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THEME:

DESIGN AND IMPLEMENTATION OF A CENTRALIZED WIRELESS MANAGEMENT SYSTEM, IN THE FACULTY OF ENGINEERING IN APPLIED SCIENCES, USING ROUTEROS, TO IMPROVE THE QUALITY OF SERVICE

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DESIGN AND IMPLEMENTATION OF A CENTRALIZED WIRELESS MANAGEMENT SYSTEM, IN THE FACULTY OF ENGINEERING IN APPLIED SCIENCES, USING ROUTEROS, TO IMPROVE THE QUALITY OF SERVICE

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Abstract — This project detailed the implementation of a system of network centralized Wi-Fi, using star topology and based on RouterOS, in the indoors of the FACULTAD DE INGENIERIA EN CIENCIAS APLICADAS (FICA), in the city Ibarra, Imbabura province, this network allow access to websites and Internet contents to students, teachers, administrators, authorities and guests, through mobile devices as: laptops, mobile phones and computers with wireless interfaces IEEE 802.11 b / g / n. This system is based on the performance of the RouterOS operating system, through the hotspot server; it allows running a centralized and personal administration, for assignment of resources such as: username, password, and bandwidth and connection time, depending on the type of user. Also, it used a personalized captive portal that provides a visual interface and access to all users, who require access from the local network to the public network. Finally, is implemented policy of static QoS, allowing priorities and bandwidth control depending on the type of service required by users within the internal network.

Allowing thus solve the problem of congestion in access to internet, in the indoors of FACULTAD DE INGENIERIA EN CIENCIAS APLICADAS (FICA). Objective: Implement a management system centralized Wi-Fi, in the Faculty of engineering in applied sciences, using RouterOS, to improve the quality of service at the level of end users. Method: Design of network based on design criteria for optimum performance and an effective resources and devices used in the construction of centralized network Wifi results: according to the above are built centralized WiFi network in the building FICA and fulfills the objective proposed based on evidence of acceptance by the users. Conclusions: The wireless access network design was the most important part in the functioning of all the implemented system. Because it succeeded in establishing policies for each access point and this finally determined the performance and availability of the Wi-Fi network in its entirety.

Keywords — Ubiquiti, D-Link, Routerboard, WiFi, CAPsMAN, Hotspot, Mikrotik, Unifi.

Resumen — En este proyecto se detalla la implementación de un sistema de red Wi-Fi centralizada, mediante una topología de red tipo estrella y basada en RouterOS, en los interiores del edificio de la FACULTAD DE INGENIERIA EN CIENCIAS APLICADAS (FICA), de la UNIVERSIDAD TECNICA DEL NORTE, ciudad de Ibarra, provincia de Imbabura, esta red permite acceso a sitios web y contenidos de la internet a estudiantes, docentes, administrativos, autoridades e invitados, a través de dispositivos móviles como: laptops, celulares y computadores con interfaces inalámbricas que soporten los estándares IEEE 802.11 b/g/n. Este sistema está basado en las prestaciones del sistema operativo RouterOS, mediante un servidor hotspot, el mismo que permite ejecutar administración centralizada y personalizada, para la asignación de recursos como: usuario, contraseña, ancho de banda y tiempo de conexión, según el tipo de usuario. También, se hace uso de un portal cautivo personalizado, que brinda la interface de visual y de acceso a todos los usuarios que requieren acceder desde la red local hacia la red pública. Finalmente, se implementa políticas de QoS estático, que permiten brindar prioridades y control de ancho de banda según el tipo de servicio requerido desde los usuarios dentro de la red interna. Permitiendo de esta manera, solucionar el problema de congestión en el acceso a internet, que tenía la FACULTAD DE INGENIERIA EN CIENCIAS APLICADAS (FICA). Objetivo: Implementar un sistema de gestión Wi-Fi centralizado, en la Facultad de Ingeniería en Ciencias Aplicadas, mediante RouterOS, para mejorar la calidad de servicio a nivel de usuarios finales. Método: Diseño de red en base a criterios de diseño para un óptimo funcionamiento y un eficaz de los recursos y dispositivos utilizados en la construcción de la red centralizada Wifi Resultados: De acuerdo a lo mencionado se contruyó la red centralizada WiFi en el edifico FICA y se satisface el objetivo propuesto en base a pruebas de aceptación por parte de los usuarios. Conclusiones: El diseño de red de acceso inalámbrica fue la parte más importante en el funcionamiento de todo el sistema implementado. Porque se logró establecer las políticas para cada punto de acceso y esto finalmente determinó el rendimiento y disponibilidad de la red Wi-Fi en su totalidad.

