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Research Article

Mobile Network optimization strategy for Urban Area environment

A. Khireddine[1*] and A. Merabet[2]

[1]Electrical engineering laboratory, faculty of technology, University of Bejaia (06000), Algeria
[2]University of Mila (43000), Algeria

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Abstract

The wireless communications applications never cease to grow and demand more each time flow, mobility and quality. That is why in recent years have been marked by the rise of a revolution in computer networks and wireless systems. Combining connectivity and mobility, these new technologies are poised to fundamentally change the information systems and infrastructure. In this paper, we propose a next generation network based on the IEEE 802.16 standard and its various technologies in order to minimize the number of antennas within the city and maximize coverage by connecting several cities together.

Keywords: *Mobile Network, Cell, Evolved Paquet Systemnetwork, wireless, path loss, model arq/harq, Cost 231, IEEE 802.16, latency, delay*

1. Introduction

Cellular network planning is driven by next generation networks towards new avenues of research. Indeed, trends are increasingly converging towards a seamless integration of existing wireless technologies, such as GSM, LAN, Ad Hoc systems into a completely heterogeneous environment ancient systems are completely end-user oriented, providing varied services at high speed and seamlessly across networks. However, in recent years, research has focused mainly on the analysis of mobile generation networks, the objective of which is to offer a whole range of services (rapid access to the Internet, electronic commerce, video conferencing, telemedicine, distance learning, etc.) each having its own characteristics and constraints.

Wireless communications applications never stop developing and each time demand greater speed, mobility and quality. This is why recent years have been marked by the rise of a real revolution in computer networks and wireless systems. By combining connectivity and mobility, these new technologies are poised to profoundly modify information systems and their infrastructures. The Architecture of an Evolved Paquet System network is shown in figure.1:

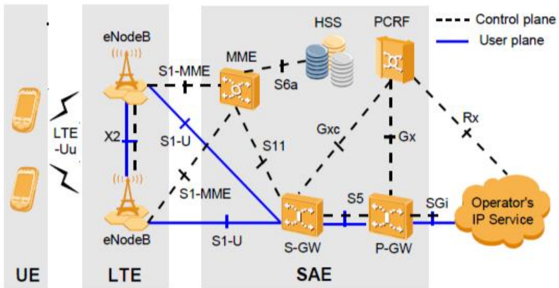

Figure1 Architecture of an Evolved Paquet System network

A. Interfaces

The interface of an imperative to respect the interface is D because it allows an ARQ / HARQ to communicate with the HLR of any other foreign network. Its compliance allows international roaming. The same respect for the A interface allows operators to have different suppliers and can change as and when deploying their networks. It is shown as:

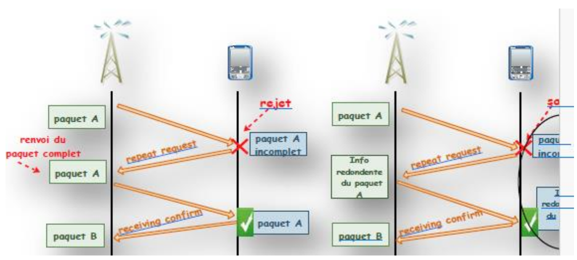

Figure2: Automatic Repeat Reqest/Hybrid Automatic Repeat Request interface

*Corresponding author's ORCID ID: 0000-0000-0000-0000
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B. Characteristics of mobile Network

The is the standard of mobile telephony standards allowing speeds up to 50 times greater than the first standard. 5G Advanced is an evolution of the standard which, while maintaining complete upward compatibility, is considered a fourth-generation standard. It integrates a MIMO multiplexing technique. Each radio channel includes a pair of two channels (or bands), one for transmitting signals from the base station to mobile stations, the downlink channel, the other for transmitting signals to mobile stations the base station, the uplink channel. uses both OFDMA and MIMO techniques (frequency, time). The 5G standard imposes basic criteria on throughput and latency. The objective of this technology is to parallelize the transport of data streams in several antennas different while keeping the same frequency. SO, several antennas are connected to the transmitter, which they emit different streams on the same frequency. The idea is to take advantage of the multi-path properties that we found in environments with obstacles where signals arrive at different times at the receiver (one fairly powerful receiver, capable of deciphering the sequences binaries that arrive at different times). It should be noted that the MIMO technique is only satisfactory in disturbed sets with obstacles and which must be avoided to use it outside.

