

World with 5G Technology: Intelligence, Scope & Hazards

Pragati Sharma¹, Dr.A.K.Gautam²

¹Research Scholar, Electronics and Communication Engg. Mewar University, Rajasthan, India

Abstract - The upcoming 5G technology going to be a new invention in the field of cellular communication as one can use worldwide cellular phones through this technology. It's the time when the sector of technology perusing high research worldwide. There is a need of such an intelligent technology which interconnects the entire world without limits and contains artificial intelligence. The artificial intelligence of 5G make user able to control his robot with his mobile phone or to automatically type the messages of your imagination and many more. All such features make 5G more attractive than previous generation phones while in previous researches data reveals that the high rate of exposure may prove as dangerous to human. In this paper we tried to figure out the 5G intelligence system and its scope along with tried to link the intelligent version of 5G with human health.

Keywords- 5G, Electromagnetic wave (EM wave), Base Transceiver Station (BTS), Global system for mobile communication (GSM), Electromagnetic Field (EMF), Nordic Mobile Telephone(NMT), Specific absorption rate (SAR), International Mobile Telecommunications (IMT), Universal Mobile Telecommunication System (UMTS), Orthogonal Frequency Division Multiplexing (OFDM), Wideband Code Division Multiple Access(WCDMA), Long Term Evolution(LTE)

I. INTRODUCTION

Cellular phones now became the necessity to communicate with people not only in voice form but also in text form via email, sms etc and live video form via video conferencing. Since 1897 when Marconi first demonstrated radio waves ability to communicate till now, different wireless communication methods and services are adapted by people throughout the world to cater the need of communication. Cellular communication is an important type of wireless communication. There are now around 1 billion users of mobile phone in India in 2015[1]. Therefore mobile phone technology getting updated many folds every decade since the launch of first generation (1G) technology. Now it's time of 5G technology which is enriched with many more features and intelligence. Main motive is to develop such a mobile standard that uses less energy and radio spectrum while delivering faster than current 4G speeds. A basic wireless network structure is shown in figure-1.

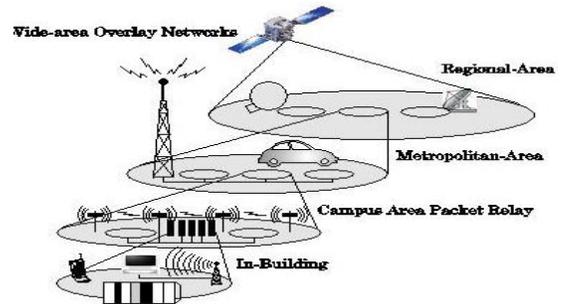


Fig-1: A view of wireless network structure

As the generation of wireless cellular communication advances, so the cellular phones structure also changes with it shown in figure-2.



Fig-2: 1G to 5G cellular phones

All the cellular wireless communication uses radio region of frequency spectrum. Figure-3 shows Frequency spectrum of RF region of cellular communication system. 5G uses millimeter waves for its communication which ranges from 30-300 GHz wide using EHF band of frequency while the lower generations work on VHF and UHF band.

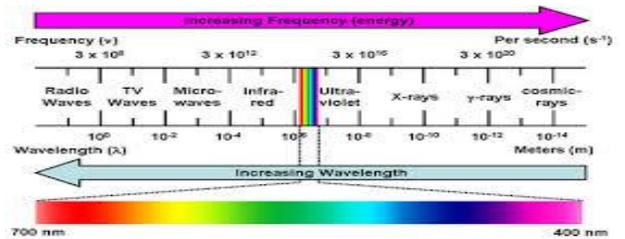


Fig-3: Frequency Spectrum of cellular communication

II. COMPARATIVE ANALYSIS: 1G TO 5G

A comparative analysis of first generation (1G) to fifth generation (5G) is given to approach all the technologies in a glance in table-1.

Table-1: Comparative analysis of 1G to 5G

| Cellular Generation | Year of Generation | Standard | Prime Features and specifications | Services offered |
|---------------------|-------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| 1G | 1981 | AMPS | Operating frequency-824-894 MHz Channel bandwidth-30 KHz M U max power-3 W Speed-2.4Kbps Modulation-FM Analogue system of communication Multiplexing-FDMA | Analog phone calls |
| 2G | 1992 | GSM | Operating frequency-890-960 MHz Channel bandwidth -200 KHz M U max power-20 W Speed- 64 Kbps TDMA or CDMA based Modulation -GMSK Secure and Mass adoption Uses digital technology Multiplexing-TDMA/CDMA | Digital phone calls and messaging |
| 3G | 2001 (In India 2008) | IMT-2000 & UMTS | Operating Frequency – 1800-2200 MHz Channel bandwidth -5MHz speed- 2 Mbps(max) Enhanced multimedia, e-mails Excellent quality of voice Able to transmit packet switch data Web browsing and video conferencing Multimedia messaging services(MMS) Better internet experience Multiplexing-WCDMA | Phone calls, messaging, better internet experience |
| 4G | 2011 | IMT Advanced (LTE) | Operating Frequency –variable frequency bands (up to 3500MHz) Channel bandwidth -20-100 MHz Speed-200 Mbps Uses OFDM transmitter Better link and communication quality More impervious to fading Inexpensive wireless broadband access Provide smooth global roaming with low cost Faster broadband internet | All IP services (including voice, messaging) |
| 5G | Early 2020 | | Operating Frequency –(30-300 GHz) millimeter waves Channel bandwidth -2-4 GHz speed –Above 1Gbps One unified global standard Internet protocol version –IPV6 Ubiquitous computing Equipped with artificial intelligence Multiple concurrent data transfer paths More secure Cell phone can work as broadband internet access | Researches going on |