Palabras Claves — Ubiquiti, D-Link, Routerboard, WiFi, CAPsMAN, Hotspot, Mikrotik, Unifi.

I. INTRODUCTION

The Faculty of engineering in applied sciences (FICA), is an educational institution level upper, belonging to the Technical University of the North, located in the city of Ibarra, the same which today with technological advancement has become a faculty pioneered the training of University student.

In the development of the academic activities and the growing demand for wireless access to Wi-Fi networks, and specifically by the facilities provided by this type of network on University campuses, arises the problem of saturation of connections in the network, which can occur in: the access network, transportation network, core network, public exit or all of the above.

According to data obtained from the Department of UTN, the Wi-Fi implemented within network systems of the FICA account with 300 users approximately, which are connected simultaneously, so the technology implemented at present not abastar is all the traffic of requests for access to the internet, causing this low quality of service on the end user.

In view of this problem arises the implementation of a management system of network-centric, which allows me to run a better centralized management of users, but decentralizing the network of Wi-Fi access, in the: classrooms, hallways and offices, to thus run a better Wi-Fi management system, and to provide better quality of service at the level of end users.

- *Wireless Technologies*

Wireless networks allow remote devices to be connected without difficulty, whether they are a few meters away or several kilometers. The installation of these networks does not require any significant change in the existing infrastructure as opposed to wired networks, where there is need to pierce the walls for cables. This has made extending the use of this technology quickly[1].

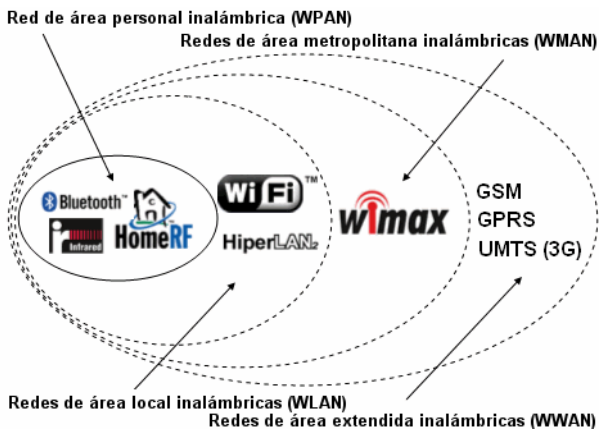

Figure 1. Wireless networking technologies
Source: [2]

The figure 1 shows the different wireless technologies, which can be classified them according to the geographical area of coverage in:

- WPAN Networks

WPAN networks through their Wireless Personal Area Network, are personal area and short-range wireless networks covering an area of some tens of meters.

- WMAN Networks

They are Wireless metropolitan area networks, also known as wireless local loop and provide an effective total speed of 1 to 10 Mbps with a range of 4 to 10 kilometers.

- WWAN Networks

They are wireless wide area networks have the broader view of all wireless networks. Basically, differs from a WLAN that uses cellular network technologies for mobile communications as:

GSM (Global System for Mobile Communication)

GPRS (General Packet Radio Service)

UMTS (Universal Mobile Telecommunication System)

- WLAN Networks

It is a system of flexible wireless communication that has similar coverage to a LAN.

