Comparative Analysis of Mobile Generations Regarding Technical Aspects

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***Abstract*– Development in human society is the essence of experience abandoned by each being through each innovation. We have seen the quick headway in the field of wireless systems that is from a straightforward broadcast in eighteenth century to 5G correspondence arrange very nearly being executed in one corner of the world. Human needs are for smarter never ended, they always try for new, smarter and faster technologies. In this paper we discuss whole developments in the field of mobile communication system from 0 to 6th generation. Now in this era we are finding way to introduce 5th generation which will be available for the customer's in near 2020's. We give the view how the 6th generation is look like, when it take place in the market of wireless communication system. We show block diagrams of signal transmission and give details of generations with the help of the diagrams. In the last portion of this paper, we discuss the effectiveness of these generations. It helps us to discover the proficient generation in the entire advancement.**

***Keywords*– Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Global System for Mobile Communication (GSM), Enhanced Data rates for GSM Evolution (EDGE), Long Term Evolution (LTE), High Speed Packet Data Access (HSPA) and Universal Mobile Telephone Services (UMTS)**

I. INTRODUCTION

The beginning of generation (0G) to the future implemented generations. A new global data communication system is the aim of the new generations of communication. The objective new generation is to provide communication ubiquitously. As the increase of users and their requirements, it makes wireless communication fast developing field. Users increases from 214 million in 1997 to 1162 million in 2002 and so on its increases day by day [1].

It is anticipated that by 2010 there will be 1700 million clients around the world which is large amount [2]. There is need to expand the technology of wireless communication according to the need. Nowadays, many things are adopted by 3rd generation which gave users to use different applications and perform many tasks.

The requirements of new technology results us 4th generation. Regardless of the enormous beginning frenzy that advanced this innovation, 4G system exists in business utilize today. Advances including versatile and exceptionally proficient adjustment, coding different access, media access, system association, systems administration that can give ultra-connectivity at high information rates with compelling QoS for next Gare are likewise portrayed [3]. An extensive variety of information rates must be upheld, up to different gigabits every second, many megabits every second should be ensured with high accessibility and unwavering quality. System versatility and adaptability are required to bolster countless gadgets with low many-sided quality and prerequisites for long battery lifetimes [4]. The fate of versatile remote correspondence systems will be encountered a few eras. This sort of improvement will drive the looks at data innovation in modern territory.

We foresee the future eras of versatile remote correspondence systems including fourth, fifth, sixth and seventh eras [5]. Back to 2nd generation (GSM) development and initial 3rd Generation W-CDMA frameworks, some key contrasts would be found noticeable all around interface usage [8]. Fourth-era frameworks will offer short-to direct range correspondences with high information rates (>100 Mbps) [6]. The portable and show commercial ventures have both built up a few versatile telecast advancements to bolster substantial scale utilization of mass interactive media administrations on cell phones [9]. The issues in past era of portable system have been talked about and finding the 3rd Generation also, 4th generation is aimed. Portable loading information is significant worry in calculation of correspondence in information exchange.

The favorable circumstances of offloading additionally talked about and examination for eras determine [10]. Versatile correspondence is consistently one of the sultriest regions that are creating at a blasting velocity, with propelled strategies developing in every one of the fields of versatile and remote correspondences. Current times are only the starting for sending 3G versatile correspondence frameworks, while research on the up and coming era of portable interchanges, 4G remote versatile systems start to make ready for what's to come.

This paper thinks about the dreams of 4G from a specialized point of view [11]. There are many different kinds of antennas which used in wireless communication network to transmitting and receiving of signals different types of antennas are discussed [21]. Fig. 1 shows the working principal of signal sending through antenna from transmitter to receiver.