III. HISTORY

Researches have been started worldwide to become the master of 5G technology. Many countries started 5G research program solely or in joint venture with some other country.

2008: NASA partnered with Geoff Brown and Machine to Machine Intelligence (M2M) Corp to develop 5G communications technology [2]. At the same year, the South Korean IT R&D program of "5G mobile communication systems based on beam division multiple access (BDMA) and relays with group cooperation" was formed.

2012: Mobile and wireless communications Enablers for the Twenty- twenty Information Society (METIS) starts its activity towards the definition of 5G. METIS intends to ensure an early global consensus on these systems [3].

2013: ITUR Working Party 5D (WP 5D) started two study items: (1) Study on IMT Vision for 2020 and beyond, and; (2) Study on future technology trends for terrestrial IMT systems. Both aiming at having a better understanding of future technical aspects of mobile communications towards the definition of the next generation mobile. At the same year on 12 May 2013, Samsung Electronics stated that they have developed the world's first "5G" system. The core technology has a maximum speed of tens of gigabits per second. In testing, the transfer speeds for the "5G" network sent data at 1.056 Gigabits/sec to a distance of up to 2 kilometers. In July 2013, India and Israel have agreed to work jointly on development of fifth generation (5G) telecom technologies [4]. On 1 October 2013, NTT (Nippon Telegraph and Telephone), the same company to launch world first 5G network in Japan [5]. On 6 November 2013, Huawei announced plans to invest a minimum of \$600 million into R&D for next generation 5G networks [6].

2014: NTT DoCoMo start testing 5G mobile networks with Alcatel Lucent, Ericsson, Fujitsu, NEC, Nokia and Samsung [7]. On 19 November 2014, Huawei and SingTel announced the signing of a MoU to launch a joint 5G innovation programme [8].

IV. INTELLIGENCE OF 5G

The researches on 5G should make an important difference with earlier generations and focused to add more intelligent features and services to the world over 4G. Every mobile with 5G technology will be equipped with IPV6 protocol and have an IP address according to the location and network being used [9]. The technology is expected to support virtual private network, advanced billing interfaces and broadcast of data in

giga bits. All network operators (GSM, CDMA, PSTN etc) can be connected to one Super Core with massive capacity [fig-4]. This is realization of single network infrastructure. This concept of Super Core will eliminate all interconnecting charges and complexities, which is right now network operator is facing thus flexible roaming facilities in 5G. 5G will offer even more flat architecture by using advanced semiconductor technologies. Li-Fi (Light and Wi-Fi) is a visible light communication network to advance 5G. This technology uses light emitting diodes to transmit data rather than radio waves as in case of Wi-Fi.

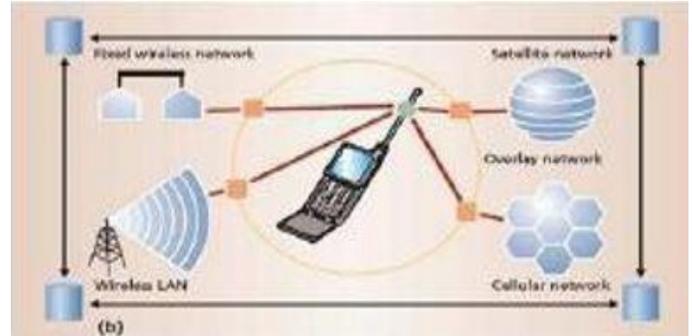


Fig-4: A super core overlay network consisting of several universal access points

V. SCOPE OF 5G

To convert cell phone into smart and intelligent phone which reach everyone's pocket, 5G plays a very vital role here. Its scope is not only restricted in India but also beneficial worldwide. 5G will appear as super-efficient mobile network and super-fast mobile network [10].

