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A Prediction Model for Electromagnetic Pollutin Index of Multi System Base Stations

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Abstract: mobile telephone is among the most popular consumer electronic devices in the modern world today. This has resulted in rapid increasing in number of mobile base stations to ensure good coverage and better quality of services, thus causing anxiety among the members of the public regarding the potential health effects caused by the radiation produced the base stations. It gives rise to a compelling case to reduce the electromagnetic pollution (EMP).

So an objective measure is a prerequisite to model, measure, monitor and manage EMP. In this paper, EMP definitions and modeling have been deal with elaborately for mobile communications and proposed electromagnetic pollution index (EPI) for multiple base stations. Relationships are derived to check the influencing factors' effect on environment and to give guidelines for consideration of EPI. To illustrate the use of EPI an example is presented. And Simulations are performed by using MATLAB tool.

Keywords: **EPI(Electromagnetic pollution index), EMR(electromagnetic radiation), multi-system base stations, *electromagnetic pollution.***

INTRODUCTION

1 Definition of EMP in mobile communication

The EMR is considered to be harmful if the power density from multiple sources exceeds a threshold level ∂ [9]. The power from multiple sources is, in general, additive and may be expressed at a point(x,y,z) as

$$P(X,Y,Z)=\sum S_i\, \sigma(\theta,\varphi)$$

$$\text{for all } S_i > \partial \quad \ldots (1)$$

Where

S_i = Received power density from the i th emitter

$\sigma(\theta,\varphi)$ = Effective aperture area for the direction of arrival (θ,φ)

The polluting energy may be expressed as integral of power i.e

$$E(X,Y,Z) = \sum \int S_i(t)\, \sigma(\theta,\varphi)\, dt$$

$$\text{for all } S_i > \partial \quad \ldots (2)$$

In the case of mobile communications, it is not practical to evaluate or measure the energy at all the points or even 'representative points' to objectively measure or compare EMP. Based on the threshold concept, it is postulated that EMP is limited to a few areas where the Base Transmitting Stations (BTS) and mobiles are radiating within a cell. Such areas may be termed as 'Pockets of Pollution' (POP).

2. Definition of Electromagnetic Pollution Index (EPI)

The Electromagnetic Pollution Index (EPI) is defined as a product of the normalized polluted area and polluting energy. The normalized polluted area is the ratio of sum of areas of all packets of pollution (POP) and area of cell, and the polluting energy is the sum of energy in all POP. It can be expressed as

$$EPI = \left(\frac{\text{Sum of area of all POP}}{\text{Area of cell}}\right)$$

$$(\text{ sum of energy in all POP}) \quad \ldots (3)$$

EPI equation can be established in simple form under considerations free space propagation, no power control and isotropic antennas for the transmission of radio frequency signal.

Assuming $\sigma(\theta,\varphi)=1$,

$$\mathrm{EPI} = \left(\frac{1}{A}\right)(\sum ai)\left(\sum \int_0^T Pi(t)dt\right) \quad .... (4)$$

Where

EPI = EMP Index in Watt-Hours

A = Area of the cell

a_i = Area of ith POP

P_i = power measured by omni directional antenna at a distance of 1m on the bore-sight of transmitting antenna

T = Time period (suggested as 24 hours)

3. Simplified model for EPI for multiple base stations:

In this section, a simplified model of EPI is presented. Considering the antenna characteristic parameters, such as the normalized directivity function, antenna gain, gain of the array element, shaped gain and so on. And the distribution of its power density of the multi system base station S is:

$$S = \sum_{i=1}^{N} \frac{P_{ki}\, G_{ki} G_{wi}}{4\pi r_i^2} F(\psi)_i^2\ F(\theta)_i^2 D_{ui} * 100 \quad .... (5)$$