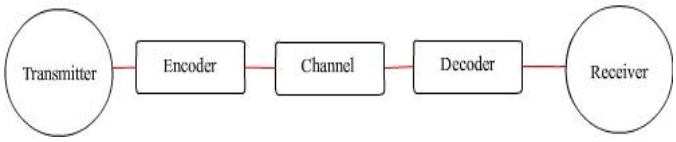

Fig. 1. Antenna Signal Transmission

II. ZERO GENERATION

Early cases of development of 0 generation are the Auto radio puhelin (ARP) dispatched in 1971s Finland is the country's first open business cellular framework. B-Netz moved in 1972 the Germany become the second country open business cell phone framework (however the first that did not require humans any more to interface calls). We had a compact executive to call in few channels but the users are increasing. 0G insinuates Pre-PDA versatile wireless communication advancement, for instance, line telephones that some had in auto mobiles before the presence of cell telephones. Convenient line phone structures went before present day cell flexible telephony advancement. PDAs are the first precursors; these systems are called 0G technology. Zero generation contains features Push to Talk, Mobile Telephone voice calling, a good range of wireless coverage. They were available as a business organization and available to the society framework. They are allotted the different frequencies to perform calling. The technology of wireless communication is mounted in automobiles, however portfolio structure manner made. Usually, the handset was mounted in the vehicle trunk and affixed to the "head" in the vehicle. The vital customers were supervisor, land specialists, and renowned individuals. It use for voice calling early days [12].

III. FIRST GENERATION

First generation is created due to need of more accuracy, speed, performance and bandwidth. It helps the user to perform speedier task then zero generation. In early 1960s zero generation there was a system in which one person can talk when he complete the other person talk due to help of push button this is overcome in the 1st generation, by giving two different frequencies [7]. This structure is a straightforward advancement made in 1980s.its main use is to send voice message to the other end. Advanced Mobile Phone System (AMPS) technology used for 1G. It use the technology to divide frequency to different users, frequency division multiple access (FDMA) using the limitation of 30KHz.where the frequency band is of 824-894MHz. It gives the speed 2.4kbps to the users. 10MHz speed included in 1988 in Chicago in area 2100 square miles. Advanced Mobile Phone System was at first dispatched by US in 1982 [13].

Table 1: Generations of Wireless Mobile Communication

Generation	Technology	Data Rate	Channel Access	Time period
1st Generation	Analog	2 Kbps	AMPS, NMT, TACS	1970 – 1980
2nd Generation	Digital Technology	64 Kbps	CDMA, TDMA	1990 – 2000
2.5th Generation	5G Data Rates	171.2 Kbps	GPRS	2001- 2004
3rd Generation	Broadband Technology	3.1 Mbps	UMTS	2004 – 2005
3.5th Generation	Data Rate	14.4 Mbps	HSPA	2006 – 2010
4th Generation	Digital Broad Band	100 Mbps	LTE	Now
5th Generation	-	Few Gbps	-	Soon…
6th Generation	-	Gbps	-	Future

IV. 2ND GENERATION

In 1980s second period remote versatile correspondence system is a mechanized development. It is speedy then the first generation having speed of 64Kbps Transmission of data communication is 30 KHz - 200 KHz. We can use 2G as sending text messages, sound messages and photo messages. CDMA and TDMA technologies are used in 2G networks. TDMA licenses division of signs into time spaces. CDMA gives each customer an unprecedented code to confer over a multiplex. The 2G are featured with GSM technology. In 1991 Finland is the developer of 2G technologies. This enabled the compact endorsers of use their cell phone in other countries as they are travelled [13]. The critical idea of W-CDMA is presentation of inter-cell asynchronous operation and the pilot channel connected with every information channel. The pilot channel makes reasonable discovery conceivable on the opposite connection. Besides, it makes it conceivable to receive impedance cancelation and versatile reception apparatus cluster methods at a later date. It is understood that cell vectorization can expand connect limit essentially, the versatile antenna cluster is seen as versatile cell vectorization and is exceptionally appealing. Other specialized elements of W-CDMA are abridged underneath:

- Fast transmit power control (TPC) on both opposite (mobile-to-cell-site) and forward (cell-site-to-portable) joins.
- Coherent Rake gathering on both connections (Orthogonal various spreading elements (SFs) in the forward connection.
- Coherent spreading-code following.
- Variable-rate transmission with visually impaired rate recognition.