- *Wi-Fi Network*

In the beginning, the wireless networks were not standardized by any standard. The main problem that existed up to then was the lack of compatibility between different manufacturers, still fulfilling all them 802.11 standard, that standard left open to the interpretation of sufficient points to systems from different manufacturers did not work together. This therefore creates the Wi-Fi Alliance, allowing mix products and make it possible to you to settle on the consumer market, to the point that today's wireless networks are known popularly known as Wi-Fi networks in reference to this organism.

The original standard also defines the Protocol of multiple access for carrier detect without collisions, CSMA/CA (carrier sense multiple access with collision avoidance).

Wi-Fi or Wi-Fi is a technology that allows electronic devices that connect to a wireless LAN (WLAN), mainly using bands of radio ISM 2.4 GHz (12 cm) and 5 GHz (6 cm). Access to a Wi-Fi network is generally protected by a password, but can be opened, allowing any device within range to gain access to resources on the network.

The Wi-Fi Alliance owns and controls the "Wi-Fi Certified" logo as a trademark, which allowed only the teams who have passed the test. Consumers who rely on this brand will have greater chance of interoperability with other brands.

Tests not only involve radio protocols and formats for interoperability data, but also security, as well as the optional test for quality of service and power management protocols. A focus on the user experience has shaped the general approach of the Wi-Fi Alliance certification program. Wi-Fi-certified products have to show that they have a good performance with other certified products, in the implementation of common applications [3].

- *Current technological situation*

Figure 2 shows the physical topology of how the network is structured FICA WiFi prior to the implementation of the project.

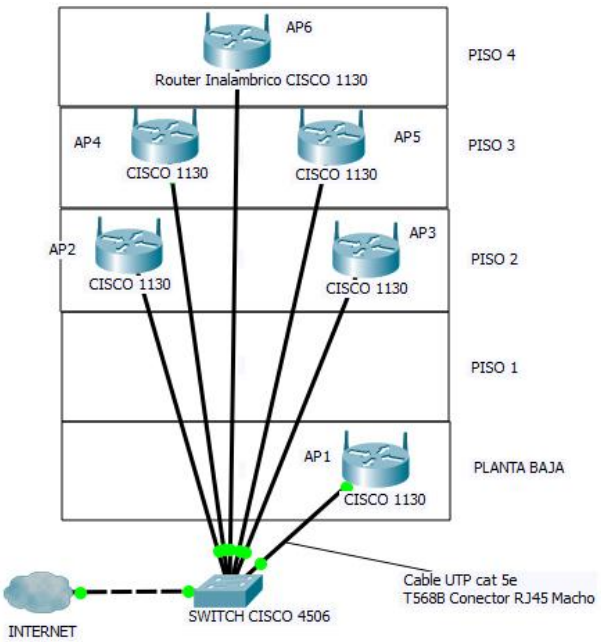

Figure 2. Physical topology of the existing network in the FICA
Source: Own

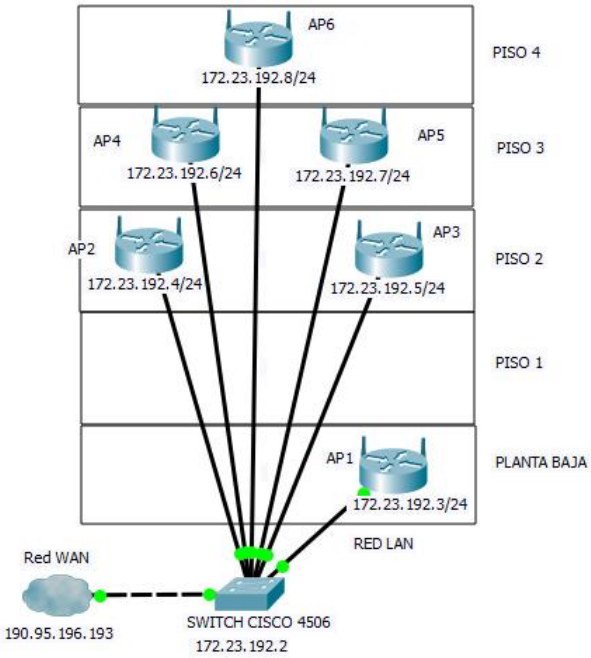

Figure 3. Logical topology of the existing network in the FICA
Source: Own

- *Justification of tests into the existing network*

Testing the information expressed in the above table was obtained and evaluating these results can clearly determine that initially the bandwidth available to the end-user is minimal and at the same time is variable, being so poor that it was not possible to make text messaging and nor was access content in real time; In addition, the high latency indicates that it is almost impossible to access to remote servers or external, as web sites content of interest to users.

