SIMULATE OF BASE RADIO STATION OF TECHNOLOGY CDMA AT THE RANGE OF FREQUENCY OF 800 MHz

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Abstract -*This paper has as an objective to assist the measurement of the values of permission maximum for electric fields, magnetic fields and power density on base radio station of the CDMA technology , at the range of 800 MHz. The permission values were regarded in ICNIRP. The simulate of field irradiated for base radio station, allows the introduction of the following data: Radio channel power (Pt); antenna gain (Gt), radio channel numbers (N), operation frequency (f), cable loss (C), direction attenuation (Atdir), minimum distance (d), reflections. Having as calculated values: Effective radiate power (ERPN), density power of sector (SS), electric field of sector (ES), magnetic field (H), density of magnetic flow (B), permission maximum exhibition of electrical field and power density. Furthermore, it shows as a result the graph of power density of sector and coverage area.*

Keywords: *base station simulate radio*

Introduction

With the frightening growth of móbile phone in the world, which is requered of providers of telecommunications services the rapid deployment of sites BTS to meet the demand of users that use the radio frequency spectrum that in general has worried regulators and scientists. Being the main concern of these means of communication, the effects of electromagnetic fields on the health of the general public, which are continuously exposed. Especially people who are around the BTS. IF nothing else, the people responsible for implementation, operation and maintenance of the sites are submitted the electromagnetic field with a higher intensity.

This concern motivated many entities and groups the research of independent study, the assess the scientific literature, in order to find evidence in order objective for a potential effect. Thousands of scientific papers were published and far examined and World Health Organization, International Commission for the protection of non-ionizing radiation (ICINIRP) and other organization of great credibility ,held several meeting, reviews and published reports, recommending turn, action and safety limits.

1- Number of sites and cell phone numbers in Brazil

The mobile phone in Brazil is divided into bands (A, B, D, E) and thought these band are allocated to shared sites, this places is where one more provider of mobile phone using the same resource infrastructure. In table 1 according to the site of telecommunication made in the number of sites per band until June 2008.

TABLE 1
SITE FOR BAND

Band	Sites for Band		
	April/08	May/08	June/08
A	11.272	11.270	11.343
B	9.587	9.625	9.646
D	10.039	10.036	10.051
E	6.098	6.154	6.190
Other	-	89	262
Total	36.996	37.085	37.230

On table 2 present the sub-frequency bands of mobile phone (A, B, D, E) and sub-band of according to the website of Teleco. The sub-band of frequency of the mobile station call up link, has a lower frequency range that the frequency of BTS. The sub-frequency band of BTS called down-link.

TABLE 2
SUB-BAND OF FREQUENCY

Frequency (MHz)	Transmission	
	Mobile station	BTS
Sub-band A	824 – 835 845 – 846,5	869 – 880 890 – 891,5
Sub-band B	835 – 845 846,5 - 849	880 – 890 891,5 - 894
Sub-band D	910 – 912,5 1710 - 1725	955 – 957,5 1805 - 1820
Sub-band E	912,5 – 915 1740 - 1755	957,5 – 960 1835 - 1850
Sub-band Extension	898,5 – 901 907,5 – 910 1725 - 1740 1775 - 1785	943 – 946' 952,5 – 955 1820 - 1835 1870 - 1880

The system mobile personal (SMP) is divided in regions and the system mobile cellular (SMC) is divided in areas by state and total 45,040 sites. In table 3, shows the of SMP, SMC of according to the website of Teleco, the number of sites by state and the number of municipalities served.

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TABLE 3
NUMBER OF SITES BY STATE

SMP	SMC	State	Sites 07/2009	Municipalities
I	3	RJ	4.566	92
		ES	1.067	78
	4	MG	5.577	848
	8	AM	567	37
		RR	51	7
		PA	1038	129
		AP	90	9
		MR	627	155
	9	BA	1.948	348
		SG	405	65
		PI	395	120
	10	CE	1.292	167
		RN	623	114
		PB	636	140
		PE	1.563	167
		AL	587	79
II	5	PR	3.087	372
		SC	1993	262
	6	RS	3.609	468
	7	MS	664	77
		MT	774	126
		GO	1.494	215
		DF	1052	1
		TC	301	90
		RON	269	44
		AC	135	17
III	1/2	SP	10.646	645
		BR	**45.040**	**4.872**

The available technologies are: AMPS, TDMA ,CDMA, GSM, WCDMA and CDMA 2000. In Brazil are about 157 million mobiles phone. The table 4 according to the website of Teleco, shows the distribution of cell phones by technology and its percentage of growth.

