

An Overview & Evolution of 5G Wireless Mobile Technology

¹ Rupayali Swaroop and ² Arun Kumar

¹Research Scholar, Department of Electronics and Communication, JECRC University, Jaipur, INDIA-303905

²Department of Electronics and Communication, JECRC University, Jaipur, INDIA-303905

E-mail: rupayali@gmail.com, Email id: arun.kumar@jecrcu.edu.in

ABSTRACT

Wireless communication is the key to communicate and exchange data to the entire world. Every year mobile industry growth has increased with the increase in demand and the users. As a result new advanced technology is being developed every time which is more user friendly and with advanced features. Subsequently it has been observed that a large user base has been shifted from fixed line to new cellular mobile telephone technology. Now the major task and focus is to establish a sound network planning and its optimum usage. This paper focuses the evolution of wireless technology and to reach at the present stage i.e. 5G networks. An overview of wireless technology and its generations through various paths developed till date has been discussed. It describes the various stages of development and its analysis of different wireless mobile communication features and its usages to the users and to the industry. Besides this we aim and always intend to improve upon the delivery of world class gushing data with safety and security of internet.

Keywords: 5G, Wireless Communication, 4G, 3G

1. INTRODUCTION

Wireless communication is a technology where microwaves are used for sending text and voice data. It also transmits information which contains image files. As the time passes the said technology has been used by small handy gadgets called mobile which can transfer data at a fast and continuous speed. However with the passage of time this technology has become very easy to use and became handy [1]. This technology because of its various usages and easy handling became the core reason for its fast expansion worldwide making the life comfortable. It has also helped the people using this technology for personal or professional communication. Since the data transfer speed is enormous more information are transferred from one place to another making the things easier for all. It also helps in taking prompt decisions when anyone has full information what is required by the user. It also helps the persons living far away from each other making them to feel at home. Largely we can say that the said technology has brought the world together and closer [2]. Prior to the invention of mobile phones the engineers developed a machine which was not a phone but a two way radio by which one can communicate. In this signals were passed between discrete cells and the base station cells. By tracing back the history the first mobile phone was launched by Motorola company on 3rd April 1973. For many years this technology were used and were known as 0G mobile. However there has been some advancements in this technology like push to talk etc[3]. Initially these phones were used in vehicle but as the technology advanced a new handy sets were developed which was referred as G type phones. Here it means next generation phones. As the time passes 1G type phones got advanced, secure and faster thus making the

network more reliable with presently used technology of 5G.[4]

2. ADVANCEMENT OF MOBILE TECHNOLOGIES

Gradually the user experiences from 1G to 5G improves and became more efficient. In a broader sense an overall communication through 5G will be very fast, smooth and making the data transfer speed very fast. The 5G network will be launched in our country in the year 2020. The figure 1 shown below gives a brief picture of cellular technology growth.

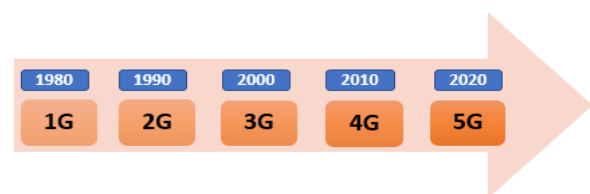


Fig 1. Evolution of wireless portable communication technologies

2.1. First Generation (1G)

Analog technology was the first introduction of 1G in the year 1980 with circuit switching system. This system was based on FDMA (Frequency Division Multiple Access) and by this technique voice calling was initiated. The bandwidth was limited to 30 KHz and the frequency range was 800 to 900MHz [4]. However, it is observed that this technology has

its own limitations such as meddling in reception, noise while transmitting the data. But on the contrary we can say that it is handy having simple infrastructure. The figure 2 illustrates below shows the gradual development of wireless mobile communication networks from 1G to 5G [5].

