

Electromagnetic Pollution: Experimental Comparison of 2G and 3G Wireless Communication Networks

Amit Kumar^{1,2}, Tanvir Singh³, Vasishath Kaushal³, Divya Khurana⁴

¹JNV Theog, Shimla, India

²College of Information Science and Technology, Nanjing Forestry University, Nanjing, China

Email: amitmehta66@gmail.com

³Centre for Development of Advanced Computing, Mohali

Email: singhtanvir21@gmail.com, vasishath@gmail.com

⁴CGC, Gharuan, Mohali, India

Email: divya61292@gmail.com

Abstract— Mobile Technologies are changing day by day and are showing latest advancements with number of additional features attracting number of users to live a smart life with smart applications without realizing about electromagnetic pollution they are creating, by virtue of which numeral health hazards are seen in different parts of world. So, in this paper, we have discussed the electromagnetic pollution and the subsequent health hazards caused by the technology advancements. Also, we have compared the radiation exposure due to 2G and 3G mobile communication technologies by using Electro smog meter which is used to measure electromagnetic pollution.

Keywords-GSM; EV-DO; UMTS; Electromagnetic Pollution; Health Hazards; Mobile Radiations;2G; 3G; Wireless Networks

I. INTRODUCTION

Phenomenal Growth of Mobile Technologies has been observed in the previous years, which was a revolution among people to work with highly efficient networks. Out of 7 Billion people alive on planet, number of active mobile phone subscriptions crossed 5.9 Billion [1]. No doubt, there is increase in number of services due to latest technologies but along with the advancements, health hazards caused by them should be considered which are well discussed in this paper. Also, this paper shows experimental observations of radiations levels for 2G and 3G wireless communication technologies. Also, health issues created by technology advancements are discussed in this paper.

II. LITERATURE SURVEY

India's telecommunication network is the second largest in the world after China telecommunication market. The number of mobile phone users increased to 87.1 million by December 2012 from 78.7 million users in October 2012, which is expected to further grow to become approximately double i.e. 164.8 million by March 2015 [9]. Furthermore, out of 1 billion users of Facebook, a total of 600 million monthly active users around the globe are mobile users [10]. Hence, the growing demand for personal telecommunications has led to escalation of base station antennas. India has about 7,36,654 base transceiver stations (BTS -2G GSM, CDMA & 3G Mobile Towers) and it is estimated that total number of base station transceivers around the

world will grow more than 17 million per year by 2017 [11, 21].

The above statistics clearly shows the inevitable evolutionary path of wireless communication networks but people are not aware of the radiation exposure and various health hazards caused by radiations. In other terms, we can call it as Electromagnetic Pollution caused by the evolution of mobile communication technologies.

The 2G (GSM and CDMA) mobile phones operate at higher power level than 3G Mobile phones. 3G has adaptive power technology in which step up technique of power control is used. Maximum power radiated by 3G is 0.125 watts for 5 MHz bandwidth, on the other hand, GSM phones radiates an average power of 0.25 and 0.125 watts for 0.2 MHz bandwidth. CDMA phones transmit a maximum 1 watt power [17, 18]. Table 1 shows the comparison between GSM, CDMA and UMTS networks according to frequency and power radiated by them.

TABLE I. POWER LEVELS FOR DIFFERENT TECHNOLOGIES

Frequency (MHz)	Maximum Power (dBm)	Maximum Power (W)
GSM 900	33	2
GSM 1800	30	1
UMTS 2100	21	0.126

Moreover, in Today's smart world, numeral features are offered by smart phones which are replica to computers with calling facility. Everyone knows additional features of smart phones except its radiation danger [5].

III. ELECTROMAGNETIC POLLUTION AND HEALTH HAZARDS

Our workspaces, homes and public places are filled with electromagnetic radiations resulting in tremendous contribution towards electromagnetic pollution. Since some electromagnetic radiations can penetrate 12 inch concrete walls, they are definitely dangerous to human health as well. Towers may contribute 40% of the total exposure by electromagnetic radiations. Hence we are becoming victims of electromagnetic pollution [12].

