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A Proportional Survey on Generations of Wireless Networks

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Abstract: *Generation (G) generally refers to a change in the nature of the system, speed, technology and frequency. Each generation have some standards, capacities, techniques and new features which differentiate it from the previous one. Mobile wireless technology is rising in swiftpace with superior techniques.This technology has made incredible growth in the last fifteen years. The mobile communication industry growth has surpassed growth of all other fields. Even our own country is not left behind. The number of Indian mobile users grown to 1.16 billion in February 2017. 4G system has been introduced in line with other countries. Talks have started about 5G / 6G implementation. The implementation of 5G /6G will most probably be the ultimate goal in the field of Communication.*

Keywords: Wireless networks, 1G, 2G, 3G, 4G, 5G.

Introduction

Mobile wireless industry has started its technology creation, revolution and evolution since early 1970s. In the past few decades, mobile wireless technologies have experience 4 or 5 generations of technology revolution and evolution, namely from 1G to 4G. The cellular concept was introduced in the 1G technology which made the large scale mobile wireless communication possible. Digital communication has replaced the analogy technology in the 2G which significantly improved the wireless communication quality. Data communication, in addition to the voice communication, has been the main focus in the 3G technologies and a converged network for both voice and data communication is emerging.

A 4G system will be able to present a complete IP explanation where voice, data and streamed multimedia can be given to users at anytime, anywhere basis, and at superior data rates than previous generations. Fifth Generation (5G) is a packet switched wireless mobile communication system with extensive area coverage and high through put. Hence it is called as Real World Wireless or wireless World Wide Web (WWWW).With continued R&D, there are many killer application opportunities for the 5G/6G as well as technological challenges.

I. EVOLUTION OF MOBILE CELLULAR NETWORKS

Cellular Mobile communication has generations as shown in the figure1. The brief description of every generation is given as under:-

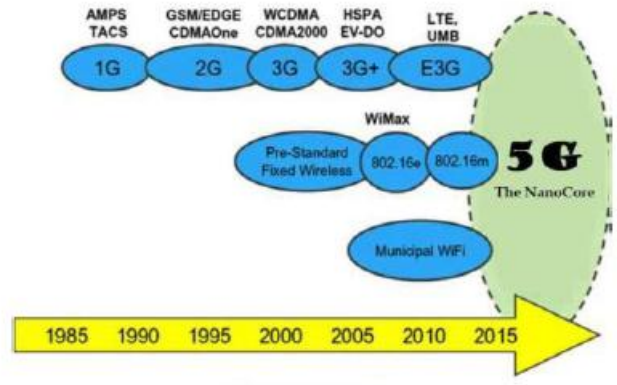

Fig. 1 Block Diagram of Evolution of Mobile Generations

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II. FIRST GENERATION TECHNOLOGY (1G)

1G refers to the first generation of mobile communication system which was launched by NTT in Japan in 1974, followed by the launch of Nordic Mobile Telephone (NMT) system in Denmark, Finland, Norway and Sweden, in 1981. Which was based on an Advance Mobile Phone Service (AMPS) technology and provide the service like – Only Voice, technology is analog; its speed is 1kbps to 2.4 kbps. It supports circuit switching and the Core Network is PSTN with a Frequency – 800- 900 MHz, Bandwidth capacity - 30 kHz. The drawback of 1G network: Poor voice links & no security at all since voice calls were played back in radio towers.

