A Review on Different Generations of Mobile Technology and Experimental Study of Radiation Levels Emitted During Wi-Fi and Mobile Data from Mobile Phones

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Abstract **–**Mobile phones have travelled a long way from being a luxury to a necessity. The journey continues and world is getting addicted to this device owing to numerous services getting available on cell phone. In fact, the term "Cell phone" is being replaced by "Smart phone" which is an integrated device which acts as a Palm Top, Camera, Mobile Phone and much more. The device has several pros but the cones have been ignored by both manufacturers as well as consumers. In today's Smart World, we have several options available to connect our Smart phone to the Internet anytime anywhere but we are unaware of the EMRs being emitted by our hand held devices and their prospective dangers. In this paper, we have reviewed the technological advancement of a mobile phone and discussed the radiation levels emitted from mobile phones in two scenarios. Firstly, when a mobile phone is being used with Mobile data ON and secondly, when a Wi-Fi connection is used to carry out the same procedure.

Keywords- *Mobile Radiations, Electromagnetic Radiation, Wi-Fi, Mobile Data.*

I. INTRODUCTION

Mobile industry has seen enormous growth in the last two decades but the last few years have been like a revolution with technological advancements in the technology. The mobile technology has evolved with generations termed as 1G, 2G, 3G and 4G, with a next step towards 5G. This growth has a dark side of the technology i.e. Electro Magnetic Radiations (EMRs). Young generation has become smarter by shifting on to smart integrated hand held devices. In fact the internet on the mobile phone is responsible for this gradual change. But no one is aware of the radiation exposure he or she has been facing by extensive and irrational use of mobile phones. In this paper we have discussed the evolution of mobile communication technology, generation by generation and the possible danger of EMRs to the human health. The paper also addresses the radiation levels in two different scenarios i.e. when we use mobile phones with Mobile Data ON and when we use a Wi-Fi connection to access internet over the mobile phone.

II. EVOLUTION FROM 1G TO 4G

A. First Generation (1G)

IG Technology was originated in NORTH AMERICA and is known as Analog Mobile Phone Systems (AMPS). Before 1G i.e. at the time of 0G, the organizations were still involved in making landline communications nationwide instead of concentrating on mobile networks which was limited to only few masses. Also the idea to standardize mobile communications was not there in the mind of organizations, that's why the mobile market was owned by regional organizations. Then revolutionary step was taken by Nordic countries which started to implement the standardization part. 1G is an analog technology. The concept of digitization of signals was not introduced since 1970's, which was the introductory session of this technology. 1G is also called as AMPS and this was based on circuit switching and it was made only for voice transferring and no data transfer was there. Inefficient use of frequency spectrum and inability to support roaming were the main reasons for generation of new technologies.

Fig.1: A base station system for 1G

As shown in fig.1, a base station system was developed at the time of 1G, which could cover 60 miles or more which was sufficient to embrace the whole metropolitan area. But only limited number of subscribers had to use the communication channels while others had to wait for their turn to come and this contributed towards the inefficiency side [1].

The most common 1G mobile systems were:

1. AMPS
2. NMT(Nordic Mobile Telephone)
3. TACS(Total Access Communication Systems)[2]

With the development of 1G mobile phones, the mobile market has showed 50 percent increase in growth annually. Till 1990 the number of subscribers has increased to 20 million.

One of the major drawback of this technology is the large size of mobile phones. The briefcase size was the smallest one. Examples are as shown in fig.2.

Fig.2: Examples of 1G

B. Second Generation (2G)

2G Technology has initialized the digitization of signals, which is the first important difference with 1G.The main aim is to travel till communication ubiquity is not reached. 2G technologies involve TDMA and CDMA (Code Division Multiple Access).Various 2G technologies are:

1. **GSM**: It is TDMA based. It was originated in Europe but in usage in most of the countries today. It covers almost 80 percent of all subscribers all over.
2. **IS-95 or CDMA** one: It is based on CDMA and is used in America and some parts of Asia. It covers 17percent of total subscribers.
3. **PDC:** PDC is Personal Digital Communication. It is based on TDMA and is used mostly in Japan.

IS-36 or D-AMPS: It is called as Digital AMPS which is again based on TDMA and in US it is denoted as Simple TDMA. It had its existence in America but they have migrated to GSM now.

