



Generations of Mobile Communication

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Abstract— Mobile communication has transfigure the way people use to communicate each other to exchange information. From the very first technology 1G in which information was exchanged in form of basic voice signals while the 2G came up with many add on features with new capacity and coverage capability. This followed by the 3G which was designed to achieve greater speeds with mobile broadband experience. 4G which is developed later which provide wide range of telecommunication services. Though the technology of communication has developed in short period of time but it is not satisfactory for the customers growing population and mobile devices around the world using this communication facilities are expecting more speed and greater services than present technologies. This lead to the development of new research of communication given name 5G which will come up with much greater speed, exceptional applications, Quality of Service (QoS). This paper will provide a review of the earlier technologies of mobile communication and on the present technology and a glimpse on the upcoming technology in future.

Keywords— Mobile Communication, 1G, 2G, 3G, 4G, 5G

I. INTRODUCTION

The roots of communication were first laid by Guglielmo Marconin through his invention of Wireless telegraph in 1896. Later in 1901 he sent Tele graphics signals from Cornwall to St. John's Newfoundland across the Atlantic Ocean a distance of 3200Km. This system helped in communicating each other by sending alphanumeric characters which are encoded in Analog signals.

Communication is the integral parts of science which has been focused on exchanging information from one point to another. The term communication was first introduced after the discovery of telephones which later replaced the telegrams and letters. Presently communication is the backbone of the society. Wireless communication which burgeons in late 90's has pervasive all over the world in terms of mobile technology and subscribers using it. Wireless communication has undergone technological advances from 1G in later 80's to 4G in 2010. At present the new technology 5G has promised revolutionary changes in communication with its advancement in technology to speed up the communication in lightening speed. As the number of cellular telephony subscriptions has surpassed the wire line telephony subscriptions the wire line telephony subscriptions this made the cellular telephony a very important tool of wireless technology. Later the development of signal processing techniques in 3G has improved the communication a lot in last decade. This rapid growth of wireless communication increased demands in network efficiency and speed of communication. The first generation wireless mobiles used Analog technology for communication which had many draw backs due to heavy devices and patchy coverage. The present wireless generation is built using Digital Technology carry more traffic and posses greater efficiency than Analog signals.

Year	Multimedia(voice)
1980	Analog, AMPS, TACS, NTI
1990	Digital IS95 IS136, GSM, PDC
2000	IMT-2000, 3G-2Mbps
2010	Broadband Wireless 4G-1Gbps

FIG 1:- EVOLUTION OF MOBILE NETWORKS

II. EVOLUTION OF MOBILE NETWORKS

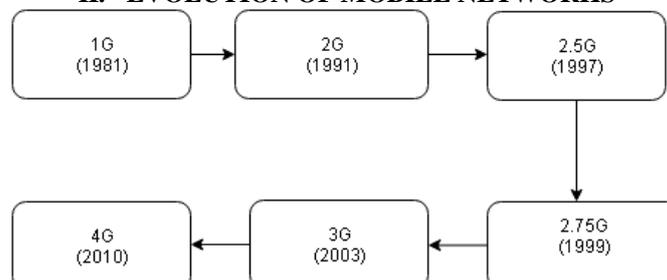


Fig 2:- Evolution of Mobile Technologies

1G (First Generation):- The Cellular network system was first came out in 1980's where the local area is divided in to cells around limited distance each served as base station. This are small Analog system in which information is sent in Analog signals .The frequency reuse concept can be used in nearby cell but not in adjacent through which number of users supported in an area increased a lot. The name given for 1G in those days is cellular phone technology working in frequency band of 150KHZ. The first cellular network was launched in Japan by NTT(Nippon Telegraph and Telephone) in 1979 in the Metropolitan area of Tokyo in a short time network has expanded and cover the total population of Japan and became the first nation on planet to implement the 1G network. Later in 1981 NMT (Nordic Mobile Telephone) extended this technology in countries of Europe (Denmark, Finland, Norway & Sweden). In USA it was first implemented in 1983 later it spread across UK, Mexico & Canada. The Technology used in 1st Generation is AMPS (Advanced Mobile Phone System) cellular technology which uses separate frequencies to be held. There is a need for proper band width in this technique for a large number of users.

