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Evaluation of the Impact of Obstacles on the Capacity of a LTE Network in Urban Area in the Uplink

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Abstract: Power control is a major issue in the deployment of 4G mobile networks. Indeed, environmental constraints (relief, Air, noise,...) affect the propagation channels of mobile network systems. The new multimedia services, which consume large amounts of radio resources (frequencies), then lead to an optimization of power control in the cellular coverage in the uplink direction. The aim is to optimize the capacity of radio resources in the cellular coverage based on a COST-231 Walfisch-Ikegami semi-empirical propagation model for power control in the upward direction. It is a question of studying the signal quality between a mobile station and the base station under the constraint of obstacles (Buildings) in order to evaluate the effect of propagation losses on the transmission power in Uplink using different frequencies of the network. Results show that the transmission power is strongly influenced by the path losses that depend on the carrier frequency. Higher the transmission frequency, the less the wave propagates due to propagation and penetration losses due to different barriers.

Keywords: 4G Networks, Uplink Power Control, Semi-Empirical Model COST-231 Walfisch-Ikegami

Introduction

In recent years, wireless technologies have developed rapidly. As a result of this evolution, transmission systems are likely to support a wide range of applications: voice, pictures, video and data. These applications require a high quality of service, which is why it is useful to have a robust system capable of managing this traffic. LTE technology in mobile networks addresses these concerns by offering several advantages, including:

- Improved throughput in Uplink and downlink
- Reducing interference

However, there are constraints that face these expectations such as:

- Cellular coverage
- Energy management
- Capacity of the access network
- Intercellular interference to edge of the cells
- Presence of obstacles is either natural or artificial

In this article, we will discuss the problem of the network's ability to ensure good cellular coverage in dense traffic areas under the constraint of the presence of obstacles, based on the parameters of power control. Aim is to analyse the effects of propagation losses on the signal transmitted at LTE-Advanced frequencies in order to optimize network capacity and cellular coverage from power control. Flowchart of this article is presented as follows: Section II presents work on LTE power control in the uplink. Section III presents the Uplink power control algorithm proposed in this paper. Section IV describes the experimental conditions, then the results of the simulations are presented and discussed. Finally, a conclusion on the research work will close this article by indicating a way forward for the further work to be carried out.

Related Work

Power control is a major challenge in today's telecommunications world. Indeed, transmission power has a significant influence on the quality of coverage and network capacity: on the Quality of Service (QoS). This is an issue that is the subject of intense research in mobile networks. Indeed, without power control, a single mobile terminal transmitting at too high a power could prevent the other terminals in the cell from communicating because several users transmit at the same frequency. So each user can be a source of interference for others. Thus, it is important to implement a mechanism that allows terminals to adjust their transmission power while ensuring good reception at the base station and also to keep their batteries as long as possible. This power problem arises both in terms of the power emitted by the mobile user and in terms of the power emitted by the base station to limit interference. The power control mechanism is used in LTE-A networks to manage: energy savings, coverage improvement, access network capacity and interference problems. Power control strategies can be divided into three categories (Belannague, 2012):

- Energy saving
- Minimization of interference at the edge of the cells
- Increased connectivity

In the literature, several studies have been proposed to solve these problems related to quality of service in LTE networks. Jerzy (2017) has proposed in his work an algorithm to reduce the transmission power in Femtocells LTE cognitive networks by satisfying a maximum number of users.

