Design and Implementation of a Node B Guanguiltagua - Quito Request for Expansion by 3G / UMTS Network for CNT E.P.

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***Abstract*— This project has been carried out in order to provide better service and ensure mobile cellular coverage in the areas of Batan Batan Bajo and Alto in the north of Quito; through the Design and Implementation of a Node_B, allowing solve the low levels of cellular signal in these sectors.**

During the development of this project, the definition of 3G / UMTS network as well as its architecture and main services are analyzed; the drive RF test was performed to determine the current state of the low levels of cellular signal in the two aforementioned sectors, thus allowing select the physical space, building or structure in which the Node_B was implemented, same site prediction nominal performed with software design and management traffic map Genex U-net; turn the respective Node_B testing was performed under the requirements and needs in delivering the site to the cellular mobile operator.

I. INTRODUCTION

The company DI TELECOM conjunction with Huawei Technologies Co., Ltd to provide solutions in ICT, provide the CNT EP fulfilling its objectives are: to provide quality services to its customers and fill gaps in coverage that prevent cellular mobile access users; presented as a solution for expanding demand for 3G / UMTS network, which will provide service to areas or sectors which is limited cellular coverage, specifically in the areas of Batan Batan Alto and Bajo in the north of Quito.

The realization of this project will contribute in providing optimal communication services to its users and to optimize the use of radio spectrum. This proposal was presented to support the lack of coverage in the aforementioned sectors; this offer focuses on the design and implementation of a Node_B, which is oriented in the project for the expansion demand for 3G / UMTS CNT EP network, this proposal presents a great benefit because the equipment used in this type Node; provide great flexibility to adhere adjacent technologies such as LTE and 4G-enabling interoperability between users.

II. THEORETICAL FUNDAMENT

3G / UMTS technology brings important aspects such as: definition of 3G technology, evolution of mobile technology over standard 3GPP main aspects of UMTS services can provide UMTS spectrum used in this type of Node_B, architecture UMTS network, WCDMA modulation type, protocols and elements of the radio access network (UTRAN), equipment installation and introduction to the Node_B smart antennas used for this type of network.

A. Definition of the Third Generation (3G)

3G is a cellular technology that allows voice, video and data at high speeds and allows services like web browsing and video. In turn are third generation mobile systems under the name IMT-2000.

3G / UMTS mobile technology is wideband is fully standardized, ie, non-proprietary. It runs on a licensed spectrum and a general service delivery as well as absolute mobility. 3G networks offer greater capacity than GSM networks as they provide support with acceptable quality video.

3G technology manifests the next evolutionary leap in mobile systems which aims to make progress in relation to the first and second generation; on the other hand the 3G standard is strongly tied to the first standards 2G (GSM, GPRS, EDGE).

B. IMT-2000

The world standard for wireless networks Third Generation (3G) developed and approved by the ITU's IMT-2000. Defined as a set of interdependent recommendations is the framework for worldwide access and allows you to connect various terrestrial or satellite systems.

The objectives of IMT-2000 are:

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- ✓ Provide worldwide coverage enabling mobile units changing systems and networks.
- ✓ Using mobile terminals, with long-range capability and ability to access multimedia services.
- ✓ Increased compatibility of radio interfaces in order to operate in different environment or media such as cars, people moving and offices, thus allowing to use a common network.
- ✓ High speed data transmission, capable of supporting both circuit switched and packet and multimedia systems. The minimum specific capabilities are:
  - Vehicle Environment: 144kbps
  - pedestrian environment: 384 kbps
  - Environment inside office: 2.048 Mbps
  - Satellite Environment: 9.6 kbps
- ✓ spectral efficiency, flexibility in the use and cost reduction as a result of the use of new technologies.

C. *Evolution of 3G Standard*

While it is true that 3G technology is an enhancement to it later generations; It is also flexible in admitting superior technology as 4G LTE is, that through the standardization group 3GPP and 3GPP2, which indicate the evolutionary process of cellular mobile network as displayed in Figure 1.

1) 3GPP: The agent group standardization of UMTS technology. It was created in December 1998 with the main objective to develop technical specifications for third generation mobile networks from GSM existing system. SITA 3GPP mobile systems such as UMTS third generation; to promote the use of Radio Access Network UMTS (UTRAN) in the IMT-2000.

2) 3GPP2: It is the commission of the evolution of CDMA to the third generation in charge, technically CDMA aware that different radios share the mimas frequencies and may be active for a long time, since the capacity of the network does not directly limit the number of active radios.

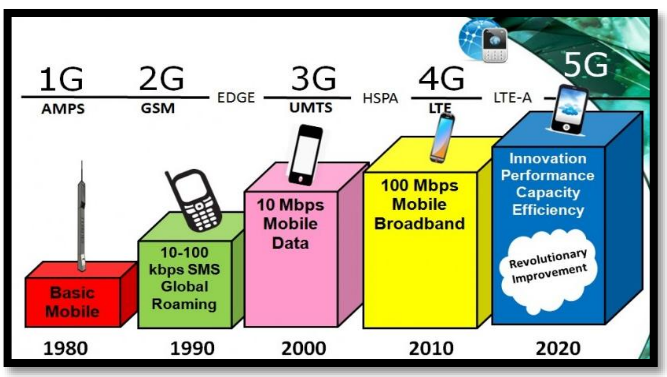

Fig. 1. Time diagram of the mobile technology evolution and what would future.

D. *Key features of UMTS*

UMTS is based directly on the Internet protocol IP telephony offers users high-quality transmit images, video communications as well as voice and data services.