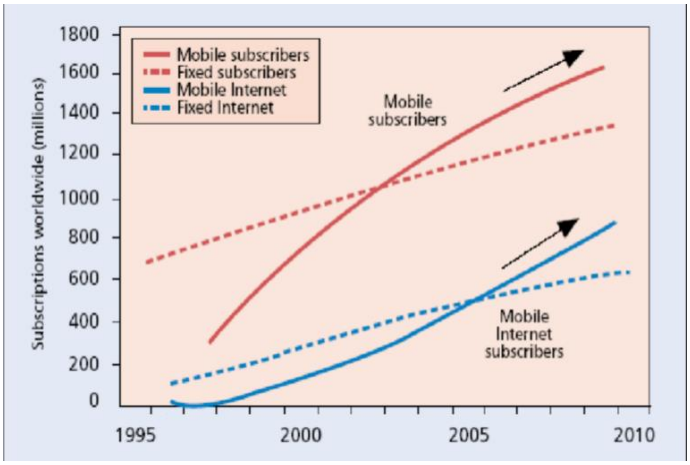

Fig.3: Increasing demands for mobile communications

Fig.3 has illustrated the yearly increase in use of mobile communication which leads to development of new technologies. GSM technologies are GSM900, GSMR, GSM1800, GSM1900, GSM 400. It involves about 250 million mobile subscribers from total of 450 million quantities including international roaming in about 150 countries. The various services of GSM standards are circuit switched voice data, fax, SMS, voicemail, WAP(Wireless Application Protocol), MLS(MOBILE Location Services) and last but not least the cell broadcast.[3]

2.5 G was introduced after 2G which is called as EDGE technology. 2.5G systems embellish the data proportions and abridges the some of its limitations. It adds packet switching features and most important are the GPRS and WAP technology. FDMA technique is used which further uses the TDMA for each frequency band and total of 8 timeslots are formed and 8 simultaneous calls can be performed on same frequency. Fig.4 will show the 2G models [4].

Fig.4: 2G Models

Add-Ons to 1G:

1. Fraud reduction.
2. Maintained privacy.
3. Introduction of SMS, e-mails.
4. Noise reduction

Lesser amount of power emissions will result in positivity towards healthy environment [6].

C. Third Generation (3G)

3G TECHNOLOGY give rise to true multi-media cell phone named 'Smartphones'. The first pre-commercial 3G network was launched by NTT Docomo in japan which was named as FOMA. Various 3G technologies are:

1. CDMA-2000: It is based on 2G CDMA
2. WCDMA: It is Wideband CDMA.
3. TD-SDMA: It is named as Time Division Synchronous CDMA.

The various features of this technology are faster transmission of data worldwide, the revolutionary rise in the network capacity, various advanced services like video conferencing, with transfer 3G network speeds up to 3 Mbps, high spectrum efficiency, and it supports both packet switching and circuit switching transmission and many more. The difference between CDMA and WCDMA for 2G and 3G respectively are shown in fig.5 [7].

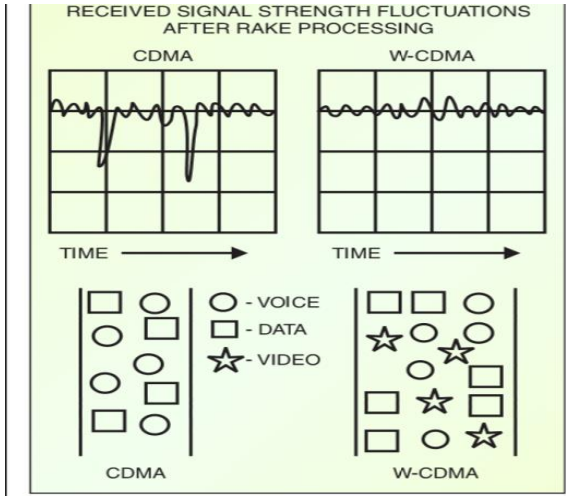

Fig.5: Difference between CDMA and WCDMA

Standards for 3G: IMT-2000 is the standard for 3G that defines various requirements stated by ITU (International Telecommunication Union). IMT is International Mobile Telecom and 2000 stands for its year for initial trial and for 2000 Mhz frequency.[8]

D. Fourth Generation (4G)

4G stands for 4th generation. 4G technology aims for merging all the mobile technologies i.e. GSM, GPRS, IMT-2000, Wi-Fi, BLUETOOTH as shown in fig.6. The user are freed to select any of the above services with reasonable prices anywhere in the world.

