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Simulation with AirMagnet Survey using Heat Maps inside Indoor Scenarios in Wireless Local Area Networks

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Abstract:- Today some of the difficulties that wireless networks of local area (WLAN) have in internal spaces, for example, buildings offices, distribution of cubicles between floors, is the adequate coverage that has access to various types of artifacts such as cell phones, laptops, computers, through the wireless connection that provides the various access points (AP) distributed in various spaces where people walk or work. In this paper, we present an analysis of the internal scenarios, considering name of AP, MAC address, channel, standard, bandwidth, type of frame and frequency at the time of the planning of a wireless network. The paper gives the idea about the utility that offers and presents the simulation software AirMagnet Survey in planning and design of wireless LAN Networks 802.11 a/b/g/n/ac in obtaining performance, security and optimal compliance of the network using heat maps. The main contribution of my proposal is the results obtained through experimentation allows obtaining relevant information for the network planner responsible for designing and implementing the wireless LAN. Similarly, it makes use of a series of scenarios for the simulation which are configured with certain characteristics, which allows the verification of the connection speed, frequency of the signal and transmission capacity facing the stages of network congestion.

***Keywords**:- wireless local area networks;wireless planning; locate of the access point;indoor scenarios;tools simulation AirMagnet Survey.*

I. INTRODUCTION

It is reality that the Wireless Local Area Networks (WLAN) have come to replace spaces in laboratories, offices, shopping centers, hospitals; where previously there was structured wiring specifically under the ANSI/TIA/EIA-568A standard. This leads to the designers and planners in WLAN networks specifically in internal scenarios must to rethink the way they are going to communicate and locate the equipment are these computers, access points, antennas, to name just a few. However, proper planning of the wireless network goes beyond providing some capacity to users [25]. In turn, the integral function of these devices depends largely on a correct planning of frequency distribution largely on a correct planning of frequency distribution and coverage quality as discussed [1], [2] that can provide base stations depending on its location.

However [3], [4] note that the planning of wireless local area networks faces two major problems. The first is the location of the access points, as shown in Fig. 1., and second, the distribution of signal frequencies in the base stations or access points.

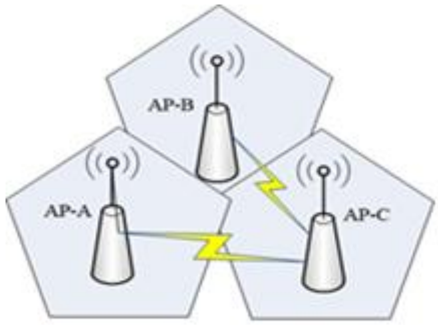

Fig 1:- Problem of location and frequency distribution of the signal at the access points.

In Fig. 1., the distribution of three access points A, B and C is observed. However, these access points (APs) are distributed in a specific space so the network designer must consider the sites that they are identified in the corners in interior environment, for example, in an office. The access points (AP–A and AP–B), emit a signal frequency simultaneously that generates a collision with the signal emitted by the base station identified as AP-C. Frequently, proper planning of a WLAN requires not only knowing the 802.11a, b, g, n, an standards but also the type of scenario for an office or hotel, scenarios in open space better known as "outdoor scenarios" that require hospital centers, undergrounds, coffee shop and commercial environments (airports, data warehouses that serve as spaces to store all types of waxes that are no longer used) in which network planning will be carried out.

On the other hand, we find in some investigations [5], [6] they state that the selection of sites forms the basis of a network which must comply with a series of requirements, such as broad coverage, high traffic capacity, but that allow to minimize the investment cost of the technological infrastructure. However [7], [8], [11] explain that the proper planning of a network is in some situations necessary to acquire adequate coverage.

Therefore, the planning of infrastructure in wireless local area networks (WLAN) that is offered in large buildings requires the consideration of aspects related to coverage, traffic densities, interference and minimization cost and so is a task difficult if it is done manually [9]. Similarly, the high level of heterogeneity and the lack of standardization in al technologies make the design of such environments a very challenging task, since each installation must be designed manually and performed "ad-hoc" for the specific building [30]. Therefore, the location of the access points [26], the behavior of the access points, the orientation of the antennas, the emission of energy [29] and the frequency channel of the antenna [10], represents a difficulty now of parameterizing these variables that are necessary in the automatic planning of this type of networks.