Gururaj and Pandiaraj (2012) have developed an algorithm to reduce interference from the power control of access points in a Femtocell network; to do this, they propose two methods to control the power of access point transmissions using flexible computing techniques: The neuro-controller for the Femtocells access point transmission power control strategy and the fuzzy logic controller for the Femtocells access point transmission power control. The reuse of frequencies in the latest generation mobile networks (4G+) results in the problem of interference in cellular coverage. There are two types of interference: intracellular interference, which is interference within the same cell and intercellular interference for adjacent cells. The development of Single Carrier Frequency Division Multiple Access (SC-FDMA) access technology has solved the problem of intracellular interference. However, with regard to intercellular interference, power control mechanisms are proposed to address it. This is the case in particular with (Sami and Stuber, 2009). Who present two algorithms of sub-carrier and power allocation sensitive to interference to solve this problem within cognitive radio networks based on OFDMA technology (Sami and Stuber, 2009; Chee *et al*., 2009) define methods for managing interference in cellular coverage in Uplink, therefore they hypothesize that power control in the upward direction in a network limited by interference can minimize energy consumption as well as some signal interference (Chee *et al*., 2009). On the other hand, Kambiz *et al*. (2003) are developing a new predictive power control algorithm based on a Dynamic Channel and Power Allocation (DCPA) scheme; This algorithm makes it possible to optimally manage the allocation of resources in non-uniform and stationary environments due to the ever-increasing capacity requirements in mobile radio systems. Thus, power control can be done in both directions: from the base station to the mobile (Downlink) and from the mobile station to the base station (Uplink) (Kambiz *et al*., 2003). In order to evaluate the overall performance of a multicellular network from the Uplink power control, Shen and Yu propose an interference-sensitive algorithm using the technique of programming the sum of the ratios to solve the problems associated with them (Kaiming and Wei, 2014). On the other hand, Asenov *et al*. (2013) use a heuristic approach to power control to improve the performance of the LTE network by considering the preferences of users with similar properties in cell coverage in the ascending direction (Asenov *et al*., 2013).

In addition to interference problems in a cell, power control is also used to improve cellular coverage of LTE networks. In general, the cell coverage problem is to optimize from propagation models. These propagation models are essential tools for radio planning in mobile networks. They make it possible to evaluate the strength of the signal received by a mobile terminal, to evaluate the coverage radii and to deduce the number of cells required to ensure coverage of a given area (Riad *et al*., 2017). Propagation models are used to characterize the attenuations undergone by a signal between two entities of a considered space (Base Station and Mobile Station). One of the important parameters to consider is distance. The further away the source is, the weaker the signal is. Radio propagation is essential for emerging technologies, so appropriate design, deployment and management strategies are developed for wireless networks. It is highly site-specific and can vary considerably depending on the terrain, operating frequency, mobile terminal speed, interface sources and other dynamic factors (Yuvraj, 2012). The quality of the signal during radio transmission depends on the losses recorded during the journey and the distance between the transmitter and the receiver. Thus, the relationship between path loss and distance from transmitter and receiver defined by the propagation model gives an idea of the allowed path loss, the maximum range of cells. Environmental and atmospheric conditions, operating frequency and distance between transmitter and receiver are factors that can affect signal path loss (Premchandra *et al*., 2015). Sivaraja and Palanisamy (2016) explain that cellular coverage can be evaluated from the Non-Line Of Sight (NLOS) path loss (Path-Loss) formula by considering the distance between the different equipment and some network parameters (Sivaraja and Palanisamy, 2016). Buenestado *et al.* (2017) propose a self-planning algorithm that adjusts the transmission power of a base station in the system (network) cell by cell by improving the overall spectral efficiency of the network in the downward direction with reduction of the transmission power of specific cells to eliminate interference problems (Buenestado *et al*., 2017). In addition, Fengming and Zhong (2013) show that downlink power control can effectively balance performance, reduce interference and optimize cell coverage by providing a method of self-organization within the femto cell (Fengming and Zhong, 2013). Also the capacity of the E-UTRAN access network can be optimized using the power control mechanisms. In the upward direction, this is UpLink Power Control (ULPC). Indeed, ULPC is an important Radio Resource Management (RRM) process in mobile networks because it has a direct impact on signal levels; interference received and battery consumption of the mobile station (Smartphone, tablet, etc.) (Fernández-Segovia *et al*., 2015). In the literature, there are two main methods of Uplink power control for Advanced LTE networks. Open Loop Power Control (OLPC) and Closed Loop Power Control (CLPC) (Amir *et al*., 2016).

