UNIVERSIDAD TÉCNICA DEL NORTE

FACULTAD DE INGENIERÍA EN CIENCIAS APLICADAS

CARRERA DE INGENIERÍA EN ELECTRÓNICA Y REDES DE COMUNICACIÓN

SCIENTIFIC REPORT

THEME:

"ANÁLISIS TÉCNICO-TEÓRICO SOBRE LA DIGITALIZACIÓN DE LA RADIODIFUSIÓN SONORA APLICANDO EL ESTÁNDAR DIGITAL RADIO MONDIALE (DRM) EN LA EMISORA UNIVERSITARIA DEL DEPARTAMENTO DE COMUNICACIÓN ORGANIZACIONAL Y TELEVISIÓN DE LA UNIVERSIDAD TÉCNICA DEL NORTE"

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IBARRA - ECUADOR

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TECHNICAL AND THEORETICAL ANALYSIS ON SCANNING SOUND BROADCASTING STANDARD APPLYING THE DIGITAL RADIO MONDIALE (DRM) OF THE STATION IN THE DEPARTMENT OF COMMUNICATION ORGANIZATIONAL AND TELEVISION OF THE TÉCNICA DEL NORTE UNIVERSITY.

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Abstract- This project is developed in order to have an efficient use of the frequency spectrum and which is currently saturated in major provinces, for this reason a study of new digital broadcasting technologies also encourage theoretically held every definition digital broadcasting systems and associated costs in the project a projection of coverage scanning is performed using the digital Radio Mondiale DRM standard. Furthermore migration analogy to digital technology is proposed, also the current design of the analog broadcast and changes to the operation of the digital broadcast applying this new radio technology, the use of ICS TELECOM software is detailed for prediction coverage at the station.

Índice de Términos—DRM+, Estándar, Migración, Radiodifusión.

I. INTRODUCCIÓN

THE BROADCASTING IN ECUADOR. It originated in 1929 in the province of Chimborazo, where its first broadcast from a radio station was known as "EL PRADO" and providing their service to the Ecuadorian citizenship. This transmission had a range of about 60 meters to the beginning aired few hours a day for several days, then there was no regulation to govern for such transmissions only were assigned an identification which was to ECUADOR , SE1G.

In the Department of Organizational Communication and Television TECHNICAL UNIVERSITY NORTH; the emission of sound broadcasting is transmitted via the FM band to the provinces of Carchi and Imbabura, causing the coverage area is limited and also occupies a large bandwidth. The lack of interest in the area of broadcasting and little support in the use of new technologies, cause this media does not provide greater coverage and transmission quality.

II. DEFINITION, TECHNOLOGY AND EQUIPMENT.

A. RADIOELECTRIC SPECTRUM

Telecommunication systems using radio spectrum, comprising the frequency bands useful for providing radio services and range from frequencies below 1 kHz to 300 GHz.

Fig. 1. Frequency Bands Radio Spectrum

Radio frequency (RF) - are a group of special waves that have their own identity in the great electromagnetic spectrum and make the radio spectrum.

B. TRANSMISSION SYSTEMS RADIO WAVES

Traveling waves can be divided into three types or forms of propagation

1) Ground waves or surface:

They are advancing on the surface of the earth, these waves are subject to obstruction of objects whether these buildings, trees, etc.

2) Direct waves or Space:

These waves follow the path of the upper layers of the atmosphere, ie follow the curvature of the earth.

3) Skywave:

The ionosphere by its characteristics acts as a mirror wave waves returning to Earth.

C. BROADCAST SYSTEMS

Broadcasting: A more restricted than that of radio, radio frequency or radio waves concept as it relates solely to transmissions intended to be received by a group of listeners.

1) Terrestrial broadcasting service:

Its limitation is the range (several kilometers) depending on the power emitted which causes consume much more power, but you can increase it by adding several broadcasting centers attached to a single center.

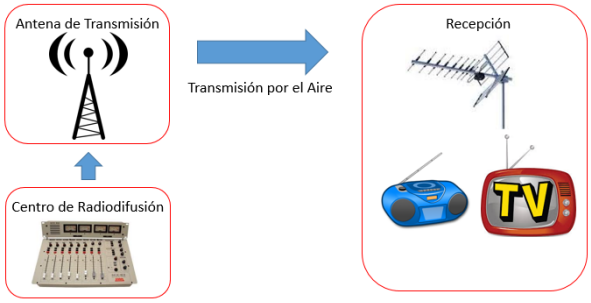

Fig. 2: Terrestrial Broadcasting scheme

2) Broadcasting Satellite Service

In this uplink service is used to send programming from a production site to a satellite, and broadcast a downward or to send directly link programming to its receptors.

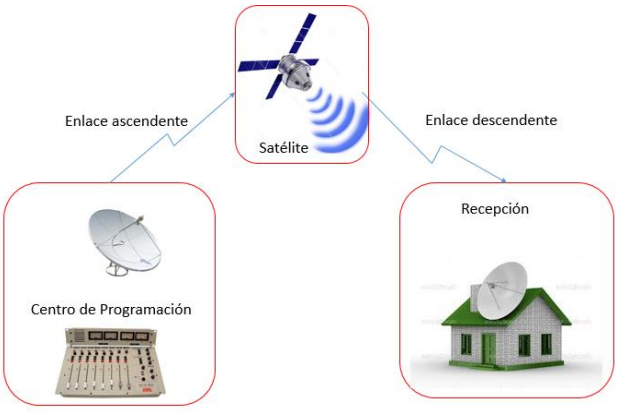

Fig. 3: Satellite Broadcasting scheme

D. BASIC STRUCTURE OF A SIGNAL TRANSMITTER.

The figure shows a diagram of the basic signal transmission, this consists of a source that may be a radio or television, an oscillator to be stable in frequency, a filter that limits the frequency range, a modulator for carrying information on a carrier, an amplifier to raise the level of the carrier generated by the oscillator and an antenna to transmit information.