C. The layers of IEEE 802.16

This standard describes the specifications of the two lowest layers of the OSI Model. the Physical layer (PHY) and the Data Link layer (Mac). In this standard, the MAC layer is designed to support the PMP (Point to Multi-Point) architecture with a BS (Base Station) which controls a set of SSs (Subscriber Stations) connected to it. Figure 3 shows how the router connects with the different cells using bridges. [1]. The router is therefore composed of several bridge interfaces; the number of these interfaces is the same as the number of cells to be connected in this subnetwork.:

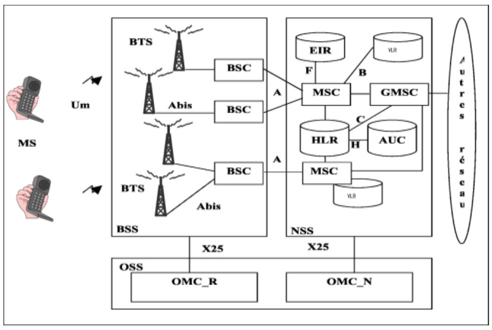

Figure.3 bridge interfaces

2. Outline of a Mobile Radio Link

The signal emitted from the base station to the mobile station is generated as follows:

• A transmitter of the base station generates an electromagnetic wave modulated at the desired frequency (among those allocated to the 4G network).
• A "coupler" allows overlapping waves produced by different transmitters on the same electrical conductor.
• A cable that acts like a waveguide, transmits the waves produced. • A duplexer separates the uplink (mobile to Base Station) and downlink (Base to mobile station).
• An antenna, also known as "air", the transition between the waveguide and free space in which these waves will propagate. • The signal is received by the antenna of the mobile terminal, transmitted via a cable (which can be very short) to the transceiver. The motive does not usually coupling devices because it consists of a single transceiver. Analysis of the uplink shows similar elements. On the base station, a multi-coupler "can have multiple receivers on the same antenna. Specifications mobile network in urban area are shown in figure 4 and table 1:

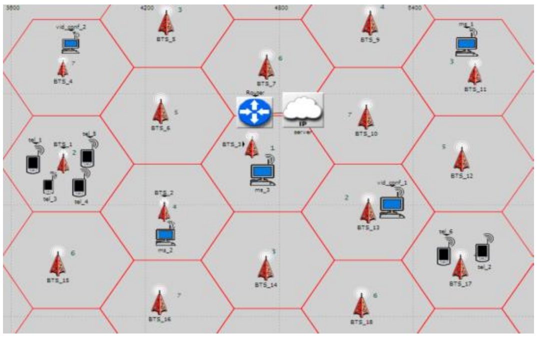

Figure 4: Specifications in mobile network in urban area

Table.1 IMT advanced Specifications for mobile network

Spécifications		IMT-Advanced Liaison descendante	IMT-Advanced Liaison ascendante
Efficacité spectrale par secteur (bits/s/Hz/secteur)	Intérieur	3	2.25
	Microcellule	2.6	1.80
	Couverture urbaine de base	2.2	1.4
	Grande vitesse	1.1	0.7
Efficacité spectrale aux limites de la cellule (bits/s/Hz)	Intérieur	0.1	0.07
	Microcellule	0.075	0.05
	Couverture urbaine de base	0.06	0.03
	Grande vitesse	0.04	0.015
Efficacité spectrale maximale (bits/s/Hz)		15	6.75
Mobilité (bits/s/Hz)	Intérieur : 0 à 10 Km/h	1.0	
	Microcellule : 10 à 30 Km/h	0.75	
	Couverture urbaine de base : 30 à 120 Km/h	0.55	
	Grande vitesse : 120 à 350 Km/h	0.25	
Largeur de bande (MHz)		Jusqu'à 40 MHz	
Latence (ms)	Plan de contrôle	100 ms	
	Plan utilisateur	10 ms	
Temps d'interruption pour la relève (ms)	Intra-fréquence	27.5 ms	
	Inter-fréquence (Intra-bande)	40 ms	
	Inter-fréquence (Inter-bande)	60 ms	
Capacité VoIP (utilisateurs actifs/secteur/MHz)	Intérieur	50	
	Microcellule	40	
	Couverture urbaine de base	40	
	Grande vitesse	30	

3. Case study of propagation models

Since the perfect representation of the basic phenomena involved in the mobile radio propagation is impossible to calculate the attenuation of the radio wave along its propagation path is always approximate. Statistical studies and mathematics have given rise to models for simulating the propagation of radio waves between transmitter and receiver, which are only algorithms for the prediction of field strength as a function of the distance. There are two broad categories of models: empirical models and statistical models [2]. Empirical models are based on statistical data. With this type of model all environmental influences are taken into account without being identified separately, which is also their main advantage. [3]. In addition, their accuracy depends not only on the accuracy of measurements, but also depends on the similarities between the environment and to analyze the environment where the measurements are already made. In other words, to ensure the effectiveness of the model, it is imperative to implement an environment that is appropriate.