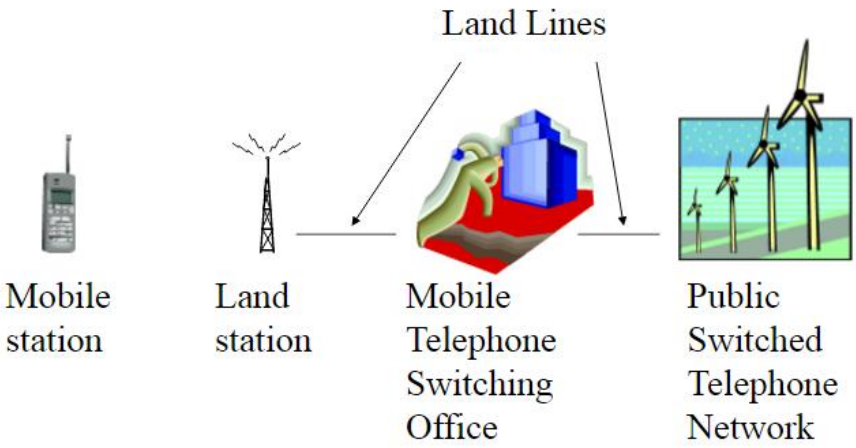

Fig. 2 Network Components of 1(G)

III. SECOND GENERATION TECHNOLOGY (2G)

2G (or 2-G) is the short form for second-generation wireless telephone technology. It cannot usually transmit data, such as email or software, other than the digital voice call itself, and other basic auxiliary data such as time and date. However, SMS messaging is also available as a form of data transmission for some standards. Second generation (2G) cellular telecom networks were commercially launched on the GSM standard in Finland by Radio linja (now part of Elisa Oyj) in 1991.GSM technology was the first one to facilitate digital voice & data and international roaming and allowing customer to roam from place to another. GSM maintains end-to-end security by retaining the confidentiality of calls using Signalling and Data Confidentiality and Mobile station Authentication.

2G technologies was based on Standard – **GSM** (Global System for Mobile Communication), **IS-95**(CDMA) - used in the Americas and parts of Asia), **JDC** (Japanese Digital Cellular) (TDMA-based), used in Japan, **iDEN** (TDMA-based), proprietary network used by Nextel in the United States. 2G technologies can be divided into Time Division Multiple Access (TDMA) based and Code Division Multiple Access (CDMA) based standards depending on the type of multiplexing used.

2G supports digital technology; its speed is 14kbps to 64 kbps, with a Frequency – 850-1 900 MHz, Bandwidth/Channel - GSM divides each 200 kHz channel into eight 25 kHz time-slots. CDMA channel is nominally 1.23 MHz wide.2G networks may support services such as WAP, MMS, SMS mobile games, and search and directory.

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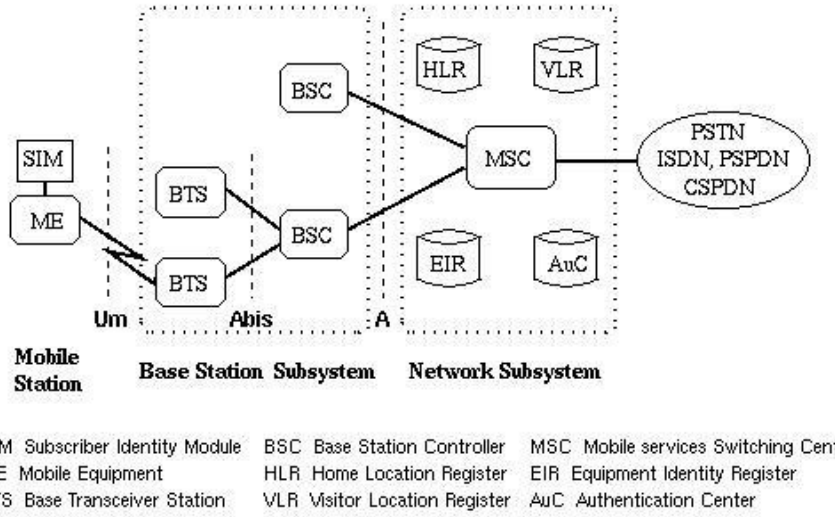

Fig. 3 Network Components of 2(G)

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IV. THIRD GENERATION TECHNOLOGY (3G)

3G is the third generation of mobile phone standards and technology, superseding 2G, and preceding 4G. It is built on the International Telecommunication Union (ITU) family of standards under the International Mobile Telecommunications programme, IMT-2000. 3G technologies allow network operators to offer users a wider range of more advanced services while achieving superior network capacity through enhanced spectral efficiency.