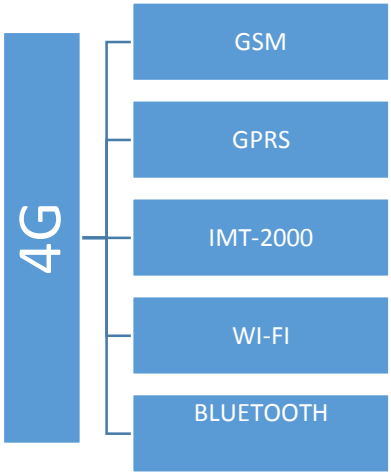

Fig.6. Inclusions for 4G

As 4G aims to consolidate all the above mentioned services,its being a positive point but on the other side, there may have some complications. The terminals shouls be like

that they must adapt themselves according to the various wireless networks having different protocols and technologies. Besides this the terminals should automatically configure that which service requires which kind of wireless network. There should be horizontal and vertical hand-offs in case of terminal mobility [9, 10].

Generation	Requirements	Comments
1G	No official requirements. Analog technology.	Deployed in the 1980s.
2G	No official requirements. Digital Technology.	First digital systems. Deployed in the 1990s. New services such as SMS and low-rate data. Primary technologies include IS-95 CDMA and GSM.
3G	ITU's IMT-2000 required 144 kbps mobile, 384 kbps pedestrian, 2 Mbps indoors	Primary technologies include CDMA2000 1X/EV-DO and UMTS-HSPA. WiMAX now an official 3G technology.
4G	ITU's IMT-Advanced requirements include ability to operate in up to 40 MHz radio channels and with very high spectral efficiency.	No technology meets requirements today. IEEE 802.16m and LTE-Advanced being designed to meet requirements.

Fig.7. Evolution of network technologies

Fig.7 describes the various requirements of 1G, 2G, 3G, 4G wireless technologies as discussed above.

III. EXPERIMENTAL STUDY OF RADIATION LEVELS FROM WI-FI AND MOBILE DATA

A. Device Used

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

Fig.7: CORNET – Electrosmog Meter

Meter Indications for Various Readings
-5dbm.....Red
-10dbm.....Red
-15dbm.....Red
-20dbm.....Yellow
-25dbm.....Yellow
-30dbm.....Yellow
-35dbm.....Green
-40dbm.....Green

Radiation Level when Mobile Data is ON

Distance (cm)	Power Radiated (dBm)
0	+2.0
10	-1.2
20	-13.4
30	-25.1
40	-27.8

Radiation Level when Wi-Fi is ON*

Distance (cm)	Power Radiated (dBm)
0	-21.3
10	-22.9
20	-24.1
30	-26.5
40	-27.8

- Wi-Fi Modem is at the distance of 3m from Mobile Phone

From the above two scenarios of data usage in mobile phones, it is clear that we are not in safer zone and hence under the blanket of electromagnetic radiations [11, 12]. So, following precautions should be kept in mind while using mobile phones:

- Use loudspeakers while calling
- Reduce excessive calling
- Do not keep your cell phone near your head or under the pillow while sleeping
- Don't call when the signal is weak, as in that case mobile phone irradiate maximally
- Use text messages when possible but in limit
- Use Bluetooth Headset
- Landline phones are more safer, so us them whenever possible

IV. CONCLUSION

The telecom industry has witnessed a revolutionary growth in last few years owing to introduction of smart phones in the

market. In fact the mobile phone has become an unavoidable gadget these days due to its integrated nature to comprise of various features which allow us to discard several other devices. The hand held device has also posed a threat to human health and environment which has highlighted the darker side of the technology. The Radiations emitted by mobile phones and mobile towers have become a critical factor and a topic of concern to address the sustainability issues related to the mobile technology. This paper presented the technological advancement of a mobile phone 1G to 4G and the radiation levels emitted from mobile phones in two scenarios. Firstly, when a mobile phone is being used with Mobile data ON and secondly, when a Wi-Fi connection is used to access internet over the mobile phone. The study indicates the potential dangers of mobile technology and the possible measures which we can take to minimize the effect of EMRs with a rational use of the technology.

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