Designing a wireless network based on the 802.11ac standard to provide Internet service to the public parks of the parish of San Antonio in the city of Ibarra.

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Summary— **The present project consists in the design of a wireless network to offer access to internet to the parks of the Parish of San Antonio de Ibarra, using the technology 802.11ac with the aim to improve the quality of life, cooperate with the development of the Tics and reduce the digital gap.**

Key words — WI-FI, IEEE 802.11ac, Tics, breach digital, WLAN and ARCOTEL.

I. INTRODUCTION

Nowadays the wireless networks are a fundamental tool for education , entertainment and communication, but lamentably in rural sectors the access to this service is limited still, by fault of infrastructure or by low economic capacity of the population.

The devices like cellphones or Tablets have turned into fundamental part of the society like a communication tool, taking advantage of the mobility of this devices to have connectivity to the Tics.

The easy access to Internet today, brings the option to propose this work, using a new technology such as 802.11ac providing efficiency, scalability and higher transmission speed over previous standards and equipment that provide guaranteed service and safety Connection.

The design of the wireless network in the Parish of San Antonio contributes to diminish the digital gap and help to resolve the problem of the access to the population with lower economic and technological possibility, offering the free access to internet in the parks of the Parish, as well as the security of the data of the users, the politics and administration of the network.

This project is according to the Plan of Development and Territorial Legislation promoted by the Autonomous Government Decentralized Parish Rural of San Antonio de Ibarra, where indicates to improve the quality of life of the citizens by means of the connectivity and use of the wireless technology WiFi based in the standard 802.11ac that adapts to cover specific zones, allowing to the habitants of the parish the benefits of the free wireless access in the parks.

II. IEEE 802.11AC

"The future wireless networks have to struggle with a much bigger demand. It foresees that for mediated of 2015, more than 50% of the Smartphones will include hardware 802.11ac." [1]

Forrester Research Predicts that 59% of all the traffic of data will happen of the connections wired up to the wireless in 2017, what means that the wireless connections are turning into the main connection of the users. The experts of the sector also predict that the number of devices connected by means of Wi-Fi will keep growing exponentially to measure that the connections of machine to machine begin to proliferate. For the architectures of WLAN, the implementations of the protocol 802.11n quickly will be substituted by the protocol 802.11ac.

"The standard 802.11ac represents the fifth generation of standard IEEE 802.11 for networks LAN wireless, and offers a connection with speed of transfer of data of at least thrice the speed of the standard 802.11n." [2]

The fifth generation of wireless networks already has been standardized, this is the first standard that provides speeds in line of gigabit allowing reach a greater performance and capacity, that is to say that the users will enjoy of a faster connection with his mobile devices 802.11ac.

A. - Improvements regarding 802.11n

- It operates in the band of 5 GHz, doing that the wireless networks are more robust and are not subject to the interference and noise that presents the band 2,4GHz.
- It is compatible with previous versions of the standard 802.11a/n, however when they connect the speed will reduce to the one of IEEE 802.11a/n, the compatibility with 802.11b/g gives when the device 802.11ac was dual this wants to say that it work in the band of frequency of 2,4GHz and 5GHz.
- 802.11n offers speed of 600Mbps whereas 802.11ac theoretical speed is 1,3Gbps.
- It has developed the union of channels of 80MHz until 160MHz, this is to follow increasing the speed to a maximum of 9,6Gbps.
- In 802.11n the modulation is 64QAM whereas in 802.11ac the modulation is 256-QAM this will serve to increase the efficiency in the transfer of data. Reaching speeds of 1.33 higher times. If the number of QAM is high, the amount of bits per symbol to be transmitted and the data transfer rate of the wireless link will be high too.

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- In 802.11n includes MIMO system this just benefits to only one device, has 4 antennas for transmission and reception whereas in 802.11ac can have 8 antennas of transmission and reception using the technology MU-MIMO which active the simultaneous transmissions for several users.
- It incorporates the technology Beamforming, in where the signal WiFi has a better penetration of the obstacles like the walls and therefore, a better coverage.

B. - Need for faster networks

More users: The wireless networks have had enough success in displacing to the connections Ethernet therefore the total volume of the traffic grows exponentially so there are more users.

More devices by user: The users tend to occupy at least two devices as it is a mobile telephone and a laptop by what this has created a dense population of devices generating more traffic and forcing to design new Wi-Fi networks.

Big applications: The users are using applications as they are videoconference, video in high definition, social networks and more services of streaming; these applications consume a big bandwidth by what need greater speed of transmission.

In consequence, it needs a greater bandwidth to satisfy the increasing demands. It is by these reasons that the standard 802.11ac will help to take these situations and give an increase in the speed of transmission to attaining the good development of the applications.

C.- Basic concepts

Antenna

"An antenna is a device designed with the aim to issue or receive signals of radiofrequency in the free space, a transmissive antenna transforms voltages in signals of radiofrequency, and a receptor makes the reverse function". [3]

This wants to say that they are devices that issue or receive electromagnetic waves being an element of transition between a device of guide of waves and the free space the air. The selection of the antennas does in base to three main factors which are:

- The polarization
- The pattern of radiation
- The rank of frequencies of operation

Access Point

 "Point of Wireless access is a device that interconnects devices of wireless communication to form a wireless network, also can transmit data by the two means (wired up and wireless). Has an IP address assigned to be able to be configured" [4]

An Access Point is a bridge of communication between the local network and the wireless network where can interconnect a number of users, are devices that act like wireless concentrators that commission to receive, store and send information by means of waves of radius between the devices connected to the network wired up and the wireless devices, these can be configured in way bridge or way repeater.

D.- Marco Regulatorio

For the operation of systems of broadband digital modulation has to fulfil with parameters established by regulator organizations of the Ecuador.

Norm for the implementation and operation of systems of broadband digital modulation.

The fundamental objective in which it bases the norm, is the one to be able to make the correct control and regulation for the installation and operation of those Radiocommunications systems that find using technical of broadband Digital Modulation in the ranks of frequencies established by the ARCOTEL and that specify in detail in the National Plan of Frequencies.