In this paper, the results and contributions achieved in the analysis of WLAN networks in internal scenarios, by using AirMagnet Survey as a simulation tool, allows the optimization of the technological infrastructure and a design and planning of this type of wireless networks.

The organization of this article is as follows. In Section 2. Methods and Materials refers to the inputs used in the preparation of this paper. In turn, Section 3. Results and Discussion, the analysis of a WLAN planning is illustrated through the AirMagnet Survey simulation tool. Section 4., explains the final considerations and details the references used in this paper.

II. METHODS AND MATERIALS

A systemic process is carried out that allows the planning and revision of the documentation from the different positions proposed by each one of the different authors.

Research is carried out on the work carried out by these authors [14-20], where what is related to the area of planning in wireless local area network is explored to compare internal scenarios with the characteristics of these environments. However, it is considered the types of environments and reports, propagation trajectory [21], location of access points, but focused on wireless local area networks (WLAN) to establish a starting point. The works that deal with the concept of planning in WLAN networks are contemplated, but specifically in environment or internal scenarios, as well as the level of noise, average of the signal-to-noise ratio (SNR), interferences of adjacent channels, modes of operation of the access points, channel width, heat maps, used to address the issue of wireless network planning which are several considering the criteria of each author.

The specialized magazines considered from a primary source perspective are those related to the IEEE, ACM, Elsevier, Springer, among others.

A. Mathematical methods for wireless localization based on internal scenarios.

In this research work, the diverse mathematical methods used for wireless location based on scenarios [12] exposed by the author Junjie are taken as references, among which proximity, triangulation and fingerprint. Of these, the so called triangulation is used, in which several authors and experts consider it as the most common technique not based on studies [27], by allowing to measure the distance between the mobile terminal and three transmitters placed in different positions, obtaining the location estimation by solving algebraic functions, since it also uses theoretical aspects from the geometry to obtain the location of a user to be determined by each of the distances that are assigned to the measurement points or access points. Clearly, non-research-based techniques are limited by the path loss model. Unfortunately, an accurate and universal path loss model is difficult to achieve in a complex and variable indoor environment [28].

In the Fig. 2., shows how to obtain the location of a user through the distance, in which there are three wireless access points A, B and C, respectively, located in fixed positions. If the distance of the user's point with respect to the three wireless access bases is known, then the location of the user's access point can be exposed as the intersection of the three circles.

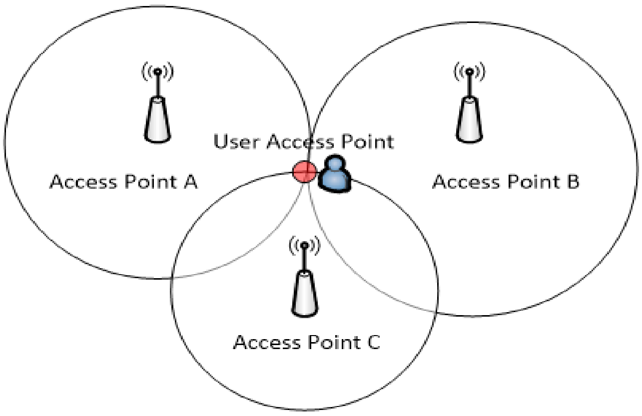

Fig 2:- Location of a user through distance.

Then, the location of a user through the distance of the access points is expressed by the following equation. In "(1)", the d, is the distance between the access points, while the Ω, refers to the user's access point and the L_s, is the distance of separation where these access points are located, for example, the wall, on the roof.

$$d = \Omega . L_s \tag{1}$$

However, the user's location can also be obtained if the angle of the base stations for the user's point in relation to the base stations is known, as seen in Fig.3., thus allowing to obtain the location of the point of user through the intersection of the three vectors.

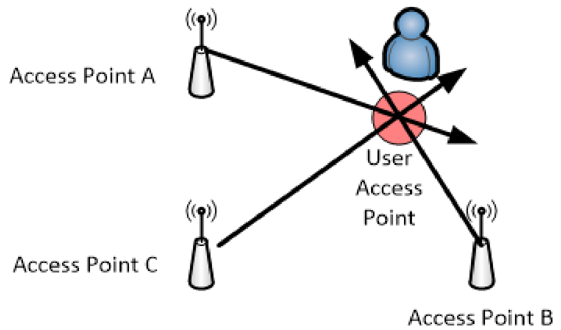

Fig 3:- Location of a user through the intersection of the three vectors.