The OPCL makes it possible to evaluate the channel losses between the base station and the mobile user in order to define the power at which the mobile terminal must emit to compensate for fading phenomena; while the CLPC compensates for rapid fading that degrades the signal regularly. In the upward direction, it is based on the principle that the base station makes frequent estimates of the Signal to Interference Ratio (SIR) and compares them to a target value. The base station asks the mobile terminal to decrease its power if the estimated value is higher than the target value and to increase its power if it's lower than the target value. With this in mind, Robert *et al.* propose to improve performance at the edge of the cells by giving an overview of the behaviour of the different types of Uplink power control such as: fractional power control and complete path loss compensation (PL), as well as the impact of specific parameters set using a complete simulation environment at the system level (Mullner *et al*., 2009). In addition, the Fractional Power Control (FPC) technique used in OLPC is characterized by two main parameters: the received power P_0 and the compensation factor α (Coupechoux and Jean-Marc, 2011). It allows mobile terminals (MS) to partially correct their path loss, thus promoting dynamic changes in transmission power (Buenestado *et al*., 2017). On this analysis, Fernández-Segovia *et al*. (2015) developed a self-planning approach method for Fractional Power Control (FPC) parameters by evaluating the nominal PUSCH power p-0 and the trajectory loss compensation α (Fernández-Segovia *et al*., 2016).

Power Control Algorithm in Uplink

LTE power control algorithms are based on both an Open Loop (OL) or Closed Loop (CL) scheme or a combination of both. Indeed, the LTE uplink has three physical channels: Physical Random Access Channel (PRACH), Physical Uplink Shared Channel (PUSCH) and Physical Uplink Control Channel (PUCCH) (Fernández-Segovia *et al*., 2015). The power control algorithm we propose aims to improve access network capacity and LTE cellular coverage in the presence of obstacles. Thus we jointly evaluate the impact of the transmission power on:

- Signal loss during transmission between the base station and the mobile station
- Cellular coverage

The transmission power used to improve Uplink capacity in LTE networks is that determined at the PUSCH physical channel level and defined in (Mullner *et al*., 2009) by:

$$P_{Tx} = Min\left\{P_{\max}, 10.\log_{10} M + P_0 + \alpha.PL + \Delta_{TF} + f\left(\Delta_i\right)\right\}. \quad (1)$$

In order to help in understanding the different parameters in the formulation in (1), the reader should consult the articles referenced in (Mullner *et al*., 2009; Bilal and Abbas, 2009):

- $P_{\max}$: Maximum permissible EU transmission power, by example at 23 dBm (200 mW)
- M: Size of PUSCH resource allocation to a specific EU expressed as number of Resource Blocks (RB) or number of Resource Blocks (RB) allocated to the EU
- P_0 Parameter specific to the cell/UE. It's used to control target SNR and is signalled by Radio Resource Control (RRC)
- α Path loss compensation factor. This is a parameter specific to a 3-bit cell in the range [0-1] reported by RRC:
    - *If* $\alpha = 1$, this is a total compensation for loss of way. We then have conventional power control
    - If $0 < \alpha < 1$ it's a fractional compensation for loss of path. This involves fractional power control

- *If* α = 0 there is no compensation for loss of way. So no power control. This means that all UEs will use the maximum allocated transmission power (Bilal, 2008)

- *PL*: Loss of way between UE and eNodeB
- Δ_{TF}: Is the cell or EU-specific modulation and coding scheme defined in the 3GPP specifications for LTE. It depends on the Transport Format (TF)
- $f\Delta_i$ defines the specific correction term Close Loop Power Control (CLPC) with increase or decrease of relative or absolute power depending on the function

The correction values Δ_i are generated by comparing the level and quality measurements filtered in Uplink with specific targets defined by a two-dimensional decision matrix. This matrix is implemented in the eNodeB and is designed generically and scalably to use QoS, PL estimates and interference in neighbouring cells to increase or decrease power. UE defines its initial transmission power according to the parameters received from the eNodeB and the calculation of its path loss. It is interesting to note that Δ_i is reported by eNodeB to any EU after establishing its initial transmission power.

That is, Δ_i has no contribution to the initial setting of the UE transmission power. The expression on the basis of which an EU establishes its initial power, can be obtained from Equation (1) by ignoring Δ_{TF} and the closed loop correction while the power limitation can be neglected because it corresponds to the EU to comply with it (Bilal, 2008). Thus, this equation becomes:

$$P_{Tx} = 10.\log_{10}(M) + P_0 + \alpha.PL \quad (2)$$

Most of the authors who studied power control from Equation (2) focused on the evaluation of the parameters P_0 and α. However, we focus on the Propagation Loss (PL) parameters that are important for the evaluation of transmission power.