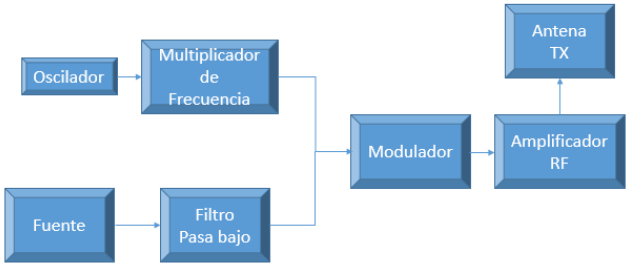

Fig. 4: Signal Transmitter scheme

E. BASIC STRUCTURE OF A SIGNAL RECEIVER.

At the reception it has a receiving antenna, an amplifier since capturing the signal can be lost and what is required is to increase its amplitude or gain, a mixer for conversion frequencies in all frequency bands, a detector.

It allows you to check the presence of radio frequency oscillators, amplifiers, and speaker to listen to the transmitted signal.

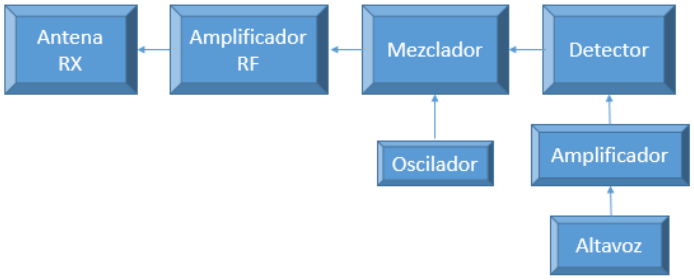

Fig.5: Diagram of a signal receiver.

F. ANALOG AND DIGITAL SIGNALS

The analog signals vary continuously between two values. The signal can take all intermediate values between the maximum and minimum.

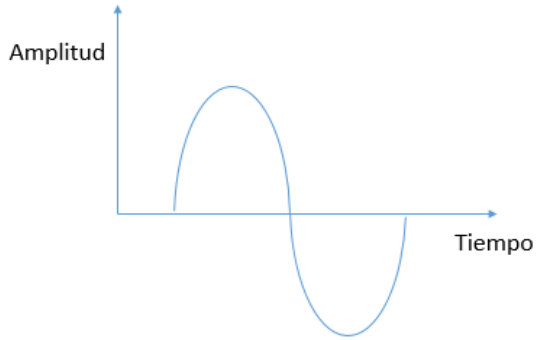

Fig.6: Analog signal

Digital signals can be taken two values either high or low or one or zero, plus these signals are less prone to interference.

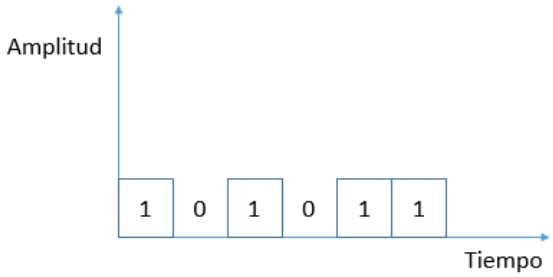

Fig.7: Digital Signal

G. DIGITAL AND ANALOG TRANSMISSIONS

A communications system is basically composed of three stages:

a. Source of information
b. Destination Information
c. Transmission medium

Communications systems comprise three main sections are: source, channel or media and a destination.

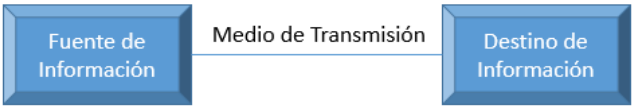

Fig. 8: Basic communications system

H. AM BROADCASTING.

AM broadcasting or broadcasting Amplitude Modulation, is a way of transmitting a signal (low frequency) as a whole (a band) of high frequency components.

Amplitude modulation was designed to transmit both audio short, medium and long wave and is to modify the amplitude of the carrier signal by the amplitude of a low frequency signal as the audio signal.

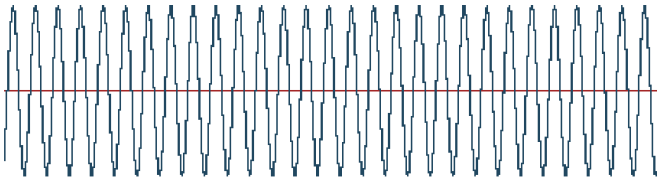

Fig. 91: Carrier signal

Now, the audio signal low frequency shown in Fig modify the amplitude of the carrier.

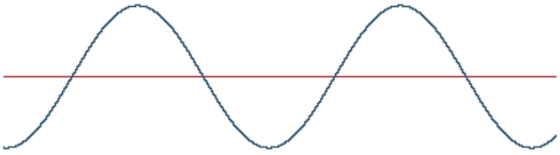

Fig.10: Audio signal Low Power

And finally, this process is known as amplitude modulation and displayed as the carrier has changed according to the signal introduced achieving modification.