Table 1. Test of speed with web tools

Tool/Detail	Download	Upload	Latency
SPEDOF.ME	340 kbps	30 kbps	1315 ms
AEPROVI	1.19 Mbps	0.21 Mbps	1256 ms

Source: Own

II. METHOD (CRITERIA DESIGN)

A. Channel selection criteria

The difference in the amount of spectrum if license is significant and the 2.4 GHz band is composed of 3 "1, 6 and 11" 20 MHz channel that do not overlap. In Japan, there are 4 channels which do not overlap, but the use of channel 14 is restricted for DSSS/CCK[4].

In Figure 4 you can see clearly how the spectrum of channels is distributed.

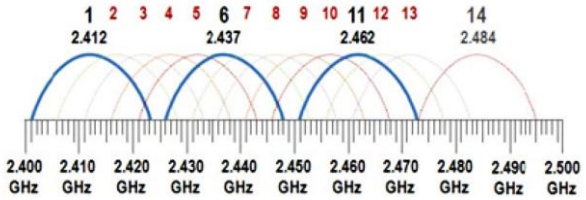

Figure 4. List of channels in the range of 2.4 GHz
Source: [4]

B. Adapt the design to the facilities

For the design of the network wifi should take into account the design and characteristics of the physical infrastructure which will be installed the service, the materials used for the construction may have a strong impact on the attenuation of signal strength, in some cases it is necessary to use multiple APs in the zones of greater interfencia [4].

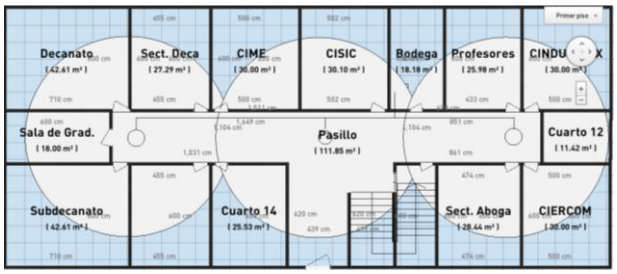

Figure 5. Design of ranges of coverage
Source: Own

C. Adequate Capacity

"Performing design with basic coverage within the coverage area, can meet the needs of the user, but it can lead to a reduced ability of users, but there are certain differences between the capabilities of wifi networks and create a cover design oriented to meet the needs of performance can be summarized under the following methods:

- Reduction of interference between neighboring channels.
- Maximization of the spectral capacity through the use of different frequencies.
- Optimize bandwidth to improve the use of the available spectral capacity.
- Balance the number of clients for each AP.
- Make a design on the basis of the quality of the service." [4].

Formula to calculate the access points needed for each floor

$$\#AP = \frac{Anchodebanda\ x\ N°Usuarios\ x\ \%Uso}{VelocidadProgramada}$$

Where:

Bandwidth for each user: 1Mbps

Number of users: 75

Average use of the network: 25%

Speed estimated by AP: 6Mbps

$$3{,}125 = \frac{1\ Mbps\ x\ 75\ Usuarios\ x\ 0.25}{6}$$

Equation 1. Calculation of access points required
Source: Own

D. Roaming WiFi (Mobility)

Wireless access points in approximately is available 100 metres from coverage, but it varies between models and manufacturers of the devices. What we want is to allow the (intinerancia or roaming) mobility of users, by placing the access points so that there is an overlap between the perimeter of coverage.

You can see in the figure below overlap indicated by the mark of red and green arrow the direction of travel of the user that happens to receive A signal toward the B sign [5].

