CALCULATION MODELS FOR AN EFFECTIVE ESTIMATE OF THE COST OF A 50MHZ BLOCK TO OPERATE THE 5G MOBILE NETWORK IN MADAGASCAR

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ABSTRACT

The frequencies for antennas used in 5G are in the 3400 - 3800 MHz band. For Madagascar, this is the 3.7 GHz band (3.6 GHz-3.8 GHz). Our work in this article consists in proposing models for calculating the cost of license to operate a 50 MHz frequency block in Madagascar, aiming to estimate a reasonable and relevant price with regard to operators and with respect to the actual economic situation of the country; and to bring benefits to the implementation of this new generation of mobile network.
Therefore we will see two main models: the one used for the case in France and another based on GSMA recommendation.

Keyword: *5G, license, 50MHz, GSMA, France, Madagascar*

1. INTRODUCTION

If the deployment of 5G in the world began in the year 2018 [1] like the case of North America, East Asia and Europe, several countries in Africa are also positioned in the implementation of the technology of this fifth generation. For Madagascar, the first 5G services was launched in June 2020 by Telma Madagascar with Ericsson. [2].
In this context of 5G deployment, the study to define the license price for the operation of frequencies in the 3.7GHz core band must be carried out. Several analyzes have already been carried out on this subject for the case of Africa, which differs greatly from the rest of the world in terms of a high cost of frequencies, a low availability of frequencies and a rather late implementation for the previous generations of mobile networks. [3] [4]
The objective of our work is therefore to offer a technologically neutral license cost so that operators can deploy new technologies using their frequency resources as soon as market demand appears.

2. FREQUENCY ALLOCATION METHODS

In Madagascar, the bandwidth planned to be allocated for 5G is 200MHz. The distribution of the frequency bandwidth to be used can be defined by the following formula (1) [5]:

$$L_{BF} = (n \times 50MHz) + (m \times 10MHz) \qquad \textbf{(1)}$$

With:
L_{BF}: The total width of the frequency band to be allocated
n: number representing the total number of 50MHz blocks corresponding to the number of potential operator, with $n \in \mathbb{N}$
m: number representing the total number of additional 10MHz frequency blocks remaining, with $m \in \mathbb{N}$

3. CALCULATION OF THE LICENSE COST FOR THE OPERATION OF THE CORE BAND IN FRANCE

3.1 Method for calculating rights and charges relating to the use of frequency bands in mainland France

The license to operate the 5G frequency band corresponds to a provision fee. Thus, any operator holding authorizations for the use of frequencies, wishing to deploy the 5G land mobile network with a fixed block and one or more additional blocks is subject to the provision charge described by the following formula (2):

$$R_{DT} = (1 \times PR_{fixed}) + (x \times PR_{add}) \qquad \textbf{(2)}$$

Where:

R_{DT}: The total annual fee for making allotted frequencies available (50MHz and 10MHz)

PR_{fixed}: The reserve price for each fixed 50 MHz block determined by the Government

PR_{add}: The reserve price of each remaining 10 MHz block

x: The number of 10MHz blocks requested by the operator

3.2 Calculating method of the reserve price of the 50 MHz frequency block in France

In order to set the amount of the license fee relating to the operation of the sets of frequencies in the 3.4GHz-3.8GHz band in France, the Secretary of State requested the advice of TERA Consultants, an expert in the sector. According to the opinion in [6], the expert favored two frequency evaluation methods, described in the following paragraphs, to make the decision:

- The benchmarking model
- The net present value model

We will describe these two models one by one and apply the benchmarking model to the case of Madagascar where we can use more concrete data.

3.2.1 Benchmarking model

Definition 01

Standardization involves studying the price of 3.5 GHz frequencies allocated for mobile services in other countries.

To transpose these frequency prices for the case of a given particular country, it is necessary to perform an arithmetic mean given by the following formula (3):

$$R_{DT} = \frac{1}{n}\sum_{i=1}^{n} R_{DT_i} \qquad \textbf{(3)}$$

With:

R_{DT}: The reserve price to be estimated

n: The number of countries to be taken into account for the benchmarking

R_{DT_i} : The reserve price in country "*i*"

3.2.2 Net Present Value model

Definition 02

The net present value (NPV) method consists of discounting, at the rate of the average cost of capital, the cash flows generated by the operation of the frequencies concerned for a generic operator. The expert recalls that this method is notably recommended by the International Telecommunications Union; it makes it possible to take into account all the characteristics of the national market where the licenses are allocated and it also makes it possible to integrate the specific obligations relating to the licenses granted. [6]

$$VAN = \sum_{t=0}^{T} \frac{CF_t}{(1+k)^t} \qquad \textbf{(4)}$$

With:

t: Designates the current period, t = 0 being the moment of decision making

T: Refers to the last period, known as the horizon

CF_t: The net cash flow for the period: difference between income and expenditure.

k: The chosen discount rate

The values of these different variables are described below according to the study carried out by the expert [6]:

- T = 15 years corresponding to the duration of the authorization to operate 5G frequencies;
- k = 7.6%, discount rate determined by Arcep using the weighted average cost of capital;
- For the net flow, the assumptions on costs and investments must take into account in particular: the different cost of the creation of a new site or of the 5G equipment of an existing site, the variable difficulty of the installation of this equipment, in particular in very urban areas, and the chronology of the equipment of the sites:
    - the specific capex corresponding to the deployment of a transmitter operating in the core band on a multi-band site;
    - the capex of the site where the 3.6 - 3.8 GHz transmitters are installed, which are shared with the other bands activated on the site;
    - the general network opexes which are allocated to the different activated frequency bands according to the share of traffic carried by the frequency bands in the total traffic on each considered site;
    - the commercial costs corresponding to commercial and general expenses assessed as a percentage of turnover;
    - the cost of the 5G "core network".
    - the cost of redeveloping the spectrum, estimated by the National Frequency Agency (ANF) at around 74 million euros

3.3 Application of the benchmarking model for the case of Madagascar

To apply the benchmarking model for calculating the price of the 50 MHz block in Madagascar, we have chosen four African countries whose average unit license costs are close to thus eliminate costs that are too high compared to the average and which are at around the world ranking of Madagascar according to the human development index (HDI).