Coverage is limited because it depends on the conditions in which the user is states that transmission speeds vary depending on mobility:

- ✓ Up to 10 km / h (users without mobility) = 2 Mbps.
- ✓ Over 100 km / h (limited mobility) = 384 Kbps
- ✓ From 500 km / h (fast mobility) = 144 Kbps

With these speeds there is compatibility with GPRS and EDGE networks in areas with UMTS coverage and capacity change cell to increase coverage and load alancing, through switching based largely on packages, therefore communications are less expensive. 3G networks offer greater security compared to the previous 2G technologies by allowing the EU to authenticate the network you are connecting to and there is integration of different services over a single connection.

E. *UMTS cell types*

Three types of cells UMTS picocells, microcells and macrocells, each with certain characteristics, such as shown in Figure 2.

1) Macrocells: provide cellular coverage in large open areas, between 1 and 40 km at a transmission speed of 114 kbps data.

2) Microcells: provide cellular coverage in urban areas and highways, a range of 50 to 1000 meters, with speeds of 384 kbps.

3) Picocells: Its use is in residential and indoor office environments, lower spokes 50 meters, with speeds of the order of 2 Mbps.

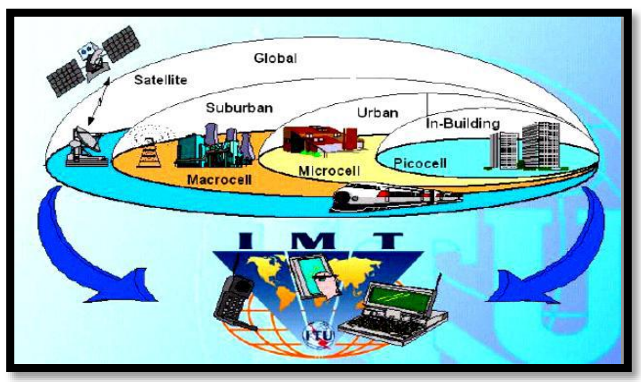

Fig. 2. Classification of cells for UMTS.

F. *UMTS Network Architecture*

The common core network uses the same network elements that GPRS and GSM, and related to a next generation network, 3G / UMTS network is made by a user equipment, access network and the core network. As it is shown in Figure 3.

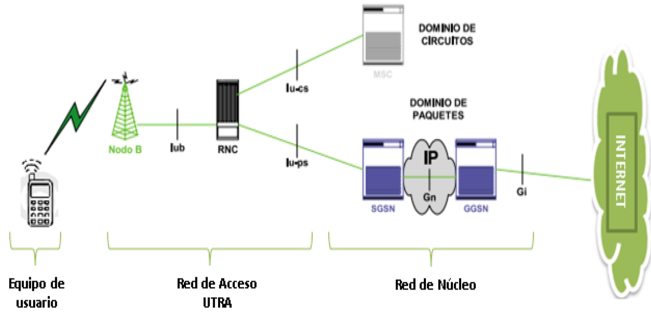

Fig. 3. Topology 3G-UMTS / HSDPA network.

1) User Equipment (UE): UE or device pho ne function is to establish the communication or n or n with Node_B, in areas where coverage; It can vary in shape and size ñ , or é n also must be adequate to support the est standardaccessories and protocols for which it was designed ñ ado. In this case, if a UE operates in is standardaccessories UMTS, must be competent to access network UTRAN trav é s of tech nol ogy WCDMA, enabling communication or n between devices m or vile, communication or n with ISDN, PSTN or GSM 2.5G systems such as, for voice and data services.

2) Radio access network UMTS (UTRAN): Set the connection or n between user equipment and network nu cleo, UTRAN is to consist of several elements, among them are the Node_B and the RNC, these elements allow control and access to voice services s u n and data requirements established by the Node_B and requested by the UE.

3) Node_B: The Node_B is equivalent to the station or UMTS n GSM Base Receiver Transmitter; the Node_B services a om to s cells, depending on the coverage area you want to achieve.

The functions performed by the Node_B are:

- ✓ The power control in closed loop Up Link.
- ✓ Report interference measurements in Up Link and n information or power in Down Link link.
- ✓ Transmission or information messages or system n according to the schedule determined by the RNC.
- ✓ Mapping resources or logical resources of Node_B in Hardware.

4) Control Radio Network (RNC): In the case of 3G-UMTS network, you have a single RNC that controls one or more Node_B. The RCN manages and controls information transmitted to or n é s trav Node_B to the Iub interface. In turn manages voice and data network commutated N u core, same link is made by the main interfaces Iu-cs and Iu-ps.

RNC functions are:

- ✓ Power control loop open for Link Up.
- ✓ Down power control Link.
- ✓ Management reports.
- ✓ Resource management transport the Iu interface.
- ✓ Or management information system and n times n or the information system.
- ✓ Management Tr Fico on common and shared channels.
- ✓ Modification or n the active group of cells (cell Change)

5) Core Network (CN): The network of nu cleo manages voice services and data, trav é s of the utilization or n two elements such as: commutation or n of circuits and commutation or n package.

6) Mobile Switching Center (MSC): The MSC is responsible for based processes or n commutation circuit (cs), same one used in GSM and UMTS systems. In turn, connects to the GSM network access and network UTRAN é s trav Iu-cs of the interface.

Its main functions are:

- ✓ Coordination or n or n the organization calls all m or vile in the jurisdiction or n of a MSC.
- ✓ Or n din allocation to resource mica
- ✓ Registration ubicaci ion.
- ✓ Functions interoperability with other networks.
- ✓ Management of change processes cell.
- ✓ Collect the data for the center BILLING or n.
- ✓ Management torque meters for encriptaci or n.
- ✓ SIGNAGE ñ exchange or n is between different interfaces.
- ✓ Management or n frequency assignment in the area to the MSC.

7) Support Node GPRS (SGSN) SGSN their function or n is characterized in mobility of the user equipment, in addition to s provide access to network m or vile data from the internet, in turn authenticates and assigns the best quality of service to each user equipment.