In USA, the specific absorption rate of a cell phone is limited to 1.6 W/Kg if used for 6 minutes per day. As per safety margin too, it should not be used for more than 18 to 24 minutes per day. But in India, people commonly use cell phones for than an hour per day. ICNIRP recommends that the localized SAR in the head be limited to 2 W/kg averaged over any 10g mass of tissues in the head (0.02 W absorbed in any 10g mass of tissue in the head) [14]. Since cell towers transmit radiations continuously people living within 10m of cell tower receive at least 10,000 times stronger signal than required.

With the exposure of electromagnetic radiation, human body absorbs radiation as it contains 70% of liquid. Different Case Studies show that people are not aware of Electromagnetic Radiations [3]. Cell phone usage poses great threat to living beings. Certain people are especially at risk to mobile phone usage. It is estimated that 3-8% of populations in developed countries suffers from electro hypersensitivity symptoms. Common symptoms are headache, fatigue, nausea, burning and itchy skin and muscle aches. Furthermore its results are debilitating. When a cell phone is used for more than 20 minutes, it results in temperature increase of ear lobes by approximately 1°C which leads to tinnitus (sensation of cell phone ring). Also, the heating inside body causes drying up of fluid around eyes, brain, joints, heart, abdomen etc. It has been revealed that it may lead to cancer too. According to Dr. Magda Havas, PhD, of the Environmental & Resources Studies Department at Trent University, Canada, if a cordless phone base station placed about two feet from your head and plugged in for three minutes at a time can significantly disrupt your heart rhythm, leading to increases in heart rate, arrhythmias and other disturbances in heart rate variability [13]. Prolonged mobile phone exposure has negative effects on sperm motility characteristics and male fertility. Infertility affects approximately 15% of couples of reproductive age, and with nearly half of these cases resulting from male factor infertility. A study that was conducted by 12 research groups in seven European countries found that in laboratory conditions radio waves from mobile phones harm body cells and damage DNA. Children are more defenseless to mobile phone radiation. Many children sleep with cell phones beneath their pillows every night without realizing their health hazards. Children using mobile phones absorb as much as double the

amount of radiation through their heads as adults [14]. Dr. Om Ghandi, a leading scientist and professor of electrical engineering at the University of Utah found that young children under 10 years of age could absorb radiation across their entire brain [15]. The radiation also has adverse effect on birds, animals and environment as well as on honey bees.

IV. MOBILE TECHNOLOGIES

In India, 2G (GSM and CDMA) technologies are used with uplink and downlink frequency ranges are shown by table 2 and table 3 [2, 7]. Also, 3G (UMTS) has been deployed in a few cities, in which base station antenna transmits in the frequency range of 2110 – 2170MHz shown in table 4 [8].

TABLE II. GSM 900 AND GSM 1800 CASE

GSM 900		GSM 1800	
Uplink	890-915 MHz	Uplink	1710-1785 MHz
Downlink	935-960 MHz	Downlink	1805-1880 MHz

TABLE III. FREQUENCIES USED IN CDMA

CDMA Worldwide		In India	
Uplink	824-849 MHz	Uplink	824-844 MHz
Downlink	869-894 MHz	Downlink	869-889 MHz

TABLE IV. FREQUENCIES USED IN W-CDMA

WCDMA 2100	
Uplink	1920–1980 MHz
Downlink	2110–2170 MHz

V. EXPERIMENTAL STUDY OF 2G & 3G MOBILE TECHNOLOGIES

We have conducted a comparison experimentally with the help of an “ElectroSmog Meter” having range (100MHz-6GHz)/ (50Hz-10 KHz). Experiment is conducted using Reliance 3G (Dongle), Tata Photon + EV-DO (Dongle) and Tata DoCoMo 2G (Dongle), using these power level has been measured with the above mentioned meter at a distance of 10 cm [4]. Table V shows the power radiated by various dongles working on 2G and 3G mobile technologies.