Inside this norm it is detailed several points that have to fulfil to be able to have in normal operation a broadband Digital Modulation System.

As it can observe in the table 1 details the characteristics technical of the MDBA systems. [5]

TABLE 1.
Technical characteristics of the Systems of MDBA

TYPE OF CONFIGURATION OF THE SYSTEM	BANDS OF OPERATION (MHz)	MAXIMUM PEAK POWER TRANSMITTER (mW)	P.I.R.E (mW)
Point-point			
Point-multipunto	902 – 928	250	----
Mobiles			
Point-point			
Point-multipunto	2400 – 2483.5	1000	----
Mobiles			
Point-point			200
Point-multipunto	5150 – 5250		
Mobiles		50[i]	
Point-point			200
Point-multipunto	5350 – 5350	----	
Mobiles		250[ii]	1000
Point-point			
Point-multipunto	5470 – 5725	250[ii]	1000
Mobiles			
Point-point			
Point-multipunto	5725 – 5850	1000	----
Mobiles			

To be able to obtain an enabling title and keep the legal operation of the broadband Digital Modulation System inside the GAD Parish of San Antonio, is necessary to carry out a procedure which is organized of the following form as it mentions the ARCOTEL [6]:

- Form ST-1To-DGGST (Form of General Information)
- Form ST-2To-DGGST (Form for technical characteristic Information and control of documentation)

- Form RC-1B (Form for Legal Information broadband Digital Modulation)
- Form RC-2To, (Form for Information of the Structure of the System of Radiocommunications)
- Form RC-3To (Form for Information of Antennas)
- Form RC-3B (Form for patterns of radiation of antennas)
- Form RC-4To (Form for Information of Equipment)
- Form RC-9B (Form for Systems of broadband Digital Modulation Link Point-Multipoint)
- Form RC-14To (Form for Diagram of the System of Radiocommunications)
- Form RC-15To (RNI-T1) (Form for Technical Study of Broadcasts of RNI)

III. DESIGN OF THE WIRELESS NETWORK

San Antonio of Ibarra finds in a process of connectivity such as it indicates it the Plan of Development and Territorial Legislation promoted by the Autonomous Government Decentralized Parish Rural of San Antonio of Ibarra, allow to his habitants a digital city so that have access to internet of free way.

A. - Points Involved

The election of the points in where it will install the internet service does by means of a technical visit to each one of the 24 neighborhoods that conforms the parish of San Antonio, choosing 6 strategic points to give access to internet under the requests of the GAD Saint Antonio which are:

- Adjust to a budget limited, since the Board has several projects of different type which also need founding.
- Benefit to the most of the habitants that conform the parish.
- Offer access to internet to the parks of more influx of people.

To fulfil with the requirements that impose has analyzed the location of the park, the quantity of people that concurrent to the park, the activities that make each one of them and of this way choose the 6 parks that cover to the majority of the habitants of the parish. Of agreement to the Plan Territorial Legislation of GAD Parish San Antonio this project corresponds to a first phase in the subject of connectivity, for which of agreement to the strategic requests defines a pilot plan with the 6 parks selected and putting to consideration that expand the project to the other zones later. This information has been provided by the GAD Parish Saint Antonio of Ibarra.

The places involved for the connectivity of the access to internet for said zone are:
- Complejo Santa Clara
- Plazoleta José Tobar
- Plaza Central de Tanguarín
- Parque Eleodoro Ayala
- Parque Barrio Sur
- Plazoleta San Agustín

B.- Considerations of Design

In the beginning of the design of a network is fundamental the knowledge of the points to which goes to loan the service of internet, his geographic coordinates, the data on the existent infrastructure and the people who is going to be benefit with the project direct and indirect as well as the capacity of bandwidth. With this and in function of the characteristics like the distance from the central node to the 6 parks and the availability of the service will make the topology that better adapt to the needs of the surroundings.

Users

To determine the number of users posed an observation of field, the lifting of this information makes of the following way:

- Look at the possible users in each one of the parks of preference Friday, Saturday and Sunday those are the days when more people visit the parks that can be in the zone of coverage. Being weekend the days in where the majority of people go to the parks to do sport, exercise out of the schedules of work and study.
- Make a counting of the users that find around the zone of coverage by means of a visit to each house, being these fixed users.
- The lifting of the information will do in three schedules of 9:00am to 11:00am, of 14:00pm to 16:00pm and of 18:00pm to 20:00pm, these schedules are of more influx of people, makes in these days and these hours in base to the activities that mention previously in each one of the parks.

With this information and a visual counting can be determinate an average of users who are going to be in the zone of coverage.

In the table 2 can observe the results obtained of the visual counting where determines an average of 28 users by park giving a total of 171 users averages in the wireless network.

TABLE 2.
Results of the total of users

RESULTS			
PARK/HOUR	9:00am to 11:00am	14:00pm to 16:00pm	18:00pm to 20:00pm
1	24,33	26,66	35
2	22	26	32
3	23,33	26	29,33
4	32,66	32	28,66
5	23,66	25,66	27,33
6	21,66	24,66	27
AVERAGE 6 PARKS	28,73	26,83	29,88
AVERAGE 3 SCHEDULES	28,48		
NUMBER OF PARKS	6		
TOTAL OF USERS	171		

Reasons of use of internet

To the moment to cater a service of internet verifies the needs of the user, as it observes in the Fig.1, in the 2013 the rural user has the need to access to the network like source of

information with 23, 5%, for communication in general with 20, 2% and for his education and learning with 48.3%, this serves like a guideline for the priorities and limitations of use of bandwidth for the users of the wireless network of the Rural Parish of San Antonio of Ibarra.
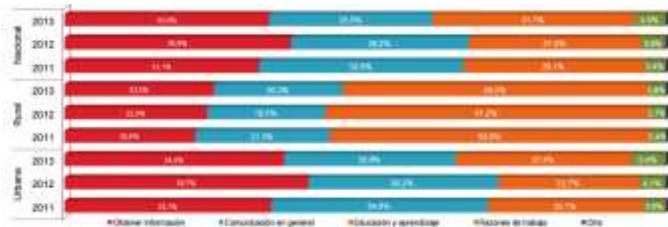

Fig. 1 Reasons of use of internet by area.