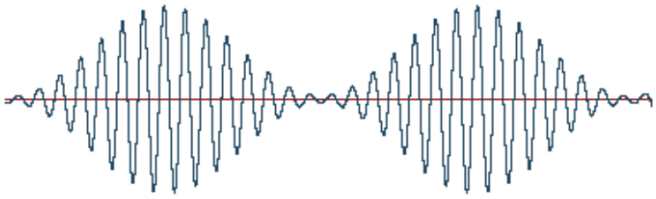

Fig. 11: Result of the AM signal structured by the carrier and audio waveform.

I. FM broadcasting

FM broadcasting or frequency modulation, the frequency of the carrier signal changes in proportion to the amplitude of the audio signal.

The FM-broadcast audio signal has a which is added to the carrier.

Fig. 22: Audio signal

The following figure shows the carrier to which the audio signal is added shown above is displayed.

Fig. 13: C*arrier*

And last it is seen that the frequency changes in the carrier signal according to the amplitude of audio added.

Fig. 14: Results FM carrier signal and structured by the audio signal.

J. CHANNELING BAND FM

100 frequencies are set at a spacing of 200 KHz, numbered from 1 to 100, starting at the first frequency 88.1 MHz

1) GROUPS OF FREQUENCIES

Groups for distribution and allocation of frequencies in the country are established. Groups: G1, G2, G3 and G4 with 17 frequencies each, and G5 and G6 groups with 16 frequencies each. The frequency separation of the same group is 1.200 kHz. According to independent operation FJ001 area of Imbabura province it contains the groups G2, G4 and G6

Definition of areas of independent operation, zonal areas of operation and frequency allocation plan.

TABLE 1
Areas of independent operation, zonal areas of operation and frequency allocation plan.

ÁREA DE OPERACIÓN INDEPENDIENTE	DESCRIPCIÓN DEL ÁREA DE OPERACIÓN INDEPENDIENTE	GRUPOS DE FRECUENCIAS	ÁREAS DE OPERACIÓN ZONAL.	FRECUENCIAS DESIGNADAS PARA ESTACIONES LOCALES.
FJ001	Provincia de Imbabura, excepto el cantón Pimampiro y las parroquias Salinas y Ambuquí.	G2, G4 Y G6	Ibarra, Otavalo Urcuqui, Atuntaqui, Cotacachi y Parroquias de Intag.	88.7 MHz 96.7 MHz 103.1 MHz

* Note: Table adapted. Source: Data acquired by the ARCOTEL

For the allocation of frequencies consecutive (adjacent), designed to serve the same area or area of operation independent zonal operation, a minimum separation of 400 kHz from the carrier frequencies of each station should be observed.

K. SPECTRUM ANALYSIS IN FM BAND

This analysis should consider the full spectrum used on the assigned service band that would result in the percentage of spectral use as shown in equation (1).

$$\%\ Uso\ Espectral = \frac{Espectro\ Utilizado}{Banda\ Asignada\ del\ Servicio} X100\%$$

(1)

$$\%\ Uso\ Espectral = \frac{(50 * 200\ KHz)x100\%}{(108-88)MHz} = 50\%$$

(2)

According to data acquired by ARCOTEL and presented in the above table, the city of Ibarra belongs to the zone FJ001 which contains frequency groups G2, G4 and G6, adding these groups a total of 50 channels for frequency allocation.

SIRATV- database can be seen that more than half of the frequencies are occupied.

This represents a progressive saturation as shown in equation (3).

$$\%\ Saturación\ del\ Espectro = \frac{Número\ de\ frecuencias\ asignadas}{Número\ de\ canales\ disponibles} X100\%$$

(3)

Are 38 stations or channels that are currently assigned in the province of Imbabura.

$$Saturación_{FM-Ibarra} = \frac{38\ estaciones\ x\ 100\%}{50\ canales} = 76\%$$

(4)

It has 800 channels nationwide, this geographical areas and groups of frequencies should this include the 3 groups G2, G4 and G6 totaling 50 channels multiplied by the average frequency per group.

Nationwide it has 936 stations between public, private and community, which results in saturation in the spectrum as shown in the following equation.

$$Saturación_{FM-Ecuador} = \frac{936\ estaciones\ x\ 100\%}{800\ canales} = 117\%$$

(5)

L. BLOCK DIAGRAM OF A DIGITAL RADIO SYSTEM

Basically a digital radio system follows a process to transform an analog source into digital. In Figure 15 a block diagram representing the process mentioned digital radio system is shown.

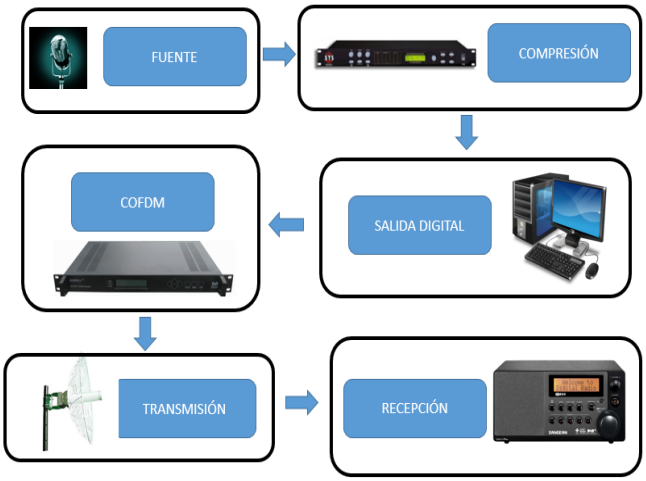

Fig. 15. Block Diagram Digital Radio System

The process is divided into:

- ✓ Source: The original sound, analog signal.
- ✓ Compression: The compression is performed through a system that reduces the amount of digital information required to be transmitted.
- ✓ Scanning: In this stage the signal is converted into binary data or binary digits.
- ✓ Modulation: By COFDM (multiplexed coded orthogonal frequency division) interference are eliminated, these interferences can be atmospheric, other electrical equipment or large obstacles such as large buildings.
- ✓ Through multiplexing various programs and services from a single block of frequencies are transmitted.
- ✓ Finally a digital receiver has digital sound and visual information.