The SGSN performs packet switching based functions are:

- ✓ It contains the information or n or n user subscription.
- ✓ The information ubicaci or n or n and the REA in the m or vile is registered to.
- ✓ You keep the position or n stations m or vile in its REA.
- ✓ Or n retransmission of data between the terminal and the SGSN GPRS.

8) Support Node Gateway GPRS (GGSN): The GGSN is the gateway or central point of connection or n between the station or nm vile or with external networks that can be Internet or a corporate network, trav é s of n the commutation or package, having co mo main character í sticas are:

- ✓ Receive external data from the Internet and send them to the SGSN that controls the terminal trav network core using protocol GPRS nel.
- ✓ Receive data is ñ SIGNAGE or from the network n n u cleo and configure the operation or corresponding n.
- ✓ Performs control of t u nel data management IP addresses.
- ✓ The PICKUP ny or output files tarificaci or n.
- ✓ The security control, packet routing and n GESTI or quality of service**.**

9) Interfaces involved in the 3G / UMTS Network

UMTS interfaces in the system following the GSM / GPRS convention and are classified according to the roles they play in 3G / UMTS architecture.

a) Iub interface: This interface is located between the RNC to and Node_B in the UTRAN, to support voice and data services offered to users or subscribers UMTS.

b) Iu interface: This interface connects the nu cleo network with UTRAN, which is considered as a reference point and m to main s for 3GPP concept. The Iu interface can have two types of instances f í SICAS to connect to two different network elements of nu cleo, all depending on whether it refers to a network - based: commutation circuits or n or n or commutation of packages.

c) Interface Iu-cs: This interface is involved in the link between the UTRAN and the MSC, is u solely for commutation or n circuit, same that is used for trasmisi or n voice service to the user equipment.

d) Iu-ps interface: This interface is responsible for connecting the UTRAN with the SGSN, it is u solely for commutation or packet n, same that is used for trasmisi or n data service to the user equipment.

10) MAP interface: The interfaces between some elements of nu core network are called MAP interfaces and are used as protocols are ñ SIGNAGE ion, such as:

a) *Gn interface*: This interface is located between SGSN and GGSN, same interface is used to support mobility between SGSN and GGSN. In this interface protocol t u nel IP - based GPRS is used to carry user data and ñ SIGNAGE or n. It can have different configurations for channels f í musicians associated Gn interface such as Ethernet, ATM, and others.

b) *Gi interface:* This interface is to only present in the GGSN. It is the interface through which you access the external data networks and specification defined the following protocols: IPv4, IPv6 and X25.

G. Technical characteristics of the Media Access WCDMA

Within this WCDMA they are:

- ✓ Support high - rate data transmission or n: 384 Kbps with wide area coverage, and 2 Mbps with local coverage.
- ✓ High service flexibility: With support multiple parallel m u variable rate services on each connection or n.
- ✓ Built - in support for future capacity and enhanced coverage, as technology í as with adaptive antennas, advanced structures ny diversity reception or transmission or n.
- ✓ Efficient packet access and support FDD and TDD.

H. WCDMA specification

The chip rate may be extended to two or three times the standard 3.84 Mbps to accommodate speeds greater than 2 Mbps data. That is why detailed below in Table 1 the technical specifications of WCDMA.

Tab.1 Technical specifications of WCDMA

MÚLTIPLE ACCESS SCHEME	DS-CDMA
DUPLEXING SHEME	FDD/TDD
DUAL MODE ACCESS PACKAGE	Combined cannel dedicated
MULTI RATE SHEME RATE / VARIABLE	Spreading factor variable and expanded milti-code
CHIP RATE	3.84 Mbps
SPACED CARRIER	4.4 – 5.2 MHz (200 KHz portador)
FRAME LEGTH	4.4 – 5.2 MHz (200 KHz portador)
SINCRONIZACIÓN INTER BASE ESTACIÓN	FDD: No synchronization is required TDD: synchronization necessary

I. Return Loss (RL)

The return loss is a measure of the reflected energy of a transmitted signal and is expressed in dB, the higher the value, the better. Reflections occur due to mismatching of impedances in the connector, a defective condition of the cable, or a bad manufacturing misfuelling. It is also produced by power loss in the signal reflected by a discontinuity in the transmission line or fiber optic.

J. Voltage ratio reflected wave (VSWR)

In a transmission line is a parameter indicating the relationship between the maximum and minimum values of a reflected wave voltage pattern. The VSWR is a special value of the SWR, which is also known as ROE (SWR). The VSWR is a measurement of impedance mismatch between the transmission line and its load. The higher the VSWR, the greater the discrepancy. The minimum value of VSWR, is the condition that the impedances of the transmission line and the load are joined perfectly, is equal to 1.

The VSWR loss being reflected wave is analyzed as a measure of impedance mismatch between the transmitter and antenna, it is why if there is a higher VSWR is worse adaptation. By taking into account the losses in transmission lines is analyzed that the absence of reflected wave ($|\Gamma| = 0$), this means that there is a perfect match, resulting in a VSWR = 1.

III. ENGINEERING PROJECT

For the execution of the engineering project has been to follow a diagram, which shows each process involved in the development and completion of the project, as shown in Figure 4.