Propagation Losses

Propagation Losses (PL) are calculated from propagation models which are essential tools for radio planning and optimization in mobile networks. They make it possible to evaluate the power of the signal emitted or received by a mobile terminal, the coverage radii and to deduce the number of cells required to cover a given area (Riad *et al*., 2017). They can therefore be used to characterize the attenuations experienced by a signal between the base station and the mobile station. Figure 1 illustrates this point.

Radio propagation assessment is essential for the development of appropriate design, deployment and management strategies for any wireless network as it is highly site-specific. There are different propagation models for LTE and by comparing them, the selection of one of them is made according to the objectives sought. The Appropriate radio propagation model is chosen taking into account the behaviour of the signal during transmission and factors that may affect path loss such as environmental conditions, operating frequency, atmospheric conditions, transmitter-receiver distance and mobile terminal speed (Premchandra *et al*., 2015). Propagation models are used to estimate the value of the path attenuation. Thus there are several types of propagation models that can be groupesd into two main categories (Yuvraj, 2012):

- **Empirical Models:** These are mathematical formulas used to predict the impact of a transmitter on a certain reception area
- **Physical Models:** Predict the propagation of radio waves and calculate its paths taking into account reflection and diffraction phenomena

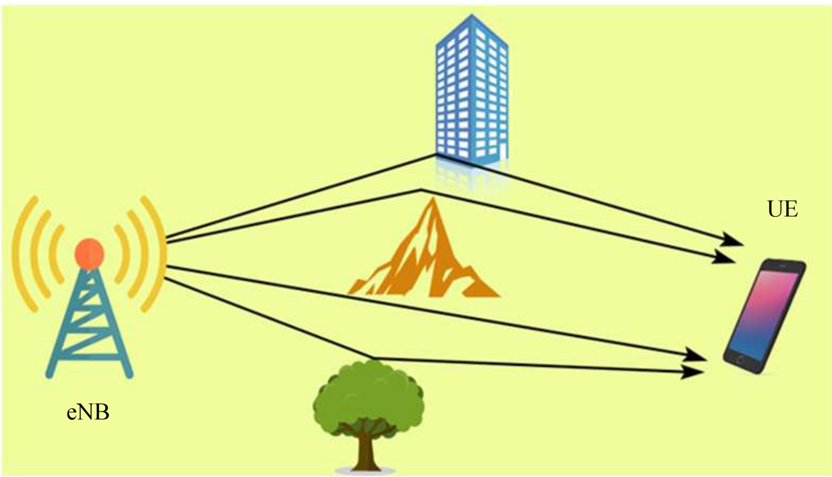

Fig. 1: Attenuation effect on a signal in the presence of obstacles

However, there are some who have characteristics of both. These are semi-empirical models.

In our study we use the formulas of the COST propagation model Walfisch-Ikegami which is part of the semi-empirical models (Yuvraj, 2012) to evaluate the impact of obstacles on path loss in emission with LTE frequencies.

Model Description

The COST-231 Walfisch-Ikegami model is an extension of the COST231-Hata model

It's a combination of the trajectory loss parameters of the Walfisch-Bertoni model and the Ikegami model (Noman *et al*., 2011; Premchandra *et al*., 2015). It's suitable for macro, micro and picocellular urban environments (valid from 20 m) in direct (Line Of Sight) and non-direct (Non Line Of Sight) visibility. It takes into account the diffraction and reflection properties of buildings by offering good accuracy (average building height and separations, average street widths, etc.) (Noman *et al*., 2011). COST-231 Walfisch-Ikegami model is characterized by two functions:

- The function of line of sight, the wording of which is as follows:

$$\mathrm{PL}_{\mathrm{LOS}}(dB) = 20\log(d) + 42.64 + 20\log(f) \quad (3)$$

- The non-direct visibility function given by:

$$\mathrm{PL}_{NLOS}(dB) = PL_{Los} + PL_{RST} + PL_{MSD} \quad (4)$$

For the rest of this article, our work is based on the model of non-direct visibility. Thus:

- PL_{LOS} is the free space attenuation and is described as follows:

$$\mathrm{PL}_{\mathrm{LOS}} = 20\log(d) + 32.45 + 20\log(f) \quad (5)$$

- PL_{RST} represents the diffraction from the roof to the street and is defined as:

$$PL_{SRT} = -16.19 - 10\log(w) + 10\log(f) + 20\log(h_b - h_r) + PL_{ORI} \quad (6)$$

