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Wireless Technologies and their Radiation Hazards: A Practical Observation

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Abstract
With the dawn of the 21st century, the communication technologies have advanced manifold. Where people earlier used to seek telephone lines to get a dial up internet connection with a speed of 56 kbps, now they can access broadband speeds on the move without any wires. So, this explains the extent to which the technology has advanced in a very short period. But, as we know that the electromagnetic waves used by the wireless systems are absorbed by the human body, so the advancement in various technologies have created health issues which will be discussed in this paper.

Keywords
Mobile Radiations, SAR, WiMAX, EGPRS, UMTS, HSPA+.

I. Introduction

The 21st century has seen a revolutionary increase in the mobile broadband customer base. More and more companies are roping in technology providers for deploying high quality broadband networks which is helping them to increase their rural footprints in the rural areas. According to recent studies, there is a large amount of increase in the mobile broadband customers due to falling prices and increasing speeds. Fig.1 shows the global mobile connections.

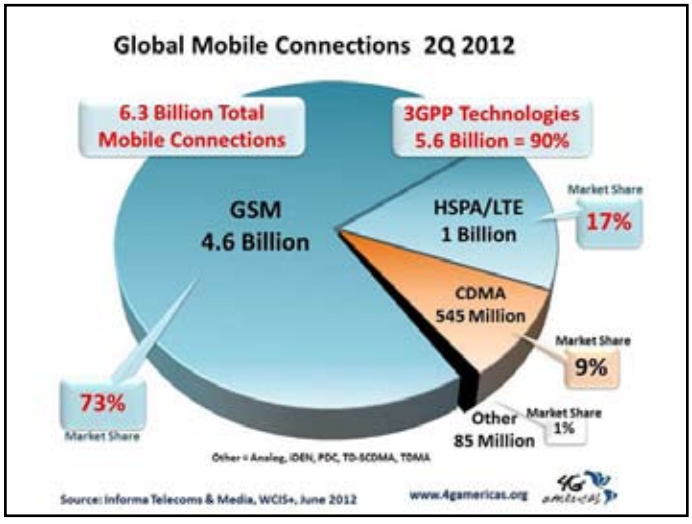

Fig. 1: Global Mobile Connections
Source: www.4gamericas.com

So, this has been a great reason for the increase in amount of radiation in our environment and in the homes as well. Since, the electromagnetic radiations are absorbed by our body; it has significant effects on the cells and tissues. Mobile phones and towers emit electromagnetic radiations which are absorbed by the human body and have hazardous health effects which can be thermal or non-thermal. Thermal effects refer to the heating up of human tissues due to absorption of radiation by the body. It is also known as SAR (Specific Absorption Rate). Non-thermal effects occur on the cells, genes and the DNA and are more harmful than thermal effects [20]. Excessive use of mobile phones can lead to headache, sleep disturbance, lack of concentration, memory loss, tinnitus (ringing in the ears) and increased risk of brain cancer. Having mobile towers in your neighbourhood can also pose health problems like severe headache, sleep disturbance, constant body pain, memory problems, joint pains etc. The more severe health effects noted include infertility, miscarriage, neurodegenerative disorders (Alzheimer's, Parkinson's, etc.), heart problems and cancer [1]. Different communication technologies use different frequencies and transmission powers, so they have different levels of SAR. We will be comparing the SAR values for different technologies to find out the most safe and most deployable technology.

II. Current Scenario of Technologies

A. 2G GSM/EDGE/GPRS

More than 5 billion people worldwide use the Global System for Mobile Communications (GSM) family of technologies. GSM is the most widely used wireless technology in the world, available in more than 219 countries and territories worldwide, with a market share of more than 90 percent. GSM has quickly become the fastest-growing wireless technology in North America and Latin America and the Caribbean. GSM's share of market in the Western Hemisphere is 75 percent with more than 750 million customer connections [2]. The GSM network is the base of further technologies like EDGE, GPRS, and UMTS etc. and GSM uses 900/1800/1900 MHz frequency spectrum worldwide [9-11].

