followed by a description of the methodology adopted in section 3. The results of the implementation of the algorithm, the validation of the results and comments will be provided in section 4 and finally a conclusion will be presented in section 5.

II. Experimental Details

2.1 Propagation environment.

This study is done in the city of Yaoundé, capital of Cameroon. We relied on the existing CDMA 2000 1X-EVDO network for doing drive test in the city. To do this, we divided the city into 3 categories namely: downtown Yaoundé, the downtown to periphery area and finally the outskirts of the city. For each category, we used 2 types of similar environments, then compared the results obtained between them. We have the table below which shows the categories with the concerned BTS:

Table 1: Types of environment

Categories	A	B	C
Urban characteristics	Dense urban	Urban	Outskirts
Concerned BTS	Ministere PTT (A1) Bastos (A2)	Hotel du plateau(B1) Biyem Assi(B2)	Ngousso Eleveur (C1) Nkomo Awae (C2)

2.2 Equipments description

2.2.1 Simplified description of BTS used.

BTS that we used for our drive tests are the ones of CAMTEL provided by the equipment manufacturer HUAWEI Technologies. We used 2 types of BTS: BTS3606 and DBS3900 all CDMA. The following table shows the specifications of the BTS

Table 2: BTS characteristics

	BTS3606	DBS3900
BTS types	Indoor BTS	Distributed BTS (Outdoor)
Number of sectors	3	3
Frequency Band	Band Class 0 (800 MHz)	Band Class 0 (800 MHz)
Downlink frequency	869 MHz - 894 MHz	869 MHz - 894 MHz
Uplink frequency	824 MHz - 849 MHz	824 MHz - 849 MHz
Max power (mono carrier)	20 W	20 W
BTS Total power (dBm)	43 dBm	43 dBm

The BTS engineering parameters are presented in the table below:

Table 3: BTS engineering parameters

BTS informations									
BTS Type	**BTS name**	**Latitude (degree)**	**Longitude (degree)**	**BTS Altitude (m)**	**Antenna height**	**Mean elevation**	**Antenna effective height**	**Antenna's Gain (dB i)**	**7/8 Feeder Cable(m)**
3606	MinistryPTT_800	3,86587	11,5125	749	40	741,82	47,18	15,5	45
3900	Ngousso-Eleveur	3,90097	11,5613	716	25	712,05	28,95	17	0
3900	Hotel du plateau	3,87946	11,5503	773	27	753,96	46,04	17	0
3606	Biyem-Assi_800	3,83441	11,4854	721	40	709,54	51,46	15,5	45
3900	Camtel Bastos	3,89719	11,50854	770	28	754,86	43,14	17	0
3900	Nkomo Awae	3,83224	11,5598	713	25	709,54	28,46	17	0

1.3 Others equipments parameters.

In order to perform the drive tests, we used a Toyota Prado VX vehicle, an ACER ASPIRE laptop, drive test software namely Pilot pioneer of Dingli communication V6.0, a LG CDMA mobile terminal, a GPS terminal, a DC/AC converter to power the PC during the measurement. The figure below shows the vehicle collection kit.

Figure 1: Drive test measurement kit installed on vehicle.

The drive test done in the area A1, A2, B1, B2, C1, C2 gave the following results.

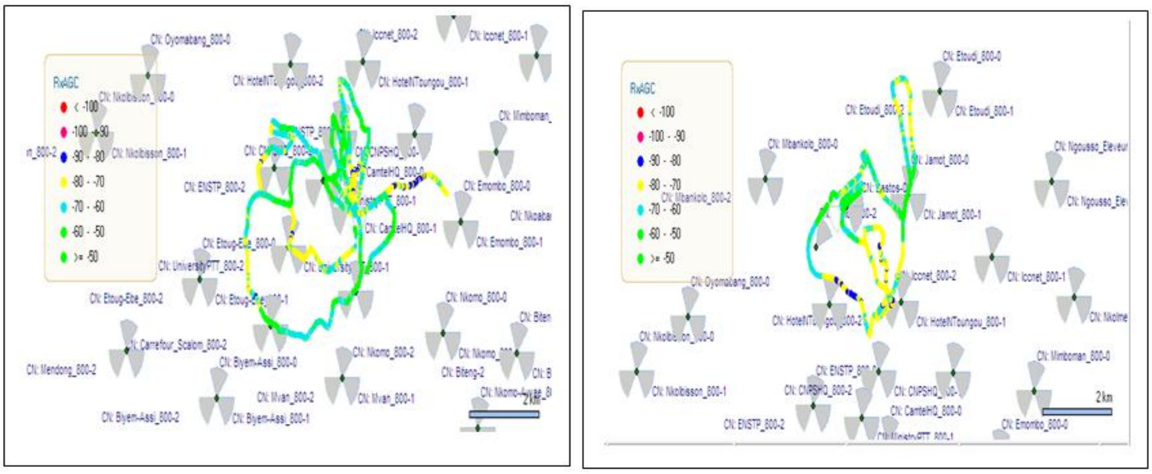

Figure 2: Drive test in centre town (A1 left side image) and in Bastos area (A2 right side image).