Where:
h_r: Size of mobile station
h_b: Size of base station
w: The street width

- PL_{ORI} is a function of the antenna orientation with respect to α street (in degrees) and is defined as follows:

$$PL_{ORI} = \begin{cases} -10 + 0.35\alpha & for\, 0 \le \alpha \le 35 \\ 25 + 0.0075(\alpha - 35) & for\, 35 \le \alpha \le 55 \\ 4 + 0.114(\alpha - 55) & for\, 55 \le \alpha \le 90 \end{cases} \quad (7)$$

- PL_{MSD} Representing the diffraction attenuation due to multiple obstacles is specified by:

$$PL_{\mathrm{MSD}} = BL_{\mathrm{BSH}} + K_A + K_D\log(d) + K_{\mathrm{F}}\log(f) - 9\log(S_B) \quad (8)$$

Or:

$$PL_{BSH} = \begin{cases} -18\log(1 + h_r - h_b) & for\ h_b \le h_r \\ 54 + 0.8(h_r - h_b)2d & for\ h_r \le h_b\ and\, d \le 0.5km \end{cases} \quad (9)$$

$$K_A = \begin{cases} 54 & for\ h_b \le h_r \\ 54 + 0.8(h_r - h_b) & for\ h_r \le h_b\ and\, 0.5\ km \le d \end{cases} \quad (10)$$

$$K_D = \begin{cases} 18 + 15\left(\dfrac{h_r - h_b}{h_b}\right) & for\ h_b \le h_r \\ 18 & for\ h_r \le h_b\ and\, 0.5\ km \le d \end{cases} \quad (11)$$

$$K_F = -4 + K\left(\frac{f}{924}\right) \quad (12)$$

k = 0,7 for suburban centres and 1.5 for metropolitan centres.

To simplify our work, we use the formula proposed by Jerzy (2017):

$$PL_{NLOS}(dB) = 20\log(d) + 46.4 + 20\log(f) + L_w \quad (13)$$

Where:
d: Distance in meter between the base station and UE.
f: Carrier frequency (MHz).
$L_w = n_w PI_w$: Expresses penetration losses due to obstacles (dB).
$L_w = 20n_w$: For thick obstacles (exterior walls)
$L_w = 5n_w$: For light obstacles (interior walls). n_w Represents the number of obstacles between the base station and mobile station.

Indeed, penetration losses can be defined as the amount of signal power (measured in dB) lost when the signal passes through an obstacle (it can be a building, a ground, a tree...). The reason for these losses is the reflection of the wave trying to pass through the obstacle and the additional absorption made by it. The calculation of these losses is important for the total loss of path. So tolerating them could be critical, especially in environments with many obstacles.

The mobile station may be moving in the cell, so there will be a variation in the number of obstacles, which can affect the propagation of the wave. To simplify our study we consider the case where the mobile station is outside the buildings and is not moving in the cell. Equation (3) is obtained from the free space propagation formula given by the following Friis relationship:

$$P_R = P_T.G_T.G_R.\left(\lambda / 4\pi d\right)^2 \quad (14)$$

Where:
P_R: Received signal strength
P_T: Power of the transmitted or transmitted signal
G_R: Antenna reception gain
G_T: Gain of the transmitting antenna
λ: Wave length

Commonly if:

$$G_T = G_R = 1; alors: \frac{P_T}{P_R}\left(4\pi d / \lambda\right)^2 = \left(4\pi df / c\right)^2 \quad (15)$$

Thus:

$$PL(dB) = 10\log\left(\frac{P_T}{P_R}\right) \quad (16)$$

$$P_L\left(dB\right) = 10\log\left(4\pi df / c\right)^2 = 20\log\left(4\pi df / c\right) \quad (17)$$

Experimental Conditions: Materials and Data

In our simulation we used a laptop PC equipped with a processor, i3-2310M CPU core(TM) @ 2.10 GHz (4 CPUs), 4Gb RAM, Intel(R) HD and a Windows10 professional 64bits OS. We did our simulations with MATLAB R2015b software.