In the Fig.2 can observe so that they use the mobile phones in a connection to internet according to the National Survey of Employment Unemployment and Subempleo – ENEMDUR – National Total.
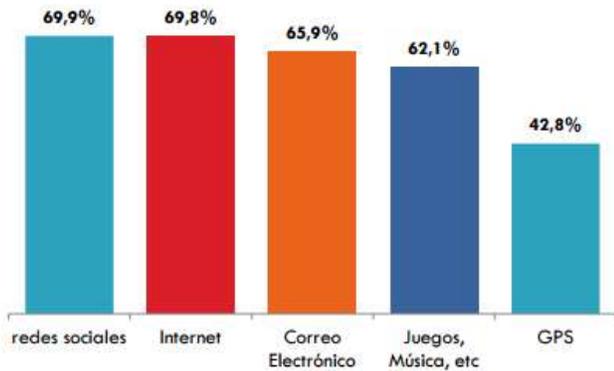
Fig. 2 so that it uses the telephone Smartphone.

We calculate the bandwidth for access to internet according to the applications to offer individually, when observing the statistics in the Fig.1 and Fig.2, the reasons by which the user accesses to internet are the following: like source of information is the navigation in web pages, like media through social networks like Facebook and services of mail, like tool of education and learning by means of queries in web pages, email and other services used for entertainment like YouTube and music.

In the table 3 observes the bandwidth that consumes each application to offer in the wireless network.

TABLE 3.
Bandwidth that consumes each application.

Application	Bandwidth by user	Bandwidth by 180 users
Navigation web	100Kbps	18Mbps
Social networks and mail	307Kbps	55,26 Mbps
Email.	100Kbps	18Mbps
YouTube and music	360Kbps	64,80Mbps

Estimate of speed of internet

analyse the table 3 and when being an open wireless network that will have a connection of 2 hours and the majority of users use a mobile device to connect in free WiFi networks, this means the user will not be able to be using all the applications at the same time by what takes the maximum value of the applications that is YouTube with a capacity of access to internet of 360Kbps by each user guaranteeing the efficiency of the network and taking in account that will be sufficient so that the user can do use of the different above-mentioned applications.

Taking in account the simultaneity factor, this wants to say there is a low probability that the 180 users use the network at the same time. Therefore it keeps a factor of simultaneity of 0, 3, that is to say that 30% of the total of users will use the service at the same time. Will be able to connect 54 users to the same hour and simultaneously of the 180 that estimates have in the network, will be able to do use of any type of application and determines by means of the following calculation that expresses in the equation 1.

$$VT = VTT \text{ x Factor of simultaneity} \quad (1)$$

In where:

VT: Speed of the factor of simultaneity.

VTT: Total speed of the network.

$$VT = 64,80 \text{Mbps x } 30\%$$

$$VT = 64,80 \text{Mbps Mbps x } 30\%$$

$$VT = 19, 44 \text{ Mbps}$$

At the moment the GAD Parish of San Antonio implement the present project will require the contracting of the service of internet of roughly 20Mbps being sufficient for like this operate of optimum way in the network and give a service of quality.

C.-General characteristics of the devices and wires

The devices necessary for the design of the network are antennas and Access point, the election of the devices goes to make in base to the maximum values to which can operate according to the regulation of the Marco Regulatory of the Ecuador described in the previous chapter.

When being a topology point multipoint and work in the frequency of 5,8GHz has to be based to the maximum values that establishes ARCOTEL for the election of the devices, such as the limits of power hammer maximum of the transmitter specified in the table 4, in what it is power of maximum transmission of 1Watt (30dBm), maximum gain of 23dBi.

The election of the devices will make in base to the rule of the country and also in base to the requests that join up to the needs of the design. As it can observe in the Table 4 the parameters that has to fulfil for the design of a wireless network.

TABLE 4.
Requests of broadband operation

Parameters	Maximum value	Units
Distance between Tx and Rx of the links.	0, 19 until 1,12	Km
Power of Tx established by ARCOTEL	30	dBm
Gain of antenna Tx established by ARCOTEL	23	dBi
Gain of antenna Rx established by ARCOTEL	23	dBi
Frequency	5,8	GHz

TABLE 5.
Mitigations of the Pigtail in different frequencies

FREQUENCY	LOSS
2 GHz	0,14 dB
2,4 GHz	0,16 dB
3 GHz	0,2 dB
5 GHz	0,24 dB
5,8 GHz	0,26 dB
6 GHz	0,28 dB

The loss of each Pigtail in the frequency of 5,8GHz is of 0,26dB, the antenna omnidirectional connects with two Pigtail of equal characteristics, therefore the losses of the wires and connectors in transmission is of 0,52dB.

D. - Simulation of radioenlaces

To the simulation use the tool Radio Mobile of systems of radioenlace uses to verify if it is optimum or not implementing a wireless system with devices and conditions that establishes the place of work, according to the results that offer the simulations can approve or no the installation of the system

Simulation of the link GAD Saint Antonio-Complex Santa Clara

The simulation goes from the GAD of Saint Antonio until the Complex Santa Clara, separated by a distance of 0,45Km, with a clear of 4,8F1, the parameters of the link such as the minimum frequency 5150MHz and maximum 5850MHz, the gain of the antenna as it is of 13dBi in transmission and 16dBi in reception, the power in transmission of 27dBm and the sensitivity in reception of -96dBm are characteristic of the manufacturers of the devices, the results obtained of the simulation with the software Irradiate Mobile are the losses in the free space takes the value of 100,8dB calculates in base to the distance visited by the signal and the lost by obstruction and interferences, the level of signal received with a value of - 45,3dBm and a value of the relative reception of 50,7dB, likes and can observe in the Fig. 3 it exists a perfect connection between both being the viable link.