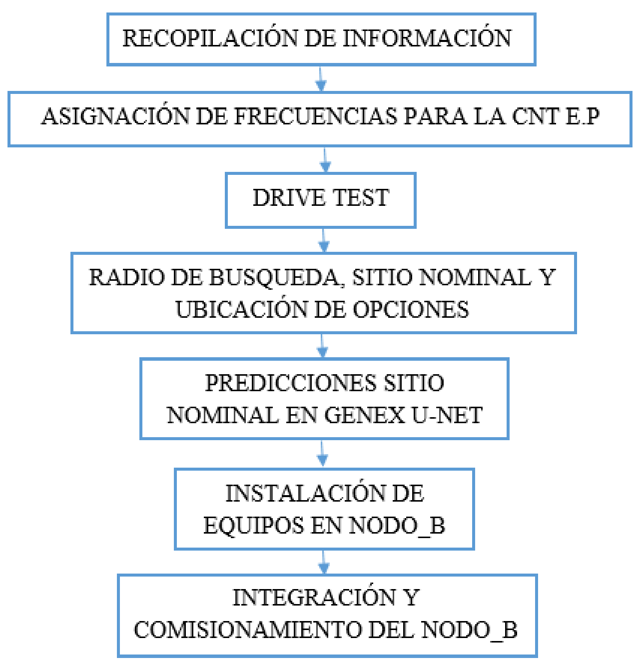

Fig. 4. Diagram forward for the Development of Engineering.

A. Allocation of frequency bands for the CNT EP

Taking into account that radio spectrum is a natural resource of the Ecuadorian government has formed a National Frequency Plan, which is responsible for organizing and distributing better the radio spectrum in order to provide greater benefit to users. According to the National Frequency Plan ARCOTEL it has been distributed to the operator CNT EP according to Table 2.

Tab. 2. Bandas de frecuencia para la CNT E.P.

Band (MHz)	Frecuency	
	Up Link (MHz)	**Down Link (MHz)**
1900	1890.0–1910.0	1970.0–1990.0
850	835.0–849.0	880.0–894.0

The frequency ranges that are allocated in the bands of 850 to 1900 MHz are divided into two bands: the frequency Down Link (DL) corresponding to the highest frequency, used to download data to the mobile device; and frequency Up Link (UL) that is less valuable and used on the mobile device for sending data to the base station. There fore the frequency to be used in the thesis project is with 1900MHz UMTS carrier.

By resolution ARCOTEL-2015-000100 October 2015, the allocation of the 1900MHz frequency band for cellular cooperators CNT EP and OTECEL SA According to resolution 738-26-CONATEL-TEL-2014 is maintained, remains the extension of the Rental Agreement Radio Spectrum under the same conditions authorized by CONATEL, as stipulated in the following articles:

"ARTICLE ONE.- In order to ensure continuity and quality in service delivery and based on the provisions of Resolution TEL-738-26-CONATEL-2014, extend the validity of Rental Agreements and Radio Spectrum National roaming signed between CNT EP. and OTECEL SA, with the same technical, economic and commercial agreed to the CNT EP and OTECEL SA on April 30, 2014, for a period of six months from the expiration of the period granted by CONATEL in the aforementioned resolution .

ARTICLE TWO.- The extension of the validity of the contracts may be terminated if there is an agreement or arrangement of National Roaming automatic in the case of National Roaming Agreement and when OTECEL SA stop using the spectrum that rents to the CNT EP if the lease of Radio Spectrum. In exercising their powers and competences, the Superintendency has made the monitoring and verification respective frequencies in blocking cc` (1905-1910 MHz and 1985-1990 MHz) for the purpose of determining the 1900 MHz Radio Bases OTECEL SA. who are making use of the leased to the CNT EP spectrum., determined that the operator OTECEL SA., at the national level has 270 base stations operating in the indicated bands, and therefore continues to use the spectrum that was leased to the CNT EP. "(ARCOTEL, 2015)

B. Drive Test de RF

Test Drive tests are performed in order to optimize coverage of the mobile network, and in this way to solve problems reported by customers due to cuts or drops calls made in a given area.

The elements involved in the drive test RF are displayed in Figure 5, which are:

1. Computer software useful to port sampling
2. Two 3G phones
3. Modem 3G
4. Scanner with:
   a. RF Antenna
   b. GPS

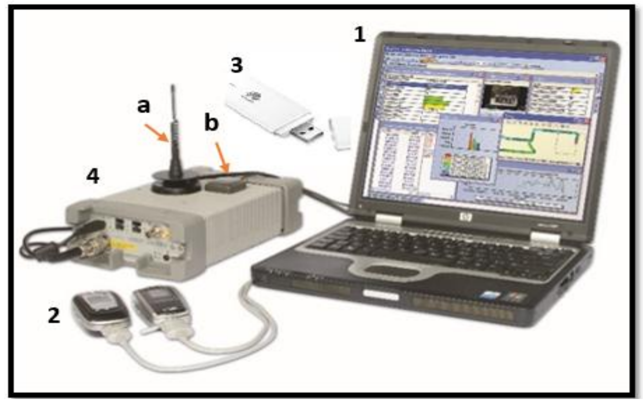

Figura 5. Elements for Drive Test RF

C. Location Area Analysis

The sectors of Batan Alto and Batan Bajo are located in the province of Pichincha, in the north of the city of Quito, as shown in Figure 6, the areas of Batan Alto and Batan Bajo not have the presence of any Node_B therefore a drive RF test is performed throughout the area to display clearly the current state of the network including the possible location of Node_B.

Fig. 6. Analysis of coverage in areas of high and low Batan Batan..

D. Road Test Test Drive RF

To set the coverage area of proposed Node_B Gualguiltahua the RF test drive, same as to determine the relevant routes, the same as is defined within the coverage area of proposed Node_B and its neighbors Node_B used. In Figure 7 routes shown to follow, considering for sector 1 North-South and South-North direction for the sector 2, through the appropriate channels to Sector 1 belonging to Batan Alto such as via Eloy Alfaro, Fernando Ayala, Portugal, José Queri, Thomas Bermont, Guangüiltahua, Granados, among others which covers a distance of 830m to the first strategic point corresponding to the Peugeot dealership and the corresponding ways to sector 2 belonging to Batan Bajo as: via Switzerland , Holland, Czechoslovakia, Portugal, El Universo, Pasaje the Sun, Gaspar de Villarroel, Republic of El Salvador, among others which covers a distance of 430m to the second strategic point corresponding to an Educational Unit; this distance of 430 m is less than the sector 1, due to the existence of a mountainous area.