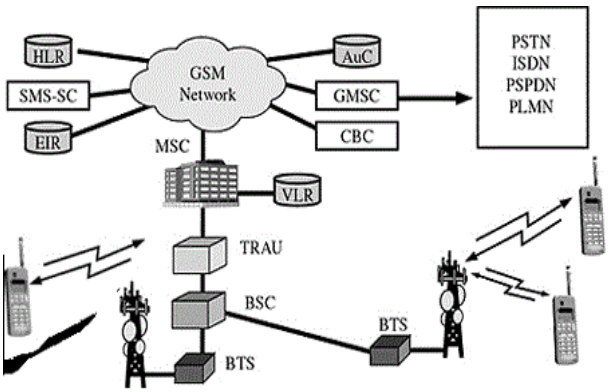

Fig. 2. 2G Network Block Diagram

The Fig. 2 shows the architecture of 2 G network.

V. 2. 25 GENERATION

The 2.5Generation, which remains for "second and a half era". The look "second and a half era" is used to depict 2nd Generation frameworks that have executed a partial change in part not with standing the structure exchanged space. "2.5G" is a casual term, created exclusively to market purposes, by the International. GPRS information exchange is commonly charged per megabyte of activity exchanged, while information correspondence by means of conventional circuit exchanging is charged every moment of association time, autonomous of whether the client really is using the limit or is in an unmoving state. 2.5G systems might bolster administrations, for example, WAP, MMS, texting portable amusements, registry [12].

VI. 2.75 GENERATION

The 2.75 Generation is the new generation name due to change in technology. EDGE (EGPRS) is a shortened form for Upgraded transmission for GSM and GPRS frameworks is an advanced cellular telephone innovation which goes about as a shock on move up to 2G and 2.5G. The new technique (EDGE) innovation is an amplified variant of GSM.

The transmission gives unmistakable and quick sending of data. It termed as single transporter. EDGE innovation was imagined and presented by Cingular, which is currently named as AT& T. EDGE is radio innovation and is a piece of new era advances. The technology (EDGE) innovation is favored over GSM because of its adaptability to convey parcel switch information. The utilization of EDGE technology innovation increased the utilization of cell telephones. The technique moves information in less seconds in the event that we contrast it and GPRS Technology. For instance a run of the mill content document of 40KB is moved in just 2 seconds when contrasted with the exchange from GPR innovation, which is 6 seconds. The greatest favorable position of using EDGE innovation is one doesn't need any new instruments with a specific end goal is to utilization of (EDGE) Technology. It did not required big changes. On the off chance that a main is GPRS Technology client he can use this innovation without paying charges [12].

VII. 3RD GENERATION

To meet developing requests in system limit, rates required for rapid information exchange and media applications, 3G measures began advancing. The frameworks are basically a direct upgrade of 2nd generation. They depend on two similar spine foundations, comprising of circuit exchanged hubs, and parcel arranged hubs [14]. Fig. 3 shows the 3G network block diagram. The third era remote portable correspondence framework was presented in 2000.The objective of 3G frameworks was to offer expanded information rates from 144kbps to384kbps in wide scope regions and 2Mbps in nearby scope areas.3G offers propelled administrations to the clients when contrasted with 1G and 2G. Along with voice correspondence it incorporates information administrations, access to TV/recordings, Web searching, email, video conferencing, paging, fax and navigational maps.

It has a transmission capacity of 15-20MHz utilized for fast web, video talking, and so on. A 3G portable framework was characterized by an association called third Generation Partnership Project (3GPP) which satisfies the IMT-2000 benchmarks. It is named as Universal Mobile Telecommunication System (UMTS) in European Countries, which is TSI driven. ITU-T named for third era framework, American named the technology CDMA used for 3G. Likewise the IMT2000 has acknowledged another 3rd generation standard from China, that is TD-SCDMA. WCDMA wireless innovation for UMTS. The main business 3G system was propelled by NTT Docomo in Japan, in 2001 [13]. 3G remains for "Third Generation" of versatile correspondences. 3G depends on the Universal Mobile Telecommunication Systems (UMTS) [16]. 3G has brought different enhancements over before eras such as worldwide wandering, rapid transmission and propelled media access. 3G presented the idea of "versatile broadband". Versatile broadband means a cell innovation that is portable and gives the velocity of broadband correspondence [15].