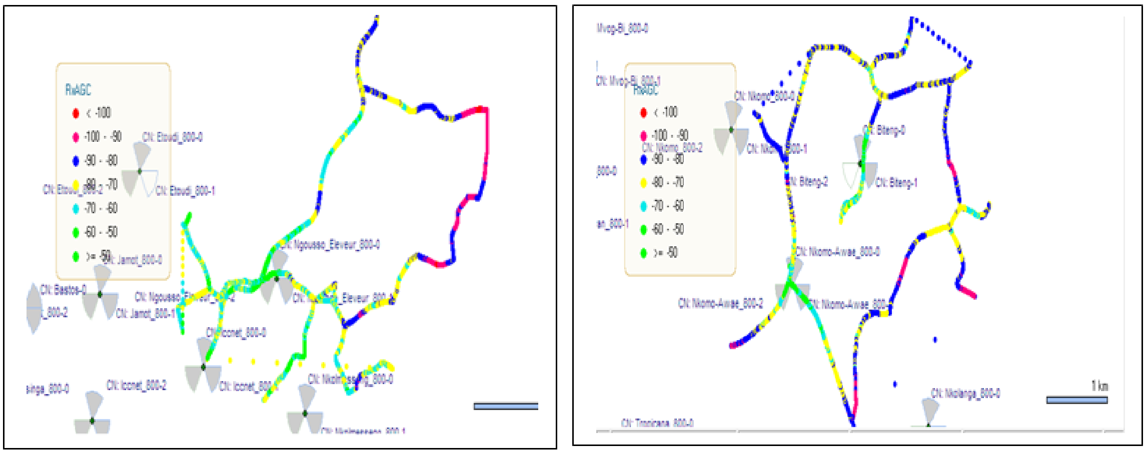

Figure 3: Drive test in Ngousso eleveur (B1 left side image) and Nkomo Awae(B2 right side image)

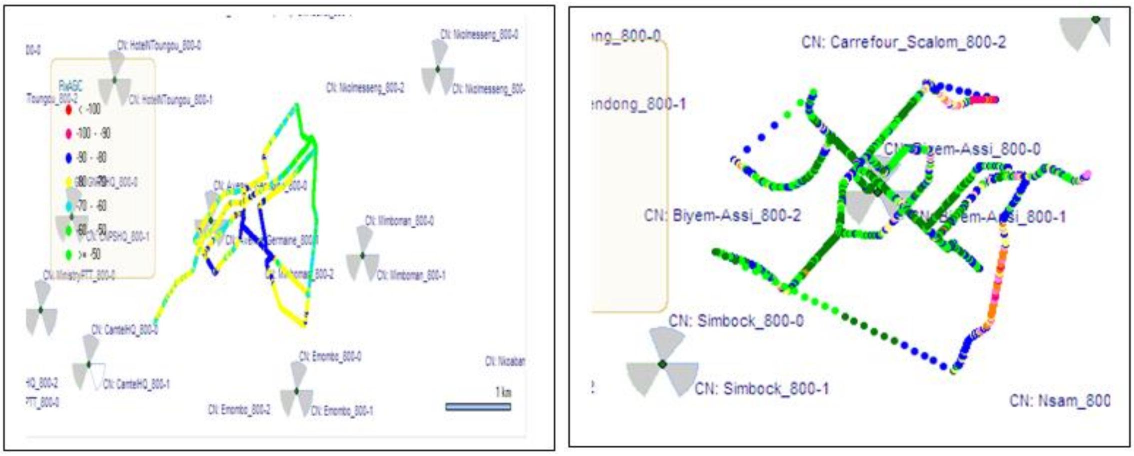

Figure 4: Drive test in Essos (C1 left side image) and Biyem Assi (C2 right side image)

III. Methodology

Many propagation models exist in the scientific literature, we present only the K factors model on which we relied for this work.

3.1 K factor propagation model [10]

The General form of the K factor model is given by the following equation:

$$L_p = K_1 + K_2\, log(d) + K_3 * h_m + K_4 * log(h_m) + K_5 * log(h_b) + K_6 * log(h_b)\, log(d) + K_{7diffn} + K_{clutter} \quad (1)$$

K_1 Constant related to the frequency, K_2 Constant of attenuation of the distance or propagation exponent, K_3 and K_4 are correction factors of mobile station height; K_5 and K_6 are correction factors of BTS height, K_7 is the diffraction factor, and $K_{clutter}$ correction factor due to clutter type.
The K parameter values vary depending on the type of terrain and the characteristics of the propagation of the city environment; the following table gives values of K for a medium-sized town.

Table 4: K factor parameters values

K parameter name	K1	K2	K3	K4	K5	K6	K7	Kclutter
Value	149	44.9	-2.49	0.00	-13.82	-6.55	-0.8	0

The above equation (1) could also be written in the following form:

$$L_p = (K_1 + K_{7diffn} + K_{clutter}) + K_2\, log(d) + K_3 * h_m + K_4 * log(h_m) + K_5 * log(h_b) + K_6\, log(h_b)\, log(d)$$

Assuming $K_1' = (K_1 + K_{7diffn} + K_{clutter})$, equation (1) gets the form below:

$$L_p = K_1 + K_2\, log(d) + K_3 * h_m + K_4 * log(h_m) + K_5 * log(h_b) + K_6\, log(h_b)\, log(d) \quad (2)$$

It is this last modified form that we will eventually use for our work.