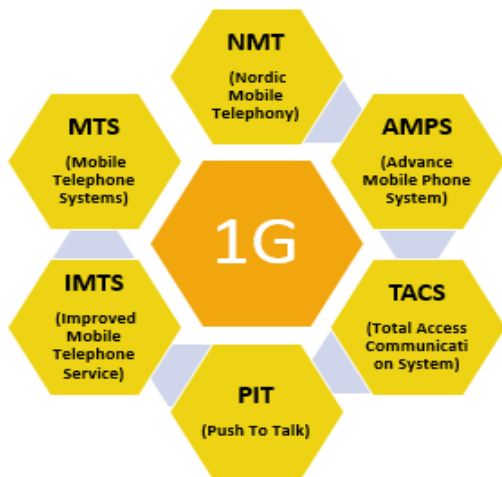


Fig 2. 1G technology standards

2.2. Second Generation (2G)

After 1G technology there has been further development in this wireless cellular technology which was based on digital system and was launched in the year 1990's. Initially when this service was used commercially limited data was transferred and then GSM was introduced in 2G network to provide voice and data services parallel. Gradually GSM technology was further advanced and GPRS was introduced with an increased speed upto 150Kbps. This GPRS is also termed as 2.5 G. Lately, this 2.5G technology under 2G has been known as EDGE (Enhanced Data rate for GSM Evolution) [6]. This is being illustrated below in figure 3.

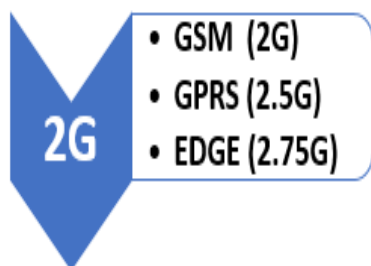


Fig 3. 2G technologies

The 2G technology has lots of improvement in voice quality with less disturbances. This is basically circuit based network which is used for transmitting and receiving the voice and data from the point of origin to the destination. To secure the transmitted data, digital encryption was used [7].

2.3. Third Generation (3G)

After 2G there has been further improvement in technology, which leads to 3G and the main focus in this was to have an introduction of QoS (Quality of Service) related to voice transmission and data security [8]. This technology was launched in the year 2000 with 144Kbps data speed for mobile users. This 3G is also known as IMT-2000, which gives 2Mbps speed for internal users and 384 Kbps for external users [9].

This mobile technology was launched by ITU (International Telecommunication Union) which demonstrated high standards as per figure 4 given below.

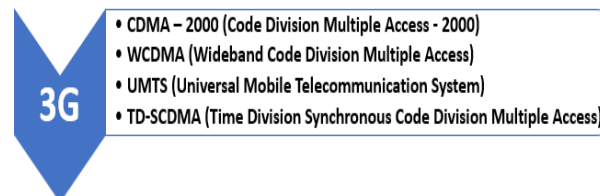


Fig 4. 3G standards

This 3G was an advanced technology with much better voice and data transmission. This was made possible by using packet technology with an exception of air interface. However this 3G technology has some advanced specialties such as high speed internet and digital broadband. This was all clubbed with QoS technology which had put the noise interference under control and this could happen because of the improved design of the equipment [10]. As we know that 3G was an upgraded version of digital broadband and internet services, it increased the data transfer speed from 144Kbps to 2Mbps. As a result there has been drastic improvement in internet services which includes SMS, Video conferencing, MMS, video etc. It also increased data security which was very vital feature of this technology. However this 3G has mainly two factors i.e. 3.5 G (HSDPA) due to which the data downlink speed was 8Mbps to 10Mbps and 3.75G (HSUPA) uplink increase up to 5.8Mbps which shows faster download. It is observed that with the fast downloading mobile battery life is less stressed [11]. All the variants of 3G are shown below in figure 5.

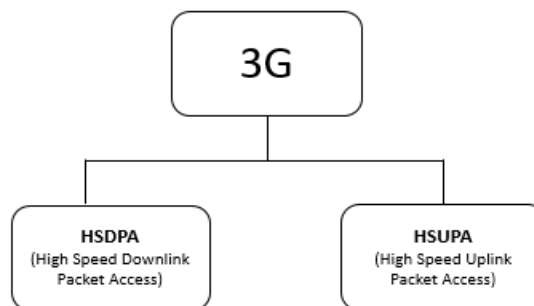


Fig 5. 3G variants

2.4. Fourth Generation (4G)

Since the 3G technology was very successful and due to increase in number of users still further need for improvement and expansion of this technology in the commercial area and with the society was felt. As a result in the year 2010, next generation 4G technology was introduced with many

©2012-20 International Journal of Information Technology and Electrical Engineering

upgradations like ITU-IMT by which the capacity goes to 40 MHz and its highest speed during handoff stages goes to 100Mbps from provider to user [12]. The details of 4G technology has been illustrated in the figure 6 given below.