Where

S= electromagnetic radiation due to multiple base stations

P_{ki} =array of transmitting antenna power due to ith bas staton

$G_{ki} G_{wi}$ = Array gain and shaped gain due to ith base station

$F(\psi)_i$ = horizontal plane directional values for ith base station

$F(\theta)_i$ = vertical plane directional value for ith base station

N= number of base stations

Let us assume shaped gain=G_{wi}= 1db then electromagnetic radiation power will be S= P that means according to single base station and $P_{ki} = P_t$; $G_{ki} = G_t$ Then from above equation4

$$P = \frac{P_t\, G_t}{4\pi} F(\psi)^2\ F(\theta)^2\ D_u * 100 \quad .... (6)$$

But from the simple antenna received power equation

$$\mathrm{P} = \frac{P_t G_t}{4\pi} \quad .... (7)$$

Assuming no power control, the minimum signal required at the maximum distance is given by

$$P_{min} = \frac{P_t G_t G_r}{{R_{max}}^2}\left(\frac{\lambda^2}{4\pi^2}\right) \quad .... (8)$$

Assuming isotropic antenna and substituting for P_t in above equation(7) yields

$$\mathrm{P} = P_{min} R_{max}^2 \left(\frac{4\pi}{\lambda^2}\right) \quad .... (9)$$

Substituting in (4), EPI is given by

$$\mathrm{EPI} = \left(\frac{\sum a_j}{A}\right)\sum \int_0^T P_{min} R_{max}^2 \left(\frac{4\pi}{\lambda^2}\right) d(t) \quad .... (10)$$

The above equation represents the summation of all the mobile emitters in a cell, but we required the summation of overall emitters i.e. BTS as well as all mobiles in single POP. So by separating the BTS related and mobile related terms in equation (10) gives modified EPI as

$$\mathrm{EPI} = \left(\frac{1}{A}\right)\left(a_{BTS} + \sum a_j\right) P_{min} P_{max}^2 \left(\frac{4\pi}{\lambda^2}\right)\left(\sum_1^{uv} \tau_i\right) + \left(\sum_1^{M} T_j\right) \quad .... (11)$$

From above equation P_t is considered

$$P = P_{min} R_{max}^2 \left(\frac{4\pi}{\lambda^2}\right) * F(\psi)^2 * F(\theta)^2 * D_u * 100$$

…. (12)

According to definition of EPI, the equation for multiple base stations is derived as

$$EPI = \sum_{BTS=1}^{N} \left\{\frac{a_{bm}}{A_{BTS}} \int_0^T P dt\right\}$$

$$= \sum_{BTS=1}^{N} \left\{\frac{a_{bm}}{A_{BTS}} PT\right\}$$

$$= \sum_{BTS=1}^{N} \left\{\left(\frac{a_{BTS} + \sum a_m}{A_{BTS}}\right) P * \left(\sum_1^{uv} \tau_i\right) + \sum_1^{M} \Gamma_m\right\}$$

…. (13)

At the time of handover between two cells, same amount of extra power we require to proper handoff. So EPI is given as

$$EPI = \sum_{BTS=1}^{N} \left\{\left[\left(\frac{a_{BTS} + \sum a_m}{A_{BTS}}\right) * P * \left(\sum_1^{uv} \tau_i\right)\right] + \sum_1^{M} \Gamma_m\right\} + P_{hpBTS-BTS} \quad …. (14)$$

And substituting P value from equation obtained the EPI for multiple base stations

$$EPI = \sum_{BTS=1}^{N} \left\{\left[\left(\frac{a_{BTS} + \sum a_m}{A_{BTS}}\right) * P_{min} * R_{max}^2 * \left(\frac{4\pi}{\lambda^2}\right) * F(\psi)^2 * F(\theta)^2 * D_u * 100 * \left(\sum_1^{uv} \tau_i\right)\right] + \sum_1^{M} \Gamma_m\right\} + P_{hpBTS-BTS}$$

…. (15)

Where

a_{BTS} = Area of POP due to Base station N

a_m = Area of POP due to jth mobile in Base station N

A_{BTS} = Area of Nth base station

u = Number of channels per Trans Receiver(TRX)

v = Number of TRX

τ_i = Average transmit time for ith channel of BTS

Γ_m = Average transmit time for jth mobile

M = Number of nodes

D_u = Duty ratio of time slot

$P_{hpBTS-BTS}$ = handoff power between different base station cells

4. Data Analysis

Field measurement approach was chosen to analyze cell tower radiations in various regions. From power density measurements and some of the assumptions EPI is predicted, shown in table..