As for deterministic models, they rely on physical principles and mathematical, for that they can be applied to different environments without their result is erroneous. Propagation models make it possible to predict the performance of the transmission network, without resorting to systematic measurements which are cumbersome and costly to implement. Based on the environment and respecting the dimensions of the area to be covered. In practice, their implementation requires a very large database of environmental features, things that are not practical because it is difficult to obtain. In addition to the algorithms used are complicated which makes their implementation limited and restricted to small areas or for microcellular environments greatly reduced. Based on the radio environment and within the dimensions of area to cover, these models can be classified into two main categories: propagation models for macrocells and propagation for microcell models.

A. Macrocellular Models

These formulas have been supplemented by the method called "COST 231, which is a set of committee bringing together European operators and manufacturers working on specific issues including the 231 studied the spread).

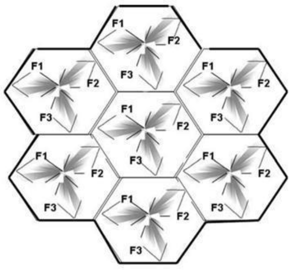

Figure 5: Macrocellular Model

Models of Hata and COST 231-Hata apply for relatively large cell sizes (especially of radius greater than or equal to 1 km) when the antenna of the base station is located above the roof level Nearby [4].

The conditions of application of the model are:

• The height of the antenna of the base station hb between 30 and 200 m;
• The height of the antenna of mobile hm between 1 and 10 m;
• The distance between the mobile and base station (km) between 1 and 20 km;
• The frequency in MHz

• H*ata Model* [4].

Hata's model applies at frequencies between 150 and 1000 MHz. In urban areas, the weakening in dB referred to herein as Lu is given by:

$$L_u = 69,55 + 26,16Log(f) - 13,82Log(h_b) - a(hm) + [44,9 - 6,55Log(h_b)] Log(d) \quad (1)$$

The parameter (hm) isa correction factor depending on the height of the antenna of the mobile station and the environment whose value is:

$a(h_m) = [l,1 Log(f) - 0,7]h_m - [1,56 Log(f) - 0,8]$ for a medium sized city.
$a(h_m) = 3,2[Log(11, 75h_m)]^2 - 4,97$ for a large city (over 400 MHz).

In the case of a user on the ground, ie to a height of 1.5 m, the coefficient a (hm) is quite negligible.

In suburban, weakening LSU expressed in dB is given by applying the formula urban areas affected by a correction:

$$L_{su} = L_u - 2[Log(f/28)]^2 - 5,4 \quad (2)$$
$$L_{ro} = L_u - 4,78[Log(f)]^2 + 18,33Log(f) - 40,94 \quad (3)$$
$$L_{rqo} = L_u - 4,78[Log(f)]^2 + 18,33Log(f) - 35,94 \quad (4)$$

• *Model COST 231-Hata*

This model can be used in all types of environments, it is based on the assumption that the transmitted wave propagates above the roofs of buildings with multiple diffraction, and the buildings are assumed to be at equal heights and uniformly spaced:

$$L_u = 46,33 + 33,9Log(f) - 13,82Log(h_b) - a(h_m) + [44,9 - 6,55Log(h_b)] Log(d) + Cm \quad (5)$$

with :
$a(h_m) = [1,1Log(f) - 0,7]h_m - [1,56Log(f) - 0,8]$
Cm = 0 dB for small city.
Cm = 3 dB for great city

B. Microcell models [5]

In urban areas, where the antenna of the base station is located below the roof level and that the transmission powers are weak, the area covered is called "microcell".

If the phone is visible from the base station (LOS, Line Of Sight), the direct path of the wave is dominant before the diffractions and reflections.

