# NORTH TECHNICAL UNIVERSITY



# ENGINEERING FACULTY IN APPLIED SCIENCES

# ENGINEERING CAREERS IN ELECTRONICS AND COMMUNICATION NETWORKS

# SCIENTIFIC ARTICLE

**THEME:**

**"FEASIBILITY STUDY OF A NODE-B (3.5G) TECHNOLOGY IN THE LA MERCED DE BUENOS AIRES COMMUNITY, CANTON SAN MIGUEL DE URCUQUÍ" FOR THE NATIONAL TELECOMMUNICATIONS CORPORATION (CNT EP)"**

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# FEASIBILITY STUDY OF A NODE-B (3.5G) TECHNOLOGY IN THE LA MERCED DE BUENOS AIRES COMMUNITY, CANTON SAN MIGUEL DE URCUQUÍ" FOR THE NATIONAL TELECOMMUNICATIONS CORPORATION (CNT EP)

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*Summary*—**This project entails the feasibility study of a Node-B (3.5G) technology in the "La Merced de Buenos Aires" community, Canton "San Miguel de Urcuquí" for the National Telecommunications Corporation (CNT EP), with the purpose of providing cellular mobile telephone coverage.**

**The Project in if it consists of three parts, the introduction to the Project, where describes as it will be developed the same, the second part refers to the studio theoretical of the technology HSDPA: operation architecture equipment and forms to implement, and in the third part states all the concerning the design of the basic station: obtaining data, all the necessary calculations, proofs of the link point ready with the new basic station and the economic analysis of the Project.**

*INDEX OF TERMS*—HSDPA,

## I. INTRODUCIÓN

En the actuality the services of telecommunications are indispensable for the economic and social development of the different communities so much urban like rural, by what posed the feasibility study of a Node-B (3.5G) technology in the "La Merced de Buenos Aires" community, Canton "San Miguel de Urcuquí" province Imbabura.

The HSDPA technology is born with the end to satisfy the requirements of the users regarding services and applications, since of agreement to the number of inhabitants and his low tax of growth is the appropriate for the use of cellular telephony, taking in account that has total compatibility with technologies ancestors and back: 3G (UMTS) and 4G (LTE) respectively.

The present project is centered in the design of a basic station of technology HSDPA, making the necessary calculations for a link point ready between the new station and the station Pablo Arenas, doing use of two software PathLoss and Irradiate Mobile that allowed to verify the feasibility of the link for a possible implementation of the project.

## II. TECHNOLOGY HSDPA (HIGH SPEED DOWNLINK PACKET ACCESS)

HSDPA Is the evolution of the cellular technology 3G UMTS1, used in the majority of cities, providing a greater speed of data downlink, what does that the majority of mobile users use the cellular technology for different activities in internet eat; the use of emails, applications of video call and a without number of applications that use in the actuality. It is compatible in his whole with WCDMA2 what does that providers and users of UMTS can do use and give support to all the referred of HSDPA. An important characteristic is that HSDPA is considered like a stage before the evolution to 4G that it is the homologation of all the networks in a future.

### A. Historical review of the mobile technology

In our day in day out always listen that 3G or 4G but in reality of what treats?, where they are the 2G or 1G? To continuation a brief history of these technologies that have evolved of transparent form for the users.

*First Generation 1G*

It was entered in the years 70, based in a group of cells interconnected, by what from the start these equipment were called cellular. His systems of transmission were analogous and his mobile equipment very big and weighed in comparison with the current.

*Second Generation 2G*

To the start of the years 90´ deploys the technology GSM3 and enter the new cellular 2G. This new mobile technology already uses a system of digital modulation which improves notably the quality of voice, but the services that offers still are limited.

1 **UMTS:** Universal Mobile Telecommunications System.
2 **WCDMA:** Wideband Code Division Multiple Access (Multiple access by division of broadband code).
3 **GSM:** Global System for Mobile communications (global System for the mobile communications).

*Third Generation 3G*

It is the start of the mobile internet that for the first time allowed to the users the use of applications of video, audio and images, all this from an improvement in the power of the antennas arriving to a cup of transmission of until 2Mbps, with this cup of transmission can see videos in real time, of some form limited by the capacity of the network to which connects the mobile equipment.

*Intermediate generation 3.5G and 3.75G*

This is an intermediate generation where obtains the technology HSPA4, is the group of two technologies HSDPA (3.5G) and HSUPA5 (3.75G), considers like the previous step to technologies 4G. It offers taxes of until 42 Mbps in link of descent and 22 Mbps in links of rise, this wants to say that in HSPA can execute any type of application and download archives of big size in little time, for example an archive of 20 MB in HSPA can download in so alone 8 seconds, whereas with UMTS, can delay until 30 minutes.