Devices for the Wireless network

The devices that go to use in the transmissive station, in the station receptor and the loss of the Pigtail Ubiquiti with his respective technical specifications are the following:

Antenna for transmission: Rocket5ac PtMP

Generally it is used for the links of distribution in the basic station for the link point multipoint with the following specifications:

- **Model:** Rocket5ac PtMP
- **Power of Transmission:** 27 dBm
- **Sensitivity of the receptor:** -96 dBm
- **Loss of the wires and connectors**: 0.52dB
- **Type of integrated antenna:** Omnidirectional 360°
- **Frequency of Operation:** 5.15 - 5.85 GHz
- **Gain of the antenna:** 13 dBi
- **Polarisation:** Double polarity

Antenna of reception: NBE-5ac-16

Generally it is used for the links of access situated in each park with the following specifications:

- **Model:** NBE-5ac-16
- **Power of Transmission:** 26 dBm
- **Sensitivity of the receptor:** -96 dBm
- **Type of antenna:** Directive
- **Frequency of Operation:** 5150 - 5850 MHz
- **Gain of the antenna:** 16 dBi
- **Polarisation:** Double polarity

Pigtail Ubiquiti

The wire that uses for the connection of the antenna omnidirectional with the Rocket5ac PtMP, is a Pigtail of 4 inches (10cm) with connectors RP-SMA male type to his two extremes.

In the table 5 observes the losses of the Pigtail in different frequencies.

Fig. 3 Link Joints Parish – Complex Santa Clara in Radius Mobile

Calculation of the Losses in the Free Space (FSL)

For the case of the link have the following data:

F= 5.8 GHz

D= 0.45 Km

The Losses in the Free Space of the link sand calculate by means of the equation 2.

$$FSL\ (dB) = 92{,}44 + 20\log(F) + 20\log(D) \qquad (2)$$

$$FSL\ (dB) = 92{,}4 + 20\ log(5.8) + 20log(0{,}45)$$

$$FSL\ (dB) = 92{,}4 + 15{,}26 - 6{,}93$$

$$FSL\ (dB) = 100{,}73$$

Calculation of the level of signal in the receptor

Calculation of the level of signal received in the receptor calculates by means of the equation 3.

$$PRx(dBm) = PTx(dBm) - LTx(dB) + GTx(dBi) - FSLx(dB) + GRx(dBi) - LRx(dB) \qquad (3)$$

$$PRx(dBm) = 27 - 0{,}52 + 13 - 100{,}73 + 16 - 0$$

$$PRx(dBm) = -45{,}25$$

Cálculo Of the margin of the power of reception

Cálculo Of the margin of the power of reception of the enlace is given by the equation 4.

$$M(dB) = PRx(dBm) - SRx(dBm) \qquad (4)$$

$$M(dB) = -45{,}25(dBm) - (-96(dBm))$$

$$M(dB) = 50{,}75 dB$$

In the table 6 observe the results of the budget of the link obtained according to the mathematical method and the software Irradiate Mobile exists a minimum variation in the level of the signal in Reception and the Margin of fading of the link because of the model of calculation of the losses that the software determines in base to stray additional by obstruction and multiple paths. It makes the calculation of agreement to the mathematical model for all the links of agreement to the exposed stage.

TABLE 6.
Comparison of link them mathematical calculation with the simulator irradiate Mobile

LINKS	COMPARISON	I irradiate mobile	Mathematical calculation
Complejo Santa Clara	Lost in the free space	100,8 dB	100,73 dB
	Level of signal in the receptor	-45,3 dBm	-45,25 dBm
	Margin of the power of reception	50,7 dB	50,75 dB
Plaza Central de Tanguarín	Lost in the free space	106,8 dB	106,46 dB
	Level of signal in the receptor	-51,3 dBm	-50,98 dBm
	Margin of the power of reception	44,7 dB	45,02 dB
Plazoleta José Tobar	Lost in the free space	105,2 dB	105,17 dB
	Level of signal in the receptor	-49,7 dBm	-49,69 dBm
	Margin of the power of reception	46,3 dB	46,31 dB
Parque Eleodoro Ayala	Lost in the free space	93,6 dB	93,24 dB
	Level of signal in the receptor	-38,1 dBm	-37,76 dBm
	Margin of the power of reception	57,9 dB	58,24 dB
Parque Barrio Sur	Lost in the free space	99,4 dB	99,49 dB
	Level of signal in the receptor	-43,9 dBm	-44,01 dBm
	Margin of the power of reception	52,1 dB	51,99 dB
Plazoleta San Agustín	Lost in the free space	108,6 dB	108,64 dB
	Level of signal in the receptor	-53,2 dBm	-53,16 dBm
	Margin of the power of reception	42,8 dB	42,84 dB