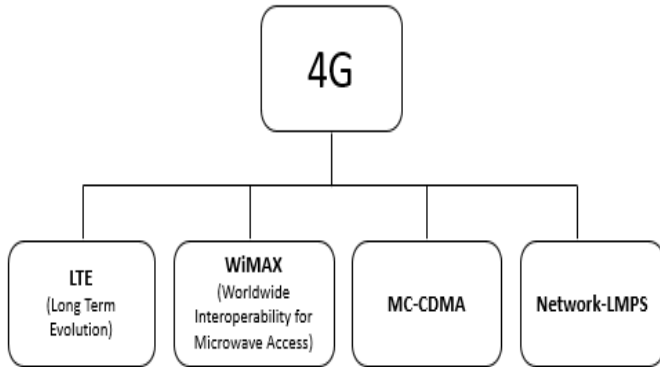


Fig 6. 4G standards

Some of the advanced features of 4G over 3G is that it has a switching type of network. In other words we can say that in 4G all type of core IP networks and switching type networks are used which is basically internet i.e. 3G uses packet switching technology and 2G uses Public Switched Telephone Network [13]. Another feature of 4G network is that it carries high speed real time data gushing to various users thus taking it to next generation technology. In this the data speed lies between 100Mbps to 1Gbps. Due to high speed data transfer, HD voice, MMS, International roaming services, SMS, gaming and MIMO technology makes this 4G an upper edge over the previous mobile technologies [14].

2.5. Fifth Generation (5G)

An emerging mobile technology which is going to further improve the facilities provided by the previous mobile networks is going to be launched in 2020 in our country as 5G. It is proposed that this technology will revolutionize in the field of virtual reality, R&D sector video applications HD audio/videos by providing at least 1.0 Gbps or more to the various users besides 10 Gbps speed for cloud computing services [15]. In figure 7 various standards of 5G has been illustrated.

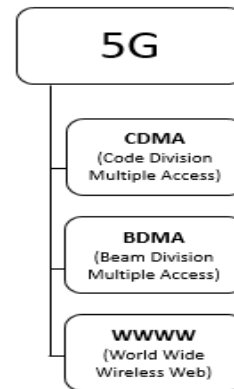


Fig 7. 5G standards

This 5G has been designed in such a way that it will assist large data speed bandwidths i.e. it should be more than 1.0Gbps supported by 3-300GHz spectrum on two ways with global connectivity [16]. This type of network is working on high speed internet and on cloud computing. This platform can manage all IP networks and can develop interface between them easily (5G-NI). However the greatest benefits highlighted was its energy efficacy and streaming data speed [17]. Also with the usage of MIMO technology in 5G, data can travel with high speed from source to the ultimate destination easily and thus improving the battery life of the mobile as compared to previous technologies [18]. However with the onset of this 5G technology still there are many issues to be resolved before launching such as framing of new policies and guidelines, its infrastructure cost, and for users it is there security and privacy [19]. Some 5G advanced applications are focused in these areas [20]:

- International roaming,
- Wearable portable devices
- Online services on gaming
- Full HD real time video calls
- Holographic reality
- Cloud computing
- Virtual communication
- online services on medicine

Table.1. 5G Parameters [21]

Features	Parameters of 5G
Capacity	100 times improves version of 4G, 1000 times high data rate speed
Increased Efficiency	Spectrum utilization increases, reliable than 4G
Version	High resolution version
Speed	10 Gbps speed, 20x faster in downloading and uploading than 4G
5G supports IOTs	Smart Home, Automatic vehicles, health, Agriculture, Education and Transport Appliances
Connectivity	5G delivers uninterrupted, constant, and reliable connections 10Gbps connection coverage
Usage of System Energy	Decrease in using of system energy