3.2 Determination flowchart

The flowchart below represents the determination of the propagation model using genetic algorithms

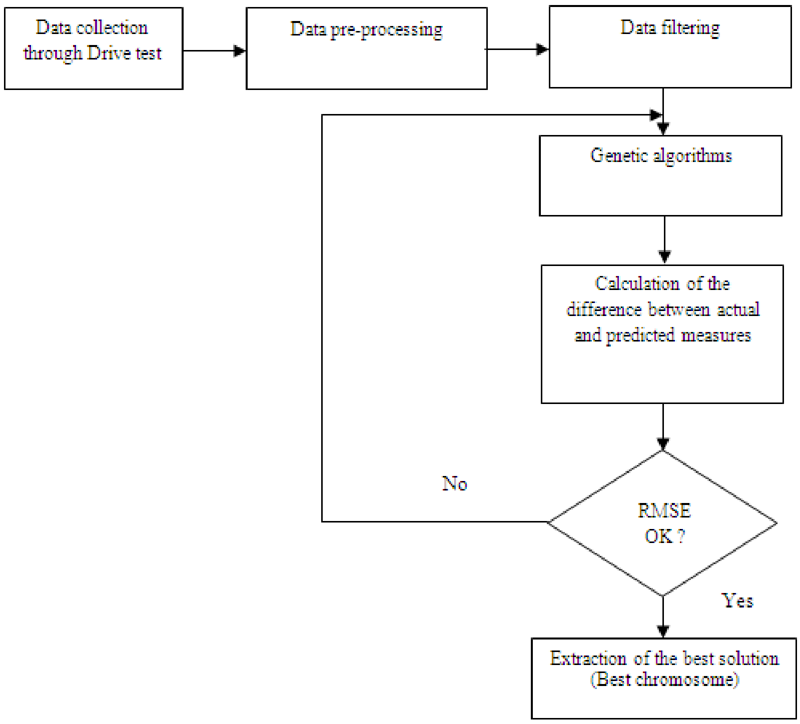

Figure 5: Algorithm implementation flowchart

In this chart, data filtering is made according to the criteria for distance and signal strength received:

Table 5: filtering criteria. [10], [11]

Minimum distance (m)	100
Maximum distance (m)	10 000
Minimum received power (dBm)	-110
Maximum received power (dBm)	-40

3.3 Genetic algorithms. [12]

A genetic algorithm enables us to find a solution by searching an extremum (maximum or minimum) on a set of possible solutions, the solution set is called search space. This algorithm is built following the points below:

- The coding of the elements of the population (chromosomes),
- The generation of the initial population,
- Evaluation of each chromosome of the population
- Selection, crossover and mutation of chromosomes,
- Criteria to stop the algorithm.

3.3.1 Modeling of our problem by genetic algorithms.

It is a question for us to find a propagation model to suit any environment.
Equation (2) above can be written in matrix form as follows:

$$\boldsymbol{L = [K_1\ K_2\ \ K_3 K_4\ K_5\ K_6}\,]* \begin{bmatrix} \boldsymbol{1} \\ \boldsymbol{log(d)} \\ \boldsymbol{H_m} \\ \boldsymbol{log(H_m)} \\ \boldsymbol{log(H_{eff})} \\ \boldsymbol{log(H_{eff}) * log(d)} \end{bmatrix} \qquad \textbf{(3)}$$

In the above equation (3) only the vector K=[$K_1\ K_2\ \ K_3 K_4\ K_5\ K_6$] **(4)** is variable depending on the values of, $i\ \boldsymbol{\epsilon\{1,2,3,4,5,6\}}$ and j an integer.

Let:

$$\boldsymbol{M} = \begin{bmatrix} \boldsymbol{1} \\ \boldsymbol{log(d)} \\ \boldsymbol{H_m} \\ \boldsymbol{log(H_m)} \\ \boldsymbol{log(H_{eff})} \\ \boldsymbol{log(H_{eff}) * log(d)} \end{bmatrix}, \qquad \textbf{(5)}$$

Therefore L can be written in the form $L = K * M$ (6); with M a constant vector for a given distance d and depending on whether we were under a base station of effective height H_{eff}.

If in the contrary the distance d varies for different measurement points, vector M becomes a $M_i$vector for various measures at different distances d_i points.

The determination of the vector K leads to the knowledge of our propagation model L. Our searching area is therefore that containing all the possible values of the vectors of the form presented as K above in (4).

So we will use a real coding as chromosomes K vectors as presented above.

It is therefore necessary for us to model the elements forming part of our genetic algorithm namely: the genes encoding type, the generation of the initial family, the evaluation function of each chromosome, the selection method, crossover and the mutation algorithms.

3.3.1.1 Genetic algorithm parameters

Subsequently we will consider the following parameters:

- Ng, the number of generations,
- Nc, the number of chromosomes of the family at any generation,
- Tc and Tm respectively crossing and mutation rates.

3.3.1.2 Encoding type.

We will use a real coding [13] representing our chromosomes in the vector form given by equation (4) above. Our chromosomes will be the K vectors.