B. Location in internal scenarios based on WiFi.

One of the advantages of using Wi-Fi positioning systems is to locate the location of most Wi-Fi compatible devices without installing additional software or making additional hardware changes. However, in WLAN environments line of sight is not required. Due to this advantage, Wi-Fi positioning systems have become the most widespread approach to interior location [22].

Most Wi-Fi based positioning systems (WLAN) are available in the form of commercial products at the prototype level based on measurements of received signal strength (RSS). Similarly, Wi-Fi based positioning systems have several advantages [23].

First, in terms of cost, the implementation of the WLAN infrastructure of the position algorithms does not require additional hardware since the network interface cards (NICs) measure the signal strength values of all the wireless access points to receiver's reach level. Therefore, the signals needed for positioning can be obtained directly from NICs available on most handheld computing devices. Due to the ubiquity of WLANs, this positioning mode provides a particularly cost-effective solution for offering LBS (Location Based Services) in domestic shopping center and residential settings [24].

Secondly, the WLAN positioning systems offer scalability in two aspects: first without cost in the infrastructure and hardware requirements, second, the number of mobile devices that subscribe to the positioning services. In this way, there are also certain limitations of WLAN: attenuation of the static environment signal, such as the wall, the movement of furniture and doors. Some of the strengths, weaknesses and opportunities of Wi-Fi are presented in Table 1. [23]

Strengths	Weaknesses	Opportunities
It is found in all buildings, good signal strength available.	The set-up of place requires a lot of time and a considerable use of manpower.	The "fingerprints" do not need geometric studies.
WiFi signals can penetrate the walls where the GPS fails.	Multipath influenced by the presence of physical objects.	Fingerprints are only needed in selected places.
Location of fingerprints in available places.	The intensity of the signal changes according to the variations that occur over time. It interferes with other devices in the ISM (bands reserved for industry, science and medicine) of 2.4 GHz.	

Table 1. Wifi Strengths, Weaknesses and Opportunities

C. Simulation tool AirMagnet Survey.

Also, in this research report the simulation tool AirMagnet Survey [13] was used, in demo version, as shown in the graphic interface of Figure 4. Because of the professional version, an additional cost must be paid. Similarly, in the demo version it was possible to carry out the respective tests required for the experimentation process necessary for this research work.

Fig 4:- AirMagnet Survey graphical interface.

For the selection of this simulation tool, AirMagnet Survey, a series of key factors related to technology and Wi-Fi standards were taken into account, 802.11 n / a / b / g / ac, type and use of antennas, speeds of the data, data loss, data overload, data balance, which stood out above all else and this is the heat maps, aspect that was not included in other tools such as Castalia, OPNET, AWG WinPro in the past, now from the Altair company, GNS3, just to mention a few.

III. RESULTS AND DISCUSSION

In planning the planning of a wireless local area network (WLAN), specifically in internal scenarios use is made of a digitized map represented by an office whose dimensions are: 29,243 m x 26,832 m. In Fig.5., three sections named S-A, S-B and S-C are identified, in which three access points (AP) will be located.

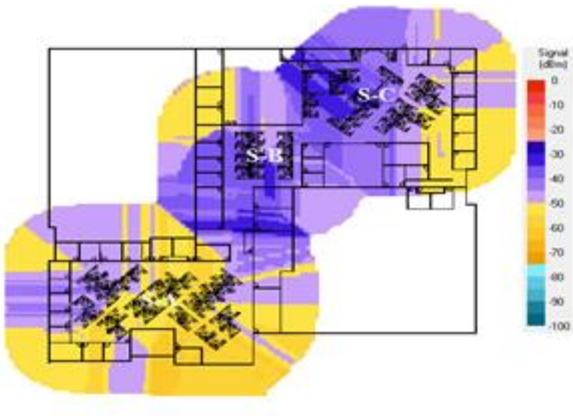

Fig 5:- Office Map.

In Figure 5, three access points (AP) are identified, positioned by each of the sections.

In turn, for the distribution of access points (AP), the coverage levels of the frequencies issued by each of these APs

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are considered. In Fig. 6., three sections are identified, identified as S-A, S-B and S-C.

Fig 6:- Location of access points (AP).

In Fig. 7., a heat map is used and the level of coverage of the frequency identified as a blue trace in which red arrows are positioned can be observed to identify the different access points (AP) located in each of the respective sections.