E. - Topology of the network
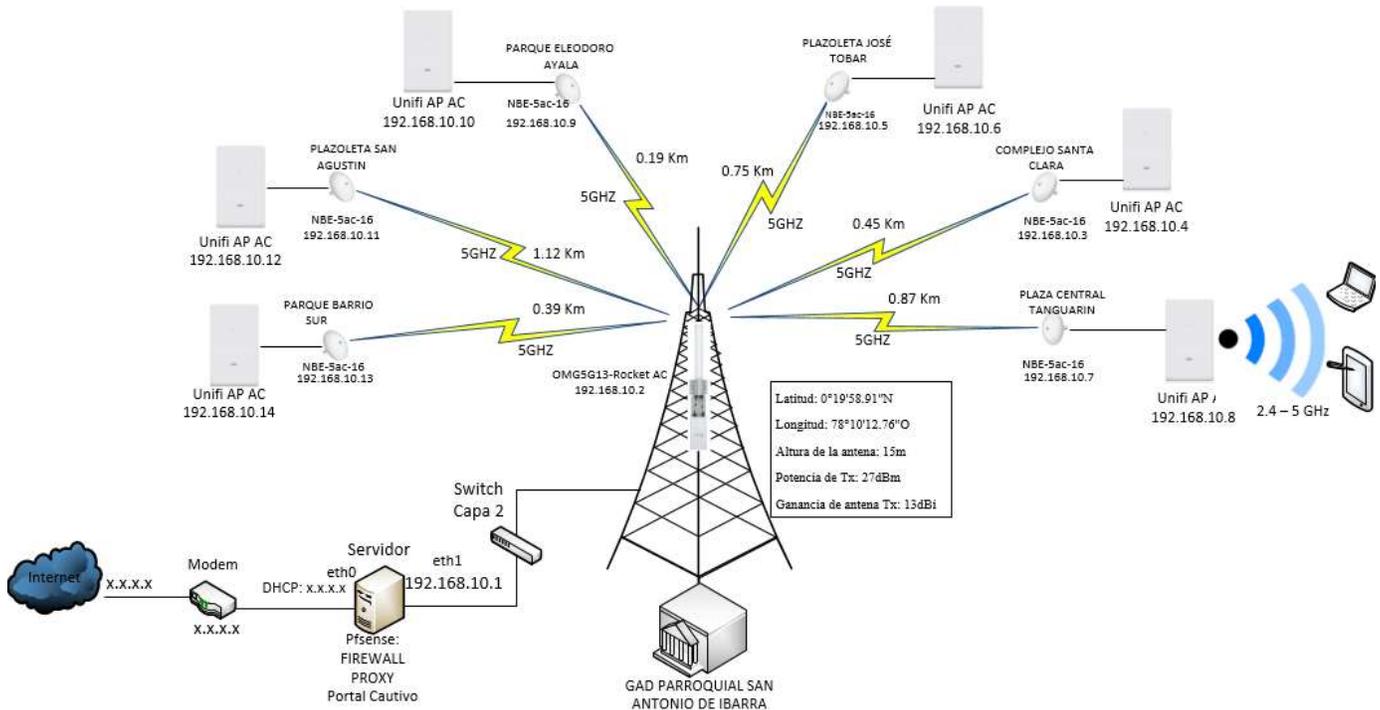
Fig. 4 Topology of the network point multipoint of the Parish Board

This topology shows the devices that uses for the wireless network as it can look in the Fig4. The captive portal and firewall proxy finds configured in a Recovered of Server PfSense which has two network interfaces, the interface eth0 connects to the ISP of the GAD Parish San Antonio it has a DHCP configuration and the interface eth1 connects to the switch with a static address 192.168.10.1, in the tower of 12m roughly of height that finds on the terrace of the board plants the antenna Ubiquiti omnidirectional included an antenna of transmission Rocket5ac PtMP, from here will do the links to 5GHz to the 6 parks respectively each one with his corresponding distance establishing the communication point multipoint to the receptors Ubiquiti NanoBeam NBE-5AC-16, which will be situated in topmasts.

In each park will be an Access point UniFi AP AC Outdoor by means of which the final user will be able to connect to the wireless network using already was Tablets, laptops or intelligent cellphones.

Routing of the network

It estimates have 180 users connected to the network, 13 devices for the communication of the wireless network these are antennas and Access point and 1 server, basing in this facts for the configuration of the devices goes to use a range of private class C Ip addresses for the distribution having 253 Ip available and to his time contemplates scalability of the network.

It is a routing without VLSM because of the back growth, as it can observe in the table 7:

TABLA 7
Direccionamiento of the devices

Teams	Direction Ip	It chewed	Gateway
Server captive portal	192.168.10.1	255.255.255.0	-
Antenna Rocket5ac PtMP	192.168.10.2	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Complejo Santa Clara	192.168.10.3	255.255.255.0	192.168.10.1
Access point Complejo Santa Clara	192.168.10.4	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Plazoleta José Tobar	192.168.10.5	255.255.255.0	192.168.10.1
Access point Plazoleta José Tobar	192.168.10.6	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Plaza Central de Tanguarín	192.168.10.7	255.255.255.0	192.168.10.1
Access point Plaza Central de Tanguarín	192.168.10.8	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Parque Eleodoro Ayala	192.168.10.9	255.255.255.0	192.168.10.1
Access point Parque Eleodoro Ayala	192.168.10.10	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Plazoleta San Agustín	192.168.10.11	255.255.255.0	192.168.10.1
Access point Plazoleta San Agustín	192.168.10.12	255.255.255.0	192.168.10.1
Antenna NBE-5ac-16 Parque Barrio Sur	192.168.10.13	255.255.255.0	192.168.10.1
Access point Parque Barrio Sur	192.168.10.14	255.255.255.0	192.168.10.1

F.- Security

The security is essential in a wireless network for the protection to the users offering a stable connection, reliable and safe. When being a public connection has to focus in ensuring the correct consumption of bandwidth, provide information of connectivity by means of a page of welcome and restriction of access to some no apt contents for minors of 18 years. For this does it to him by means of a captive portal and a firewall/proxy.

The minimum requests for the platform of administration and management of wireless network and users can observe in the table 8 being the following:

TABLA 8
Minimum requests of security

Requests	Characteristics
No users authentication	For being a wireless network for public spaces, has to allow that the users connect by means of a captive portal, where configure a welcome page, which indicate which are the terms and conditions to be able to access to the service that goes to offer.
Open Source	When being a public institution has to do use of free software like technological tool for the development of social projects, save resources in hardware and in proprietary licences.
Monitory and administration in real time	Can make configurations in real time, monitor the consumption of bandwidth.
Firewall And captive portal	Have the functionality of firewall proxy to restrict the unsuitable traffic and a captive portal to administer the time of connection of the users and the bandwidth, both contents in the same platform, to save resources.
Easy handle	The GAD Parish San Antonio does not have a department of Tics, for this reason has to look for an easy tool to handle and administer so that the person commissioned to handle the security of the network can familiarize quickly with the server of administration and management.