Drawbacks of 1G:-

The major disadvantage of 1G is the quality of voice, there was no clarity of noise and a constant disturbance from background noise.

2G (Second Generation):- 2G cellular technology was launched officially in Finland by Radiolinja in 1991 on the GSM(Global System for Mobile) standard. The technology used in it is completely different from that of 1G. In 2G we use digital signal for voice transmission with a speed up to 64kbps.2G Technology came up with many data services for mobile. VMS (Voice Mail Service) was also and value added service in 2G. A new feature Short Message service (SMS) was an added on in 2G it use Band width range of 30-200KHZ. Many different technologies were used under 2G they are GPRS (General Packet Radio Service) CDMA (Code division multiple access) GSM(Global System for Mobile) EDGE(Enhanced Data for Global Evolution). GSM which is the first digital mobile cellular system which is still spread all over and used widely as technique of 2G. GSM was implemented in Europe by ETSI (European Telecommunications Standards Institute) to support the concept of international roaming. This worked as an overcome of 1G dis-advantage in lacking of roaming services.

Issues with 2G

A place where population is lower producing a weaker digital signal on higher frequencies may not be able to reach the cell tower. Simple has a smooth rot bend, advanced a spiked stepy one. This can be both preference and a detriment. Under great conditions, computerized will sound better. Under somewhat more terrible conditions, simple will encounter static, while advanced has incidental dropouts.

2.5G (Generation):- This is a technology which was introduced in 1990's. It uses a technology GPRS (General Packet Radio Service) stand. In this technique delivering packet switched data capabilities to already existing GSM (Global System for Mobile) networks. A add on feature of sending Graphics data as packets is available in this technology packet switching made its impact with increasing Internet and Internet protocol. EDGE(Enhanced Data for Global Evolution) network is an example of 2.5G.

3G (Third Generation):- Edge technique faced an drawback in packet transferring which leads to lower the efficiency in the system. So to overcome it and to standardize a single global network protocol instead of different other techniques 3G was made. International mobile Telecommunications-2000(IMT) known as 3G uses wide band wireless network which made to increase the clarity of signal. A technique called Packet Switching is used to send the Data. Along with Voice Communication services 3G provides data services to Television, video & services like Global roaming works up to range of 2100MHZ with a band width of 15020MHZ. It provides a high speed internet services, video chatting, GPS & Car navigation Digital catalog shopping, Video streaming much faster. Mainly 3G used as a wide band voice channel in which the whole world is taken as village and it creates connections from one person to another no matter where the location of each other is.

Issues of 3G:-

Equivalent to 3G the expense of information to utilize 3G is progressively this is because of high band width transmission of 3G advancements; power utilization expanded a considerable measure which prompts decrease the battery life really quick.

4G (Fourth Generation):- This is the most recent redesign of innovation in versatile correspondence field it is 10times quicker than 3G. 4G depends on an innovation called LTE(Long-Term Evolution) a complete IP based innovation for data transmission. Teliasonera which is the first telecom operation in the world to launch 4G which happened in 2009 on December 14, 2009 in the capital of Sweden and Norway. LTE which was created later to upgrade 3G network. LTE uses the OFDM modulation technique which provides the spectral efficiency to achieve high data rates but with an addition of multiple share a common channel. The concept of OFDM is to divide the channel in to many narrow sub-carriers spacing is an orthogonal which helps to reduce interfere with each other despite the lack of guard bands between them. OFDM uses frequency and time to spread the data all across providing high speed & good signal reliability.

Issue with 4G

3G and 4G segments made for one landmass is not generally perfect with another mainland sue to conveying recurrence groups. Another conspicuous issue in 4G frameworks is to make higher piece rates accessible in bigger bit of the cell, particularly to clients in an uncovered position in the middle of a few base stations. In flow explore, this issue is tended to by macro diversity strategies, otherwise called bunch agreeable transfer, furthermore by Beam-Division.