B. UMTS/WCDMA/HSPA/Evolved HSPA

Universal Mobile Telecommunications System (UMTS) is a voice and high-speed data technology that is part of the International Telecommunication Union's (ITU) IMT-2000 family of third-generation (3G) wireless standards [3]. We use WCDMA and UMTS interchangeably since the former is the radio technology used in latter. UMTS is based on Internet Protocol (IP) technology with user achievable peak data rates of 350 kbps and more typical speeds for both the uplink and the downlink at 200 to 300 kbps. UMTS technology is more mature and benefits from research and development that began in the early 1990s. It has been thoroughly trialed, tested and commercially deployed. UMTS deployment offers stable network infrastructures and attractive, reliable mobile devices that have rich capabilities. With the addition of HSPA for high-speed packet data services, UMTS-HSPA is quickly emerging as the dominant global mobile-broadband network. The advancement to evolved HSPA aka HSPA+ has further increased the data rates to upto 21.1 Mbps (Downlink) and 5.6 Mbps (Uplink) and lowered the latency in the connection [6-8].

C. CDMA2000 -1X AND EV-DO

Likewise GSM, the CDMA technologies also have not been so far behind. The CDMA standard also advanced to 3G and introduced Evolution-Data Optimized. The EV-DO standard offers downlink speeds of upto 3.6 Mbps as compared to the CDMA2000 -1X RTT which offered upto 144 kbps of downlink [12-14].

D. Wi-Fi

The IEEE 802.11 standard provides a very high speed and reliable wireless link which can successfully be used as a replacement to wired LAN connection [15, 16]. Hence Wi-Fi is also called as Wireless LAN or WLAN. It offers a speed of up to 54 Mbps without MIMO and 150 Mbps with MIMO (802.11n). It operates at a frequency of 2.4 GHz (for 802.11 b/g/n) and at 5 GHz (for 802.11a).

Wi-Fi also has become an important technology for the deployment of Unlicensed Mobile Access (UMA) services. These typically involve a handset that includes a cellular and Wi-Fi radio that can take advantage of a campus or in-home Wi-Fi router to place calls using VoIP technology that can then transfer seamlessly to a cellular network once outside the range of the Wi-Fi signal. Unlike VoIP calling, when UMA customers leave home or exit a Wi-Fi hotspot, their calls are seamlessly transferred to that operator's GSM-HSPA wireless network. Calls also transfer from the wireless network onto Wi-Fi [4].

E. Wi-MAX

Worldwide interoperateability for microwave access (Wi-MAX) IEEE 802.16 emerged as a standard for the deployment of wire line DSL internet like speeds in remote locations [17-19]. WiMAX technology is very cheap as only one BTS is required for coverage in a 15 Km area. The WiMAX technology can offer speeds of up to 37 Mbps for 802.16e – 2005 standard. Some of WiMAX's principal differences from HSPA are that mobile WiMAX uses OFDMA and is only initially standardized for Time Division Duplex (TDD) spectrum bands which are limited in global availability. LTE, the next evolution for UMTS-HSPA, is also based on OFDMA and is available in both the Frequency Division Duplex (FDD) – which is widely available spectrum – and TDD spectrum bands. Mobile WiMAX equipment manufacturers are working on what is called half-duplex FDD for the technology, which would allow a user to only transmit or receive information at one time, unlike full-duplex FDD's ability to support both transmit and receive signals at the same time [5].

III. Comparison of Radiation Levels of Various Technologies

Measurements of power transmitted by different devices like Cellular phones, Data Cards (Internet Dongle), Blue tooth, WiFi Device etc. were taken by our research team in Mohali (Punjab), India by keeping the RF EMF meter at various distances and the observations recorded are interpreted on the Power Transmitted vs. Distance Graphs/Charts (Refer Fig. 3 to Fig. 8)

A. Experimental Study Performed by CORNET ED-75, Electro Smog Meter

1. Laptop Used

Compaq 510, Intel(R) Core(TM) 2 Duo CPU, T5870 @ 2.00GHz

2. Mobile Used

Nokia X2-00, V 08.25, RM-618, 1.28 W/kg (head), 0.89 W/kg (body) (US)

Nokia C3-00, V 08.63, RM-614, 1.11 W/kg (head), 0.87 W/kg (body) (US)

Nokia C2-02, V 06.51, RM-692, 0.68 W/kg (head), 0.55 W/kg (body) (US)

3. Internet Dongle Used

ZTE USB dongle running on GSM 1800 MHz band and UMTS 2100 MHz band

4. Device Used

CORNET ED-75, Electro smog Meter, RF/LF Field Strength power meter (100MHz-6GHz)/ (50Hz-10 KHz) (see fig. 2)

Fig. 2: CORNET – Electrosmog Meter

Meter Indications for Various Readings

-5dbm.....Red
-10dbm.....Red
-15dbm.....Red
-20dbm.....Yellow
-25dbm.....Yellow
-30dbm.....Yellow
-35dbm.....Green
-40dbm.....Green

Table 1 to 6 shows the mean value of the observations recorded for various technologies, under different conditions and varying distances with corresponding graphical representation of the same in fig. 3 to fig. 8.