*Fourth Generation 4G*

It is a technology of new generation based only in the protocol IP like the convergence of networks wired and wireless that is to say is a network of networks, with the capacity to transmit to speeds of access to 100Mbps in movement and of 1G in rest without losing the quality of the service in any instant. All this with the greater possible security and to a relatively low cost.
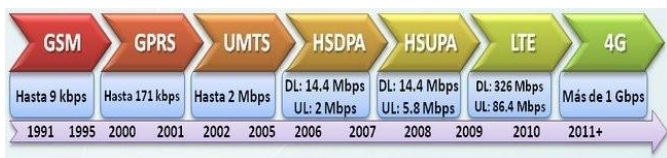


Figure 1: Line of evolution of the mobile technologies
Source: LTE-Advanced, all what need to know on the authentic Fourth Generation of the mobile Internet. Published on 17 September 2014. Recovered on 22 April 2015 of http://www.xatakamovil.com/conectividad/lte-advanced-todo-lo-que-necesitas-saber-sobre-la-autentica-cuarta-generacion-de-la-internet-movil

*B. Basic elements of a network of mobile telephony*

*Central Mobil Commutation (MSC)*

The Central Mobile Commutation is where finds the cerebral part of the network, this contains a system of commutation cellular and a central processor. A MSC can connect to several basic stations (RBS). The Central Mobile Commutation connects regularly to the Public Telephone Network Commutated (PSTN).

*Station Irradiate Base (RBS)*

The basic station or also known like Node B, contains the different equipment of transmission and reception, feeding of

4 **HSPA:** High Speed Packet Access
5 **HSUPA:** High-Speed Uplink Packet Access (ascending

voltage, antennas and systems of air conditioned. A RBS communicates only with an alone central Mobile Commutation, anyway commissions to cater the interfaces between the mobile station and the MSC.

*Mobile station (MS)*

It is user equipment mobile also knows it to him like EU (Equipment of User). His main function is to direct the signals to the half physicist to the moment to board a communication. It is composed by a transceiver, the unit of control and an antenna.

*Interface of Air*

It is the link of radius between the EU and the Node B for his simultaneous communication.

*Cell*

The cell is the geographic area of coverage of a basic station, can have several forms, in mobile telephony considers of hexagonal form.
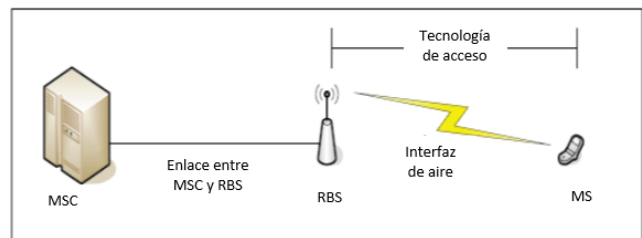


Figure 2: Elements of a network of mobile telephony
Source: COMPARATIVE ANALYSIS OF THE BROADBAND WIRELESS TECHNOLOGIES FOR ACCESS To INTERNET, HSPA (HIGH SPEED PACKET ACCESS) And WiMAX (802.16and-2005), Ortiz Diego, p. 20.
Edited by: Víctor Pozo

*C. Architecture HSDPA*

The main characteristic of HSDPA, is to retain the correct operation of the version 99, divided between layers and nodes the most possible that can . The minimization in the changes of architecture is desirable, and simplifies the migration to HSDPA, in networks UMTS already installed and also allows safe operations in environments where no all the cells have been updated to the functionalities of HSDPA (MORILLO, 2010, pág. 54).

In HSDPA enters a new sub-layer MAC in the node B designated; MAChs, that is the manager of the programming and the control of speed, also makes operations of the protocol H-ARQ, to reduce the time of transmission regarding the version 99. By what considers that not only is necessary to make improvements in the RNC (Radius Network Control) but the main part where affects the inclusion of this new technology is in the Node B or also designated BTS (Basic station)

Access of packages to high speed)

The basic architecture of the network HSDPA consists in three subsystems:
- User Equipment (EU),
- Universal Terrestrial Irradiate Access Network (UTRAN) and
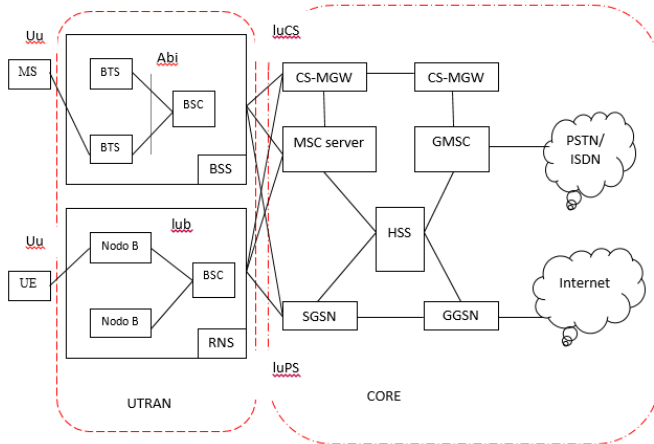- Core Network (CN)



Figure 3: Architecture HSDPA
Source: COMPARATIVE ANALYSIS OF THE BROADBAND WIRELESS TECHNOLOGIES FOR ACCESS To INTERNET, HSPA (HIGH SPEED PACKET ACCESS) And WiMAX (802.16and-2005), Ortiz Diego. Edited by Víctor Pozo