TABLE V. POWER RADIATED BY DIFFERENT TECHNOLOGIES

Technology	Power (in dBm)	Distance
Reliance 3G (Dongle)*	-40dBm	10 cm
Reliance 3G (Dongle)**	-17 dBm	10 cm
Tata Photon+ EV-DO (Dongle)	-32dBm	10 cm
Tata DoCoMo 2G (Dongle)	-5dBm	10 cm

*Readings are taken in residential area of town having excellent signal strength and so, high speeds as follows (results from speedtest.net):

- Ping: 89ms
- Download Speed: 5.80 Mbps

- Upload Speed: 3.06 Mbps
- ** Readings are taken in industrial area of city having poor signal strength and so, slower speeds as follows:
 - Ping: 157 ms
 - Download Speed: 2.32 Mbps
 - Upload Speed: 0.98 Mbps
 - The dongle got heated up after a few minutes of operation.

These results are suggestive of higher power transmission (due to the power control algorithm used in 3G networks) and so forth, higher radiation level (nearly equivalent to 2G networks at areas of excellent signal strength) at points where signal strength is poor.

A. Key features of 3G over 2G

3G has numeral key features. We have summarized its three important features which are helpful in reducing output power.

Fast Power Control: 3G has fast power control mechanism which adjusts the power in 0.6ms whereas in case of 2G, time period is 60ms [20-22].

Soft Handovers: 3G support Soft and Softer Handover which means UE (User Equipment) keeps always one radio link as frequency is same in W-CDMA.

Low initial power: 2G uses step down technology in which mobile starts with maximum power for several seconds and step down its power to such extent so that call is established. On the other hand, 3G uses step up mechanism which means phone starts with low power and step up its power [20, 22].

VI. PRECAUTIONS

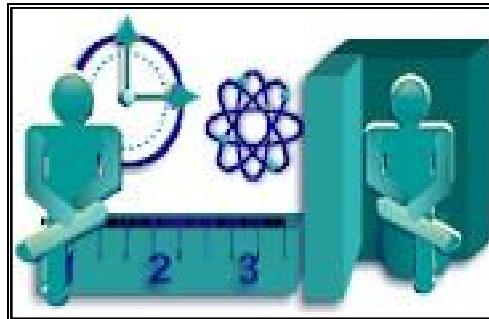


Fig.1 Basic concepts of radiation protection: time, distance and shielding

A. Time

The amount of radiation exposure increases and decreases with the time people spend near the source of radiation.

B. Distance

The further away people are from a radiation source, the lower is their exposure. The exposure of an individual sitting 4 feet from a radiation source will be 1/4 the exposure of an individual sitting 2 feet from the same source

C. Shielding

Shielding is something between a person and source of the radiation which absorb the radiations [16].

Figure 1 shows basic concept of radiation protection which are discussed above. Apart from these and as per DOT (Department of Telecommunication), following precautions should be taken into account for the protection purposes:

- Use loudspeakers
- Reduce excessive calling
- Make distance from the mobile device e.g. do not keep your cell phone near your head/pillow while you sleep
- Always check the signal intensity and don't call when the signal is weak, because then your mobile will irradiate maximally [6].

- Use text messages when possible but in limit
- Bluetooth Headset can be used
- Prefer landline over mobile phones if possible
- Avoid keeping mobile phone near breast and pants pocket [19].

VII. CONCLUSION

Little bit poor connectivity is better than poor health. Electromagnetic fields have swamped our natural environment and are showing ill-effects to not only human health but also on animals and plants. Results are showing that 3G is safer than 2G due to its numeral advance features such as fast power control functionality, soft handovers, low initial power, etc. Also, Radiation level decreases with increase in the distance from the mobile phone.