The performance of the system is assessed analytically. The analyses are made for the case of medium-sized cells with a radius r = 1000m; hence the estimated path loss at a distance of 1000 m. In our calculations, we use parameters such as carrier frequencies, distance and the presence of three obstacles between transmitter and receiver. The LTE system under consideration uses a channel width of 5 MHz, i.e., 25 Resource Blocks (RB) of 180 kHz each. Uplink transmission is limited to 5 resource blocks per User Equipment (UE), which represents a reasonable compromise between throughput, power propagation and increased bandwidth noise. The path loss and transmission power are calculated from Equations (2) and (4) above. Resulting graphs are plotted using MATLAB. Radio propagation model describes the behaviour of the signal when it is transmitted from the transmitter to the receiver. It gives a relationship with the distance between transmitter and receiver and the loss of path. From the loss of path, we can get an idea of the power that the mobile terminal must emit to access the radio resources in the cell. The loss of trajectory or propagation depends on frequencies, the environment (rural, urban, suburban) and the distance between transmitter and receiver. The simulation parameters are given in Table 2. They are used in the simulation scenario to obtain the given results. To make our scenario more practical in the simulations, NLOS is used in urban conditions because of the traffic density in this type of environment.

Simulation Results

LTE technology transmits on six (6) different channels. Each channel is assigned to a frequency and each frequency type determines a number of resource blocks available (See Table 1).

The following figures are the results of the simulations obtained with the parameters mentioned in Table 2. In the first graph (Fig. 2) we present the results of the transmitted power and trajectory in the absence of obstacles (buildings). Then we show the results with the presence of obstacles in the second graph (Fig. 3).

Table 1: Bandwidths for the LTE network per channel

Number of channel	Channel bandwidth (Mhz)	Number of resource blocks
1	1.4	6
2	3.0	15
3	5.0	25
4	10.0	50
5	15.0	75
6	20.0	100

Table 2: System-level simulation model parameters

Parameters	Values
Frequency band (Mhz)	f = 1.4; 3; 5; 10; 15; 20
Number of resource blocks M	M = 6; 15; 25; 50; 75; 100
Transmitter distance d(m)	d = 1000 m
Path loss compensation factor a	α = 0.2; 0.4; 0.6; 0.8; 0.9; 1
Rated power contained in a resource block Po	Po = -110; -105; -100; -90; -80; -60
Loss of penetration P_{LW} (dB)	20Db
Loss of path with obstacle (dB)	PL_{NLOS}(db) = 20 log(d)+46.4+20log(f)+L_W
Loss of path with obstacle (dB)	P_{TX} = 10.log$_{10}M$+P_0+α PL
Number of obstacles	3 (Building)