Table 1: Power Radiated Vs Distance During Call using Bluetooth Device

Distance (cm)	Power Radiated (dBm)
0	-3.5
10	-29.3
20	-30.3
30	-32.5
40	-36.2

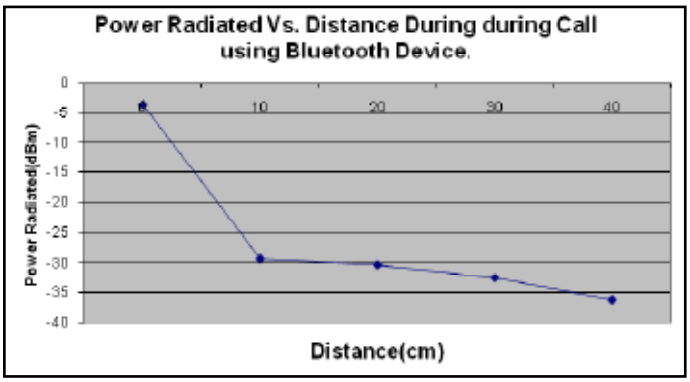

Fig. 3: Power Radiated Vs Distance During Call using Bluetooth Device

Table 2: Power Radiated Vs Distance During Ringing of Cellphone (Incoming)

Distance (cm)	Power Radiated (dBm)
0	-0.72
50	-18.66
100	-23.24
150	-34.46
200	-38.5
250	-39.54

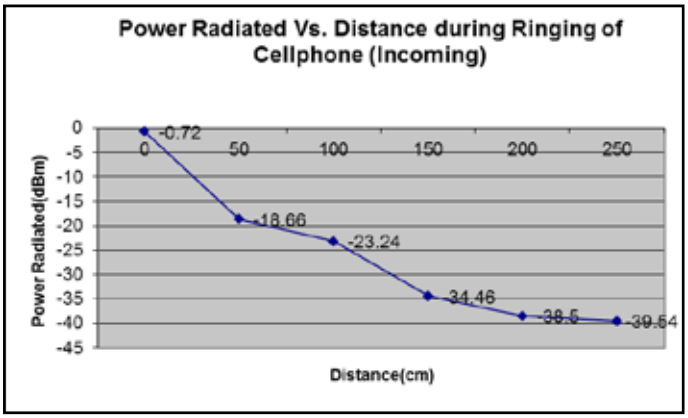

Fig. 4: Power Radiated Vs Distance During Ringing of Cellphone (Incoming)

Table 3: Power Radiated Vs Distance During Ringing of Cellphone (Outgoing)

Distance (cm)	Power Radiated (dBm)
0	4.54
50	-7.64
100	-26.08
150	-21.7
200	-32.94
250	-36.28

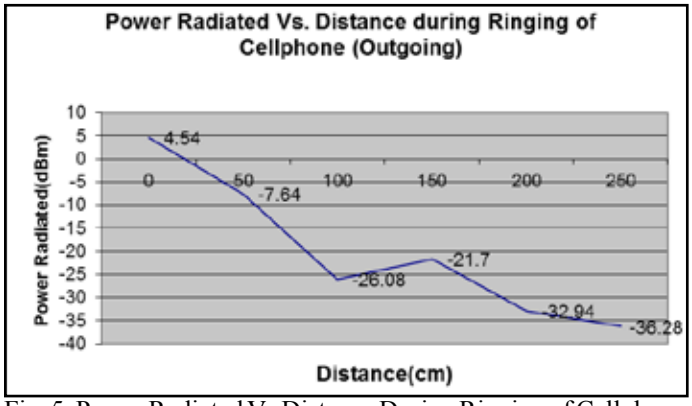

Fig. 5: Power Radiated Vs Distance During Ringing of Cellphone (Outgoing)

Table 4: Power Radiated Vs Distance During Call (Incoming)