3.3.1.3 Evaluation function.

Here, we have to minimize the Euclidean distance between the measured values of the propagation loss and those predicted by the propagation model. Let $L = \{L_j\}_{j=1:T}$ the set of measured values; where T represents the total number of measurement points of L. K^j is a possible solution vector to our optimization problem and M_i the column vector defined by (5). The evaluation function [14] of our chromosomes K^j will be:

$$\boldsymbol{f_{cout} = min\left\{\frac{1}{T}\sum_{i=1}^{T}(L_i - (K^j * M_i))^2\right\}}. \qquad \textbf{(6)}$$

This is for every chromosome K^j for j=1: Nc.

3.3.1.4 Generation of starting family F

The starting family that we generate is made up of different chromosomes K^j randomly generated, meeting certain criteria of integrity on the values of the different K_i^j for i = 1:6.
Then $F = [K_1^j\ K_2^j\ K_3^j\ K_4^j\ K_5^j\ K_6^j]_{j=1:Nc}$. Okumura Hata model, K factors model and free space propagation model put on form (4) above will give the values in the following table:

Table 5: Propagation models into the form K (4).

Propagation model	K1	K2	K3	K4	K5	K6
Okumura Hata	146,56	44.9	0	0	-13.82	-6,55
Free space	91.28	20	0	0	0	0
K factors	149	44.9	-2.49	0	-13.82	-6,55

The first 3 chromosomes of our initial family will be the chromosomes corresponding to Okumura Hata model, K factors and free space above. We need to generate the other chromosomes in order to complete the size of the family to Nc chromosomes. We have the following criteria for generation of the different parameters.

a) Generation of $\boldsymbol{K_4^j}$

The parameters $\boldsymbol{K_4^j}$ is a micro adjustment parameter with value between 0 and 1, then: $\mathbf{0 \le K_4^j \le 1}$. We have the following algorithm:

For j = 4 :Nc do
K_4^j=rand (1)
End for

b) Generation of $\boldsymbol{K_1^j}$

We are searching K_1^j between the values of the parameters K1 of free space and OKUMURA-HATA model. Let K_{1el} and K_{1ok} respectively the parameters K1 for of free space and OKUMURA-HATA model, then we will have: $K_{1el} \le K_1^j \le K_{1ok}$. We will generate random values between K_{1el} and K_{1ok}.
All this allows us to have the following algorithm:

For j = 4 :Nc do
$K_1^j = K_{1el} + (K_{1ok} - K_{1el}) * rand(1)$
End for

c) Generation of $\boldsymbol{K_6^j}$

We will search this parameter between the values -6.55 and 0, what justifies this choice is that this setting is worth these respective values for Okumura Hata and free space loss model. We will therefore have the algorithm below:

For j = 4 :Nc do
K_6^j=-6.55*rand (1)
End for

d) Generation of parameter $\boldsymbol{K_2^j}$

The global adjustment parameter K2 should follow the criteria below:
$K_{2el} \le K_2^j + K_6^j log(H_b) \le K_{2ok}$, in fact $K_2^j + K_6^j log(H_b)$ is the distance attenuation factor and for that should be comprise between K_{2el} and K_{2ok}. $K_{2el} = 20$, and $K_{2ok} = 44.9 - 6.55 log(H_b)$, now in urban areas, the minimum possible height for a base station is 20 meters, this minimum value of Hb, allows us to obtain the maximum value of $K_{2ok} = 36.8$. This allows us to write that:

$$20 - K_6^j log(H_b) \le K_2^j \le 36.8 - K_6^j log(H_b)$$

We can deduce the following algorithm:

For j = 4 : Nc do
$K_2^j = 20 - K_6^j\ log(H_b) + (36.8 - 20) * rand(1)$
End for

e) Generation of $\boldsymbol{K_5^j}$

This parameter is negative and is in between -13.82 and 0. (-13.82 is the parameter value for K factor and Okumura Hata model**)**, we can then deduce the algorithm below:

For j = 4 : Nc do

K_5^j =-13.82+13.82*rand (1)
End for

f) Generation of K_3^j

Finally the parameter K_3^j will vary between -2.49 and 0 for 800MHz frequency band, value defined by K factor propagation model, from which we derive the algorithm below:

For j = 4 : Nc do
K_3^j =-2 .49+2.49*rand (1)
End for

The overall starting family generation algorithm is therefore with $F(i,j) = K_i^j$;

```
Begin
   F(1) = Kok ;
   F(2)= Kel ;
   F(3)= Kkfac ;
         For j = 4 : Nc do
             F (j, 4) = rand (1);
             F(j,1) = K1el + (K1ok − K1el) ∗ rand(1) ;
            F=-6.55*rand (1);
           F(j,2) = 20 − K6^j log(Hb) + (36.8 − 20) ∗ rand(1)
           F (j, 5) =-13.82+13.82*rand (1)
          F (j, 3) =-2 .49+2.49*rand (1)
       End for
End
```

3.3.1.5 Selection.

The selection mechanism that we adopt for this work is the elitism [15]. Will be selected for the crossover only the best individuals i.e. those which the evaluation function is minimal.