Fig. 7. Road Drive Test RF.

E. Search Radio, Nominal Site and Location Options

To obtain the location of the site as a first step is taken into account using the Google Earth tool because it allows us to visualize geographically the sectors that will provide coverage, placing the most strategic points to cover hue cos coverage given in the sectors of Batan Alto and Batan Bajo in the north of Quito, along with the support of a team of people that make up the four important areas such as: Radio frequency or RF, Transmission, Civil Works , Energy and additionally negotiator which performs the necessary documentation for renting the physical space where the installation of equipment for the new Node_B be possible; taking into account the criterion RF is dominant in meeting coverage goals, which is to solve the low levels of cellular signal.

In Figure 8 you can see the OPC1 and OPC2, which were chosen by having an area or space available for installation of equipment, in addition to meeting the objectives of RF coverage.

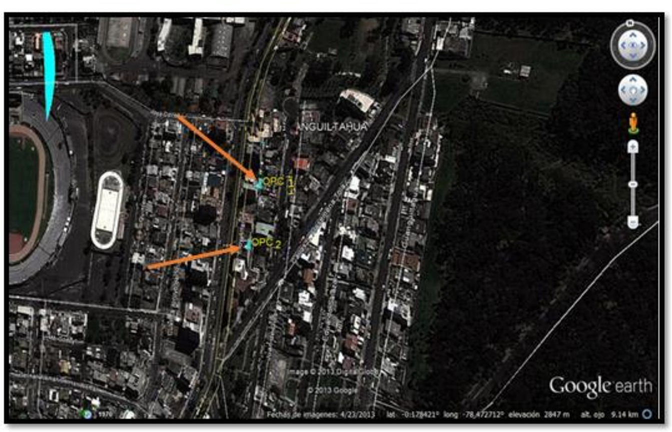

Fig. 8. Radio search nominal site and location options

F. Nominal choice Site

The OPC1 was chosen; since there is no problem with the choice of site, since its goal is to improve coverage in the areas of Batan Batan Alto and Bajo in the north of Quito; It is therefore recommended to install two sector antennas with azimuth angles of 80 ° and 160 °; which they were chosen because they meet with line of sight and allow fully cover strategic points; for sector 1 (Peugeot) and sector 2 (Education Unit).

This process predictions of coverage for each selected option selected in the search process, they are done with the help of software GENEX U-NET, same to simulate the behavior of each chosen option, so you can select which of the two options is the best installation point.

1) Tilt Mechanic

It is the physical antenna tilt, ie has an inclination on a shaft where the radiating element, which is technically called erraje rests. It has positive tilt and negative tilt.

2) Tilt Electrical

It is nonphysical inclination, ie a variation of the phase of the transmitted signal. It is characterized by concentrating the energy transmitted to the center of radiation and only have Downtilt. The inclination angle of the phase of the transmitted signal is the change manually the sty located at the bottom of the antenna, as well depending on the strategic points requested by the operator, in the first case is sector 1 the strategic point is the Peugeot dealership and in the second case it is the sector 2, the strategic point is an educational institution.

3) Azimuth

The azimuth is determined in a new Node_B inspection, this process is done by directing the compass to the objectives; for Azimuth angle calculation once located on Google Earth options displayed in Figure 9; OPC1 line from the North line and lines that are the highest priority strategic points for the two sectors, depending on customer requirements - operator, same meeting the coverage targets. To verify the accuracy of the angles measured with the help of a digital Grader on the geographical area projected by Google Earth, which allows verification with respect to the North line angles correspond to the lines drawn in the two sectors, same angles azimuth measured are: 80 ° for sector 1 and sector 2 160 °.

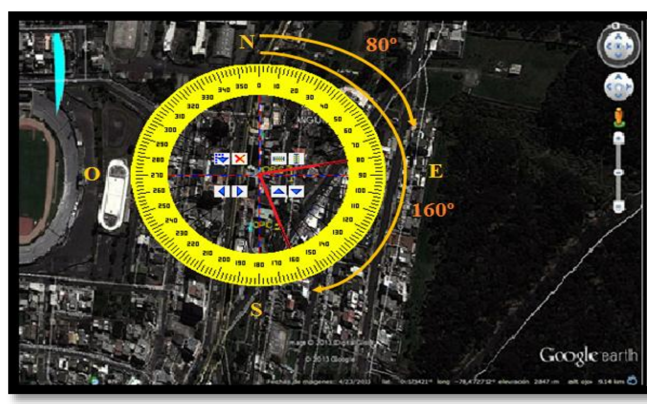

Fig. 9. Horizontal orientation azimuth from the north cardinal point of 0 to 360 degrees

G. Standard Propagation Model (SPM)

The model of standard propagation is a model that is derived from the formula model Hata, this model is used especially within the range of frequencies between 150MHz ~ 3500MHz, for distances of 1 to 20 km, and is very suitable for technologies such as GSM900 / 1800, UMTS, CDMA2000, WiMAX and LTE, is calculated by Equation 1:

$$P_R = P_{Tx} + G_{Tx} - (K_1 + K_2 \log(d) + K_3 \log(H_{Txeff}) + K_4 Diffraction\ nLoss + K_5 \log(d) \log(H_{Txeff}) + K_6\, H_{Rxeff} + K_7 \log(H_{Rxeff}) + K_{clutter} f(clutter) + K_{hill,LOS} \quad \textbf{(Ec.1)}$$

This model uses the terrain profile, diffraction mechanisms and takes into account the kinds of land use (Clutter) and effective antenna heights in order to calculate the path loss (path loss). SPM model accuracy is generally based around K_n modifying factors, which are defined by the prediction tool GNEX U-net, Table 2 shows some possible values for the constants used in the model formula SPM.