Note that the HDI can be classified into three categories: low, medium and high; the case of Madagascar is "low".

Table (01) below represents the respective prices for these countries and their HDI category.

Table -1: Prices of 5G frequencies in other African countries

Country	Estimated prices of 5G frequencies	HDI Category
Morocco	61 Million euros	Medium
Senegal	51 Million euros	Low
Ghana	28 Million euros	Medium
Guinea	80 Million euros	Low

These values are estimated prices compared to the license cost for 4G obtained by adjusting with a parameter noted β which represents the ratio between the price of the 4G mobile license and that of the 5G mobile license in some countries, we used β = 0.9 [7]

By applying the benchmarking formula (3) with these estimated data for the case of Madagascar we have:

$$R_{DT} = C_{f1} \approx 55\,000\,000€ \quad (5)$$

4. CALCULATION MODEL BASED ON GSMA STUDIES

4.1 Description of the model

According to studies by GSMA, the international association of mobile operators, reserve prices for frequencies in Africa are the highest compared to the world average. This may explain the fact that we find the most indebted countries there. In addition, there are fewer frequencies available in Africa compared to the world average with a significant delay in the allocation of these frequencies. [3] [8]

For the case of 5G deployment, GSMA recommends licenses for more frequencies, issued earlier and at affordable prices, can bring benefits to African consumers.

It is in this sense that we will propose a calculation model for an effective estimate of frequency prices in Madagascar which will be based on a price metric called "the unit frequency price per income".

Definition 03

The unit frequency price per income is the price per MHz, per year and per GDP (Gross Domestic Product). It makes it possible to measure the value of frequencies (as an entry or access cost), in relation to the value of the market in which operators are investing (as an exit from their potential market).

It is therefore necessary to take into account the fact that incomes per capita vary considerably in Africa and in the rest of the world. [8]

From this metric, the calculation of the frequency cost for the 50MHz block is given by formula (6):

$$C_f = C_a + C_{Gf} + C_{mi} \quad \textbf{(6)}$$

With:

C_f: 50MHz frequency block cost

C_a: Frequency access cost based on the frequency unit price metric per income

C_{Gf} : One-off fee for frequency management

C_{mi} : Hardware and infrastructure control fee

4.2 Application of the model for the case of Madagascar

4.2.1 Calculation of the frequency access cost

From the definition of the unit frequency price per income, it is calculated by formula (7):

$$C_a = P_u \times L_B \times D_L \times GDP \times N_a \times T_C \quad \textbf{(7)}$$

With:

C_a: Frequency access cost based on the frequency unit price metric per income

P_u : Unit frequency price per income

L_B : Block frequency bandwidth

D_L: Duration of the 5G license grant

GDP : Gross Domestic Product per capita

N_a : Estimated number of 5G subscribers in Madagascar

T_C : Euro / US dollar PPP exchange rate

In order to set the unit frequency price per income to be used in Madagascar, we have averaged the current prices for the case in Africa, and in other developing countries.

These data are illustrated by table (02)

Table -2: Unit price of frequencies by income [8]

Location	Unit price of frequencies by income (per million revenues ($))
Africa	3.44
Other developing countries	2.46
P_u	2.95

Subsequently, the following table (03) summarizes the values of the parameters used for the calculation of the access cost.

Table -3: Parameter values used

Parameter	Value used
P_u	2.95 $ per million revenue
L_B	50 MHz
D_L	15 years
GDP (2021)	554 dollars per capita
N_a	1.5 Million of subscribers
T_C (2020)	0.711

By applying these data in formula (6), we will have the cost of access to the frequencies, that is:

$$C_a \approx 1\,307\,000€ \qquad \textbf{(8)}$$

4.2.2 Calculation of the cost of the 50MHz block

From the work done in [7], we have the cost of frequency management $\boldsymbol{C_{Gf}}$ and the cost of material and infrastructure control $\boldsymbol{C_{mi}}$ for the case of Madagascar, as the following:

$$C_{Gf} \approx 5\,666\,667\text{ € Et } C_{mi} \approx 50\,000\,000€ \qquad \textbf{(9)}$$

Thus, we can deduce the frequency cost for the 50MHz block by formula (6) from the values (8) and (9):

$$C_{f2} \approx \mathbf{57\,000\,000\ €} \quad \textbf{(10)}$$

5. CONCLUSIONS

In this work we saw two calculation models to estimate the price of the 50MHz block to be used for the 5G network in Madagascar: the benchmarking model used in France to determine theirs and the model based on GSMA recommendations.

We have therefore taken into account various parameters in estimating this price so that it is not too high. Indeed, studies carried out by GSMA have shown that when the frequency prices offered to operators are reasonable, the latter will be able to offer both quality services, with wide coverage and high speed, but above all within the reach of consumers. Our approach therefore aims to have a positive impact on the economic level, in particular on Madagascar's mobile telephony sector.

Finally, as frequency licenses may include obligations (example of minimum coverage levels, implying additional costs for operators), the effective cost of the 50 MHz block in Madagascar, based on our results, is then estimated an average at around 56 million euros.

6. REFERENCES

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