The attenuation is estimated by the formula proposed by the Committee COST 231:

Llosa = 42.6 + 20log (f) + 26Log (d). for d> 0.02 km (6)

It is relevant for frequencies from 800 to 2000 MHz with an antenna movable between 1 and 3 m and a base station antenna between 4 and 50 m.

A simple model, when the mobile is no longer in the same street as the base station is to consider that the waves propagate along the streets as in a waveguide, and as the distance along the streets. [6].

4. **Simulation and results**

Here is the table that determines the definition of the propagation parameters and calculation of attenuation and power (Table III):

Table 2. Propagation Parameters

Settings Introduced	*Hata model*	Cost 231 model	*Microcell model*
Transmit power (dBm)	30	30	30
Transmit gain (dB)	12	12	12
Hauteur de la BTS(m)	50	50	50
CableLoss/connectors(dB)	4	4	4
Coupling loss (dB)	3	3	3
Receive gain (dB)	7	7	7
MSheight (m)	1.5	1.5	1.5
Distance BTS - MS (km)	< d	< d	< d
Frequency (MHz)	800	800	800
Protection margin (dB)	3	3	3

We use the COST231-HATA propagation model, with for the different services presented in the power balance, we seek to estimate the radius of the cells for each environment. [7].

We will now vary the distance (base station - mobile station) to compare the predictions of different propagation models.

• 1st case : d = 10 km(for a great area)

Results of prediction and power are shown in figure 6:

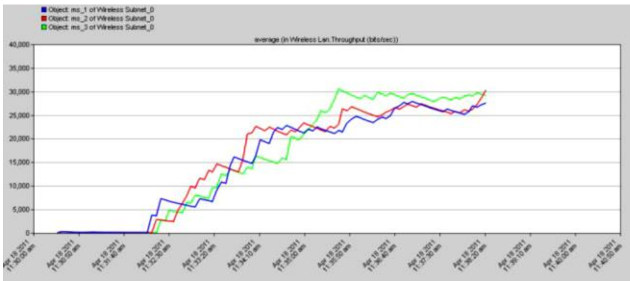

Figure 6. Prediction ion function of distance

The two curves presented show that the model Hata (macro-cell) is optimal for rural areas compared to all other models.

• 2nd case: d=10km (if an urban area)

Results of calculation of Attenuation and power function in urban area are shown as follows for 400 stations:

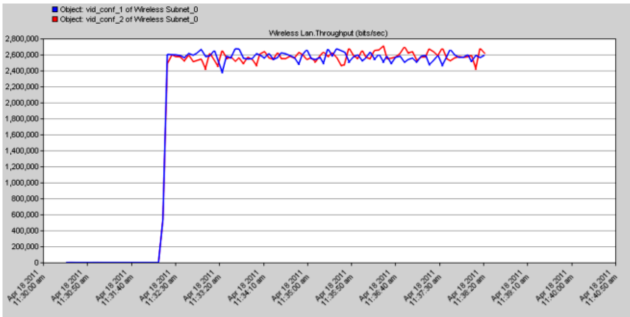

Figure. 7. End-to-end delay (400 stations)

In this case, the two curves presented above show that the model micro-cell is optimal for urban areas compared to all other models (Hata and COST 231). [8].

The traffic map allows you to enter data on 5G network traffic in the area to be planned. There are various types of traffic maps. In our study, we define a traffic map which is based on population density. We consider three types of environment: Urban, Sub_Urban, Rural. Each environment was introduced by limiting the zones by their geographic coordinates.

The results obtained for each area are shown as:

Table.3: Urban, Sub_Urban, Rural. Each environment

Environ ment	Are as (k m^2)	Hb	Coverage radius by area (km)					Cover age area per site (k m^2)
			CS 12.2 kbp s	PS6 4 kbp s	PS1 44 kbp s	PS3 84 kbps	La moy-enne	
Urban	4.67	15	0.61	0.52	0.43	0.32	0.47	0.43
Subur ban	19.7	25	1.83	1.56	1.29	1.07	1.43	3.98
Rural	21	30	2.37	2.02	1.67	1.38	1.86	6.74

the case, the two curves presented in figures 8,10 show that the model micro-cell is optimal for urban areas compared to all other models (Hata and COST 231).