Tab.2. SPM values multiplicative factors (Thick Urbano)

Parámeters	**Mínimum**	**Tipical Value**	**Máximum**
K1	Variable	Variable	Variable
K2	20	44.9	70
K3	-20	5.83	20
K4	0	0.5	0.8
K5	-10	-6.55	0
K6	-1	0	0
K7	-10	0	0

K1 is a constant and its value depends on the radio frequency. Its value has great influence on the values given to clutter losses as seen in Table 3 and Table 4.

Tab.3. Description of clutter losses

Frecuencia (MHz)	**K1**
935	12.5
1805	22
1930	23
2110	23.8
1900	23
2300	24.7
2500	25.4
2700	26.1
3300	27.8
3500	28.3

Tab.4. Description of clutter losses

Pérdidas de Clutter	**fclutter**
Denso Urbano (Edificios mayores a 7 pisos)	4 a 5 (Valor a considerar 4)
Bosque	2 a 3
Urbano (Edificios más pequeños con calles pequeñas y medianas)	0
Suburbano (Con pequeños edificios)	-5 a -3
Industrial	-5 a -3
Abierto en zonas urbanas	-6 a -4
Abierto	-12 a -10
Agua	-14 a -12

Substituting the values,

$$P_{Tx} = -91 - 18 + (23 + 44.9 \log(1000) + 5.83 \log(30) + 0.5\,(0) - 6.55 \log(1000) \log(30) + 0\,(2) + 0 \log(2) + 1\,(4) + 0)$$

$$P_{Tx} = -91 - 18 + (23 + 134.92 + 8.95 + 0 - 29.02 + 0 + 0 + 4 + 0)$$

$$P_{Tx} = -91 - 18 + 141{,}85$$

$$P_{Tx} = 32.85 \approx 33 \text{ dBm}$$

For conversion to 33dBm watts, it is performed through Equation 2:

$$P_{(W)} = 1\text{W} \cdot 10^{(33\text{dBm}/10)} / 1000 = 1.99 \text{ W} \approx 2 \text{ W} \qquad \textbf{(Ec.2)}$$

$$P_{Tx} = 33\ dBm = 2\ W$$

H. *Area Calculation Cell Coverage of Node_B*

To check the coverage area having the cell Node_B raised, the propagation model SPM therefore according to Equation 1, the parameter "d", which represents the radius of coverage of the cell is cleared is used. The procedure for clearance of the variable "d" and replacing the values obtained are presented below:

$$d = 10\text{^}\{(-33 - 18 - (-91) + 23 - 8.61 - 0.5\,(0) - 0.5\,(0) - 1\,(4) - 0)/(44.9 + 9.67)\}$$

$$d = 10\text{^}\{0.92\}$$

$d = 8.31\ Km$; Radio coverage of the cell Node_B

Therefore, the coverage area of the cell Node_B is calculated through Equation 3, and displayed in Figure 10.

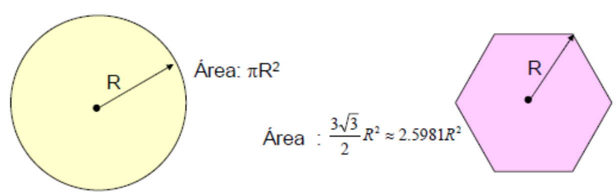

Fig.10. Coverage Area for Cellular Cell

$$\text{Área} = 2.5981 * R^2 \qquad \textbf{(Ec.3)}$$

Substituting the calculated radius of the proposed Node_B cell, we have::

$$\text{Área} = 2.5981 * 8.31^2$$

Área = 21.59 Km^2; Coverage area of the cell Node_B

I. *Results Link Budget*

Link Budget are the initial parameters for the new station that enters the network engages and can work with your environment, the cell parameters of the new Node_B, power parameters and CPICH are those that are set in the prediction tool .

It is a way to qualify the transmission performance is summarized as accounting for all profits and losses incurred through the transmission medium it indicates the performance that the new radio system will perform when implemented on stations existing bases designed under UMTS / HSPA + technology. Resultados Link Budget

The results in Table 5 are basically the requirements requested by the mobile cellular operator, to design 3G network so that the design process will be based on this information.

Tab.5. Link Budget results in the 1900 MHz band.

LINK BUDGET		
Stage	**THICK URBAN**	
Tecnology	**UMTS**	
Type of Environment	**OUTDOOR**	
Banwidth (MHz)	**5**	
USER EQUIPMENT		
Receiving Power	-90	dBm
Antenna Gain	0	dBi
Body Losses	3	dB
Receiver Sensitivity	-110,43	dBm
NODE_B		
Power Transmission Channel CPICH	33	dBm
Maximum Power Transmission Node_B	43	dBm
Noise factor	4	dB
Thermal noise power	-81,86	dBm
Charge factor	50	%
Interference margin	3,01	dB
Background noise	-74,85	dBm
Requirements Eb / No	4.50	dB
EIRP	50,2	dBm
Gain Process	37,07	dB
Antenna Gain	18	dBi
Cable and Connector Loss	0.8	dB
Fading margin	10.3	dB
Multipath fading	1.45	dB
SHO gain	4	dB
standard deviation or standard deviation composite shadow compuesta	8	dB
Penetration Loss	15	dB
Load Fluctuation	0,5	dB

Then these values will be taken directly prediction software that interprets us through graphical planning that will cover for 3G / UMTS network of our design.