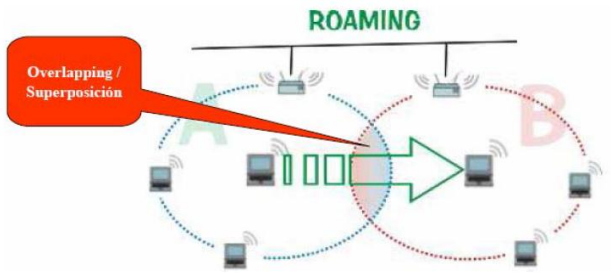

Figure 6. Roaming
Source: [5]

E. Implementation of Wi-Fi management system

For deployment topologies for the new network of the building be redesign FICA.

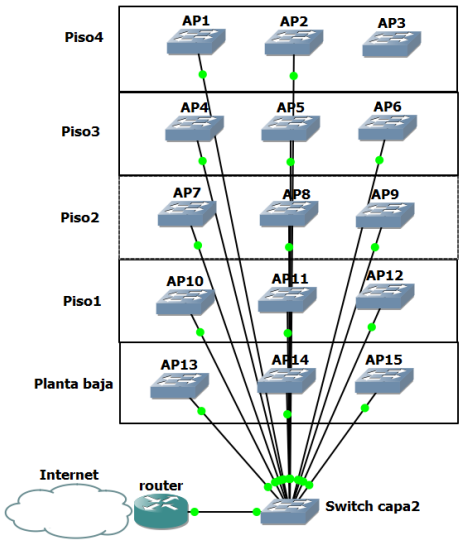

Figure 7. Physical topology for the new network FICA
Source: Own

Figure 7 shows the physical topology for the new network and displays the final wiring diagram that would have the Wi-Fi network from a front view of the building of the Faculty.

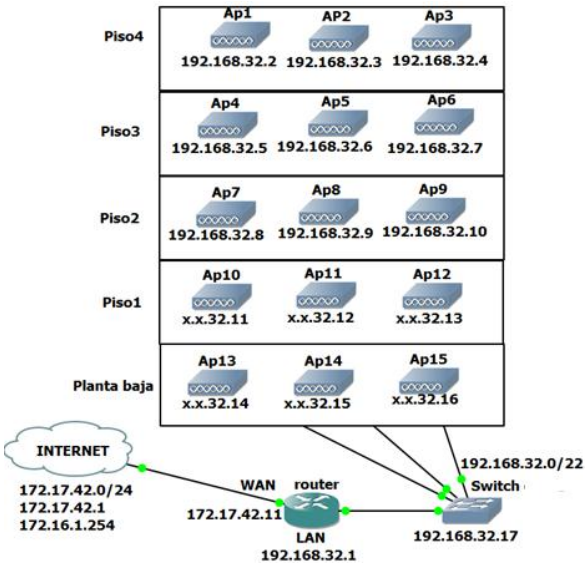

Figure 8. Logical topology for the new network FICA
Source: Own

Figure 8 provides more detailed information on the new network using the logical topology routing.

F. Frequency distribution of the new WiFi network

It is necessary to address the issue of overlapping per floor, should be considered also that the implementation of the building is made of concrete, between floors signal could reach adjacent either by refraction or diffraction. To avoid this a matrix is designed for teams that are one above other between floors do not have overlapping.

Table 2. Distribution of frequencies for the cAP2n.

FLOOR 4	AP1	AP2	AP3
	2412 Mhz	2437 Mhz	2462 Mhz
FLOOR 3	AP4	AP5	AP6
	2462 Mhz	2412 Mhz	2437 Mhz
FLOOR 2	AP7	AP8	AP9
	2412 Mhz	2437 Mhz	2462 Mhz
FLOOR 1	AP10	AP11	AP12
	2437 Mhz	2462 Mhz	2412 Mhz
GROUND	AP13	AP14	AP15
FLOOR	2412 Mhz	2437 Mhz	2462 Mhz

Source: Own

G. Design Alternatives

To determine the best solution to be implemented in the Wi-Fi network of the FICA, a comparative analysis of Mikrotik, Ubiquiti & Dlink, taking as a reference the technical characteristics. In addition, it should be indicated that all these alternatives are proprietary platforms that allow for centralized management of Wi-Fi networks, where you need to manage multiple access points in real time.