III. EVOLUTION OF 4G

History:-

After the implementation of 3G to overcome flaws in it a new technology was developed known as 4G. 4G(Fourth Generation) is the fourth generation of cellular wireless standards. 4G came up with many add-on features than compare to other generations. It is not only restricted to mobile communication other broad band wireless communications also use 4G.4G provides a good quality of sound to high definition of video to high data rates of wireless communication channel. 4G is known as MAGIC (Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service) in short form of its uses . 4G at first was launched by Teliasonera operator in late 2009 in the city of Stockholm and Oslo. After a year it was launched in Finland. With 4G (fourth generation) technology the users mobile communication broadband speed up to ten times higher than of 3G. 4G technology is mainly based on the LTE technology (Long Time Evolution), an international standard and a complete IP based oriented technology for data transmission in wireless communication.

Requirement of 4G:-

At first after the development of 4G it was only used for military applications and for scientific communication. But later the need of wireless communication for a common person in terms of speed and data rates increased this lead to the implementation of 4g to all other wireless communication devices. As the internet revolutionized the world the net of internet on mobile became a main challenge in wireless communication. The development of technology from 1G to 2G improved qualities of voice communication and 2g to 3G was upgraded by the need to allow voice and data communication through the wireless device. Where 4G implementation had lead to a high quality of voice communication and high data transmission in other needs.

Technology of 4G:-

The Technology used in the 4G network is Long Term Evolution (LTE) Standard is mainly based on the GSM/EDGE and UMTS/HSPA, Multiple In Multiple Input Multiple Output (MIMO), Orthogonal Frequency Digital Multiplexing (OFDM). This mainly runs on the technique of time division

MIMO(Multiple Input Multiple Output) Introduction:- In the year 1988 Bell Laboratories were the first in world to demonstrate the MIMO system under the laboratory conditions. In the very next year 1999 Gigabit wireless Inc. and Stanford University collaborating and developed a new technique of using MIMO and demonstrated the transmission technique of MIMO they brought up. In MIMO basically at the transmitting and receiving end multiple antennas are used it is an antenna technology application. The antennas at the end of each communications circuit are combined together to minimize errors and optimize data speed.

It is of two types 1) spatial multiplexing 2) spatial diversity

- 1) Spatial Multiplexing:- This form of MIMO help to produce additional Data Capacity by using different paths to carry additional traffic which lead to increase of data throughout the capability
- 2) Spatial Diversity:- It is often refer to transmitting and receiving diversity.

Orthogonal Frequency Division Multiplexing:- OFDM has its notable advantages over other widely used wireless access techniques of other generation of mobile communications , such as Time-Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA) and Code Division Multiple Access (CDMA). The concept of OFDM is that the radio channel is divided into many number of narrow band, low-rate and frequency-non selective sub channels or subcarriers, so that multiple amount of signals can be transmitted in parallel, while maintaining a high spectral efficiency at the same time. Each subcarrier delivers the information of the user which result in simple multiple access known as Orthogonal Frequency-Division Multiple Access (OFDMA). This helps different media such as video, graphics, speech, text or other data to be transmitted within the same radio link, depending on the specific types of services and their Quality-of-Service (QoS) requirements. Besides, in OFDM frameworks distinctive modulation schemes can be utilized for various subcarriers. For instance, the user near the Base Station (BS) might have a moderately decent channel quality, in this way they can utilize high-arrange adjustment plans to build their information rates. By difference, for those user that are a long way from the BS or are overhauled in profoundly stacked urban territories, where the subcarriers' quality is relied upon to be poor, low-arrange adjustment plans can be summoned. OFDM utilizes IFFT as a part of transmitter and FFT in receiver.

MIMO-OFDM:- As the OFDM support the concept of more antennas and large band widths for transmission MIMO logic can be mixed up with the OFDM concept to produce greater speeds. By adopting the MIMO-OFDM concept in wireless devices we can achieve the speed rate of several hundreds of Mbits/s. As the MIMO-OFDM is a way of communication which involves parallel transmission in space and frequency domains this help in achieving greater transmission rate than other technologies.