J. RF coverage prediction UMTS OPC1

For OPC1 you have determined the values in Table 5, values that are optimal for meeting the coverage targets in the areas of Batan Batan Alto and Bajo in the north of Quito.

Figure 11 shows the behavior of Node_B coverage levels, without the presence of the coverage areas of neighboring Node_B. The interpretation depends on the graph legend obtained in RSCP coverage analysis performed in the drive test RF for which; indicates that the color green is the area of most optical coverage in signal reception, both the received power level RSCP, the quality of Ec / Io and minimum error rate BLER signal, the blue color determines the signals very acceptable where voice and data acceptable to the EU, determines levels of reception power of the minimum EU blue color, but if you provide quality voice services and data, the yellow color determines unacceptable levels in the signal reception, causing loss of coverage and failure to access voice and data services; finally the red color determines degraded signals; which they are total loss of signal, and the color lead is exclusion zone 1 where a mountainous area, determined by the irregularity of the terrain and lack of line of sight is identified.

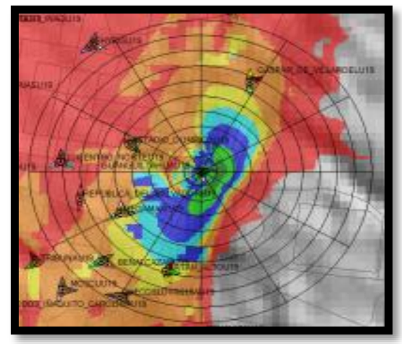

Fig.11. Coverage levels Node_B.

Figure 12 represents the behavior of coverage levels including neighboring Node_B, as also displayed and determines that there is no over-lapamiento between neighboring cells Node_B.

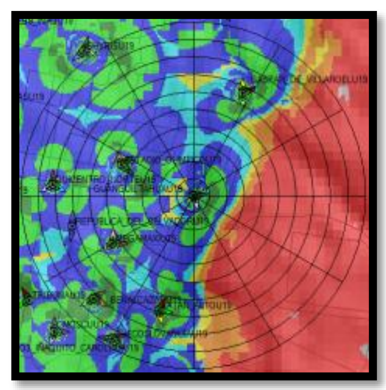

Fig.12. Coverage levels included Node_B neighbors.

K. Implementation of Nodo_B

For a better understanding of the requirements for the implementation of the new Node_B, it has made a diagram or flow chart displayed in Figure 13; content starts with a plan UMTS network that is according to the requirements of mobile cellular operator, which is identified with 3G cells for mobile devices or EU; whereas coverage analysis is performed through RF drive test, which determines coverage holes in areas with low levels of cellular signals. Allowing to establish the search for a site or option where the implementation of the new Node_B that meets the objectives RF and net agreement between all areas of interest to the project possible. If the analysis in site is best suited to engineering level it is appropriate in the preparation of a Technical Site Survey (TSS), through which shows the data obtained in the field inspection, allowing verify the dimensions of the structural elements as well as the state in which the building is located, which has good conditions.

Studies by civil works, we find that the structure if it has sufficient capacity to withstand the gravitational loads and overloads from the installation of telecommunications equipment such as: Mini Shelter, RF Antennas and corresponding RRU, which are supported in two masts 3m, which are fixed and located in the columns of the terrace or top tier of the building structure, and mainly fulfilling the objectives of coverage and line of sight, taking into account the use of three types of height masts ranging from 3, 6 and 9 meters, the height requirement to use and mainly depends on the line of sight exists in the area of coverage to be achieved; analysis is verified on the photo shoot on the deck every 30 °, therefore to have line of sight is only 3m masts used. Considering that the structure has sufficient capacity to withstand an equivalent seismic load 10% of its own weight, and further winds of 120 km / h applied on the structure, including the positioning of equipment according to the resistance Floor terrace, this analysis are applied based on the structure as described in the ANSI / TIA Standard 222F, which constitutes the greatest horizontal load that could be applied to it. In the case of installing new equipment must perform a new structural analysis.

When installing all telecommunications equipment, commissioning and integration of the new Node_B, which allows communication with the RNC, the MPLS 3G operator, the transmission and reception of cellular signals corresponding to the 3G / UMTS cells is carried out; to complete the process of commissioning the delivery of the site is done through a Aceptance Test Protocol (ATP), a document in which all equipment installed and operating telecommunications, with their respective performance tests are analyzed; if this process is not delivering according to operator requirements, the site does not accept an extension resulting delivery 15 days; by re-commissioning of Node_B and verifying whether each of the installed equipment is faulty. By verifying all the problems presented in the first visit, a return visit in which the operator confirms whether the Node_B meets the requirements for delivery is made, if successful is determined as requirements of the new Node_B achieved.

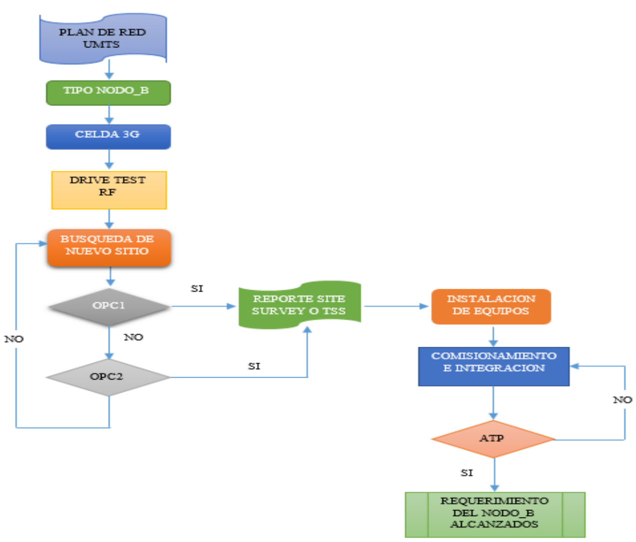

Fig.13. Flow chart of the requirements for the implementation of a Node_B

IV. FUNCIONALITY TEST

In the Rack Huawei Minishelter the Aceptance Test Protocol (ATP) commissioning and integration and Aceptance Test Protocol (ATP) installation, same as the respective settings made in the equipment shown in the following sections was performed; later in the masts as supports of sector antennas the Aceptance Test Protocol (ATP) of the radiant system was performed.