TABLE 4
MILLION PHONES BY TECHNOLOGY

Technology	May 2009	
	Mobiles	Growth
AMPS	6.417	0,00 %
TDMA	498.8182	0,32 %
CDMA	10.540.394	6,69 %
GSM	140.208.374	89,02 %
WCDMA	1.619.203	1,03 %
CDMA 2000	312.666	0,20%
Data terminal	4.315.941	100%
Total	157.501.813	100%

2- NUMBER OF PHONES IN THE WORLD

In figure 1, according to the website of Teleco the end of the second quarter of 2008 existed in the world 3.96 billion mobile, with a penetration of 55 phone per 100 inhabitants billion mobile phones, 88% belonging to the family of GSM and WCDMA according to the source of "UIT", "wireless intelligence" e GSA.

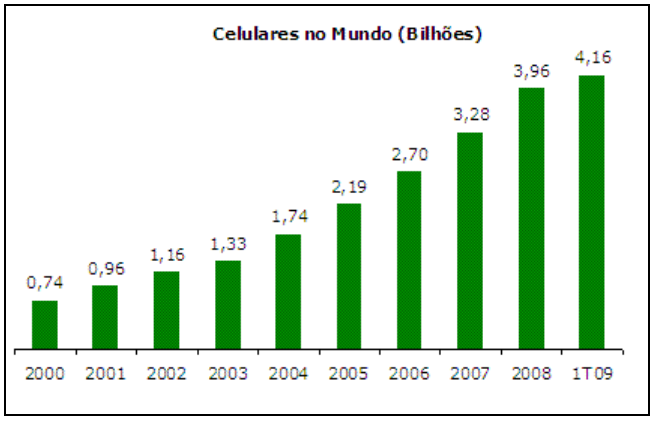

FIGURE 1
PHONE IN THE WORLD

3 – Equation of Propagation System of RF

3.1- Effective Radiated Power (ERPN) on dBm.

ERPn (dBm) = 10. log N + Pt(dBm) + G(dBd) (1)

ERPn (dBm) ..... Effective radiated power of the channel of RF.

10. log N..... Number of radio channel of radio in a sector of a cell.

Pt(dBm).....Transmission power of the RF channel.

G(dBd) .....Antenna gain in a sector of the cell.

3.2 – Effective Radiated Power (ERPn) on W

ERPn (w) = $10.^{ERPn(dBm):10} . 10^{-3}$ (2)

ERPn (dBm) .....Effective radiated power of channel RF.

3.3 - Power Density in the Sector (Ss) on dBm

Ss(dBm) = ERPn (dBm) + 10.log 2,56 (dB) – C (dB) – Aten.dir (dB) – 10 log 4¶ - 20 log d (m) (3)

ERPn(dBm)..... Effective radiated power of channel RF.

10.log 2,56) (dB)..... Factor of reflection.

C(dB).....Losses in the cable.

Aten.dir (dB).....Attenuation away from the main lobe of the antenna

10log 4¶(dB).....Attenuation due to distance.

20log d(m).....Attenuation of the distance between antenna and the point to be measured.

Observation. Attenuation due to the remoteness of the main lobe is extracted from the diagram of radiation from the antenna provided by the manufacturer.

3.4 - Power Density in the Sector (Ss) on w/ m^2

$$S(w/m^2) = \frac{Pt}{4\prod d^2} \quad (4)$$

$$S(w/m^2) = \frac{Pt.Gt}{4\prod .d^2}.2{,}56 \quad (5)$$

2,56.....Factor of reflection

ERPi = Pt. Gt (6)

ERPi.....Effective isotropic radiated.

$$S(w/m^2) = \frac{ERPi}{4\prod .d^2}.2{,}56 \quad (7)$$

$$Ss\ (w/\ m\dot{2}\ ) = \quad 10.^{Ss(dBm)/10}.10^{-3} \quad (8)$$

3.5 – Minimun Distance r(m) of BTS.

$$r(m) = 8{,}16\ .\sqrt{ERPn(w) : f(mhz)} \quad (9)$$

ERPN (w)..... Effective radiated Power of the "n' radio channel.

f(MHz)……..... Carrier frequency CDMA RF system.