## D. CONSIDERATIONS FOR THE DESIGN OF A RADIUS LINK POINT Ready MAT

### FACTOR OF CURVATURE OF THE EARTH (FACTOR K)

To understand about the factor of curvature of the earth considers two paths curves, one that relates with the curvature of the earth and the second to the stratification of the troposphere. If it understands that the temperature and the humidity that exists on the atmosphere, go down his values in proportion to the height on the level of the sea, affects to the reflection of the electromagnetic waves in a big percentage, by what the pattern of propagation refract in the atmosphere.
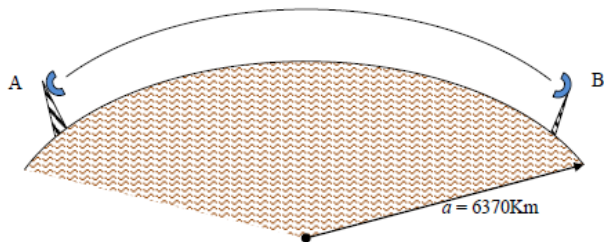


Figure 5: Pattern of terrestrial propagation

Source: (LAZCANO, 2009)

The value of K in normal atmospheric conditions, can vary of agreement to the region. If they consider high and dry regions the variation comes from 1, 2 until 2 or 3 in humid coastal regions.

When K tends to an infinite value, represents that the earth is perfectly flat, due to the fact that his curvature is equal to the one of the earth.
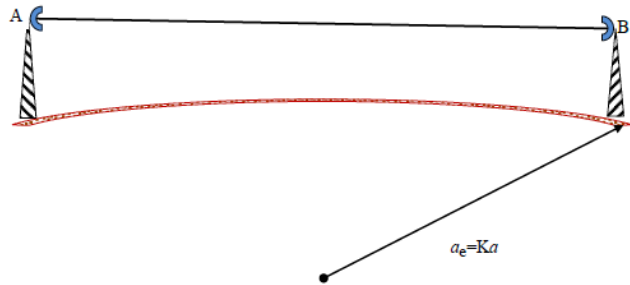


Figure 4: Factor of correction of the radius of the earth. So that the propagation was rectilinear

Source: (LAZCANO, 2009)

Another case have for the opposite form of curvature of the earth, this produces when the value K diminishes to less than 1. This effect produces anomalies of propagation, by what the distance could remain obstructed and would be very vulnerable to the fading caused by the effect of multiple distances.

In the table 1 can see the factor K varies of agreement to the region that belongs.

Table 1: Variations of the factor K of agreement to the region

| TYPE OF REGION | FACTOR K |
|---|---|
| In polar zones | 6/5 or 4/3 |
| In temperate zones | 4/3 |
| In tropical zones | 4/3 or 3/2 |
| In Mexico | 4/3 |

Elaborated by: Víctor Pozo

Source: (LAZCANO, 2009)

The value of the radius of the earth also affects in relation to the factor of curvature. To continuation detail the new values of the radius of the earth in the table2.

Table 2: Variation of the radius of the earth for the factor K

| FACTOR K | NEW RADIUS OF THE EARTH in Km |
|---|---|
| 2/3 | 4246 |

| 1 | 6370 |
|---|---|
| 6/5 | 7644 |
| 4/3 | 8493 |
| 3/2 | 9555 |

Elaborated by: Víctor Pozo

Source: (LAZCANO, 2009)

STROKE OF PROFILE OF THE TERRAIN

Before making the proofs of propagation of a link point ready, is necessary to trace the profile of the terrain between the two places that chose for the radio link, including all the heights of the points and of the obstacles obtained of the geographic maps.



Figure 6: Example of profile of terrain elaborated in the software PathLoss

Elaborated by: Víctor Pozo

THE ZONES OF FRESNEL

It considers like zone of Fresnel to the volume that exists between the space of the transmitter and receptor of an electromagnetic wave, of such form that the gap between the waves do not surpass the 180º.

The formula of calculation of the zones of Fresnel is:

$$h_0 = \sqrt{\frac{\lambda d_1 d_2}{D}}$$

Where:

$h_0$= radius of the enésima zone of Fresnel in metres (n=1, 2, 3...).

$d_1$ = distance from the transmitter to the object in metres.

$d_2$ = distance from the object to the receptor in meters.
$\lambda$ = Wavelength of the signal transmitted in meters.
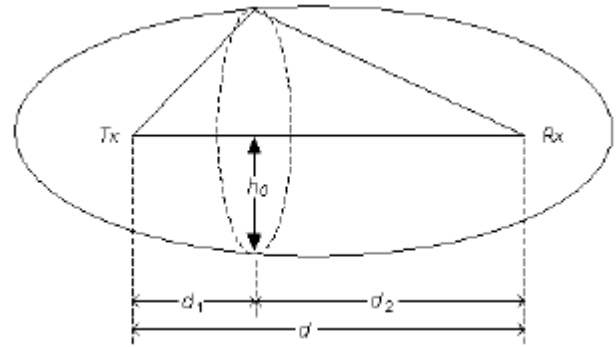D= total distance of the distance.



Figure 7: Ellipsoid of Fresnel

Source: (LAZCANO, 2009)

MARGIN OF CLEAR OF THE OBSTACLE ($h_c$)

Another appearance to consider to the moment to make a radius link, is the place where finds the obstacle and see if it is feasible or no the link.