3.3.1.6 Crossover

Given, Tc the crossing rate and Nc the number of chromosomes, the number of individuals undergoing the crossing will therefore be:

$\mathrm{Cross} = \mathrm{E}(\mathrm{Nc} * \mathrm{Tc})$, where E is the integer part of any real number. Individuals can be cross only if there are in pairs; one must therefore correct Cross to make it even.
$\mathrm{Cross} = \mathrm{E}(\mathrm{Nc} * \mathrm{Tc})$, if E (Nc*Tc) is even.
$\mathrm{Cross} = \mathrm{E}(\mathrm{Nc} * \mathrm{Tc}) + 1$, if E (Nc*Tc) is odd.

Call by P1 and P2 respectively 2 chromosomes parents of the family F and f1 and f2 2 children of the crossing of parents an alpha a real between 0 and 1.
P1= [K_1 (P_1) K_2 (P_1) K_3 (P_1) K_4 (P_1) K_5 (P_1) K_6 (P_1)];
P2= [K_1 (P_2) K_2 (P_2) K_3 (P_2) K_4 (P_2) K_5 (P_2) K_6 (P_2)].

We will perform a proportional crossing for the K_1 parameter, and integral crossing for K_2, K_4, K_5 and K_6. The K_3 parameter will not intervene in the operation of crossing. **feval** here refer to the evaluation function.
And so we have the algorithm below. **feval** is the evaluation function.

```
Begin
         K1 (f1) = alpha* K1(P1) + (1-alpha) K1(P2).
         K2 (f1)= K2(P2) ;  K4 (f1)= K4(P2) ;  K5 (f1)= K5(P2) ;  K6 (f1)= K6(P2)
         K1 (f2) = alpha* K1(P2) + (1-alpha) K1(P1).
         K2 (f2)= K2(P1) ; K4 (f2)= K4(P1) ; K5 (f2)= K5(P1) ; K6 (f2)= K6(P1)
         If  feval(f1) <feval(P1) et  feval(f1) <feval(P2)
         Then P1=f1
         End if
         if feval(f2) <feval(P2) et  feval(f1) <feval(P1)
         Then P2=f2
         End if
End
```

6.1.1.1 Mutation

Here considering that the rate of mutation is Tm, we will mutate individuals that have not been involved in crossover mechanism to give them a chance to improve so if possible to participate in the next reproduction. We will therefore choose random individuals then mutate them and replace the old (parent or former) by the mutants. The mutation will operate on a global adjustment parameter, the number of possible mutations is:
Nmut = E(Tm * Nc * 6) + 1 (6 is the size of a Chromosome).
The algorithm of mutation is given below:

```
Begin
        Nmut = E (tm * Nc * 6) +1
        For i=1: Nmut
        mut= E (cross+1+(Nc-(cross+1)) * rand(1)) + 1
        F(mut,2)=20 - F(mut,6)*log(Hb) +16.38*rand(1);
End
```

IV. Results And Comments

Having implemented the genetic algorithm as described above on the radio measurement data obtained in Yaoundé by setting the parameters as follows:
Nc = 60; NG = 100; Tc = 0.6; Tm = 0.01; alpha = 0.6, we obtained the results as presented below. NG is the number of generations, Nc the number of chromosomes.
The model will be seen as accurate if the RMSE between the values of prediction and measured is less than 8 dB; (RMSE < 8dB). [16]

4.1 Results per zone

We obtained the representatives curves below, the actual measurements are in blue, Okumura Hata model in green, and the free space propagation model in yellow, the new model obtained via Genetic Algorithms in red and that obtained by implementing the linear regression in black**. In the following tables, RMSE (OK) will refer to the RMSE calculate using Okumura Hata model relatively to drive test datas.**

a) Zone A1 : Yaoundé centre town.

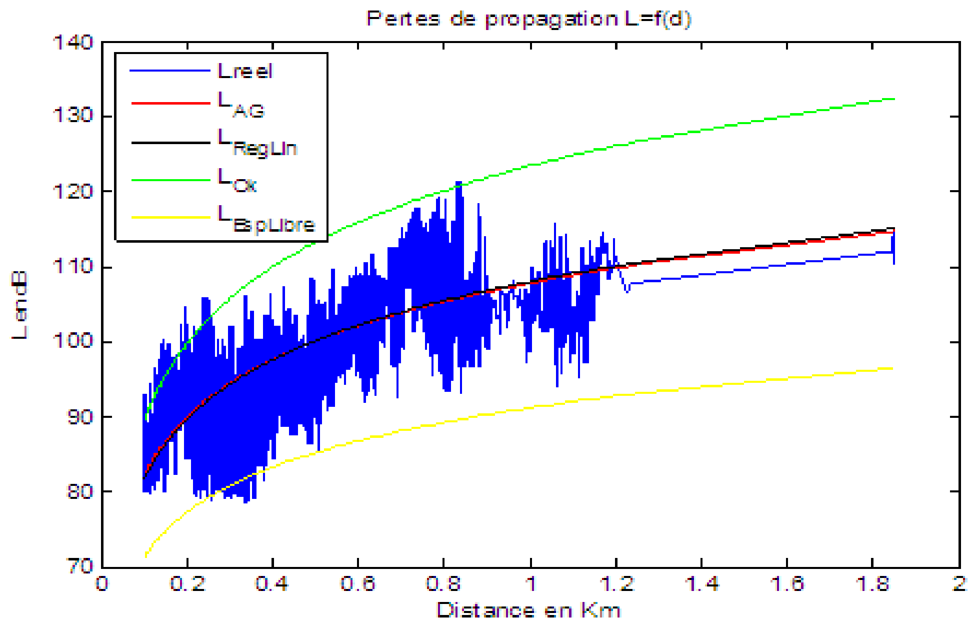

Figure 6: Actual data in Centre town VS predicted measurements.