S.NO	DISTANCE (m)	POWER DENSITY (µW/m2)	EPI (Watt-Hr)
1	5	443.0569	5.3394 e+008
2	10	110.7642	3.0471 e+008
3	15	49.2285	1.9576 e+008
4	20	27.6911	1.4083 e+008
5	25	17.7223	1.1848 e+008
6	30	12.30	9.5145 e+007
7	35	9.0420	8.94 12e+007
8	40	6.9228	6.8456 e+007
9	45	5.4698	6.3767 e+007
10	50	4.4306	5.8230 e+007
11	100	1.1076	2.7877 e+007

Table 1 Density and EPI prediction values for multiple base stations:

The table 1.1 gives information that at the center of the base station the maximum radiation or power density occurs and where the mobile unit moves away from the base station the Electromagnetic radiation decreases. Accordingly the electromagnetic pollution index value varies with respect to distance.

6. Illustration

It can be illustrated with an example of considering single base station having radius R=3000 m as shown in figure (a). the same geographical area is covered by splitting into 7 cells, each of radius r=1000m , as shown in figure(b).

The values of number of channel per trans receiver and number of trans receivers are taken as u=8 and v=7 respectively for larger cell and v=1 in smaller cell. Then the surface plots of radiated power in micro watts per m2 in POP due to BTS for threshold ∂=170 µW/m2 for large cell and small cell is shown in figure1.1 and figure1.2

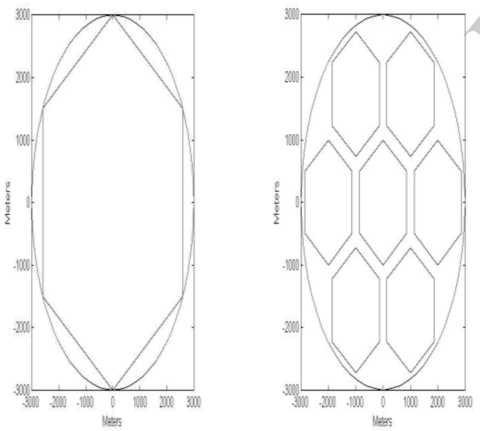

Figure (a) & (b)