M. SFN SINGLE FREQUENCY NETWORKS

Schemes of single frequency networks are somewhat analogous to the wireless communication systems such as mobile telephony or WI-FI systems.

They are often named as systems transmitting with macro-diversity with CDMA "soft handoff" or single frequency networks dynamics.

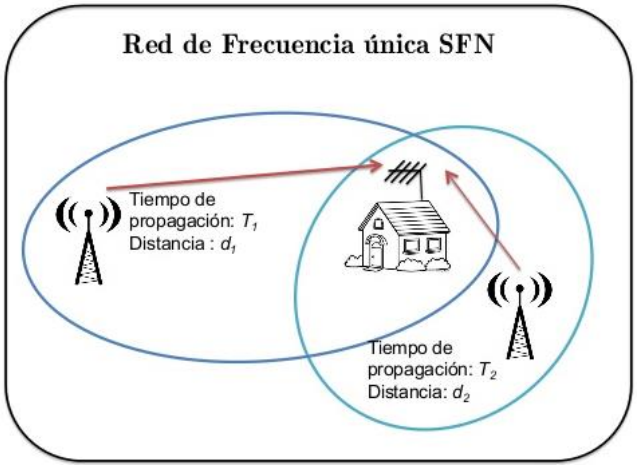

Fig. 16: SFN operation scheme

Transmission with single frequency networks can be considered as a form of multi-path propagation. The recipients receive the echoes of the same signal, so that it can be constructive or destructive interference that may cause lightheadedness or "fading".

N. DIGITAL BROADCAST STANDARDS

The most common standards for the digitization of radio broadcasting are as follows.

1) DAB DIGITAL BROADCAST

DAB (Digital Audio Broadcasting) is a European standard and a standard adopted by ETSI (European Telecommunications Standards Institute - European Telecommunications Standards Institute) and the EBU (European Broadcasting Union - European Broadcasting Union). Countries where this system is used are: Spain, Italy, Sweden, Germany, France, United Kingdom and Belgium, Canada and some Asian countries such as China.

Transmission bands used are:

- ✓ Band III (from 174 to 240 MHz)
- ✓ Band L (from 1452 to 1492 MHz)

2) DIGITAL BROADCAST IBOC

IBOC (in-band on-channel) is a term that describes the existence of AM and FM analogue broadcasting as bands and channel schemes for digital transmissions.

Transmission bands used are below 30 MHz (AM) and including frequencies 535-1710 kHz (OC) and FM 88-108 MHz.

Work in the MF (300-3000 kHz) band is exemplified Broadcasting AM (medium wave), Radio hobby, Avalanche Beacons

The difference between AM and FM IBOC digital system is that it has an analog FM exciter and to this is added an IBOC exciter.

3) ISDB-T

ISDB or Integrated Services Digital Broadcasting is a set of standards created by Japan for broadcasting digital radio and digital television.

As the European standard DVB, ISDB is comprised of a family of components. The best known is the terrestrial digital TV (ISDB-T and ISDB-Tb) but also make the television satellite (ISDB-S), cable TV (ISDB-C), etc.

Characteristics

- ✓ Transmission of an HDTV channel and a channel to mobile phones within a bandwidth of 6 MHz, reserved for analog TV broadcasts
- ✓ Select the transmission between two and three television channels in standard definition (SDTV) instead of one in HDTV, SDTV by multiplexing channels. The combination of these services may be changed at any time.

4) DIGITAL BROADCAST DRM

DRM (Digital Radio Mondiale) is a digital radio standard that has been designed by broadcasters that if they were companies and organizations trying to create an international standard, with the active support and participation of manufacturers of transmitters and receivers and other parts stakeholders such as regulatory bodies like ETSI - ITU (International Telecommunication Union).

On the official website of DRM various operating modes, which can be broadly divided into two groups, they are described:

- ✓ Mode DRM30, They are specifically designed to use AM broadcasting bands below 30 MHz
- ✓ Mode DRM+, They are using the spectrum of 30 MHz to 300 MHz, centered on the FM broadcast band II

a. Spectrum analysis DRM +

As seen with FM, the same process is carried out with the standard DRM + the same parameters are taken to perform this analysis. That is, the total spectrum channel is taken into use with the difference that for the combined mode 200 KHz is added to the sum of the spectrum.

$$\%\ Uso\ Espectral = \frac{Espectro\ Utilizado}{Banda\ Asignada\ del\ Servicio} X100\%$$

(6)

$$\%\ Uso\ Espectral = \frac{(50 * (200 + 100)\ KHz) x100\%}{(108 - 88) MHz} = 75\%$$

(7)

As shown in equation (7), using the combination of FM and DRM + 75% efficient spectrum use is obtained. As if all the digital system performs better efficiency is obtained since the use of the spectrum would have 199 channels of 100 KHz from 88.1 to 107.9 MHz.

$$\%\ Uso\ Espectral_{Nacional} = \frac{(199\ canales * 100\ KHz) x100\%}{(108 - 88) MHz} = 99.5\%$$

(8)

Among the features of DRM it has mentioned that multiservice, i.e. you can have up to 4 services for the same bandwidth.