Table 2 : Comparative Study of Generations[22]

TECHNOLOGY	1G	2G	3G	4G	5G
Generations	First Generation	Second Generation	Third Generation	Forth Generation	Fifth Generation
Deployment years	1980-1990	1991-2007	2008-2011	2012-2019	2020 onwards
First place of commercialized	U.S.A.	Finland	Japan	South Korea	San Marino
Multiplexing		FDMA	TDMA,CDMA	CDMA	CDMA
Bandwidth	2 Kbps to 2.4 Kbps	16 Kbps to 64 Kbps	2 Mbps to 30 Mbps	100 Mbps to 1 Gbps	Higher than 1 Gbps
Frequency	824 MHz o 894 MHz	850 MHz to 1900 MHz	1.8 GHz to 2.5 GHz	2 GHz to 8 GHz	3 GHz to 300 GHz
Standards	MTS , IMTS, AMTS	EDGE, GSM	IMT2000, HSUPA, HSDPA	LTE, LTE Advanced Wi-Max, Wi-Fi	Single Unified
Techonlogy	Analog	Digital	UMTS, EDGE, WCDMA, IP, HSUPA, HSDPA	Wi-Max, WiFi, WLAN, LTE, LTEA, OFDM, OFDMA, MC-CDMA, LMPS	4G+WWWW, 4G, OFDM
Switching	Circuit	Circuit	Circuit, Packet	Packet	Packet
MIMO				Compatible	Compatible
Hand-Off	Horizontal	Horizontal	Horizontal	Vertical, Horizontal	Vertical, Horizontal
Services	Only voice calls and no data	Voice calls, data, messages	Voice calls, high data rate speed, messages	Roaming , Global data/information available , high data rate, multimedia, videos, messages	International roaming, Global data/information available, Voice/ data calls ,high data rate, multimedia, videos, information in Gbps,

3. CONCLUSION

As the demand of users of wireless mobile technology increased, it developed pressure on the professionals to come out with the new designs and advance technologies. This is how the mobile development journey began and on every new development there has been some new features are added which supported the users and the speed. A brief development stages narrates that 1G was just an analog technology but in 2G this analog technology got changed into digital signals. But in 3G it provides internet and also enhanced speed of data

to the users. However, 4G was still more advanced with much better speed of data in order to improve the performance of multimedia and the internet. This was based on QoS technology. With this it becomes possible to provide fast internet and video calling type of facilities. However 5G still an advanced version of very high speed transfer of the data bi-directional in real time with improved battery life of the devices. This paper has explained the evolution of wireless mobile technology and gives a brief history how this G technology got improvised and became user friendly from 1G to 5G thus giving benefits to the society and the ultimate user.

Suryakala, "An Evaluation of Different Network's Architecture Design," IJIRCCE, vol. 4 Issue 11, pp.18995-19000, November 2016