The equation that defines the margin of clear on an obstacle is the following:

$$h_c = h_1 - \frac{d_1}{D}(h_1 - h_2) - \frac{d_1 d_2}{2\,Ka} - h_s = [metres]$$

Where:
$h_1$=height of the transmitter
$h_2$ =height of the receptor
$h_s$= Height of an obstacle
$d_1$= distance of the distance to the obstacle (Km)
$d_2$ =is the distance of the distance to the obstacle (Km)
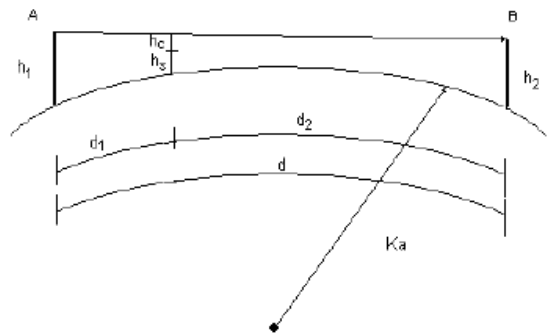D= is the total distance of the distance (Km)



Figure 8: Margin of clear $h_c$

Source: (LAZCANO, 2009)

HEIGHT OF THE ANTENNA

Afterwards to calculate the first zone of Fresnel, is necessary to propose the height of the antenna in the first place.

With the height of the first place proposed, proceeds to the calculation of the height of the second place, through the following equation.

$$h_2 \geq \frac{D}{d_1}(h_0 + h_s) - \frac{d_2}{d_1}(h_1) + \frac{Dd_2}{2\,Ka} \qquad (1)$$
$$= [metres]$$

$h_0$= radius of the first zone of Fresnel
$h_1$= height proposed for the first place
$d_1$= is the distance of the distance to the obstacle (Km)
$d_2$= is the distance of the distance to the obstacle (Km)
D=is the total distance of the distance (Km)
$h_s$= Is the height of obstacle
Ka = equivalent To (4/3) (6.37x10  6 m)

LOSSES IN THE FREE SPACE

To the moment to make a radio link is necessary to know that, the electromagnetic waves are affected by the Earth and the atmosphere that surrounds the wave. In the case of a link point ready has to take into account, the low portion of the no ionized atmosphere, that finds under the 20 Km (Troposphere).

$$L = 32.46 + 20\log(f_{MHz}) + 20\log(d_{Km})$$

Losses of transmission by diffraction because of the acute edge

It calculates  by means of the equation:
$$Pérdidas\ Of\ Tx\ by\ difracciorn\ (dB)$$
$$= 16 + 20\log(\frac{h_c}{h_0})$$

Considering $\frac{h_c}{h_0} \geq 3$

GAIN OF THE ANTENNA

In a managerial antenna, the managerial antenna focuses  to a specific direction more than in others. The antenna is a passive device, so the power of total exit cannot be greater than the one of entrance. It considers that the antenna has greater gain in his direction or directions of maximum radiation, when it compares with a source isotropic (LAZCANO, 2009, pág. 40).

The gain of a parabolic antenna defines:

$$G = 10\log\left[\eta\left(\frac{\pi D}{\lambda}\right)^2\right] = dB$$

Where:
D= diameter of the antenna in meters
λ= Wavelength in meters
$\eta$= Efficiency of the antenna

Power Isotropic Effective Irradiated (PIRE)

The PIRE refers to the quantity of power that will issue an antenna isotropic to the receptor. The PIRE takes into account the gain of the antenna and the losses in   the line of transmission, expresses  in decibels.

It is defined by the following expression:

$$PIRE = P_{Tx} - L_c + G_{to}$$

Where:
$P_{Tx}$= Improves of transmission
$L_c$= losses in  the line of transmission
$G_{to}$= gain of the antenna

Angle Azimuth

The angle of azimuth, is the angle that measures from the north in sense of the hands of the clock. His value varies from 0º until 360º, by what can situate  in the four quadrants, that define  from the north rightwards.
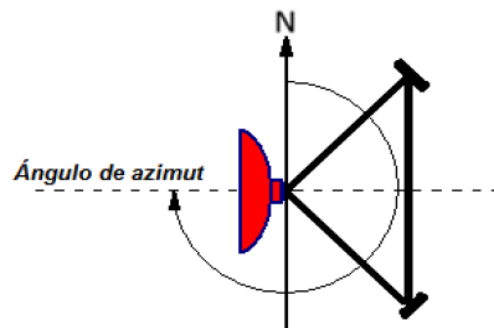


Figure 9: Angle azimuth 270 degrees

Source: (LAZCANO, 2009)

Margin of Thermal Fading (TFM)

For the calculation of the margin of fading, uses all the values of losses between the signal sent (NRSD) and the threshold of reception of the equipment of radio (T), this indicates the level of power that reduces in the receptor, considering a limit of tax of error required. It expresses with the following formula:

$$TFM = NRSD\text{-}T$$

Hydrometeors

The hydrometeors are meteors formed by small aqueous particles, liquid and solid suspended in the atmosphere and that hamper notably the vision. Between the main find ; the rain, the snow, the hail, hoarfrost and fog.

RELATION SIGNAL To NOISE (S/N)

The relation signal to noise defines eat; the relation that exists between the power of the signal wished with the power of the noise in a specific point for some specific conditions.