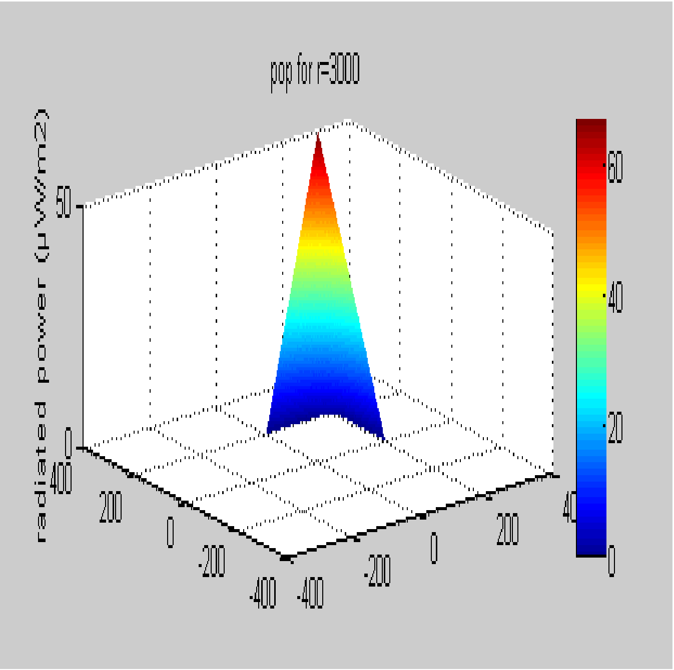

Figure.1.1: Pocket o Pollution for Radius of 3000m

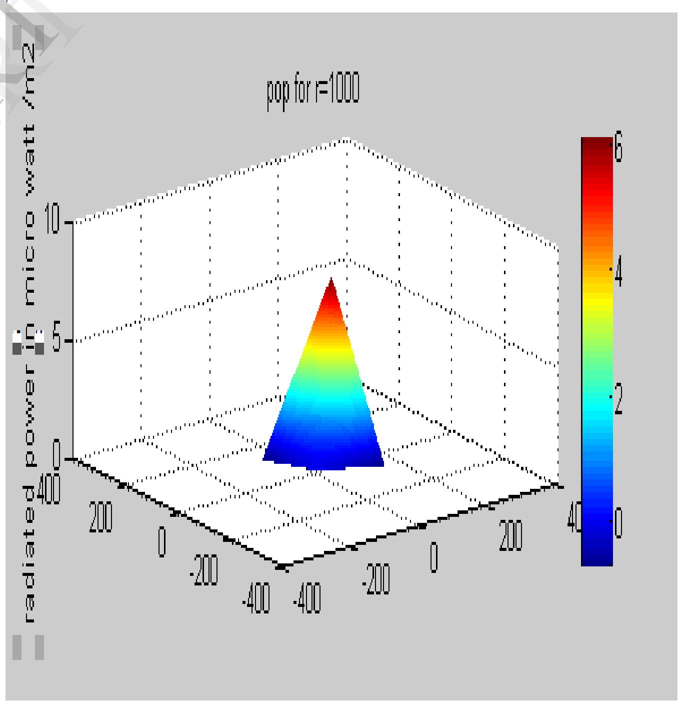

Figure1.2 : Pocket of Pollution of Radius of 1000m

5. Conclusion

It is critical to manage EMP to accomplish 'True' Green Mobile Communications. Defining an objective measure for EMP is a necessary first step. In this thesis, EPI for multiple base stations is proposed as the product of normalized area of POPs and polluting energy. Such an objective measure is expected to help in quantifying EMP, comparing alternative network designs and managing EMP. A simplified model for EPI for multiple base stations has been presented, along with an illustrative example. This model is compared with practical measurement model by using Android Mobile with an application of RF Signal Tracker.

This model is helpful in gaining insights into this new field, leading to the identification of several multi-disciplinary research areas for further work. The simplified model validates the intuitive strategy to use smaller cells to reduce EMP. As smaller cell size also facilitates other green practices, the future points to Pico and Nano-cells as the way for a greener and safer biosphere.

REFERENCES

[1] Telecom Regulatory Authority of India, Consultation Paper on Green Telecommunications, pp. 3, February 2011.

[2] Adamantia Fragopoulou,1 Yuri Grigoriev,2 Olle Johansson,3 Lukas H Margaritis,1 Lloyd Morgan,4 Elihu Richter5 and Cindy Sage6 " *Scientific panel on electromagnetic field health risks: Consensus points, Recommendations, and Rationales* " scientific meeting: Seletun, Norway, November 17-21, 2009" reviews on Environmental health volume 25, no. 4, 2010.

[3] Guidelines for limiting exposure to time varying electric, magnetic and electromagnetic fields (Up to 300GHz), Health Physics, International Commission on Non-Ionizing Radiation Protection, Vol. 74 No 4, 1998.

[4] WHO press release, "IARC classifies radio frequency electromagnetic fields as possibly carcinogenic to humans," No. 208, May 2011.

[5] Committee on the Environment, Agriculture and Local and Regional Affairs, "The potential dangers of electromagnetic fields and their effect on the environment," Doc. 12608, May 2011.

[6] Ulrich Warnke, "Bees, Birds and Mankind – Destroying Nature by Electropollution"; A Brochure Series by the Competence Initiative for the Protection of Humanity, Environment and Democracy.

[7] Ministry of Environment and Forests, Government of India report, "Possible impacts of communication towers on wildlife including birds and bees," October 2011.

[8] O. Gen»c, M. Bayrak, and E. Yald³z "*Analysis Of The Effects Of Gsm Bands To The Electromagnetic Pollution In The Rf Spectrum*" Progress In Electromagnetics Research, PIER 101, 17{32, 2010

[9] AF Ismail, W.Hashim" *Predicting Radio Frequency Radiation From mobile communication Base stations*" International Journal of Computer and Communication Engineering,*Vol.2*,No.4, July 2013.

[10] P. Venkatapathy, J. Jena, A. Jandhyala, Electromagnetic Pollution Index –A Key Attribute of Green Mobile Communications, IEEE, 2012.