Made the comparative between the different captive portals so much free like owners concludes that Pfsense, has included like native modules the functionality of firewall, captive portal and other characteristics that can be exploded in a future.

Pfsense Fulfils with the basic requests established that they join up to the design of the wireless network. It has of the possibility to fulfil the objectives, being a totally free software and prepared for open systems and public wireless networks.

G.- Administration

For the administration details the specific function that makes each one of the following parameters:

Firewall Proxy Pfsense: This will be configured to give protection to the users, will have the function to block the contained unsuitable web. When being a state entity the one who will give the access to internet to public spaces and an open network connected people of all age and basing in the code of the childhood and adolescence in the art. 47 numeral f mentions "to Sanction of agreement to the foreseen in this Law, to the people that facilitate to the minors: books, writings, propaganda, videos or any another half auditory and/or visual that do mentions of the violence or the crime, that have images or contents pornográficos or that prejudice the training of the lower", is for this reason that it forbids access to sexual content.

- Forbid all the pages with sexual content as it is pornography.

Captive portal Pfsense: This will be the attendant of stops can access to internet will have to accept the terms and conditions, control the time of connection and the bandwidth.

- Allow access to governmental pages as it is the page of the Parish Board of San Antonio. www.gadsanantoniodeibarra.gob.ec/
- It will give a time of connection of two hours to each user, this time gives in view of that it is a public network and the users are sporadic and taking of reference the project Ibarra Digital where the connection is of 4 daily hours; likewise the network of access to free internet of the city of Guayaquil that the municipality establishes a time of connection in the year 2015 by 30 daily minutes, in the 2016 the access will be free by 40 minutes and like this successively until arriving to the 2017 until the 2019, with a connection of 45 minutes.

UniFi: This is a software that provides an easy administration of the network, the function that makes is to monitor the Access point and visualize the number of users that are connected to the wireless network and in that band of frequency are working was in 2,4GHz or in 5GHz.

H. - Plan of Tests

In this subject, taking in account that treats of a proposal of design and still do not have the teams and necessary materials to implement in all the parks, has considered make the proofs in the Complex Santa Clara, chose this place in view of that has the optimum requirements for the link eat: line of sight, height, ease of access, infrastructure, feeding.

It makes a test of the link GAD San Antonio of Ibarra-Complex Santa Clara, with the teams that makes are with a sectorial antenna in view of that the antenna omnidirectional ac there is not a provider in Ecuador. This antenna goes with the antenna Rocket5ac PtMP for the transmissive station. And for the station receptor plants the antenna NBE-5ac-16 in a tube galvanized and right there will connect the AP Outdoor.

For this proof connects the server such as it indicates in the topology of network como can see in the Fig.4, a card of network eth 0 is connected to the modem of the GAD Saint Antonio which has a speed of 3,5Mbps, and the another card eth1 is connected to the antenna of transmission that finds in the tower of the board by means of a wire utp category 6To. For the respective funcionamiento makes the respective configurations in the devices Ubiquiti.

Test of connection of users to the network

It makes the connection of an user to the wireless network Complex call Santa Clara, likes and can observe in the figure 5 connects to the network.
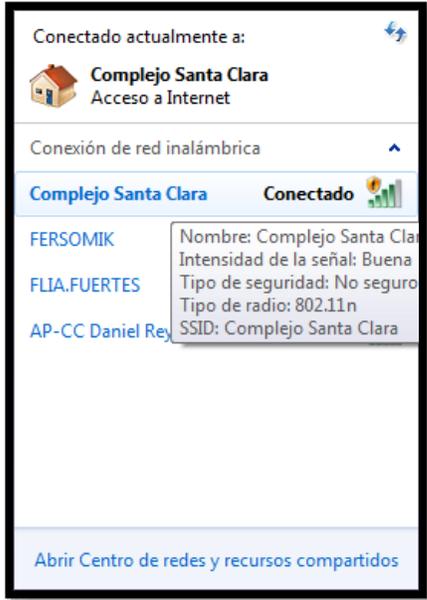
Fig. 5 Connection to the Complex wireless network Santa Clara

Once that it connect to the network, the user will not be able to sail until it accept the terms and conditions of the captive portal likes and can observe in the Fig. 6.
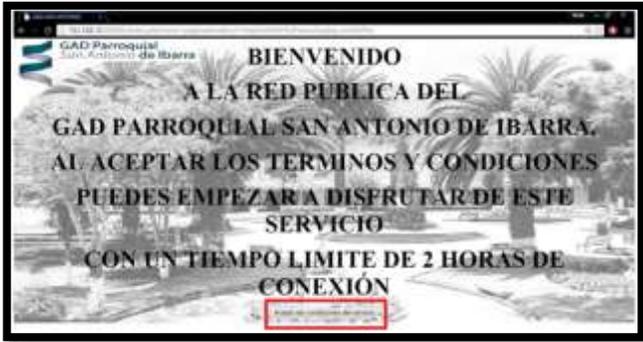
Fig. 6 Screen of conditions of connection

With this proof can see that it has a system without authentication and that to be able to sail in internet has to accept the conditions of the service

- Entry to Internet of the User: In this proof goes to www.google.com to check that once that it has accepted has access to internet. As it observes in the Fig. 7.
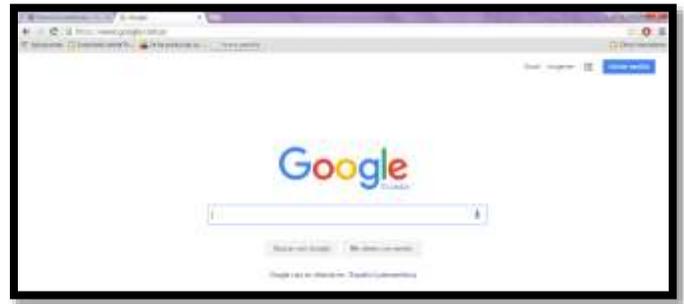
Fig. 7 Testing of access to internet

Once that it has access to Internet, checks the following rules of proxy.