Relation of the power of the signal wished to the power of noise in a specific point and for some specific conditions in a point given.

$$\frac{S}{N}(dB) = 10log\frac{P_s}{P_N} \qquad (2)$$

Where:
$P_s$= Improves of the signal.
$P_N$= Improves of the noise

2.1 PROPAGATION OKUMURA-HATA MODEL

It is a model of propagation for systems of mobile communication, where present additional losses by terrestrial obstacles. It is based in the concept of expansion ahead of spherical wave, by what the signal irradiates from a punctual source in the space.

It is given by the following formula:

$$L_b = 46,3 + 33,9logf - 13,82logh_t - \qquad (25)$$
$$to(\quad_{h\,m}) + (44,9 - 6,55logh_t)logd$$

Where:
$L_b$: Loss of the link
f: Frequency between 1500 and 2000 MHz
$h_t$: Height of the basic station
$h_m$: Height of the telephone receptor
d: Distance of the link

## III. STUDY OF FEASIBILITY OF THE DESIGN OF THE STATION BUENOS AIRES OF TECHNOLOGY 3.5G (HIGH SPEED DOWNLINK PACKET ACCESS)

The Merced de Buenos Aires, finds situated in the canton San Miguel of Urcuquí to the north west of the city of Ibarra, to 120 km, by the route Ibarra-Saint Lorenzo. Has 1.893 inhabitants representing 12,65% of the population according to the statistical data of the census made in the year 2010 by part of the INEC, with a surface of 766.083 km2. His topography finds between the 800 to 4400 msnm, and has a variety of climates that vary from temperate subtropical until the cold of the moors.



Figure 10: The Merced de Buenos Aires Map

Source: Municipal Government of Urcuquí. Recovered to 22 May 2015 of:
http://www.municipiourcuqui.gob.ec/munurcuqui/index.php/2014-08-15-16-40-26/ubicacion-geografica.

Edited by: Víctor Pozo

*A. CALCULATION MICROWAVES LINK BETWEEN THE BASIC STATION PABLO ARENAS And THE REPEATER BUENOS AIRES*

*Calculations to make*

The calculations to realizer by the two stretches of the link, are the following.

1. Terrain profile
2. The first Fresnel zone
3. Antennas height
4. Obstacle attenuation
5. Losses in the free space
6. Losses in transmission line and connectors
7. Calculation the reception power
8. Unavailability of the system
9. Fading margin
10. Voltage received
11. Elevation angle
12. Azimuth

13. Calculation Isotropically Irradiated power Equivalent

Then has the table with the summary of the calculations made.

Table3: Summary of data of the link Pablo Arenas Buenos Aires

| Variables | Pablo Arenas-Quillopamba | Quillopamba-Buenos Aires |
|---|---|---|
| Pperation Frequency | fTx= 14500 MHz fRx=14528 MHz | fTx= 15000 MHz fRx=15028 MHz |
| The first Fresnel zone | $h_0$= 3,088 m | $h_0$= 4,564 m |
| Antennas height | $h_1$= 2354,3 masl $h_2$= 3868 masl. | $h_1$= 3838 masl $h_2$= 2629 masl. |
| Obstacle attenuation | $L_D(v) = -0,25\ dB$ | $L_D(v) = -0,25\ dB$ |
| Losses in the free space | $L = 316,42\ dB$ | $L = 315,04\ dB$ |
| Losses in lines of transmission and connectors | $L_{lTx} = 5,5\ dB$ | $L_{lTx} = 2,5\ dB$ |
| Reception power | Pr=-125,67 dBm | Pr=-122,15 dBm |
| Indisponibilidad Of the system | 528 minutes to the year | 528 minutes to the year |
| Fading Margin | $MD = -33,22\ dB$ | $MD = -35,73dB$ |
| Voltage received | $V_{Rx} = 0,053\ v$ | $V_{Rx} = 0,054\ v$ |
| Angle of elevation | $\alpha = 7,98°$ | $\alpha = 7,63°$ |
| Azimuth | Pablo Arenas= 302,64° Quillopamba= 122,64° | Quillopamba= 336,60° Buenos Aires= 156,60° |
| Calculation Isotropically Irradiated power Equivalent | $PIRE = 105,5\ dBm$ | $PIRE = 108,5\ dBm$ |

Elaborated by: Víctor Pozo

## B. EQUIPMENT And ACCESSORIES To USE IN THE LINK PABLO ARENAS BUENOS AIRES.

To describe the equipment to use, first make a diagram of how are distributed the equipment.
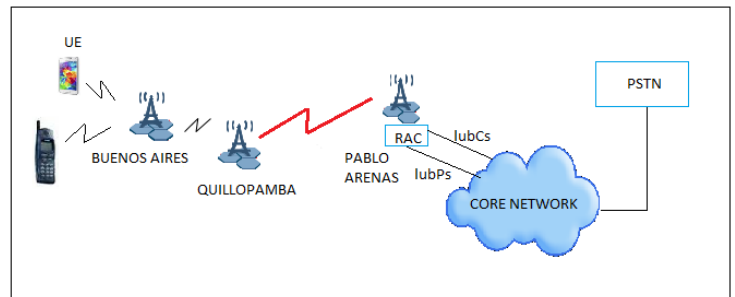


Figure 11: Distribution diagrams equipment

Elaborated by: Víctor Pozo

## DETERMINATION OF EQUIPMENT REQUIRED FOR THE INSTALLATION OF THE BASIC STATION

In a basic station, has the following necessary elements for his operation:

1. Board of energy.
2. Put to earth.
3. Equipment of Basic Radio for outside or inner.
4. Antenna microwaves.
5. Cellular tower
6. Sectorial antennas.