If a saturation analysis spectrum is performed but with the combination of FM and DRM + has the following result.

$$\%\ Saturación_{FM-DRM+} = \frac{(50\ estaciones\ ) x100\%}{(50\ canales * 4\ estaciones)} = 25\%$$

(9)

The result of equation (9) shows that has 25% less saturation by combining FM and DRM +. If this process applies at the national level have.

$$\%\ Saturación_{FM-DRM+-Nacional} = \frac{(936\ estaciones\ ) x100\%}{(800\ canales * 4\ estaciones)} = 29.25\%$$

(10)

This represents a 29.25% decrease saturation nationwide spectrum in the case of implementing a hybrid between FM and DRM +.

In the case of having a complete digital system that is all DRM +, the following would:

$$\%\ Saturación_{DRM+-Ibarra} = \frac{(38\ estaciones\ )x100\%}{(199\ canales * 4\ estaciones)} = 4.77\%$$

(11)

Lower saturation is observed in the area of the city of Ibarra, now nationwide with a complete DRM + system allows two adjacent channel transmitters and have the following:

$$\%\ Saturación_{DRM+-Nacional} = \frac{(936\ estaciones\ )x100\%}{(800 * 2) canales * 4\ estaciones)} = 14.625\%$$

(12)

This result gives us a lower saturation nationwide with fully digital system using DRM +.

O. ADDED VALUE OF DIGITAL RADIO

The evolution in technology has made it possible for radio stations have the ability to access the service scanning with certain advantages that are considered value added.

As shown in the figure below, digitization provides additional services and flexibility to manage multimedia content as well as advertising, images, games and more.

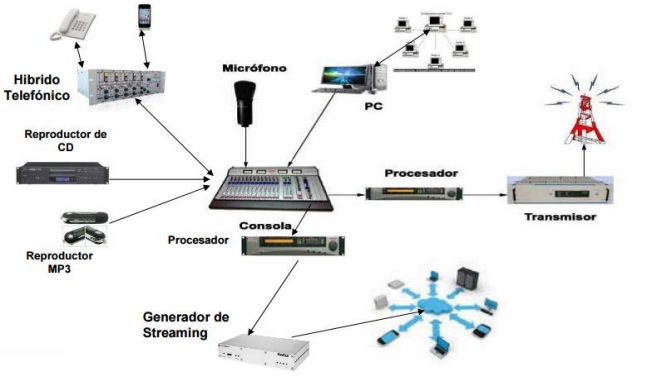

Fig. 17. Value Added Digital Radio

DRM has its own value-added services consortium:

- ✓ Text messages DRM
- ✓ Text information service Journaline
- ✓ EPG
- ✓ SLIDESHOW
- ✓ DIVEEMO

III. PROPOSAL FOR SCANNING THE RADIO UNIVERSITY APPLYING THE STANDARD DRM.

Proposal for digitization are considered own location parameters of the radio station UTN.

Table 2.
Location Cerro Radio Station in Cotacachi

Ubicación	Latitud	Longitud	Altura
Estación UTN	00° 21' 28.68"N	78° 06' 38.81" O	2206.10 m

* Note: Table adapted. Source: Data acquired by the ARCOTEL

In addition to the radio link parameters of the university station.

Table 3.
Radio link parameters of the university station.

Parámetros	Valor
Potencia de Salida	410 W
Perdidas Cable	1,5
Ancho de Banda	200 KHz
Estación FM	Normal
Forma Recepción Señal	Radioeléctrico
P.E.R	1000
Altura Torre	30 m
Tipo Antenas	Arreglo 4 Radiadores con pantalla reflectora

* Note: Table adapted. Source: Data acquired by the ARCOTEL

A. CURRENT DESIGN COLLEGE RADIO CHANNEL

The operation scheme is shown based on blocks, and each block describes the tools used equipment from its source to its destination. Consideration should be given to the steps of the scheme are:

1) Issuance System

The following figure shows the first part of this diagram shows, this has to do with the source or recording station and this is called emission system.

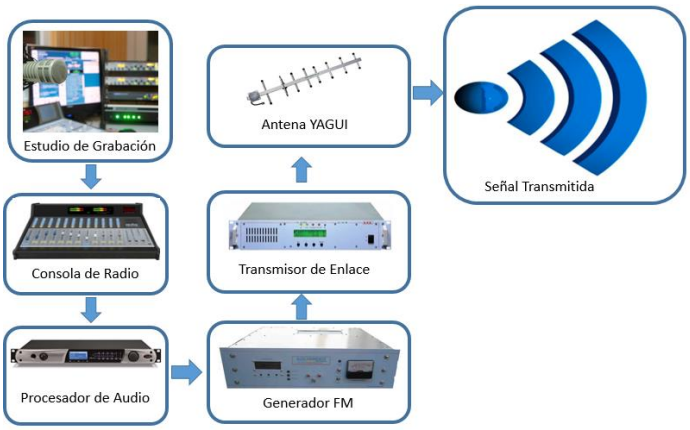

Fig. 18: Operation scheme Canal University - Broadcast System

2) Transmission system

The transmission system is located away from the station, is in the Cerro Cotacachi also stands at a height above sea level of 3966 m.