3.6 – Electric Field in the Sector (Es) v/m

$$Es\ (v/m) = \sqrt{377.Ss.(w/m2)} \quad (10)$$

377.....Intrinsic impedance in vacuum on Ω.

$Ss(w/m^2)$..... Power density in the sector.

4 – Permissible Values in the Frequency Range (MHz): 869 á 894.

4.1 –Eletric Fiend EEMP (maximum permissible exposure) v/m

$$EEMP\ (V/m) = 1{,}37.\ \sqrt{f(mhz)} \quad (11)$$

4.2 - Power Density SEMP (maximum permissible exposure) mW / $cm\dot{2}$

$$SEMP\ (\ mW\ /cm\dot{2}\ )\ = f(MHz)\ /\ 2000 \quad (12)$$

4.3 - Power Density SEMP (maximum permissible exposure) w / $m2'$

$$SEMP(w/m2') = f\ (MHz)\ /\ 200 \quad (13)$$

4.4 – Magnetic Field H (A/m)

$$H\ (A/m) = 0{,}0037.\sqrt{f(mhz)} \quad (14)$$

4.5 – Magnetic Flux Magnético B (µT)

$$B\ (\mu T) = \sqrt{0{,}0046.f(MHz)} \quad (15)$$

5 – Presentation of the Simulator for Verification of the Studies.

5.1- Calculations Performed by the Simulator

In the panel below shows the calculations dynamically, when it changes the values of power of channel RF (Pt), antenna gain (Gt), channel number of RF (N), frequency freqüência (f), cable loss (C), directional attenuation (Adir), distance (d) refletion (Refl). The figura 2 shows the calculations.

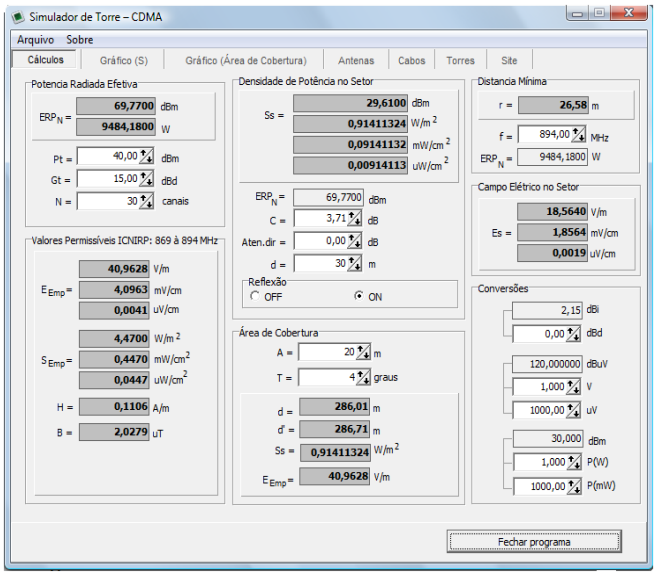

FIGURE 2
CALCULATIONS

5.2 – GRAPH OF POWER DENSITY

This Field is displayed in the variation in density of Power "S" and when the variables are changed: Power of the radio channel (Pt), Antenna gain (Gt), Number of radio channel (N), Cable losses (C), Directional attenuation (Atdir) e Reflection of the route (Refl).

The graph of power density is presented figure 3 , which shows the coverage radius in meters from the center of the cell. Noting that the density of power, Is greater in the Center of the cell and is reduced gradually as moves away from the Center of the cell.