### a)  Board of energy

The board of energy, supplies energy of 220V in alternating current to all the equipment of the BTS. Also it has the function of illumination of the BTS and caters the light of balizaje that situates in the highest part of the tower.

Figure11: Board of energy

Source: The Blog of the Mobile Communications

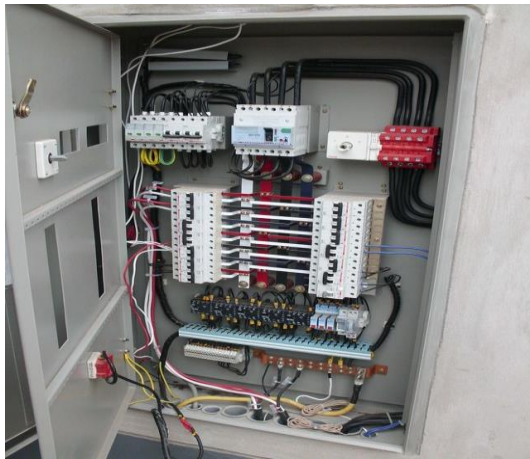. Recovered on 07 December of the 2015 of http://blogcomunicacionesmoviles.blogspot.com/2011/07/esta cion-base-cellular-ebc.html

b)      *Element of put to earth*

Of agreement to the recommendations of the ITU-T K27 (Configurations of electrical continuity and put to earth inside the buildings of telecommunications) and of the IUT-T K56 (Protection of the stations of base electric radio against the ray), specify that the type of put to earth to use in a basic station is the one of electrode of multiple wands (see figure 56).
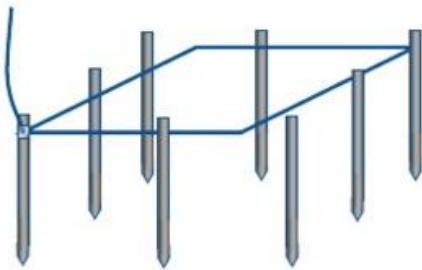


Figure 12: Multiple wands electrode

Source: http://image.slidesharecdn.com/presentaciondemedicionderesi stenciadetierra-120503120437-phpapp01/95/medicion-de-resistencia-de-tierra-3-728.jpg?cb=1336046803

c)      *Equipment of basic radio*

The equipment of basic radio are the most important element of a BTS, in these equipment is where generate the signals of radius frequency that visit by the feeders and  trasmiten by the antennas to the space.

It praise equipment of basic radio have  a bank of batteries, in case of absence or fails of electrical energy can supply a feeding of two to six hours.

Of agreement to his location classify in equipment of Indoor or Outdoor, when the equipment install inside a room or when the equipment install in the external part.



Figure 13: Basic radio equipment

Source: (UTRERAS, 2014, pág. 94)

d)      *Antenna microwaves*

It is the half of transmission that uses for the link between the BTS with line of sight, transmit voice and data through radiofrequency with wavelengths. In the figure 59, shows an example of an antenna microwave.



Figure 1: Antenna microwaves

Recovered on 07 December of the 2015  of https://www.google.com.ec/url?sa=i&rct=j&q=&esrc=s&sour ce=images&cd=&cad=rja&uact=8&see=0ahUKEwjYvd7Thc vJAhVMXh4KHXFVBuIQjRwIBw&url=http%3To%2F%2f www.ensenadamexico.net%2Fhector%2Fit%2Freporte_anten nas.php&psig=AFQjCNG5_EH66wMOR_mKu5imhyD0EiiI4 w&ust=1449622066095086

e)      *Cellular tower*

The cellular coverage depends on the height of the tower, since this allows us obtain a line of sight of the link microwaves. In the figure 60, shows an example of cellular tower of triangular form.



*Figure14: Cellular Tower*

*Recovered on 07 December of the 2015  of*
http://4.bp.blogspot.com/_oc8eeekx9cg/tmxrddox63i/aaaaaaaa aa4/tuxx4gqexge/s1600/imagen9.jpg

### f)        Sectorial antennas

The sectorial antennas are those that energy irradiate from the  BBU. They are of type signpost of form lengthened, and like his name indicates it the type of radiation is of sectorial type.

They exist antennas of only band (Single Band) and of double band (Dual Band). In both cases to obtain a better quality of signal use a method of diversity of space, due to the fact that in his internal structure are composed of an arrangement of dipoles.



Figure15: sectorial Antennas

Recovered on 07 December of the 2015  of

http://www.mibqyyo.com/articulos/wp-content/uploads/sites/4/2014/06/array-ubiquiti.jpg

### C.  ECONOMIC ANALYSIS

For the economic analysis is necessary to estimate the budget of implementation of a basic station like the equipment of transmission microwaves for the link. For this has  the offers of againsttación in the ecuadorian market.