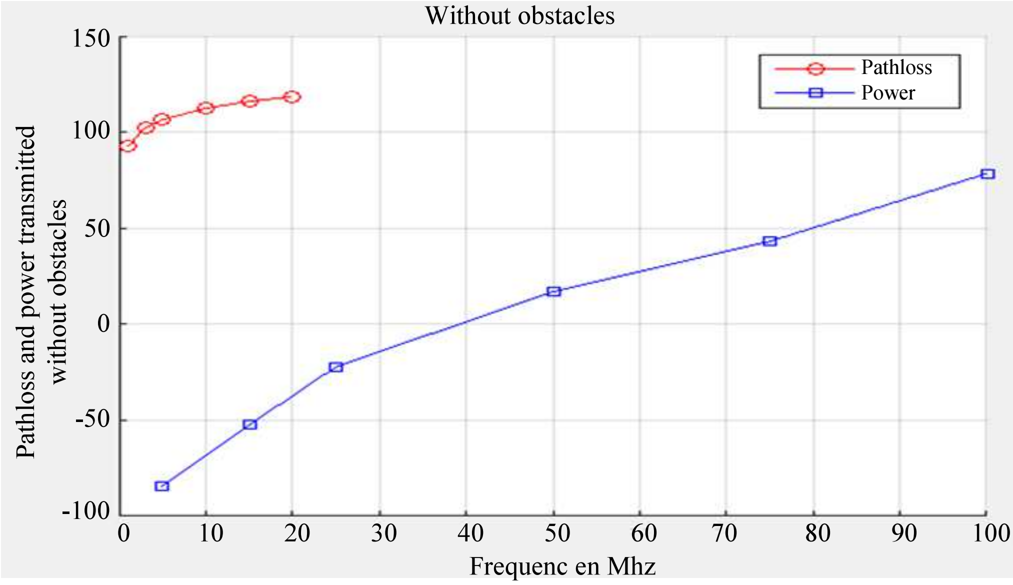

Fig. 2: Propagation and transmission power in the absence of obstacles

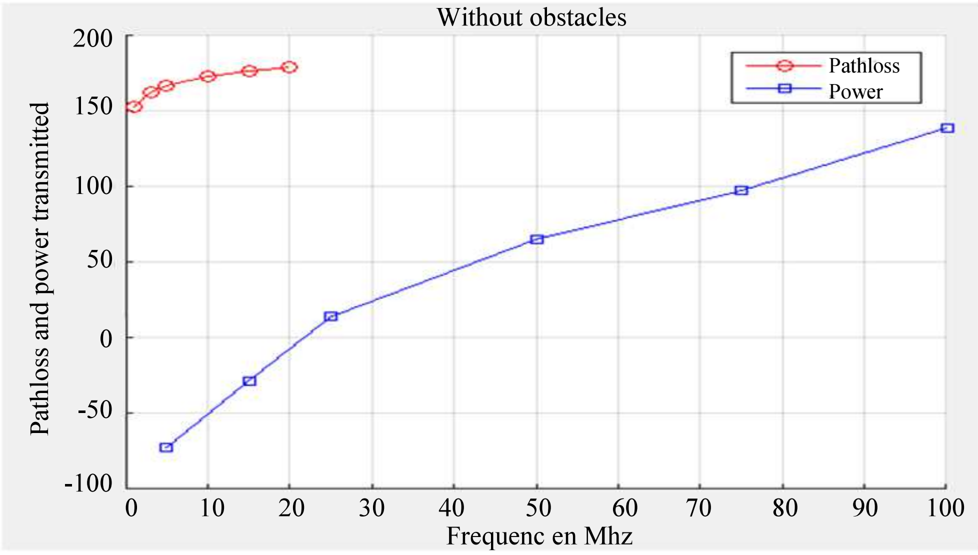

Fig. 3: Propagation and transmission power in the presence of obstacles

Analyses and Interpretations

In Fig. 2 and 3, the red curves represent the propagation losses and the blue curves represent the transmission power. Figure 2 shows the propagation losses and transmission power in the absence of obstacles. Figure 3 shows the propagation losses and transmission power in an environment with buildings present we limited ourselves to three obstacles (buildings: buildings) to simplify our study. In the absence of buildings (Fig. 2), for the 1.4 MHz frequency, the propagation loss is less than 100 dB and with the frequencies of 3 MHz, 5 MHz, 10 MHz, 15 MHz and 20 MHz the losses are greater than 100 dB. In the same environment, we notice that the emission powers for the frequencies of 1.4 Mhz, 3 Mhz and 5 Mhz are less than 0 dB. Unlike the frequencies of 10 Mhz, 15 Mhz and 20 Mhz where the emitted powers are greater at 0 dB. On the other hand, the emitted powers are greater than 0 dB for the frequencies of 5 Mhz, 10 Mhz, 15 Mhz and 20 Mhz. In Fig. 4, we simultaneously evaluated the effect of propagation losses on emission powers in environments with buildings at each frequency.