MIMO OFDM is based on Fast Fourier Transform (FFT/IFFT) algorithm and MIMO encoding system. It can be adopted in various wireless transmission systems such as WIMAX, LTE

LTE(Long Term Evolution)

It is a 4G wireless broadband technology developed by the Third Generation Partnership project (3GPP) . LTE provides the highest data rates ever in communication with 100Mbps download stream and 50-30Mbps of upstream. LTE is mainly based on the TCP/IP model based. It deals with every type of data voice, video, and messaging traffic. LTE uses the MIMO-OFDM technology for the transmission and receiving of data.

IV. COMPARISON OF 1G, 2G, 3G, 4G

	1G	2G	3G	4G
Introduced Year	1980	1993	2001	2009
Technology	AMPS	IS-95, GSM	IMT2000, WCDMA	LTE, WiMAX
Speed of Data Rates	2.4Kbps-14.4Kbps	14.4Kbps	3.1Mbps	100Mbps
Internet services	No Internet	Narrowband	Broadband	Ultra Broadband
Band-width	Analog	25MHZ	25MHZ	100MHZ
Band type	Narrowband	Narrowband	Wideband	Ultra wide band
Carrier Frequency	30Khz	200Khz	5Mhz	15Mhz
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA
Core Network	PSTN	PSTN	Packet Networking	Internet
Switching	Circuit	Circuit Packet	Packet	All Packet

V. FUTURE OF WIRELESS COMMUNICATION (5G)

At present the world is busy in deployment of 4G LTE Technology in 2-3year 4g will concluded. As the increasing population had lead to increase in number of mobile devices on planet the present technology 4G is not able to give the speed and features everyone are expecting. So a new technology providing really good speed on communication is needed. At present 5G is only in research development area but in future it will take over the world with its speed and data carrying capabilities. 5G technologies will start deployment in 2-3years around 2020. This technology will give us many new unseen features of earlier generations of mobile technology. One of the main features 5G gone a have is accessing multiple wireless technologies and switch in between. 5G may solve the frequency licensing and spectrum management issues. 5G have different modulation schemes and error control schemes.

Features	5G
Data Bandwidth	1Gbps and Higher
Standards	Single unified standard
Multiple access	CDMA & BDMA
Core Network	Internet
Technology	Unified IP and seamless combination of broadband (WWW)
Switching	All Packet

Key Features of 5G networks

- 5G will be fast among all the earlier technologies and more reliable.
- High speed, High uploading speed, and low cost per bit comparable to other technologies, It supports video streaming, voice, internet and other broad band services bidirectional and accurate traffic statistics.
- Every device will have an IP address according to the location and usage of network.
- 5G will broadcast data in Giga bit that support lot of connections.
- 5G have a high capability towards supporting Software and Consultancy.
- 5G costs will be cheap and available to every person.
- In this technology whole world will be divided as a small village. So someone calling a person in Norway from India the phone connection will be held normally like a local connection.
- Present technology 4G LTE have its download speed between 5-12mbps and transfer speed between 2-5mbps. 5G when contrasted with this 4G will 100times speedier in pace.
- 5G will expend less power than different advancements and reduced latency.
- The new billing interfaces of 5G technology makes in more attractive and effective.
- 5G technologies gone support a virtual private networks.

VI. CONCLUSION

4G technology though has many advantages over previous generations of mobile technology also have its own disadvantages. Hence it cannot cover the whole population and provide the facilities everyone are expecting Though the mobile operators are busy spreading it all over the world people have the idea of it advantages and disadvantages. So a more fast and reliable technology is what a customer everyone looking for which can provide him greater speed and effective communication this lead to the development of 5G which have the capacity to full fill every one need in present fast growing life with its feature. 5G gone be cheap rates and high reliable than preceding technologies gone be implemented by 2020 which is under development at present.

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