Table 4: Costs of equipment offered by Huawei and by the portal of public shopping.

| EQUIPMENT | MARK | MODEL | TOTAL PRICE (USD) |
|---|---|---|---|
| Basic station | Huawei | DBS 3900 | 145181,00 |
| Humper BSC | Huawei | Huper BSC6680 | 50104,00 |
| Rack Of WM | Huawei | APM200 | 2619,62 |
| The subscriber terminal | Huawei | indoor / outdor BM632 | 348,14 |
| Preventive maintenance | | | 0 |
| Equipment of energy DC | | | |
| Rectificadores | EMERSON | PS48600 | 6646,15 |
| Batteries Bank | COSLIGHT | 6GFMZ | 2688,64 |
| Spares | | | 20219,07 |

| | | | |
|---|---|---|---|
| Licenciamientos | | | 481000,0 |
| For Cabinets | | | 18902,70 |
| Expansions | | | 9250,00 |
| System of Management | Huawei | M200 And AP Manager | 271797,91 |
| Software | Huawei | | 50000,00 |
| Stations Controller | Huawei | WASN9770 | 181863,66 |
| Others | Server AAA | | 190249,00 |
| | Server DNS and DHCP | | 64.472,00 |
| Subtotal | | | 1495341,89 |
| Incidentals 10% | | | 149534,189 |
| TOTAL | | | 1644876,08 |

Source: it
Report_Total_of_Processes_2014_final_Transparency.
Recovered of:
https://www.compraspublicas.gob.ec/procesocontratacion/compras/pc/informacionprocesocontratacion2.cpe?idsolicompra=z-rsvhfqrfbq7bqq4nnsvqoncapu4_8uxrbuwzle8fa

The total costs of implementation obtain of the union of the equipment costs and the costs of engineering.

In the table 40, makes a summary of the equipment and of engineering costs.

Table 5: Costs of Implementation

| DESCRIPTION | COSTS |
|---|---|
| Equipment costs | 40420,00 |
| Engineering costs | 1644876,08 |
| TOTAL | 1685296,08 |

Source: Víctor Pozo

Flow of box

To obtain the flow of box base us in the plans telephony tariff and data that has CNT EP.

In the table, shows the plan of reference to use for the realization of the flow of box in the next 10 years.

Table 6: Plans of reference for flow of box.

| PLAN | MONTHLY COST (USD) | ANNUAL COST (USD) |
|---|---|---|
| 2000 MB | 25,75 | 309 |

Source:
https://www.cnt.gob.ec/movil/plan/planes_datos_voz_lte/

Of agreement to the survey obtained a number of 1048 possible customer of telephony and mobile internet, east is our starting point to make the indicators of profitability of the project, taking into account a growth of 2% to the year according to the calculation of the future demand.

Table 7: Flow of box to 10 years

| NUMBER OF YEARS | USERS | MONTHLY ENTRY (USD) | ENTRY ToNUAL (USD) | SUM |
|---|---|---|---|---|
| 1 | 1048 | 26986 | 323832 | 323832 |
| 2 | 1069 | 27526,75 | 330321 | 654153 |
| 3 | 1090 | 28067,5 | 336810 | 990963 |
| 4 | 1111 | 28608.25 | 343299 | 1334262 |
| 5 | 1133 | 29174,75 | 350097 | 1684359 |
| 6 | 1155 | 29741.25 | 356895 | 2041254 |
| 7 | 1178 | 30333.5 | 364002 | 2405256 |
| 8 | 1201 | 30925.75 | 371109 | 2776365 |
| 9 | 1225 | 31543.75 | 378525 | 3154890 |
| 10 | 1249 | 32161.75 | 385941 | 3540831 |

Source: Víctor Pozo

INDICATORS OF PROFITABILITY

CNT EP. When being a public company bill to his users, by what is necessary to make an analysis of profitability with ends of lucre. For this uses the following indicators:

Net current value (GO)
Internal tax of return (TIR)
Relation benefit cost (B/C)
Period of recovery of the investment (PRI)

Net current value (GO)

The project is profitable = GO positive, when it has a go the same to zero is indifferent to accept or no the project.

But if the GO is lower to zero the project is not viable.

It defines by the following formula:

$$They\ GO = -I_0 + \sum_{n=1}^{m} \frac{F_n}{(1-i)^n}$$

Where:
I0= Initial Investment
Fn= Net flows
m= Number of periods considered
i= Prices of interest (9,33% valid in the market)

Replacing have:

$$They\ GO = -1685296 + \frac{323832}{(1-0,0933)^1} + \frac{330321}{(1-0,0933)^2}$$
$$+ \frac{336810}{(1-0,0933)^3} + \frac{343299}{(1-0,0933)^4}$$
$$+ \frac{350097}{(1-0,0933)^5} + \frac{356895}{(1-0,0933)^6}$$
$$+ \frac{364002}{(1-0,0933)^7} + \frac{371109}{(1-0,0933)^8}$$
$$+ \frac{378525}{(1-0,0933)^9} + \frac{385941}{(1-0,0933)^{10}}$$

They GO=4723762,244

The value of the GO is upper to zero, therefore the project is profitable.