- Forbid all the pages with sexual content.

It does not allow the entry to unsuitable content as it is pornography the access is deny. As it observes in the Fig.8 it will not be able to ingress to unsuitable pages.

Fig. 8 <denied access to unsuitable pages

IV. REFERENTIAL BUDGET

In the table 9 presents the total cost for the design of the network cost of equipment, cost of topmasts for the installation of the receptors devices, price to cancel by the links and hand-held cost of work.

TABLA 9
Referential budget of the total cost

Type	Total cost
Cost of Devices	9399,2
Cost of operation of the radioenlace	1655,51
Cost of Topmasts	576,74
Cost of installation	1459,20
Cost of Technician	480
Total cost	13570,65

A.- Analysis Cost Benefit

The Analysis of Cost Benefit provides a measure of the profitability of a project, making the comparison of the costs of the devices with the profits expected in the realization of the same.

This method applies to social works, projects, private companies, among others, loaning attention to the importance of his social or economic consequences.

Due to the fact that in this project does not expect have economic income for being a social project can not make the calculation of the cost benefit being a project without ends of lucre. But it has social profits in the moment that implement the wireless network in the Parish of San Antonio.

Ecuadorian state

For the practical analysis of the profits have the following Fig.9 that illustrates us the analysis of the profits, the decrease of the breach digital and as it improves the quality of life by means of the implementation of a wireless network.
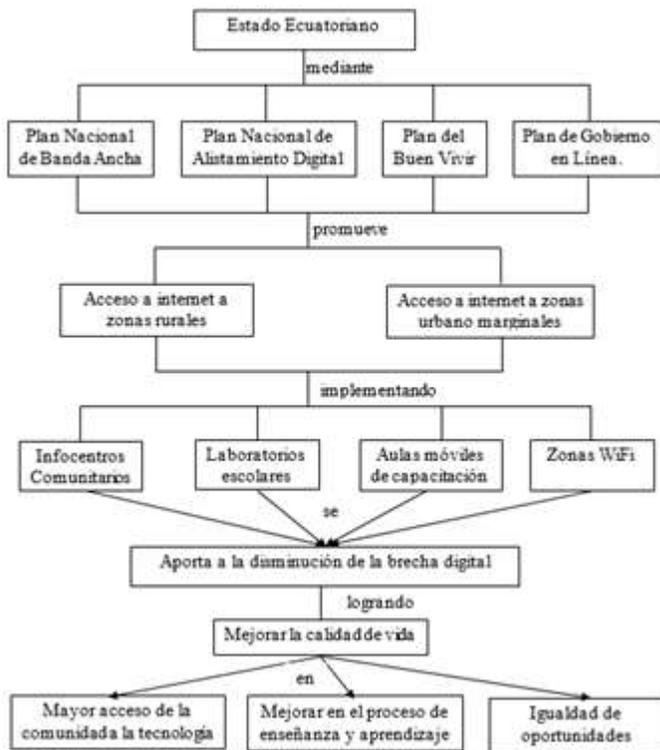

Fig. 9 Analyses of profits when it implement a wireless network

Improve the quality of life

The quality of life measures with profits that will have the citizens when they do use of the Technologies of the Information and Communication which are:

- Greater access of the community to the technology

Of agreement to the statistics where explains that the rural zones have lower access to internet and a high percentage of citizens of these zones access to the service by means of public centers, is for this reason that they have of greater points of connection in the parks, exists greater probability that the pobladores of said zones can access to these technologies of communication and information improving with this the possibility of access to the citizens of San Antonio of Ibarra, contributing to increase the indexes of access to internet in the rural zone and benefiting to the majority of citizens of the parish.

The project has focused in benefiting to the most of citizens, being the 6 zones of service strategic points that have more influx of people and to his time helps to go up the indexes of access to internet of the Parish, since basing in previous statistics found that of 4930 houses only 1300 have access to internet in his home by means of the different providers of the service, this project looks for to have a positive impact since it would offer to the people that do not have access to internet the possibility to do it in public places of free way.

- Improve in the process of education and learning

The access to internet has a big impact in the education, because of the big quantity of present information in the network, to which can access so much educational like students, being an essential tool for the realization of tasks and investigation.

In base to the statistics of the INEC in the use of internet of the rural zone knows that the user of these zones uses internet for education and learning with a percentage of 48, 3% constituting this branch as of main use for said habitants, by what by means of the implementation of this network will help to improve the conditions of learning of the students that are around the points to offer the service.

They benefited the students of the school educational centers and schools that find around the 6 zones, in the case of the point of the Park Eleodoro Ayala would benefit to the two schools that find near to this point as it is the School Víctor Mideros, the School Daniel Kings and the school Institute Inocencio Jácome, in the Park Neighborhood South will benefit to the students of the school José Miguel Leoro Vásquez, in the Central Square of Tanguarín benefited to the students of the school Francisco Calderón.

- Equality of opportunities

Taking in account the statistics of use of internet in the Ecuador observes that roughly 50% of the population of urban zones has access to internet whereas the ones of rural zones have an approximate of 25%, by what considers necessary elevate these indexes and like this treat to balance the difference that exists of a zone with regard to another, allowing to the rural user access to the profits that offers a connection of internet as they are: in education, in communication, in information and ease of transact with some dependencies of government and companies that use this platform.

The implementation of the wireless network in the parks of Saint Antonio of Ibarra, would constitute a big contribution to the community, since it would allow them to the inhabitants of the parish enjoy of the profits that the access to internet offers them in the actuality, and like this also improve the indexes of access to internet in rural zones of this way would help to diminish the breach digital.

Benefits when the wireless network be implemented in the Parish of San Antonio

The proposal of wireless network represents for the GAD Parish Saint Antonio improves in the economic development, social and cultural when allowing the universal access to the

Technologies of the Information and Communication.