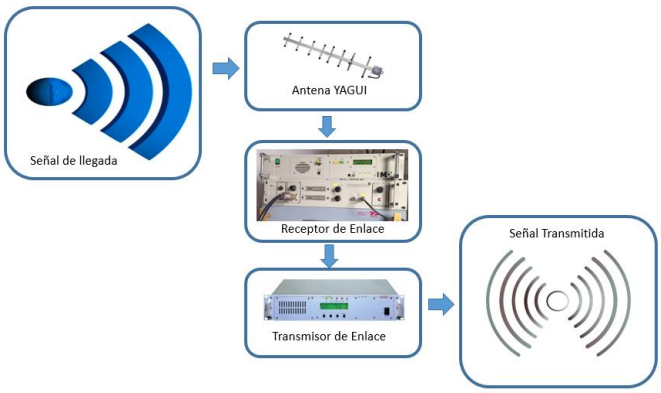

Fig. 19: Operation scheme Canal Universitario - Transmission System

3) Receiving device

Receiving systems are simply devices that help us capture and reproduce the signals sent by the radio stations.

Fig. 20: Receiving device - Home

B. Features Link

The transmitting antenna should have sufficient power for the signal to be picked up at the destination, emits signals with a very low debanda wide receiving antennas instead have a width wider band and receiving signals of various frequencies, so that the signals sent must be amplified subsequently.

• **Bandwidth** — It is the frequency range in which the antenna operates.

• **Gain antenna** — It indicates the emissivity of an antenna. Which is obtained by comparing the power emitted in the preferential direction with the mean power emitted in all directions. If the antenna is isotropic your gain is unity.

• **Efficiency of an antenna** — It is the relationship between the power emitted by the antenna and the power captured by the receiving antenna, this parameter allows us to know the losses that occur in the transmission process.

• **Antenna length** — It depends primarily on the frequency of the signal to be transmitted or received. These dimensions should be at least of the order of one tenth of the wavelength of the signal.

• **Microwave link cable** — To interconnect the processing unit with an external radio frequency unit cable is required and an internal RG8

Table 4.
Additional parameters Antenna Mounting

Parámetros	Valor
Número de Antenas	4
Azimut	75
Inclinación	-5
Ganancia	5,37
Patrón de Radiación	Directivo
Polarización	Circular

*Note: Data acquired by the ARCOTEL

C. DRM30 and DRM ANALYSIS FOR DESIGN OF COVERAGE

To determine the coverage area using DRM must know some parameters being this transmission modes and frequency DRM is intended to scan.

The modes are:

• DRM30
• DRM+

Mode DRM30— Thus equivalents denominator contains A, B, C, D, and a modulation and coding scheme (MSC) with QAM options with their respective bandwidth for each mode.

Table 5.

Transmission modes DRM30

Modo	MSC: Opciones QAM	Opciones de ancho de banda (KHz)	Usos Típicos
A	16, 64	4.5, 5, 9, 10, 18, 20	LF y MF onda de superficie, line de vista en banda de 26 MHz
B	16, 64	4.5, 5, 9, 10, 18, 20	HF y MF transmisión en onda espacial
C	16, 64	10, 20	Dificultad de onda espacial sobre canales HF
D	16, 64	10, 20	Efecto Doppler Alto y dispersión del retardo

* Note: Transmission modes DRM30

Transmission mode DRM+— This mode is known as Mode E.

Table 6.

Transmission modes DRM+

Modo	MSC: Opciones QAM	Opciones de ancho de banda (KHz)	Usos Típicos
E	4, 16	100	Transmisiones VHF y en las bandas sobre los 30 MHz

* Note: Transmission modes DRM+

College radio works 101.1 MHz frequency is in FM and a frequency is about 30 MHz, this frequency based on the design of the university station coverage is performed.

D. DESIGN WITH RADIO EQUIPMENT DRM IN COLLEGE STATION RADIO

At this stage some of the equipment that can be replaced during migration of analog to digital technology detailing.

1) ISSUER SYSTEM SCHEME WITH DRM

For the scheme of operation of the station using the DRM standard it is considered variations in equipment.

Inside the recording studio — equipment as microphones and other accessories will be maintained.

Audio consoles — currently it has an analog-digital hybrid console. This console at the moment works on the analog model for the analog to digital transition an additional console is required since this has digital inputs and outputs for use in the scanning process.

The audio processor — aims to adapt the analog signal and digital make if it is required, this is useful for storing information necessary audio and available when needed, this team like the FM generator and transmitter can be replaced easily by a DRM content server, plus a team that modulates the signal and digital signal transmitter.

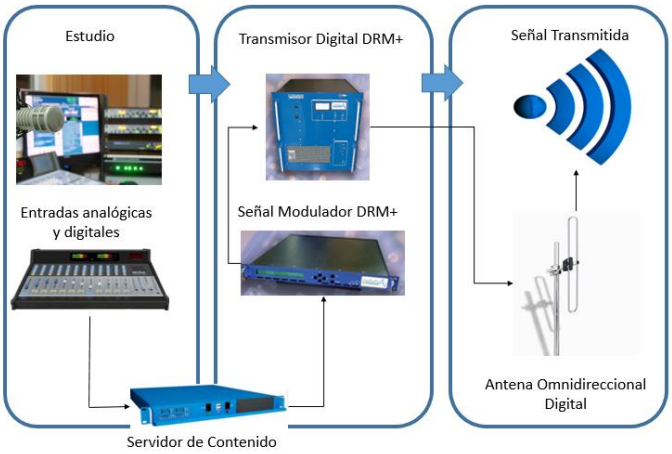

Fig. 21: Operation scheme Canal University - Broadcast System DRM
Source: Author - DRM Consortium

Como It is shown in the figure above, once you reach the transmitter requires an antenna to send the signal, formerly a Yagi antenna had but for the digital delivery process takes a digital antenna.

2) OUTLINE OF TRANSMISSION SYSTEM WITH DRM

For the scheme of the transmission system some of the elements with one, for transmission on FM you have a reception team link and a transmitter, now for scanning a single team consisting of a receptor- be submitted replaced transmitter, this is shown in the following figure.