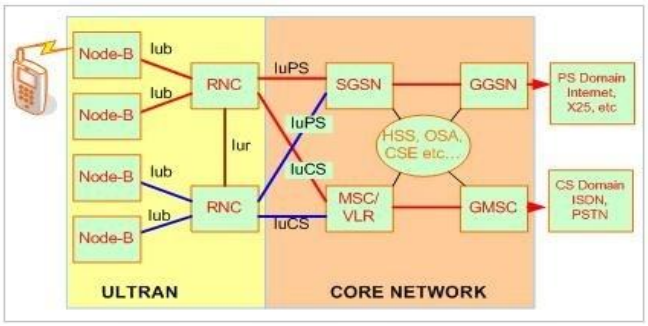

Fig. 3. Block diagram of 3G network

VIII. 4TH GENERATION

The 4G standards are designed to provide comprehensive IP solution where users are facilitated to access voice, data and streamed multimedia at "Anytime and Anywhere". Global mobility is supported using global mobility protocols like IPv6. 4G standards are developed not only to support upcoming generations of telecommunications but also to support fixed wireless networks. WiMAX and LTE are

renowned technologies being used with 4G network today. Sprint and Verizon wireless are US telecommunication companies which are using WiMAX and LTE technologies respectively for their 4G network. WiMAX stands for "Worldwide Interoperability for Microwave Access" [20]. 4G standards have been laid down to overcome the drawbacks of 3G and caters us with the higher definition of voice, video calling and speedy transmission rates. 4G grants numerous facilities which were not supported in 3Generation or any other standard before 4th generation.

It provides high speed internet facility. Therefore it is also known as mobile ultra-broadband internet access. 4G makes us believe that miracle can happen. Therefore, "MAGIC" word is used to describe 4G [17]. It depends on wireless MAN technology. WiMAX is a wireless broadband technology that conveys high speeds like Wi-Fi to wide areas. It relies on the IEEE 802.16 [20]. It can also be used to provide dormitory connectivity. It also connects Wi-Fi and WLAN hotspots to internet. It provide a mobile broadband connectivity which is an alternative to DSL and cable. WiMAX works in similar manner as Wi-Fi but at faster speeds over larger distances and for larger number of March 2015 488 Aashna Vijay, Mamta Rawat, Deepa Yadav users. WiMAX is reachable to remote areas which are way difficult for wired connections to reach by overcoming the geographical limitations of conventional wired infrastructure. WiMAX provides wireless broadband access to rural areas, highly elevated areas and inside the buildings. It is aimed to provide broadband like connectivity to portable devices. Sprint's 4G wireless network uses WiMAX technology for better connectivity. It declared that WiMAX provides3Mbps to 6 Mbps of downloading speeds and an average downloading speed is above 10Mbps. LTE was developed by a telecommunication in 2004.SAE is the new era for GPRS [19]. The word LTE includes both LTE and SAE technology [20]. 4G is aimed to provide high date rate, adjustable bandwidth and low latency. Network architecture of LTE has been framed to reinforce stupendous performance to the users. Verizon exclaims that LTE can deliver data rate between 5 mbps to 12 mbps however, LTE was designed to provide 15 mbps of speed. 4G technology has than introduced the most interesting concept of IPv6 [18]. IPv6 gives large address space which is 128 bits long.

IPv6 is developed to allow the expansion of the protocol if needed by new technology. IPv4 has finite number of addresses that can be assigned to the devices connected to the internet at one time. NAT only cover up the problem instead to solving it permanently. This leads to the evolution of IPv6 that assigns a unique IP address to each and every system. After implementation of IPv6 each host can communicate with every other host on the network with few restrictions like institutions' policies and firewalls. This kind of 4G network is known as 3.9G. The very first release version of 4G was not as per the standards described by ITU but it is still publicized as 4G. Fig. 4 shows the development of 4G from the past generations.