A. Address Verification IP

As a first test IP addresses configured in the ports of Fast Ethernet transmission is verified, this process is done by executing the command DEVIP LST.

When performing this procedure configured IP addresses on port FE / GE of BBU3900 directly in WMPT / UTRP card, subrack 0, slot 0 and port 0 is displayed.

To verify that Ping tests are successful run from the LMT software, within which the following successful connections between verified:

1) The IP service with the RNC, is found that there is connectivity between the Node_B and the RNC, it means that the RNC must be registered with the IP Node_B.

2) The IP Gateway service , it is found that the way from the Node_B towards MPLS is enabled .

3) The IP Management with M2000 manager, will check that the Node_B is registered in the management or n Operator.

4) The IP service with IPCLOCK, indicates the synchronism between the RNC and Node_B.

B. Changing Cell ID on a call from 3G to 3G

Within these tests is shown that by making a call within the coverage area there is a change between cells without interference, this process is called Soft Handover, same as evidenced through the application G-NETtrack Lite, which It allows me to evaluate the types of cells within the coverage area Node_B, as shown in Figure 14.

Capture CELLID Identification of Sector 1.	**Capture CELLID Identification of Sector 2.**

Fig.14. *Soft Handover Fig.14.Visualización through EU.* G-NetTrack Lite

.

C. Test VSWR

In this measurement process as a first point of VSWR maximum value obtained on-site installation time of Jumper (Antenna / RRU) is verified. We must take into account that the range of frequencies used for measurement is 1850 MHz to 2000 MHz, as the measuring equipment (SITEMASTER), you get the exact values of VSWR defining the operating frequency of Node_B is 1900 MHz.

As a fundamental part of these tests all graphs obtained and recorded in the test equipment must have the following nomenclature to identify the site, sector and antenna port: SITE NAME - SECTOR (1, 2, 3) - PUERTO (0 , 1), as displayed in Figure 15.

In Figure 15; the first measurement indicates the sector VSWR (1-0), taking into account the scoreboard with the highest peak loss reflected wave; maximum value of 1.16 VSWR

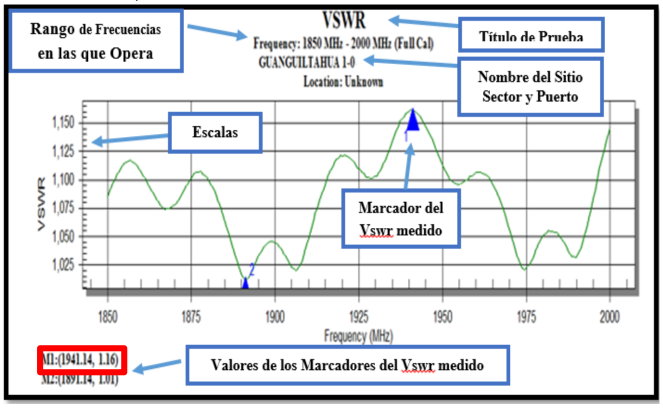

Fig.15. VSWR 1-0.

V. Conclusiones

Upon completion of the analysis made in the design of the new Node_B, initial results were obtained through the RF drive test, which checked with the manual calculations that were made for the propagation model and link budget; where the results vary depending on each parameter as transmission power CPICH (2W), maximum power in the Node_B (20W) operates, carrier frequency (1900 MHz), bandwidth (5 MHz), gain RF antenna (18dBi), coverage area of the cell Node_B (21.59 km 2), among others, which are admitted to the U-Net software for creating traffic maps analyzing the coverage levels and nonexistence of on-lapamiento between cells, and thus set the nominal prediction site where the new Node_B implemented.

Design embodied 3G / UMTS network; by reporting technical inspection of the site or Technical Site Survey (TSS), the gathering of information in the field and the projection of the site was made; with which the installation and adjustment of Node_B was made, taking into account studies by civil works, as to the ability of the structure to withstand the gravitational loads and overloads of telecommunications equipment, under the ANSI / TIA 222F , indicating that the structure has sufficient capacity to withstand seismic loading equivalent to 10% of its own weight, and further winds of 120 km / h applied on the structure,

Under recommendations of the supplier of telecommunications equipment, specified that in the three types of masts with heights ranging from 3, 6 and 9 meters, the requirement of height to use only depends and mainly line of sight exists in the coverage area to be covered; analysis is verified on the photo shoot on the deck every 30 °, therefore to have line of sight is only 3m masts used.

Commissioning and integration of Node_B Guangüiltahua was carried out by the platform internal management Local mantenance Terminal (LMT), which verifies the following parameters: versions of the BBU, Ethernet ports in state UP, remote activation measurements of VSWR with manager M2000, IP addresses Management and Service configured, sizing channel voice traffic (6 channels), dimensioning traffic channel data (16 channels) and alarm status, parameters found according to the requirements of cellular mobile telephone operator.

The Node_B acceptance testing was performed by the CNT EP; This process is effected by using functional tests through a document called Protocol Acceptance Testing or ATP, in tests to consider evidence Ping were performed verifying connectivity and synchronization between the Node_B with manager M2000 and the RNC which were successful. One of the most demanding for the delivery of site tests is to verify the loss or VSWR reflected wave in each sector, satisfactory results for the operator since they are within the range of minor losses to 1.3 VSWR.

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