Internal tax of return (TIR)

The internal tax of return, refers to the tax of performance used in the budget of capital to measure the profitability of the investments and if this value is greater that the tax of interest the project is viable.

It calculates by means of the following formula:

$$0 = -I_0 + \sum_{n=1}^{m} \frac{F_n}{(1-TIR)^n}$$

Where:
I0= Initial Investment
Fn= Net flows
m= Number of total periods
r= Prices intern of return
Replacing:

$$0 = -1685296 + \frac{323832}{(1-TIR)^1} + \frac{330321}{(1-TIR)^2} + \frac{336810}{(1-TIR)^3}$$
$$+ \frac{343299}{(1-TIR)^4} + \frac{350097}{(1-TIR)^5} + \frac{356895}{(1-TIR)^6}$$
$$+ \frac{3364002}{(1-TIR)^7} + \frac{371109}{(1-TIR)^8} + \frac{378525}{(1-TIR)^9}$$
$$+ \frac{385941}{(1-TIR)^{10}}$$

TIR= 15,83%

The value of the TIR is upper to the tax of interest in the market that is of 9, 33%, by what the project is viable.

Relation benefit cost (B/C)

This value allows us determine the profitability of the project in general terms. The result expresses the money won in each dollar that invests in the project.

It defines it the following formula:

$$\frac{B}{C} = \frac{\sum_1^n GO_n}{I_0}$$

Where:
They GO= net current Value
n= Length of the project in years
Io= Initial investment

Replacing:

$$\frac{B}{C} = \frac{4723762,244}{1685296} = 2,8\ usd$$

The relation cost benefit gives a value of 2,8, what wants to say that by each dollar invested obtains 2,8 dollars of gain to 10 years.

Period of recovery of the investment (PRI)

This period indicates the necessary time to recover the capital invested.

Between shorter was the most viable period is the project.

A form to calculate the PRI is to go accumulating the net flows until cover the investment.

Table 8: net Flows until covering the investment

| NUMBER OF YEARS | NET FLOWS (USD) | NET FLOWS ACCUMULATED |
|---|---|---|
| 1 | 323832 | 323832 |
| 2 | 330321 | 654153 |
| 3 | 336810 | 990963 |
| 4 | 343299 | 1334262 |
| 5 | 350097 | 1684359 |

| | | |
|---|---|---|
| 6 | 356895 | 2041254 |
| 7 | 364002 | 2405256 |
| 8 | 371109 | 2776365 |
| 9 | 378525 | 3154890 |
| 10 | 385941 | 3540831 |

Source: Víctor Pozo

Doing a comparative between the initial value of investment of 1685296,08 and the net flow accumulated in the fifth year of 1684359, are values almost equal, by what considers that the period of recovery of the information finds between the fifth and sixth year.

## IV. CONCLUSIONS

- The introduction of the present project allows to cover the expectations and requests of the users, regarding the services of telecommunications so much voice and data with a suitable bandwidth for these needs.

- It determined that the best place for the location of the new basic station is the mountain of Quillopamba, since has a line of sight without obstacles with the station Pablo Arenas, with a zone of Fresnel of 3 meters and power of reception of 23,4 dB, that allows to access to the network of access of CNT EP and to his time with the zone populated of the Merced de Buenos Aires, where proposes a repeater of signal.

- It proposed use the basic station DBS 3900, due to the fact that the CNT EP has an agreement recognized with the company Huawei, and also by his characteristics of compatibility with previous technologies like UMTS and back like LTE, which is a very important appearance to the hour offer a service of greater efficiency.

- In base to the ITU-R, chose the band of frequency of 14,4-15,35 GHz, which allowed to obtain the data described in the table 32, that supported with the technical equipment parameters, determined the feasibility of the link point ready from the station Pablo Arenas until the repeater Buenos Aires by means of the simulation in the software Irradiate Mobile.

- It does not exist profitability in the short term, due to the fact that the growth in the parish is hardly of 2%, by what does a flow of box for ten years (see table 43) and determined that the initial investment recovers between the fifth and sixth year.

- Of agreement to the economic analysis of the project recommends the implementation of the same place that the indicators of profitability show his feasibility and like this fulfil with one of the aims of the National Plan of the Good Live.

## V. RECOMMENDATIONS

- It recommends that to the moment to make the design of a radius link, takes in account the best route and compatible equipment with previous and back technologies that allow to cover the necessary characteristics for the optimum operation of the link.

- With the concerning the catchment of information, recommends elaborate easy surveys to understand and that are not too long, with the aim to have a better interpretation of data.

- To the moment of the installation of the antennas recommends the correct configuration of physical parameters (TIL electrical and TIL mechanical), by what of this depends the area of coverage of the network.

- To the moment to determine the frequency of work for the different stretches of the link has to consider the distance between points and that adapt to the National Plan of Frequencies issued by the ARCOTEL (Agency of Regulation and Control of the Telecommunications).

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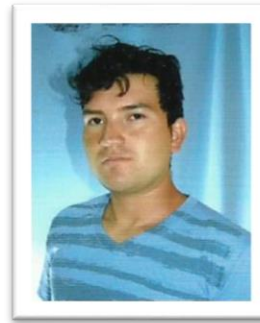
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