Distance (cm)	Power Radiated (dBm)
0cm	5
50cm	-16.1
100cm	-19.7
150cm	-27.9
200cm	-35.3
250cm	-47.3

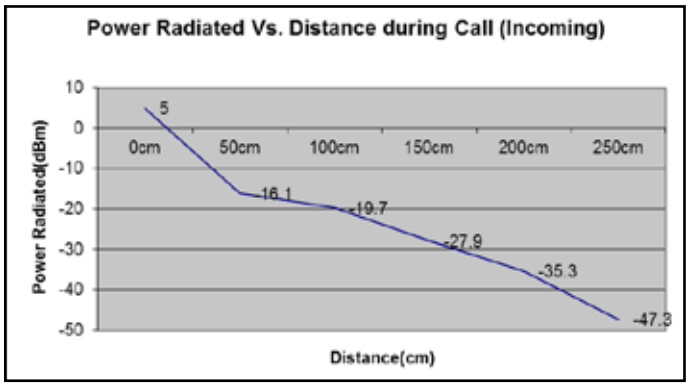

Fig. 6: Power Radiated Vs Distance During Call (Incoming)

Table 5: Power Radiated Vs Distance During Call (Outgoing)

Distance (cm)	Power Radiated (dBm)
0cm	5
50cm	-23.8
100cm	-32.8
150cm	-33.4
200cm	-33.6
250cm	-42.8

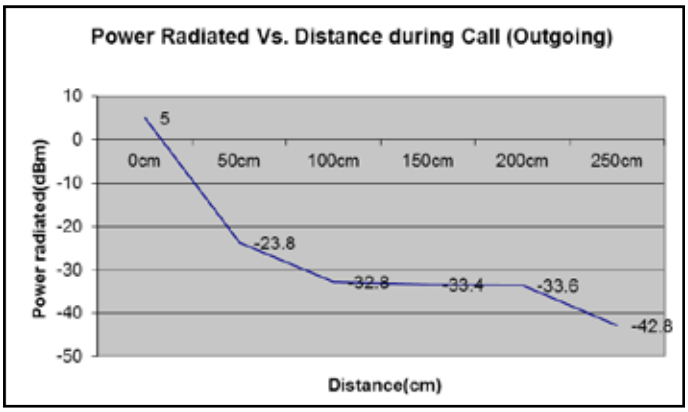

Fig. 8: Power Radiated Vs Distance During Call (Outgoing)

Table 6: Power Radiated Vs Distance During Ringing of WiFi Connectivity

Distance (cm)	Power Radiated (dBm)
0cm	-8.2
10cm	-13.7
20cm	-20.2
30cm	-23.6
40cm	-22.6
50cm	-25.7
60cm	-25
80cm	-30.1
110cm	-25.2

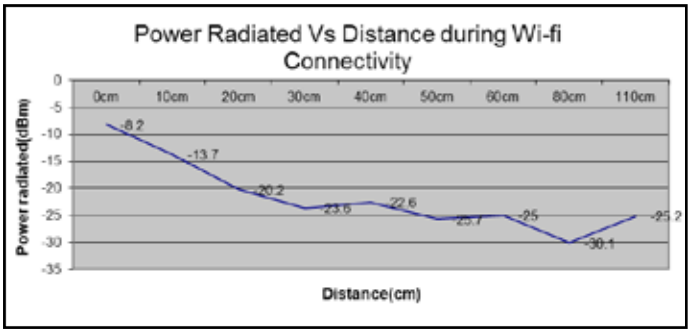

Fig. 9: Power Radiated Vs Distance During Ringing of WiFi Connectivity

IV. Result

It has been observed that the radiation level decreases with increase in the distance from the mobile phone. Moreover the increase in distance also results in a comparatively safer level (Yellow or Green) of radiations which confirms the fact that it is not safe to keep and use the cell phone close to our body. Use of Bluetooth and ear phones can be safer choice while using the cellphone (both in case of incoming and outgoing calls).

V. Conclusion

Our living environment is being swamped with electromagnetic fields that raise intensity levels and show a wide range of novel characteristics. We should aware about the danger of Radiation levels which we have discussed in our paper by performing some experiments at different distances. In this paper, we took some practical observations to justify the possible health implications caused by mobile radiations and the precautions which can be taken to avoid the dangerous levels of radiations.

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