The table below gives the results of genetic algorithms and linear regression.

Table 6: Results from the city center.

Zone	Methode	K1	K2	K3	K4	K5	K6	**RMSE**	**RMSE(OK)**
A1	GA	125.6569	34.4485	-2.4900	0	-4.6067	-6.55	**6.5704**	
	Lin Regression	134.8893	37.2911	-2.4900	0	-13.8200	-6.55	**6.7137**	**14.9345**

Note that we have a RMSE <8dB which confirms the reliability of the result and better than **RMSE(OK).**

b) Zone A2 : Bastos area (Ambassy quaters)

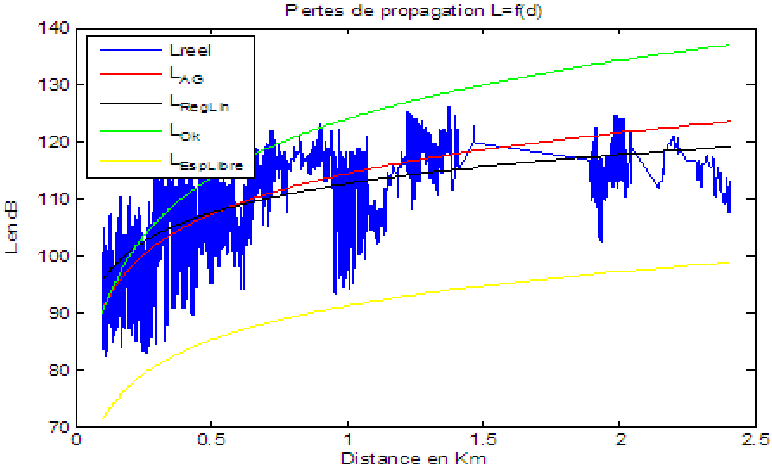

Figure 7: Actual data in Bastos VS predicted measurements.

The table below gives the results of genetic algorithms and linear regression.

Table 7: Results from bastos area.

Zone	Methode	K1	K2	K3	K4	K5	K6	**RMSE**	**RMSE(OK)**
A2	GA	125.6569	34.4485	-2.4900	0	-4.6067	-6.55	**6.5704**	
	Lin regression	138.9332	27.7118	-2.4900	0	-13.8200	-6.55	**6.1059**	**11,2924**

Note that we have a RMSE <8dB which confirms the reliability of the result and better than **RMSE(OK).**

c) Zone B1 : Biyem Assi area

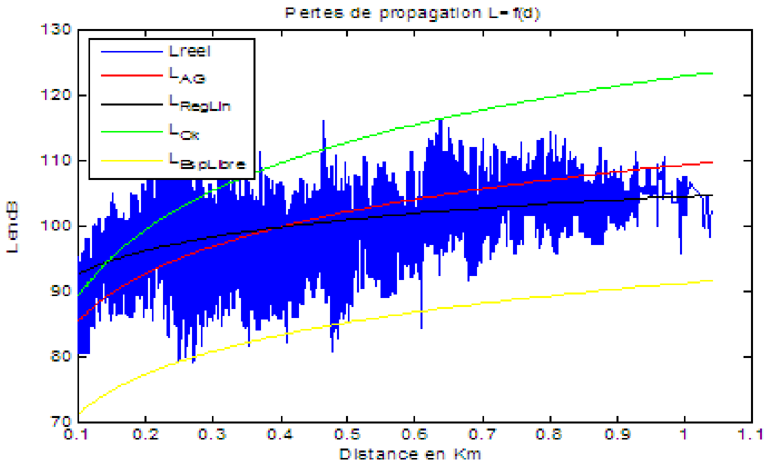

Figure 8: Actual data in Biyem Assi VS predicted measurements.

The table below gives the results of genetic algorithms and linear regression.

Table 8: Results from Biyem Assi area.

Zone	Methode	K1	K2	K3	K4	K5	K6	**RMSE**	**RMSE(OK)**
B1	GA	121.3351	35.1371	-2.4900	0	-4.8370	-6.55	**6.1845**	
	Lin Regression	131.9004	23.1678	-2.4900	0	-13.820	-6.55	**5.3883**	**12,3604**

Note that we have a RMSE <8dB which confirms the reliability of the result and better than RMSE(OK).

a) Zone B2 : Essos-Mvog Ada area

The table below gives the results of genetic algorithms and linear regression.

Table 9: Results from Essos Mvog Ada area.

Zone	Methode	K1	K2	K3	K4	K5	K6	**RMSE**	**RMSE(OK)**
B2	GA	127.8881	35.3815	-2.4900	0	-5.5280	-6.55	**7.3976**	
	Lin Regression	141.7505	36.5336	-2.4900	0	-13.82	-6.55	**7.3907**	**11,5989**

Note that we have a RMSE <8dB which confirms the reliability of the result and better than RMSE(OK).