The power function of distance characteristic is shown in figure.8

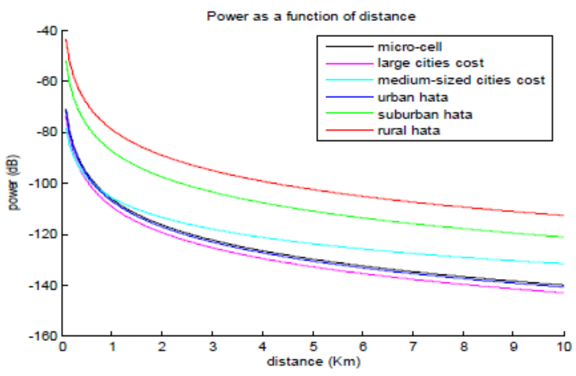

Figure 8. Power function of distance

Telephony Based on IP voice where time parameters constitute the most fundamental of factors, these parameters are necessary to ensure comfort reasonable use (delay and jitter). values recommended by the ITU are:

Table 4: values recommended by the ITU

Latency(Délai)	< 150 ms	> 150 ms & <300 ms	> 300 ms
Jitter(Gigue)	< 20 ms	> 20 ms & < 50 ms	> 50 ms
Performance	**Excellent**	**Good**	**Poor**

The curve presented on the Figures 9, show the simulation results of End-to-end delay :

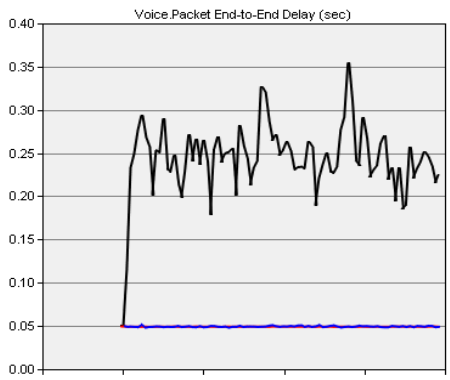

Figure 9: End-to-end delay

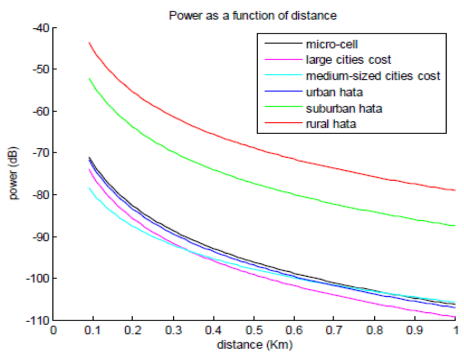

Figure 10. Power function of distance for each area

In this case, the two curves presented above show that the model micro-cell is optimal for urban areas compared to all other models (Hata and COST 231).

The traffic map allows you to enter data on 5G (network traffic in the area to be planned. There are various types of traffic maps. In our study, we define a traffic map which is based on population density. We consider three types of environment: Urban, Sub_Urban, Rural.Each environment was introduced by limiting the zones by their geographic coordinates (figure.11).

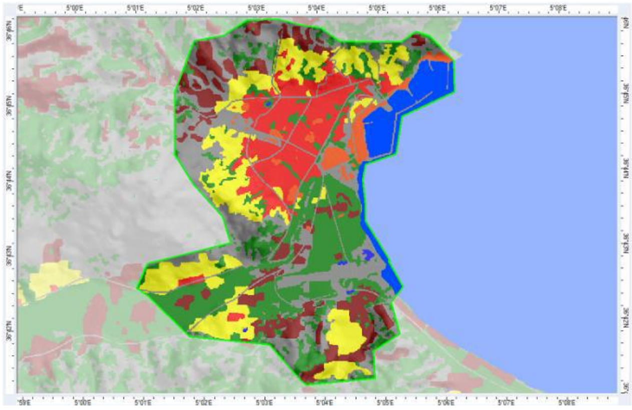

Figure 11: Urban, Sub_Urban area , Rural environment

The choice of inter-site distance must take into account coverage and soft handover factors. An overlap area of 25% to 30% between the coverage areas of neighboring sites is necessary for the soft handover process. The following figure presents the different parameters of urban area and shows the positioning of different sites.

Conclusion

Our results show that for a rural area where the number of subscribers is low (respectively for an urban area where the number of subscribers is important), the different path loss models are compared and analysis in two areas like urban and rural using non-linear mathematical model with the practical data.

In this paper we have seen the different fundamental notions of mobile network. We focused on the Air interface and the various key integrated technologies such as OFDMA, SCFDM and MIMO to achieve higher speeds.

We analysis that micro-cell models are best in urban areas. Hata models are most suitable for rural areas.

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