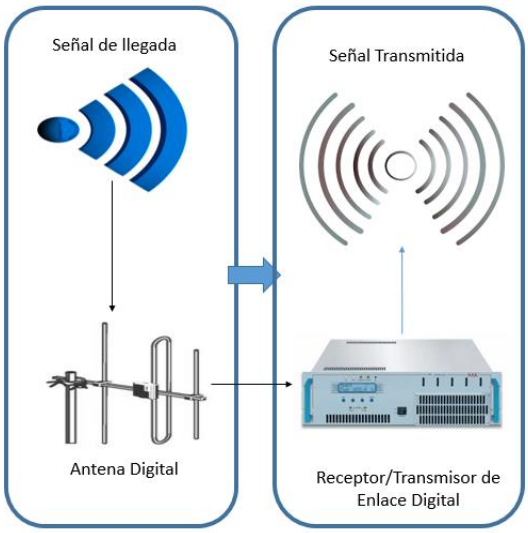

Fig. 22: Operation scheme Canal Universitario - Transmission System DRM
Source: Author - DRM Consortium

3) DESIGN MOBILE RADIO COVERAGE

To compare programs and ICS TELECOM MOBILE RADIO proceed to perform simulation tests coverage each with which it began with MOBILE RADIO, then a table with the necessary data for the simulation is presented.

Link testing is done in the software MOBILE RADIO with the following results shown in the table below.

Table 7.
Test Results link Cerro Cotacachi - UTV

Parámetros	**Valor**	
Distancia	25.474	km
Precisión	12.7	m
Frecuencia	920.000	MHz
Potencia de Radiación Isotrópica Equivalente	707.594	W
Ganancia del sistema	173.02	dB
Fiabilidad requerida	70.000	%
Señal recibida	-60.66	dBm
Señal recibida	207.41	µV
Margen de escucha	52.36	dB

Souce: Author - Radio Mobile

4) ICS TELECOM DESIGN OF COVERAGE

The design is based on coverage using ICS TELECOM software, based on the characteristics described above, a simulation coverage is performed to check the change theoretically based on the power supplied to the FM transition DRM +.

Coverage tests and results — detailed in comparison with FM system and DRM +. Thus he first auditioned with FM adding the same parameters with which it works now.

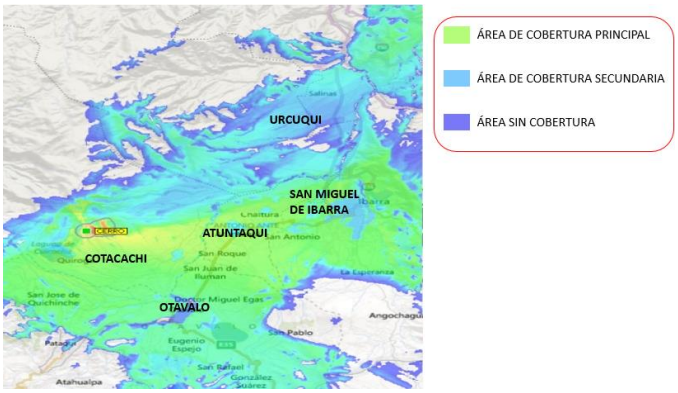

Fig.23: Prediction FM coverage

Source: ARCOTEL – Author

Using data obtained by ARCOTEL and the Department of Television and Radio Technical University North, changing the FM system it is performed by the DRM + standard as this according to the CONSORTIUM DRM (2013) can achieve the same coverage as FM causing a lower power costs are reduced electricity consumption.

The simulation process begins coverage by data entered the prediction process begins and the software performs the necessary calculations to show a representation of the sectors where they have coverage.

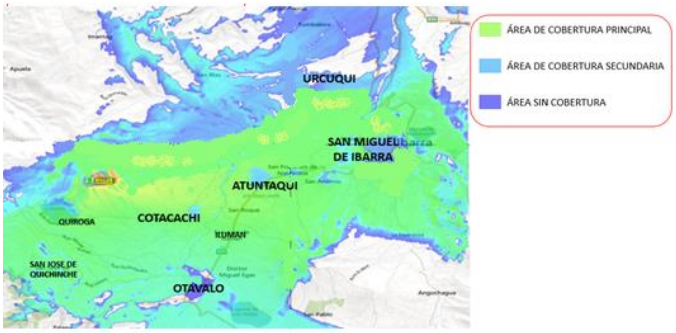

Fig. 24: Vision Coverage DRM

Source: ARCOTEL – Author

When comparing Figures 23 Figure 23 has a similar coverage despite the power emitted in FM (410W) is greater than the power emitted in DRM (100W), this shows that DRM achieves a lower power consumption and reaches similar to FM coverage.

5) COMPARISON CHART BETWEEN TESTING DRM + AND FM

Based on the previously demonstrated using data and software ICSTELECOM have the following comparative table with the characteristics or parameters that are relevant in the area of coverage shown.

Table 8.

Comparison Chart between DRM+ and FM standard

SISTEMA	FM	DRM+
Frecuencia de Trabajo	101.1 MHz	
Potencia Nominal	410 W	200 W
Potencia Pruebas Software	410 W	100 W
Cobertura Teórica	50 km teóricos	50 km teóricos
Cobertura Real	27.75 km	26.50 km
Ancho de banda	200 KHz	100 KHz
Uso del espectro	50% menos	75 % menos
Ganancia	5,37 dB	6.76 dB

Source: AUTHOR - Coverage Testing ICS TELECOM

IV. ESTIMATED COST OF EQUIPMENT AND BENEFITS.

Components for implementing — DRM digital radio are shown in the following table:

Table 9.