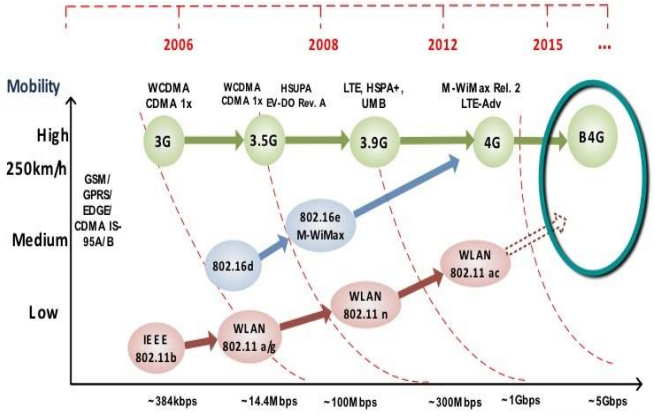

Fig. 4. Development from 3G to 4G block diagram

IX. 5TH GENERATION

The fifth era versatile and remote correspondence system is the genuine world of remote which would be upheld by, MC-CDMA, OFDM, Network-LMDS, LAS-CDMA, UWB, IPv6.5G can be called as the ideal genuine remote world or World Wide Wireless Web(WWWW) as it has no impediments. The fundamental convention using both 4th generation and 5th generation is IPv6 [18]. 5G expects to give boundless access to data and the capacity to share information anyplace, at whatever time by anybody for the advantage of the world. The 5G advances cover all the propelled highlights which makes 5G portable innovations most effective and will be in colossal interest in future. The 5G portable is IP based for remote system interoperability and versatile.

The institutionalization exercises for 5G have as of now begun for the current year which might prompt business accessibility around 2020. In 5G system, the Physical and Data Link layer characterizes the 5G remote innovation showing it as an Open Wireless Architecture (OWA).The 5G innovation likewise keep up virtual multi-remote system. This Network perform layer is isolated two layers; upper framework layer for convenient terminal and lower framework layer for interface. Here all the steering will be founded on IP addresses which would be distinctive in every system of IP around the whole world. In 5G innovation the higher piece rate misfortune is overcome by utilizing Open Transport Protocol (OTP). OTP is upheld by Session layer and Transport [13]. Fig. 4 shows the architecture design of the 5th generation of mobile communication system. 5G offers bidirectional data transmission and less activity:

- 5G gives vast TV of information in Gigabit.
- 5G utilizes diverse tweak systems and blunder control methods.
- 5G innovation offer transporter class entryway with unparalleled consistency.
- 5G innovation underpins virtual private system.
- 5G furnishes 25Mbps network speed with information data transfer capacity higher than 1 GB.
- 5G terminals have programming characterized radios.

- 5G gives wide ranges of high speed channels.
- Remote diagnostics is an extraordinary element of 5G.
- The transferring and downloading pace of 5G is high.
- 5G gives many channels without gushing.

Fig. 5 shows the efficiency of 5th generation.

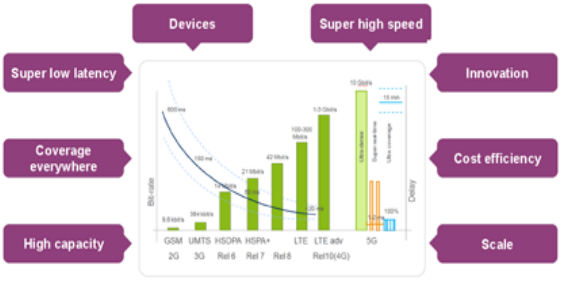

Fig. 5. 5G Efficiency diagram

X. 6TH GENERATION

The 6th era portable and remote correspondence system can incorporate the satellite correspondence systems and 5G to give worldwide scope. The satellite correspondence system might comprise of telecom satellite systems, earth imaging satellite systems and route satellite systems. The objective of 6G is to coordinate these sorts of satellite systems to give system position identifier, mixed media and web availability, and climate data administrations to the portable clients. The four nations which have these satellite frameworks are: The Galileo by Europe, the COMPASS by China and the GLONASS by Russia, The Global Position System (GPS) by United State of America. In the event that 6G coordinates with 5G with these satellite systems, it would have four distinct gauges. So handoff and meandering will be a major issue in 6G. The radio over fiber framework is now in presence, yet with the coming of 6G innovation, humankind will be all the more near any extra-terrestrial development in the universe [13].