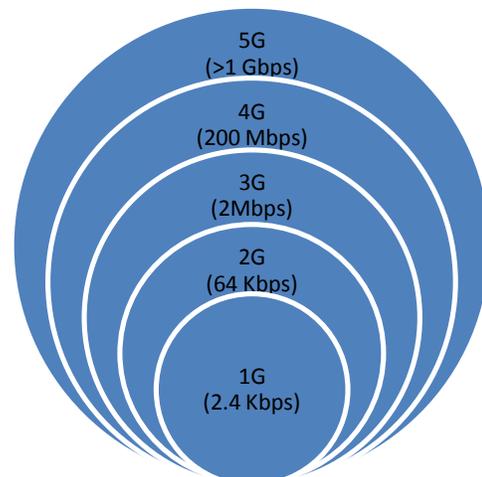


Fig-5: All generations with their data speed

5G spectral efficiency and coverage should be significantly large compared to 4G because it will be able to serve up to 100,000's simultaneous connections along with 1Gbps speed. 5G network is very fast and reliable. The concept of hand held devices is going to be revolutionized with the advent of 5G. High speed, high capacity, and low cost per bit are its key features. It Support interactive multimedia, voice, streaming video, Internet, and other broadband services, more effectively and more attractively. As far as speed is concerned, 5G beats all the generations of mobile communication

VI. EFFECTS OF 5G

There are widespread concerns which show the possibility that exposure to the radio frequency (RF) fields from cellular phones or their base transceiver stations (BTS) could affect people health. New mobile generations are typically assigned new frequency bands with wider spectral bandwidth per frequency channel. BTS distribute a signal and send it to mobile phone using the available frequency spectrum (bandwidth). The broader the bandwidth the more information could be transmitted in a given unit of time. Therefore if one is accessing the online movie or playing online game then it requires more bandwidth than accessing a website with still images or text. Its true in cellular context that increasing download speed increases number of bits per second thus an increased energy per second and thereby increased radiation power[11]. If one is watching movie online then the user receives more radiation which can cause of many problems. It also been proved in earlier researches that as the frequency of communication increased then the radiation also gets high. The RF exposure can be quantified in terms of amount of energy absorbed by a unit mass of the object. This is expressed as SAR with units of W/Kg. Thus 5G may put more amount of radiation risk due to its working in high frequency band.

SAR: SAR stands for 'Specific Absorption Rate' which is basically the amount of radiation a human body will absorb from a cell phone[12]. Thus SAR depicts the rate at which the electromagnetic energy is converted into heat. The lower the rate, the less radiation will be absorbed. The standard limit of SAR set for cell phone radiation for the public is 1.6 Watt/Kg averaged over one gram of body tissue.

$$SAR = \sigma E_i^2 / \rho$$

Where σ = electric conductivity (S/m),

ρ = tissue density (Kg/m³)

and E_i = induced electric field (V/m) inside that tissue .

*Description of *#07#*

It is the radiation measure code which is used to depict actual SAR for particular mobile phone. If it goes beyond range then it is mandatory to change the cell phone otherwise it may cause a great risk for health.

VII. RESULTS AND DISCUSSIONS

The ongoing 5G technology caters the need of today's digital technology to enhance and facilitate human lifestyles. The high bandwidth used by new generations of mobile phone is advantageous at one end of endless interactive features while disadvantageous due to higher radiation problem which may affect human health. Radiation measure specific absorption rate (SAR) is being calculated and checked for safety level by many national and international agencies like International Commission Of Non Ionizing Radiation Protection (ICNIRP)[13], National council on Radiation Protection and measurement (NCRP)[14], Federal Communication Commission (FCC)[15] and The Institute of Electrical & Electronic Engineers (IEEE)[16]. The uninterrupted speed of internet access which is a prime feature of 5G plays a vital role of increased time exposure of user with phone and its endless connectivity services. Due to more dependency on phone ,With ever increase in time duration user remain in full contact of the radiation level for a larger number of time which is highly hazardous for health as already proved in many studies published in various international research papers. It can be reduced up to a level by keeping the phone distant to body using hands free gadgets.

VIII. CONCLUSION

5G will be a worldwide global standard with numerous features not come before. 5G technology has a bright future because it can handle best technologies and offer priceless handset to their customers.

5G is a boon and a bane both for its users. Due to increased dependence of user on mobile, the danger of its radiation also raised because if we use cell phone for longer duration or be in close proximity of it then the radiation increased multiple folds. It is also dangerous for children because children absorb energy differently than adults and it depends on their tissue composition. The better alternative is to use the hand free which makes cell phone distant not to affect directly to the body organ thus radiation decreased up to some extent. At the same time it is also suggested to use cell phone for less duration of time because a longer duration can cause a continuous exposure of radiation which may create problem.

Further investigations are required to clarify the mechanism of action of the applied 5G technology along with its hazardous

effects for future health risk assessments. The research must be of high scientific quality with clearly defined hypotheses. As 5G is planned to launch up to 2020 therefore to get maximum benefit to user of 5G, it's all pros and cons aspects must be clearly investigated. It must also be check against safety standards of radiation. A new technology to be used in 5G is Li-Fi and it is also useful to prevent the radio frequency wave radiation effect because it works on data through light waves not via radio waves.

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Pragati Sharma received her bachelor's degree in Electronics & Communication Engg. in 2002 and Masters' degree in 2006. She is currently pursuing her Ph.D. in Electronics & Communication Engg. from Mewar University Chittorgarh.



Dr. A.K. Gautam has a wide list of publications in National/International Journals and Conference proceedings of repute. He did his Ph.D. in 2003. He is a reviewer for many international Journals. He has 26 years of teaching and industrial experience and author of many technical books. Many research scholars have submitted their research work under his able guidance.