Between the users benefit direct state a total of 180 users between the 6 zones to offer the access to internet of free way and the beneficiaries indirect that are around 15509 habitants, in such a way that it contribute to the decrease of the breach digital especially focused in the rural sector where the indexes of access to internet according to the surveys of the INEC are basses in comparison to the ones of the urban zones.

The breach digital reduces in Ecuador with the politics of the Government to expand the access to internet to rural and urban zones marginales, through the implementation of the designated infocentros, school laboratories, zones WIFI and mobile classrooms of qualification [7], in the moment that it implement this project in the parish of San Antonio will contribute to the decrease of the breach digital, use the service of internet like a tool to exchange information, educate, work and communicate, when integrating the technologies of the Information and Communication.

When implementing the design of the wireless network in the public parks of the Parish of Saint Antonio will increase the number of people with access to internet, with the object to reduce the breach digital such as it indicates the broadband National Plan, National Plan of Digital Isolation, Plan of the Good Live and Plan of Government on line. In consequence, will be contributing to reduce the above-mentioned indexes.

The profits that will have the citizens of the Parish of Saint Antonio when using the wireless network, is to have the ease to access to information on: the planillas of basic services, banks, SRI, IESS, among others; allowing them optimize time and costs of formality, so much to the user as to the entity.

The 6 zones to offer the access to internet are situated to side of schools and schools, by what would benefit to several students out of the schedule of classes so that they make his tasks, because of the importance that nowadays constitutes the internet like tool for the educational process, improving like this the quality of life of the students and saving money to the same when being a free service.

The parish of San Antonio characterizes by his tourism in craftsmanship's, the access to a network of internet would allow to the traders and customers exchange information by means of web services, this would give to the artisans of the parish the possibility to do know his products and make the sales of the same to the visitors handling technological tools.

V. CONCLUSIONS

The proposal of wireless network represents for the GAD Parish Saint Antonio improves in some appearances; allow the economic development, social and cultural when allowing the universal access to the technologies of the Information and Communication (TIC), contributing with the state politics in relation to the broadband National Plan, National Plan of Digital Enlistment, Plan of the Good Live and Plan of Government on line contributing to the decrease of the digital gap, by means of the design of zones WiFi applying the standard 802.11ac to this project contributing with advantages with regard to previous standards as it is his speed of transmission faster and operates in the band of 5Ghz by what is less liable to the interference and noise, being a free band no congestionada regarding the band 2.4Ghz; doing to the most robust network, flexible and scalable.

In base to the analysis made to determine the bandwidth of the applications to offer in the wireless network and the surveys of the INEC, and taking in account the factor of simultaneity exists a low probability that a big quantity of users connect at the same time to the network, with which determined the speed that has to have the GAD Parish San Antonio to offer the service, the same that it would have to be of minimum 20Mbps, being sufficient so that the network work properly and offer a connection of quality.

In base to the requests of the design and subjects to the resolution TEL-560-18-CONATATEL-2010 that mentions necessary technical specifications for this type of networks, chose devices of Ubiquiti Networks being a technology that projects regarding Cisco and Mikrotik in what it is cost benefit, included license in each team in such a way that it save resources when being subjects to a budget limited and fulfilling with the parameters established by the marco regulatory.

By means of the utilization of the tool Irradiate Mobile made the respective simulations of the 6 links, fulfilling with the parameters mentioned as it is to obtain a line of direct sight clearing 60% of the first zone of Fresnel; concluding that the radioenlaces are reliable and viable.

In the design of the network uses the standard 802.11ac which works in the free band of 5,8GHz, for the utilization of this band in the network has to fulfil with some parameters allowed for the implementation and operation of systems of broadband Digital Modulation which are power of transmission, gain of antennas and necessary forms to legalize the radioenlaces, all these specifications find in the frame regulatory.

When being an open connection to all the users without distinction of age establish restrictions of offensive pages no apt for minors of age, basing in the code of the childhood and adolescence where expresses that the boys and teenagers do not have to be exposed to unsuitable content like the pornography, by what propose rules of filtered of pages with unsuitable content for the minors.

The use of free software like technological tool for the development of social and educational projects has like advantage reduce the costs and possesses characteristics like stability, security and open source, the server Pfsense fulfils with all the requests to offer security and administration of the network.

The investment that represents the project is social because it benefits to 180 direct users and 15509 beneficiaries indirect of the services of internet that will loan the parish of Saint Antonio, the return of the investment of this project will see reflected in the satisfaction of the user being a project without ends of lucre in the moment that implement , offering equality of opportunities to the users of the rural zones, increasing the indexes of access to internet and contributing to the decrease of the digital gap.

I. REFERENCES

[1] Fluke Networks Corporation, 26 March 2014. [On line]. Available: http://es.flukenetworks.com/content/white-paper-impact-80211ac-wireless-networks-network-technicians.

[2] Motorola Solutions, «WHAT HAS TO KNOW ABOUT THE STANDARD 802.11AC,» 2013. [On line].

[3] S. Vázquez Peralta, «technical Study and design for the deployment of a wireless broadband network in the canton Chordeleg using technology of access Wi-Fi in distinct points of the canton and inside the I. Municipalidad Of Chordeleg,» Thesis Maestria, Cuenca, Ecuador, 2010.

[4] M. Muslim Vallina, Infrastructures of networks of data and systems of telephony, Madrid: Parainfo, 2013.

[5] Resolution TEL-560-18-CONATATEL, «THE NATIONAL COUNCIL OF TELECOMMUNICATIONS,» 2010. [On line]. Available: http://www.arcotel.gob.ec/wp-content/uploads/downloads/2015/06/560_tel_18_conatel.pdf.

[6] ARCOTEL, «System of broadband Digital Modulation,» 2015. [On line]. Available: http://www.arcotel.gob.ec.

[7] Agency of News Andes, «Access to internet reduces brecha digital in Ecuador,» 18 August 2014. [On line]. Available: http://www.andes.info.ec/es/noticias/acceso-internet-reduce-brecha-digital-ecuador.html.

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