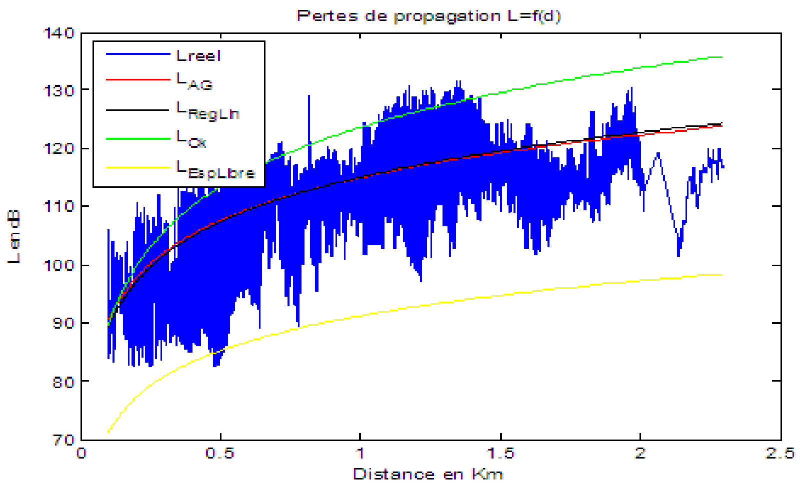

Figure 9: Actual data in Essos Camp Sonel area VS predicted measurements.

e) Zone C1 : Quartier Ngousso Eleveur

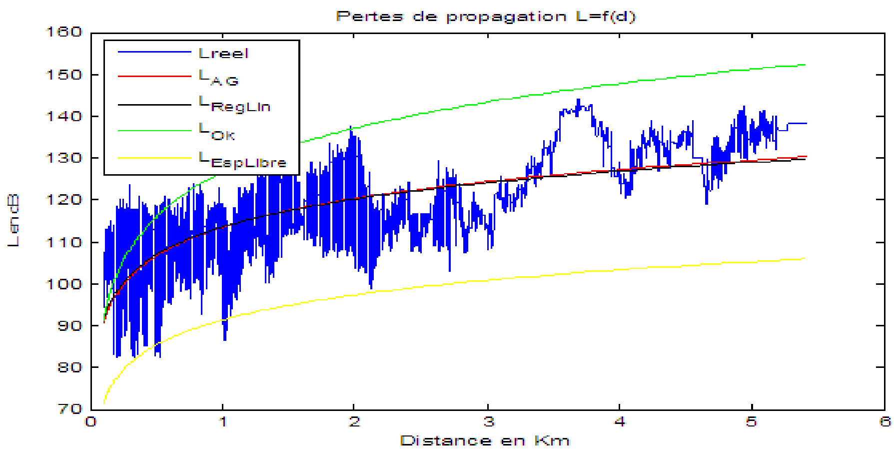

Figure 10: Actual data in Ngousso Eleveur area VS predicted measurements.

The table below gives the results of genetic algorithms and linear regression.

Table 10: Results from Ngousso Eleveur area.

Zone	Methode	K1	K2	K3	K4	K5	K6	**RMSE**	**RMSE(OK)**
C1	GA	122.4182	32.5658	-2.4900	0	-3.6853	-6.55	**7.8990**	
	Lin Regression	137.3067	31.8195	-2.4900	0	-13.82	-6.55	**7.8927**	**16,8067**

Note that we have a RMSE <8dB which confirms the reliability of the result and better than RMSE (OK).

Zone C2: Nkomo Awae area

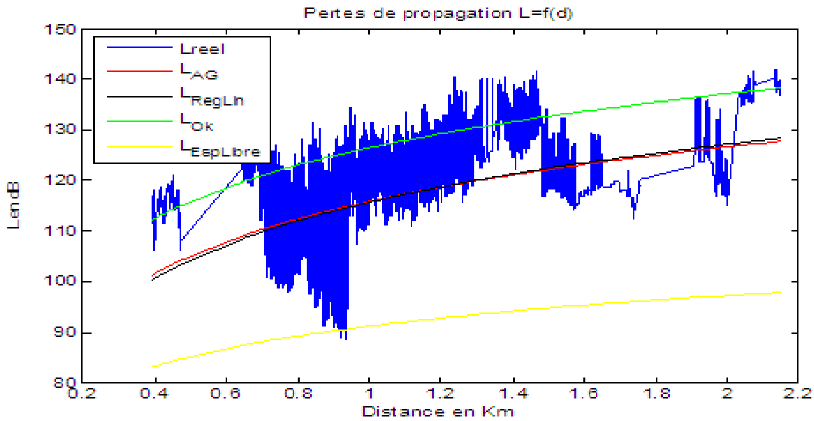

Figure 11: Actual data in nkomo Awae area VS predicted measurements.

Table 11: Results from Ngousso Eleveur area.