REFERENCES

- [1] A. Kumar, Y. Liu, J. Sengupta, Divya, "Evolution of Mobile Wireless Communication Networks: 1G to 4G", International Journal of Electronics & Communication Technology IJECT Vol. 1, Issue 1, December 2010.
- [2] R. Yadav, "Challenges and Evolution of Next generation Wireless Communication," IMECS, vol. 2, March 2017
- [3] A. Vijay, M. Rawat, D. Yadav,"4G Networks in Cellular Communication: A Survey", International Journal of Innovations & Advancement in Computer Science IJIACS, Volume 4, Special Issue, March 2015.
- [4] Q. K. Ud Din Arshad, A. U. Kashif and I. M. Quershi, "A Review on the Evolution of Cellular Technologies," 2019 16th International Bhurban Conference on Applied Sciences and Technology (IBCAST), Islamabad, Pakistan, 2019, pp. 989-993, doi: 10.1109/IBCAST.2019.8667173.
- [5] P. Sharma, "Evolution of Mobile Wireless Communication Networks-1G to 5G as well as Future Prospective of Next Generation Communication Network," IJCSMC, vol. 2 Issue 8, pp.47-53, August 2013
- [6] R. Sood, Atul Garg, " Digital Society from 1G to 5G: A Comparative Study," IJAIEM, vol. 3 Issue 2, February 2014.
- [7] S. Jaiswal, A. Kumar, N. Kumari, " Development of Wireless Communication Networks: From 1G to 5G," IJECS, vol. 3 Issue 5, pp.6053-6056, May 2014.
- [8] H. Singh, " Evolution of G: Wireless telephony generations," IJCSIT, vol. 3 Issue 2, pp.135-141, February 2016
- [9] K. Pandya, " Comparative Study on Wireless Mobile Technology: 1G, 2G, 3G, 4G and 5G," IJRTER, vol. 1 Issue 1, pp.24-27, September 2015
- [10] Kumar, Arun & Gupta, Manisha "Key Technologies and Problems in Deployment of 5G Mobile Communication System", 1. 2394-4714, March 2015
- [11] P.Karthika, G.ThirumaniAatthi, M.Saranya, S.
- [12] P. Goyal, A. K. Sahoo, "A Roadmap towards Connected Living: 5G Mobile Technology", (IJITEE) ISSN: 2278-3075, Volume-9, Issue-1, November 2019
- [13] K. Pandya, " Wireless Mobile Technology: 1G, 2G, 3G, 4G and 5G," IJRTER, vol. 1 Issue 1, pp.24-27, September 2015.
- [14] S. Yadav, S. Singh, "Review Paper on Development of Mobile Wireless Technologies (1G to 5G)", IJCSMC, Vol. 7, Issue. 5, pg.94 – 100, May 2018
- [15] M. Benisha, R. Thandaiah Prabu, Thulasi Bai, "Evolution of Mobile Generation Technology", (IJRTE) ISSN: 2277-3878, Volume-7, Issue-5S4, February 2019.
- [16] A. Kumar and M. Gupta, "A comprehensive study of PAPR reduction techniques: Design of DSLM-CT joint reduction technique for advanced waveform", Soft Computing, 2020. DOI: 10.1007/s00500-020-05086-1.
- [17] A. Kumar, "Detection in 5G mobile Communication System using hybrid technique", National Academy Science Letter, 2020. DOI: 10.1007/s40009-020-00962-8.
- [18] A. Kumar, "A novel hybrid PAPR reduction technique for NOMA and FBMC system and its impact in power amplifiers, IETE Journal of Research, 2019.https://doi.org/10.1080/03772063.2019.1682692
- [19] Z. Song, X. Wang, Y. Liu and Z. Zhang, "Joint Spectrum Resource Allocation in NOMA-based Cognitive Radio Network With SWIPT," in *IEEE Access*, vol. 7, pp. 89594-89603, 2019.
- [20] P. Goyal, Ashok Kumar Sahoo, "A Roadmap towards Connected Living: 5G Mobile Technology", (IJITEE) ISSN: 2278-3075, Volume-9, Issue-1, November 2019

- [21] A. Kuma, S. Bharti and Manish Gupta, "FBMC Vs OFDM: 5G Mobile Communication System", International Journal of Systems, Control and Communications, 10(3), pp. 250-264, 2019.

AUTHOR PROFILES

Ms. Rupayali Swaroop has completed her B.Tech in Electronics and communication department from JECRC University in the year 2016 and then did her M.Tech in Digital Communication from Electronics and Communication department from Jagannath University in the year 2018. She is a member of IEEE. Presently, she is a research scholar and pursuing for Ph.D from JECRC University in the field of 5G communications

Dr. Arun Kumar obtained his doctoral degree in the field of Knowledge mobile communication system which was awarded in 2016. He has served in the field of education for over 7 years and is currently in service at JECRC University, Jaipur, India. His current research interests are in the area of, 5G, OFDM, CDMA, Spectrum sensing, peak to average power ratio, advance modulation schemes, Antenna and UWB system. He is a member of IEEE. He has published more than 50+ paper in SCI/Scopus Indexed Journals. He is Reviewer of many SCI and Scopus indexed international journals.