Upon completion of the process of evaluation of each selected technology is evidenced by the comparative summary is the most appropriate to be used in the implementation of the new system of management Wi-Fi Mikrotik Cap2n that satisfies the characteristics proposed by 83%.

Table 3. Summary of the comparative selection results

CARACTERÍSTICAS	DAP-2660	Cap2n	Unifi
Rango de frecuencia	2	1	1
Seguridad Inalámbrica	6	8	6
Estándares de red	6	3	3
Velocidades máximas	2	1	1
Indicador	1	1	1
Certificación	5	5	3
Adaptador de corriente y consumo energético	3	7	5
Cobertura	1	3	2
Dimensiones y peso	No aplica	No aplica	No aplica
Suma / 35	26	29	22
Total %	76%	83%	63%

Source: Own

H. Cost-benefit analysis

Is also a comparative analysis of prices and brands as you can see in the following table, giving an added value to the comparative analysis carried out for the selection of the most suitable technology.

Table 4. Comparative analysis of brands with prices

	MODELO	CANTIDAD DE APs	P. UNITARIO	TOTAL
D-link	DAP-2660	15	200,00	3000,00
Mikrotik	Cap2n	15	70,00	1050,00
Ubiquiti	Unifi UAP	15	90,00	1350,00

Source: Own

III. ANALYSIS OF RESULTS

- Analysis of the acceptance tests allow to demonstrate that the management system centralized Wi-Fi, in the Faculty of engineering in applied sciences, has improved its quality of service at the level of end users giving satisfaction to the posed requirements.

IV. CONCLUSIONS

- After analyzing the current situation of the FICA was determined that the system's Wi-Fi network that worked prior to the development of this project and had a bad design in the interconnection of the points of access across the entire building. Since these were connected interchangeably in any point of the network immediately, while the geography of the building provided make centralisation of the APs, on the basis of a network topology type star.
- Was collected information from the Department's systems was very important, and thanks to that we could determine the specific causes that caused the degradation of the Wi-Fi network.
- The design of wireless access network was the most important part in the functioning of all the implemented system. Because it succeeded in establishing policies for each access point and this finally determined the performance and availability of the Wi-Fi network in its entirety.
- The implementation of the Wi-Fi network had some variants, especially in cabling, due to the re location of the quarter of teams that made within the FICA.
- The selection of the brand and capabilities that provide the equipment to be used is very decisive in the final solution implemented. As in our case. Mikrotik is a brand of affordable costs, but with very high performance in terms of its performance. In addition, the administration of these teams is very friendly with the user.
- Performance of each access point is directly related to the quality of stations in the same, i.e. If an AP has several stations recorded signals between - 90 and - 60 dBm, the lower signal station will make that you degrade the quality of all the AP, including the stations with best connection parameters.
- Acceptance testing is performed with evaluating the actions of real users with satisfactory results, also conducted technical tests to the network to determine that the quality of service would be ideal for testing with real users.

V. RECOMMENDATIONS

- Whenever a mixed network is implemented as it is the case of the present project, it is recommended to certify structured cabling to prevent the degradation of the system on any network segment use of faulty wiring.
- Implement a database that allows tracking of users, passwords, and allocation of resources that operate parallel to the access implemented Wi-Fi network to improve the administration of users within the network.
- It is recommended to create Wi-Fi zones of high speed where the operating characteristics of the network for both the access point and station are completely customized based on high performance, such as IEEE 802 wireless standards. 11n and IEEE 802. 11ac. In this single area will be allowed stations which comply with the technical specifications of interoperability with the available access network.
- To be transmitted in band not a degree within the College there is many networks causing interference to the Wi-Fi network implemented, by such reason is recommended to establish an inspection campaign to suppress all those networks that are not necessary.

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