DRM+ equipment

Equipos DRM	MARCA
Servidor de Contenido	DIGIDIA
Transmisor	DIGIDIA
Modulador	DIGIDIA, HARRIS
Receptor	DIGIDIA, HARRIS, VARIOS

Source: DIGIDIA - Author

Teams working hybridizes way — with the digital system, you can be seen in the following table:

Table 10.
Microwave equipment

Enlace Microondas
Radioenlace microondas
Antenas direccionales con ganancia > 4dB

Source: DIGIDIA - Author

In summary, the costs associated far below.

Table 11.
Cost Summary scanning equipment

Equipos	COSTOS
Equipos DRM	215,000 dólares
Enlace Microondas	7,500 dólares
Equipos complementarios	9,000 dólares
TOTAL	231,500 dólares

Source: Author

DRM receptors — they are simple and easy to use with better audio quality and multimedia applications. The costs relate to DRM receptors differ depending on the manufacturer.

Table 121.
DRM receiver

Equipos	UNIDADES	COSTOS
Receptor Monitoreo	2	400 dólares
TOTAL		400 dólares

Fuente: Autor

V. REGULATORY ANALYSIS.

DRM + is considered as approved by ETSI in 2009 and its use of spectrum is in the range of 30 to 174 MHz standard. Several documents recovered from ARCOTEL now deemed to mention the regulatory aspects about the current regulation in Ecuador and fundamental parameters to add to DRM as a possible solution to scanning.

A) AGENCY AND CONTROL

ARCOTEL (2015) "... with administrative, technical, economic, financial and equity capital under the Ministry rector of Telecommunications and - under Article 41 the Telecommunications Act, the Agency for Regulation and Control Telecoms the society of the information…".

Article 18 of the third supplement Telecommunications Act talking about the use and exploitation of radio spectrum.

The radio spectrum is — "... A well in the public domain and a limited state, inalienable, imprescriptible and indefeasible ... resource."

Now regarding the use of this title issued by ARCOTEL to use it is required.

The Council Regulation of Communication — (CORDICOM) is responsible for approving the regulations for communications projects, the Communications Act requires for television, radio and subscription certain audiovisual systems.

B) CONSIDERATIONS FOR REGULATION OF DIGITAL BROADCASTING IN THE COUNTRY.

In the third supplement the organic law of communications — Article 106 states that "... the radio spectrum intended for operation of radio stations and broadcast television will be distributed equally into three parts, reserving 33% of these frequencies for the operation of public media, 33% for operation of private media, and 34% for the operation of private media ... ". This is done in order for state resources.

The transitional provisions — talk about migration to digitalization according to the Twenty- provision mentions "... the number of new frequencies and radio and television that are obtained from the transition from analogue to digital will be administered by the State ...". Whether mentioned that despite the switch from analog to digital, the state will be administering the assigned frequencies.

The DRM Consortium — founded in 1998 to promote the adoption of standards Digital Radio Mondiale worldwide, is a nonprofit organization with 100 members, including broadcasters, manufacturers, regulators and research institutes working together for the benefit of the broadcasting.

DRM is an open standard digital radio — for all frequency bands. It covers frequencies below 30 MHz, and bands long, medium and short wave (LW, MW and SW).

DRM+— It is for frequencies above 30 MHz, and the FM broadcast band.

C) PAYMENTS FOR GRANTING OF PUBLIC ENTERPRISES.

As mentioned in the ARCOTEL subscription RESOLUTION 2015 0824 Title respective Habilitante accordance with the provisions of Article 5 paragraph 6 of the Regulations for the Award of Titles Enabling be available; the effect being due to consider what is stated in Article 6 of that regulation and Article 60 of the Telecommunications Act, exempting payments delos fees allocation and utilization of frequencies to public media.

Article Three — He mentions that "Under the provisions of Article 60 of the Telecommunications Act, the public service broadcasting type, is not required to pay fees for allocation and use of frequencies."

VI. CONCLUSIONS

Saturation of radio spectrum in the country has led to important decisions in the field of broadcasting, ie it comes to finding new ways to counteract this problem but at the same time provide better services.

The transition from analog to digital technologies have led to the study of new systems of digital sound broadcasting such as IBOC, DAB and DRM, according to an analysis of its features is concluded that the DRM system is the one that mostly suits the needs also allows the coexistence of digital and analog equipment also watching from the economic point of view the implementation of these systems involves less investment for broadcasters.

One of the advantages of the DRM system is not subject to licensing, ie, is free and compatible with AM and FM systems. Power consumption is a big advantage in DRM systems over analog systems and thanks to ICS software TELECOM it was noted that using less power DRM can cover the same area with FM coverage.

Once the study concludes that the DRM system is the standard that better adapts to the needs of digital radio in Ecuador since during the transition period provides a robust signal that also operates in hybrid mode, ie, simultaneously transmits analog and digital signal does not require the immediate reorganization of the electromagnetic spectrum because it uses gaps currently used for analog stations, and finally have free access to technical standards, and thanks to that all manufacturers have the ability to design and manufacture equipment for this technology.

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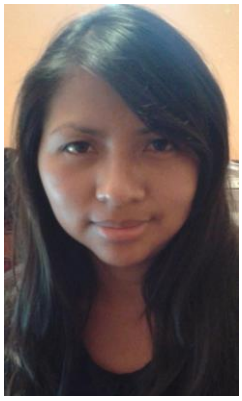

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