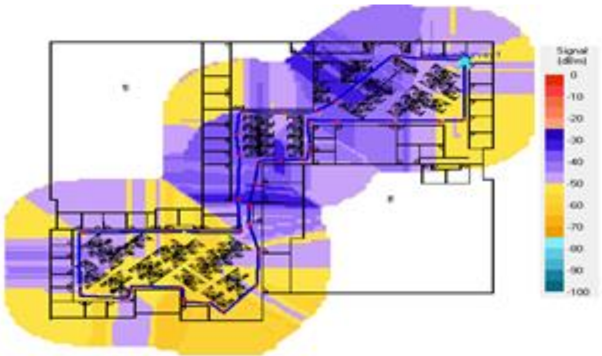

Fig 7:- Level of coverage of the frequency of the AP.

In turn, in Fig. 8., we can observe the different interference levels of the adjacent channels of each of the access points. The blue colors indicate the highest levels of interference or critical, while the red colors show us the lowest interference levels. So, the interferences that occur are due to the obstacles with which the frequency of the signal collides and therefore the user will not be able to connect to the offered services.

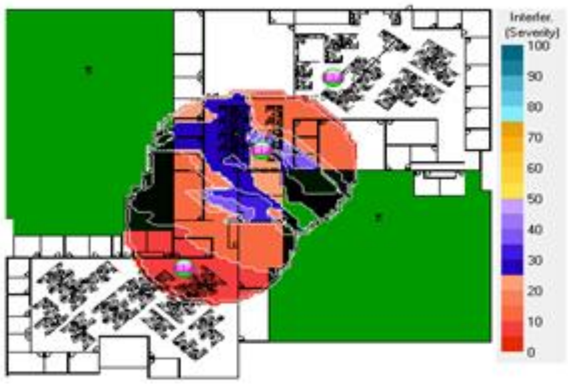

Fig 8:- Interference of adjacent channels.

On the other hand, with respect to the frequency distribution of the access points, the following information is available, which is shown in Table II.

Name of AP	MAC address	Channel	Standard	Bandwidth	Type of Frame	Frequency
AP1: 89:66 :DC	00:24:9 7:89:66 :DC	64	802.1 1 a	20 MHz	Legacy	5.0 GHz
AP2: E4:0 F:BC	00:1E:4 A:E4:0 F:BC	149	802.1 1 a	20 MHz	Legacy	5.0 GHz
AP3: A6:5 B:DC	00:17: DF:A6: 5B:DC	149,1	802.1 1 n	40 MHz	HT - Mixto	5.0 GHz

Table 2. Relevant aspects related to frequency distribution

From Table 2., it is commented that 40 MHz is a bandwidth built into the 802.11n standard that occupies a space of 20 MHz or 40 MHz of the spectrum in a wireless data network and uses a HT-frame format Mixed that allows to establish protection mechanisms facilitating the coexistence with other 802.11 a / b / g standards, including those equipment that does not belong to a WLAN network. Another aspect to comment is the 0.8 µs (milliseconds) of guard band that use the 802.11a standards, respectively, since they allow to increase the speed of data transfer. In turn, the 802.11n and its 0.4 µs allow an increase of 11%. At the same time, the 5GHz that are used as the central frequency, allows the wireless network to work better since it is less congested and allows to achieve a higher performance.

IV. CONCLUSIONS

In this paper, the planning with respect to how the access points in a local wireless network will be distributed in internal or closed scenarios, acquires greater relevance because the network planner requires a greater precision now of locate these access points so that there are no collisions between the frequencies. The novelty in these planning processes is that they have simulation tools at the network level, which allow analyzing the behavior of certain elements related to the distribution of frequencies, interferences of adjacent channels, the relationship that may exist between the signal and the noise, the materials that make up the walls and practical issues that are related to the level of coverage of the frequency of each of these access points in a closed environment. All the above, helps to have a better perspective and decision making, when carrying out a planning of WLAN networks, in internal scenarios by the planner and designer of the network. As lines of research, it is proposed to use a survey based technique, also known as the fingerprinting technique fingerprinting (FP), since when locating an object (access point) in space there is a unique signature called fingerprint (FP) that can be used to infer an unknown position in internal environments. PF itself is a manifestation of a physical phenomenon related to the interaction of a given signal for example, radio (RF) and magnetic field with the internal or external environment. The most popular FP based on RF is

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RSS. The main reason is that RSS is easily available in many standard wireless implementations (for example, wireless and cellular local area networks (WLAN)).

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