Zone	Méthode	K1	K2	K3	K4	K5	K6	RMSE	RMSE(OK)
C2	GA	130.9568	45.4324	-2.4900	0	-7.8313	-6.55	**10.8068**	
	Lin Regression	139.4966	47.7877	-2.4900	0	-13.8200	-6.55	**10.7990**	**15,3274**

In this specific case, the RMSE is greater than 8dB, but the value obtain is still better than Okumura Hata RMSE. This special value of the RMSE can be explained by the complexity of the concerned environnement.

4.2 Summary of results

In all the area A1, A2, B1, B2, C1, C2 above, the RMSE obtain through the new model made up using genetic algorithm is better than the one calculate using Okumura Hata model. The solution for every zone is the best chromosomes in the family with minimum value of the RMSE after Ng generations.

For the whole town of Yaoundé, by retaining only the chromosomes having given a RMSE < 8dB, we can deduce an average chromosome (average value of chromosomes retained by area). The final result and the corresponding formula are given below.

Table 12: Final chromosome retained as new propagation model

	Methode	K1	K2	K3	K4	K5	K6
Final solution	GA	124,08	34,82	-2,49	0	-5,11	-6,55

$$\mathbf{L = 124.08 + 34.82\log(d) - 2.49 * h_m - 5.11 * \log(H_{eff}) - 6.55 * \log(H_{eff}) * \log(d)}$$

This final formula can be seen as the propagation model adapted to the environment of Yaoundé.

V. Conclusion.

This paper presents a new method for the determination of propagation model relatively to a given environment. The method described is original and could very well be used to design or calibrate propagation models. The advantages of this approach is that, the genetic algorithm doesn't provide only one solution to the problem, but a set of good solutions according to the stopping criteria (based on the number of generations or the acceptable RMSE), amongst these solutions, the best one (with minimum value of RMSE) in the last generation is selected as the final solution of the problem.

Measurements made on the city of Yaoundé as application gave us very good results with an RMSE less than 8dB for most of the selected areas in the city; compare to Okumura Hata RMSE obtained, the new model gives a better result .This means that it is accurate. The results obtained are very similar to those obtained by the method of linear regression used by most authors around the world as calibration procedure.

Références

[1]. Chhaya Dalela, and all « tuning of Cost231 Hata modele for radio wave propagation prediction », Academy & Industry Research Collaboration Center, May 2012.

[2]. Medeisis and Kajackas « The tuned Okumura Hata model in urban and rural zones at Lituania at 160, 450, 900 and 1800 MHz bands », Vehicular Technology Conference Proceedings, VTC 2000-Spring Tokyo. IEEE 51st Volume 3 Pages 1815 – 1818, 2000.

[3]. Prasad and al « Tuning of COST-231Hata model based on various data sets generated over various regions of India »,

[4]. Mardeni &Priya and All, optimized COST-231 Hata model to predict path loss for suburban and open urban environments in the 2360-2390MHz, Progress In Electromagnetics Research C, Vol. 13, 91-106, 2010.

[5]. MingjingYang; and al « A Linear Least Square Method of Propagation Model Tuning for 3G Radio Network Planning », Natural Computation, 2008. ICNC '08. Fourth International Conference on Vol. 5, pages 150 – 154, 2008.

[6]. Chen, Y.H. and Hsieh, K.L « A Dual Least-Square Approach of Tuning Optimal Propagation Model for existing 3G Radio Network », Vehicular Technology Conference, 2006. VTC 2006-Spring. IEEE 63rd Vol. 6, pages 2942 – 2946, 2006.

[7]. Simi I.S and al « Minimax LS algorithm for automatic propagation model tuning », Proceeding of the 9th Telecommunications Forum (TELFOR 2001), Belgrade, Nov.2001.

[8]. Allam Mousa, Yousef Dama and Al «Optimizing Outdoor Propagation Model based on Measurements for Multiple RF Cell ». International Journal of Computer Applications (0975 – 8887) Volume 60– No.5, December 2012

[9]. HUAWEI Technologies, BTS3606CE&BTS3606AC and 3900 Series CDMA Product Documentation, pages 138-139.

[10]. HUAWEI Technologies, CW Test and Propagation Model Tuning Report (Template), 20 Mars 2014, page 7.

[11]. Standard Propagation Model Calibration guide, Avril 2004, page 23.

[12]. Ricardo Salem Zebulum, Marco Aurélio and al, Evolutionary Electronics: Automatic Design of Electronic Circuits and Systems by Genetic AlgorithmsEvolutionnary, pages 25-27, 2002.

[13]. D.E Goldberg. Real-coded genetic algorithms, virtual alphabets and blocking. Complex Systems, 1991. Pages 139-167,

[14]. Allam Mousa and all, Optimizing Outdoor Propagation Model based on Measurements for Multiple RF Cell**,** International Journal of Computer Applications (0975 – 8887) Volume 60– No.5, December 2012.

[15]. Ricardo Salem Zebulum, Marco Aurélio and al, Evolutionary Electronics: Automatic Design of Electronic Circuits and Systems by Genetic Algorithms Evolutionnary, 2002, pages 32-35.

[16]. A. Bhuvaneshwari, R. Hemalatha, T. Satyasavithri ;Statistical Tuning of the Best suited Prediction Model for Measurements made in Hyderabad City of Southern India. Proceedings of the World Congress on Engineering and Computer Science 2013 Vol II WCECS 2013, San Francisco, USA pages 23-25 October, 2013.