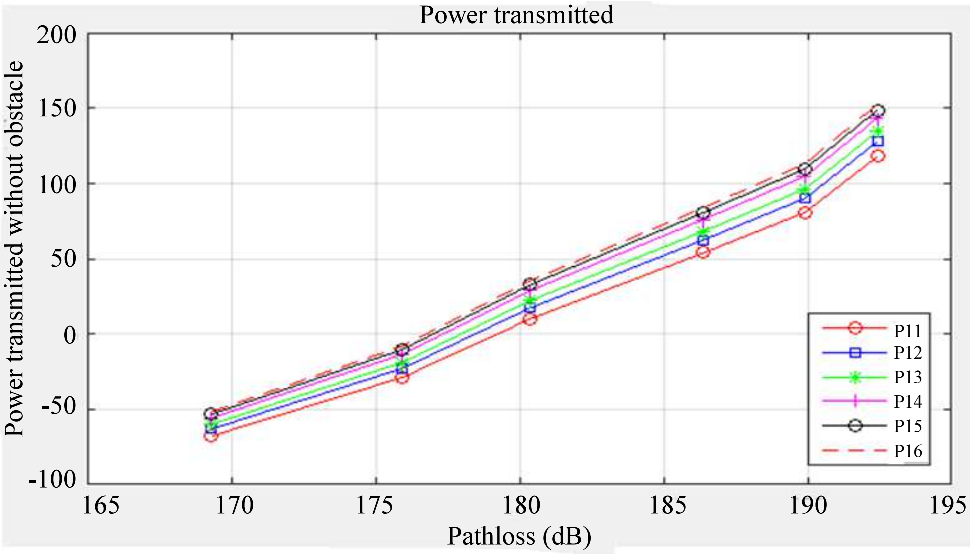

Fig. 4: Transmitting power as a function of propagation losses for each frequency

In this figure we also see that only propagation losses using the frequencies of 1.4 Mhz and 3 Mhz allow acceptable emission powers, i.e. less than 0 dB.

We can therefore say that the higher the frequencies, the greater the propagation losses. This is due to the fact that high frequencies emit at short wavelengths. Also the presence of obstacles such as buildings considerably degrades the transmitted signal. Likewise, the increase in path losses weakens the transmitted signal due to multi-path effects; this leads to a need to increase the transmission power in order to maintain the minimum level of the signal up to the receiver. Thus, the battery life of mobile stations can be reduced and also create interference, especially for those at the edge of the cells. Therefore, to minimize the transmission power it is preferable to choose low frequencies which are also limited in number of resource blocks.

Discussion

Transmission power as a function dependent on propagation losses was studied using frequencies from LTE technology. Indeed, data traffic is carried out through the radio waves transmitted and received by the various equipment that make up the network (base stations and UEs). These waves are emitted from a certain number of frequencies: from 1.4Mhz to 20Mhz.The impact of propagation losses on transmission power is evaluated using formulae (2) and (13). In Fig. 2, with propagation losses below 150dB, transmission powers are below 100dB. This is due to the absence of obstacles in the environment. With propagation losses greater than 150 dB in (Fig. 3), the transmission power is above 100 dB for only frequencies greater than 15 Mhz. We developed our scenario with the presence of 3 obstacles (buildings) between the base station and the EU. It can therefore be said that the higher the frequencies, the greater the propagation losses and this leads to an increase in transmission power (Fig. 4). High frequencies transmit at short distances, unlike low frequencies which transmit over long distances. As a result, the transmission power decreases as you move further away from the transmitter and the wave encounters obstacles in its path. The presence of obstacles such as buildings considerably degrades the transmitted signal due to multi-path effects. Thus, based on path or propagation losses depending on frequencies, the environment (rural, urban, suburban) and the distance between transmitter and receiver, the transmission power of the mobile phone in a cell can be estimated. The high presence of obstacles in an environment requires an increase in transmission power to maintain the signal level to the receiver. However, increasing power can degrade system capacity, reduce the resistance of mobile station batteries and create interference at cell edges. It's therefore necessary to optimize the transmission power by taking into account the different obstacles in the propagation environment in order to guarantee the quality of service.

Conclusion

In this work we analyzed the impact of propagation loss on transmission power in the cellular coverage of LTE-Advanced networks in Uplink with the presence of obstacles. An analytical approach has been adopted for parameters such as frequency, resource blocks and path losses. We have shown that transmission power is influenced by path losses, which in turn depend on the carrier frequency. The higher the transmission frequency, the less the wave propagates due to propagation and penetration losses due to different obstacles. Thus, it is preferable to transmit on frequencies but they are unfortunately limited in terms of the number of resource blocks.

In our future work, we will propose a model for optimizing uplink power control. This model will take into account the main parameters relating to obstacles such as: building size, weight, wall thickness, as well as EU mobility. Indeed, these parameters represent a real challenge for the optimization of LTE-Advanced

Author's Contributions

All authors equally contributed (Literature review, model definition, experiments and interpretation of results) to the success of the manuscript. Also, all authors participated in writing the manuscript.

Ethics

This article has not been published in any other scientific journal or elsewhere. This article is an original research paper.

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