REFERENCES

- [1] Amit Kumar, Tanvir Singh, DivyaKhurana, "Energy Optimization in Wireless Communication Network through Renewable Energy Sources (RES)", IEEE Explore, IEEE 5TH India International Conference on Power Electronics (IICPE), Delhi Technology University, New Delhi, 6-8 December, 2012.
- [2] Prince Verma, Tanvir Singh, Amit Kumar. "Electromagnetic Radiation Exposure: A Survey Report". International Conference on Emerging Trends in Engineering and Technology (IETET-2012) at Geeta Institute of Technology and Management, Kanipla, Kurukshetra, Haryana, India (9-11 Nov, 2012), International Journal of Applied Engineering Research, IJAER Vol. 7 No.11, 2012.
- [3] MohitKaushal, Tanvir Singh, Amit Kumar, "Effects of Mobile Tower Radiations & Case Studies of different Countries", 3rd International Conference on Emerging Trends in Engineering & Technology (IETET2012), International Journal of Applied Engineering Research.
- [4] Amit Kumar, VasishathKaushal, Tanvir Singh, Dr.Sawtantar Singh Khurmi, "Wireless Technologies and their Radiation Hazards: A Practical Observation", International Journal of Electronics & Communication Technology, IJECT Vol. 3, Issue 3, July - Sept 2012.
- [5] Devinder Singh, Tanvir Singh, Amit Kumar, "Smart Phones Vs Tablets: A Review", International Journal of Electronics & Communication Technology, IJECT Vol. 3, Issue 3, July - Sept 2012.
- [6] Amit Kumar, Tanvir Singh, Dr. Yunfei Liu, Dr. Sawtantar Singh Khurmi, "Health Implications of Mobile Radiations & Role of SAR", The Second International Conference on Interdisciplinary Research and Development, Bangkok, Thailand, 1 June, 2012. Special Issue of the International Journal of the Computer, the Internet and Management (IJCIM) (Accepted).
- [7] Tanvir Singh, Amit Kumar, Dr. Sawtantar Singh Khurmi, "Scarce Frequency Spectrum and Multiple Access Techniques in Mobile Communication Networks", IJECT Vol. 2, Issue 2, June 2011.
- [8] Girish Kumar, "Report on Cell Tower Radiation", December 2010
- [9] "Internet mobile users set to double to 165 m by 2015", January 2, 2013, [On-line]. Available: <http://www.thehindu.com/sci-tech/internet/internet-mobile-users-set-to-double-to-165-m-by-2015/article4265560.ece>.
- [10] Emil Protalinski, "600 million of Facebook's 1 billion users are mobile", October 4, 2012 [On-line]. Available: <http://thenextweb.com/facebook/2012/10/04/facebook-now-has-600-million-monthly-active-mobile-users>
- [11] Campbell, Calif., "Declining Base Station Transceiver Market to Stabilize with LTE", August 2, 2012, [On-line]. Available: <http://www.prnewswire.com/news-releases/declining-base-station-transceiver-market-to-stabilize-with-lte-164726716.html>
- [12] "Electromagnetic Pollution", [On-line]. Available: <http://www.emwatch.com/>
- [13] "Raising Awareness about Electromagnetic Pollution", [On-line]. Available: <http://articles.mercola.com/sites/articles/archive/2011/02/16/raising-awareness-about-electromagnetic-pollution.aspx>
- [14] Prof. Girish Kumar, "Report on cell tower radiation submitted to secretary, DOT, Delhi", December 2010
- [15] "Children Endangered by Cell Phone Radiation", [On-line]. Available: <http://www.internationalparentingassociation.org/BrainDevelopment/cellphones.html>
- [16] "Radiation Protection Basics" (7-7-12), [On-line]. Available: http://www.epa.gov/rpdweb00/understand/protection_basics.html
- [17] Byte Beats, Output power levels for GSM and UMTS systems, August 2011, [On-line]. Available: <http://bytebeats.com/2011/08/09/output-power-levels-for-gsm-and-umts-systems/>
- [18] ACMA, Electromagnetic energy and 3G mobile phones fact sheet, [On-line]. Available: http://www.acma.gov.au/WEB/STANDARD/pc=PC_1746
- [19] Mobile Communication Radio Waves & Safety, Department of Telecommunication, Ministry of Communications & IT, Government of India, [On-line]. Available: http://www.dot.gov.in/Electrical/Journey%20to%20EMF%20Radiation/Mobile_Communication-Radio_Waves_and_Safety_3_oct_12_final.pdf

- [20] ETSI Specification 3GPP TS 25.214 version 6.6.0: 'Universal Mobile Telecommunications System (UMTS); Physical layer procedures (FDD)', June 2005
- [21] ETSI Specification 3GPP TS 05.08 version 8.22.0: 'Digital cellular telecommunications system; Radio subsystem link control', Nov. 2004
- [22] J. Baumann, F.M. Landstorfer, L. Geisbusch and R. Georg, "Evaluation of radiation exposure by UMTS mobile phones", Electronics Letters, 16th February 2006, Vol. 42 No. 4