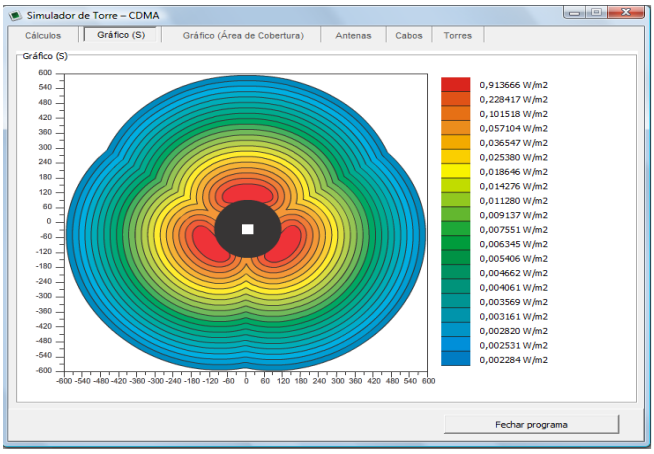

FIGURE 3
POWER DENSITY

5.3 – Graphic Coverage Area

This graphic shows the change in the coverage area of a cell when we change the values of antenna height (A) e a inclinação (ângulo) da antena (T).

Área de Cobertura de uma célula, e quando são alterados os valores de Altura de antena (A) and inclination (angle) of the antenna(T).

The Height values of antenna (A) are adjusted from 0 to 60 meters and the values of antenna tilt (T) are included in a range of 1 to 16 degrees.

The figure 4 following is an example of the coverage area with an antenna heigth of 60 meters and an inclination of 3 degrees.

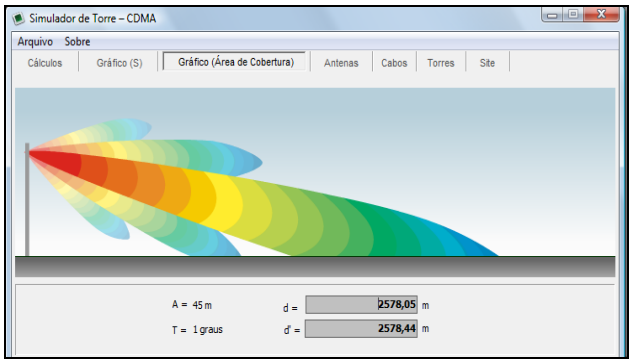

FIGURE 4
COVERAGE AREA

5.4 – DATABASE BTS

Through an icon "Site" tower Simulator CDMA is possible the level of Brazil to list all the radio base stations of a city, neighborhood or a specific path.

The figure 5 according to the site ANATEL, you clicked on the icon site and in turn opened the fields to be completed: UF, name the municipality, neighborhood and street. Was completed only the state (MG) and the city of Uberlandia to discover the quantities of radio base station.

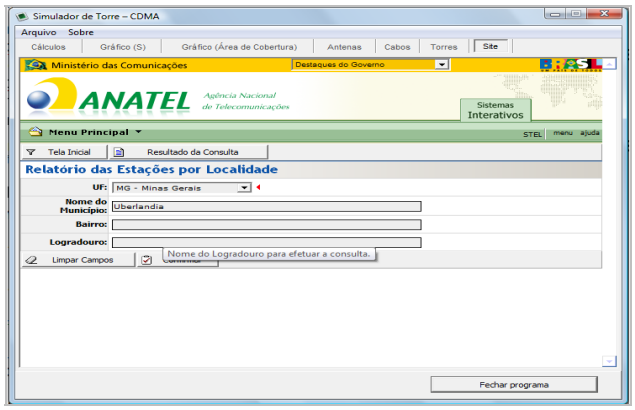

FIGURE 5
REPORT OF THE STATION BY LOCATION

The figure 6 below the query result totaled 237 Erbs distribuited among the operators: Claro, CTBC, Telemig Celular, TIM Nordeste, TNL PCS.

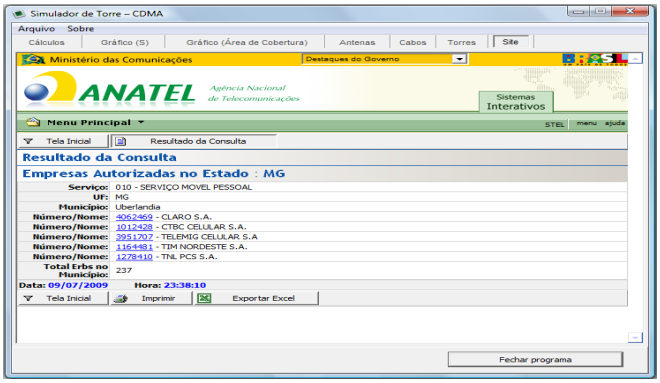

FIGURE 6
QUERY RESULT

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