- Ultra-quick Internet access.
- Sea to Space Communication.
- Smart Homes, Cities and Villages.
- Data rates will be up to 10-11 Gbps.
- May be utilized as a part of the creation of Energy from galactic world.
- Smart Homes, Space innovation, Defense applications will be changed with 6G systems.
- Satellite to Satellite Communication.
- Mind to Mind Communication might be conceivable.
- Natural Calamities will be controlled with 6G systems.

XI. COMPARISON TABLE OF BASIC NETWORK GENERATIONS

Here is comparison in Table 2 between the four main generation of wireless mobile communication (1G, 2G, 3G, 4G) according to their speed, technology, bandwidth etc.

XII. EFFICIENCY COMPARISON OF GENERATIONS

With the help of given details in this paper of the generations we do comparison between some of the main generation of mobile communication. We do comparison according to their applications, performance, data rate, channel range etc. As the development are making in the field of mobile communication, the y become smarter, efficient and speedy. In 1st generation the mobile communication system is analog which starts new era of distance mobile communication system. The technology use for the first generation is (FDMA) using the limitation of 30KHz.where the frequency band is of 824-894MHz. It gives the speed 2.4kbps to the users. In 2G which is more advanced then the past generation give access to use internet in mobile and in 2G the technology become digital. In 2004 the technology become more advance the data rate becomes faster (3.1 Mbps), UMTS technology use for 3G.

These days we are using the 4G (LTE) which is more efficient then the past generation in speed, technology, downloading, uploading, network architecture etc. Now there is working on the next generation which is named as 5G which will be the most smarter and speedy then the past generation. Fig. 6 shows the efficiency of all generations.

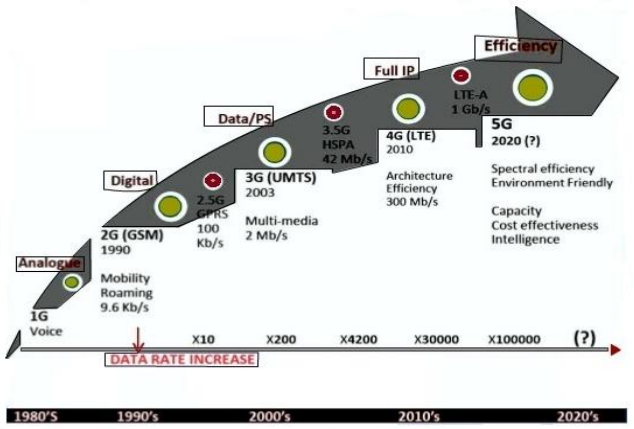

Fig. 6. Development in wireless communication system

XIII. CONCLUSION

This paper gives a vast knowledge about the generation of mobile communication networks from it starting to the future technologies. The requirement in mobile communication is accurate, speedy, highly smart etc. so there are many developments are encountered. The 5G points a genuine remote world without any confinements while 6G incorporates 5G with satellite systems. Because of variable advancements and norms, with 6G handoff/meandering will be an issue.

Table 2: Generation Technology Comparison

Key Parameters	First Generation (1G)	Second Generation (2G)	Third Generation (3G)	Fourth Generation (4G)
Development	1970-1980	1990-2004	2004-2010	2015-till now
Data Rate	2 Kbps	14.4-64 Kbps	3.1Mbps average speed 0.5Mbps-1.5 Mbps	2-12 Mbps average speed of 100Mbps-300 Mbps
Download (downlink)	-	144 Kbps	100 Mbps	1Gbps
Upload (uplink)	-	20 Kbps	5 Mbps	500 Mbps
Bandwidth	800-900 MHz	850- 1900 MHz(GSM) 825- 849MHz (CDMA)	1.8 – 2.5GHz	2 – 8 GHz
Switching Technology	Circuit	Circuit, Packet	Both circuit and packet switching	Packet switching
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA2000,WCDMA	OFDM-OFDMA
Network architecture	AMPS	GSM	Cell-Based (WAN)	WAN-LAN
Forward error correction	Manual	Automatically	turbo codes for error correction	Linked codes for error correction
Internet protocol	-	GPRS-EDGE	Air link protocols	IPv4, Ipv6
Core Network	PSTN	PSTN	Packet N/W	Internet

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