Services contain Wireless voice telephony, high speed internet access, fixed wireless Internet access, video calls, chatting & conferencing, mobile TV, Video on demand, Location-based services, Telemedicine, Web browsing, e-mail, paging, fax and navigational maps, Mobile gaming, mobile music, multimedia services like digital photos and movies.Added features also include HSPA data transmission skills which are able to deliver speeds up to 14.4Mbit/s on the downlink and 5.8Mbit/s on the uplink. Spectral efficiency or spectrum efficiency refers to the amount of information that can be communicated over a given bandwidth in a specific digital communication system. High-Speed Packet Access (HSPA) is a collection of mobile telephony protocols that spread and increase the performance of existing UMTS protocols.

3G technologies make use of TDMA and CDMA.3G (Third Generation Technology) technologies make use of value added services like mobile television, GPS (global positioning system) and video conferencing. The basic feature of 3G Technology is fast data transfer rates. There are many 3G technologies like W-CDMA, GSM EDGE, UMTS, DECT, WiMax and CDMA 2000. Improved data rates for GSM progression or EDGE is termed to as a backward digital technology, because it can operate with older devices. 3G has the following enhancements over 2G and previous networks:

1) Enhanced audio and video streaming;
2) Several Times higher data speed;
3) Video-conferencing support;
4) Web and WAP browsing at higher speeds;
5) IPTV (TV through the Internet) support.

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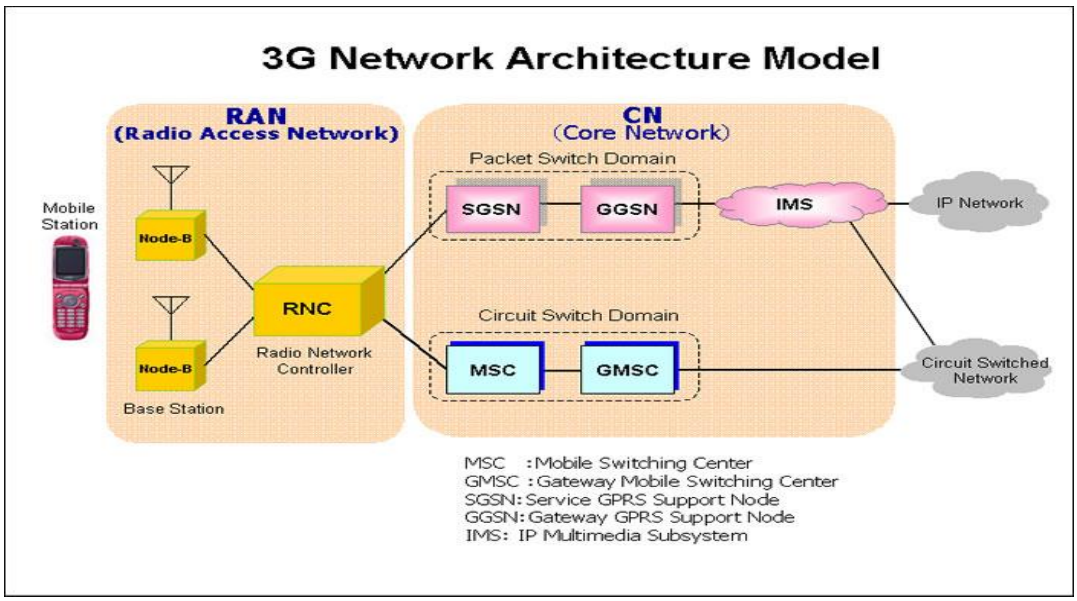

Fig .4 Network components of 3(G)

V. FOURTH GENERATION TECHNOLOGY (3G)

A fourth generation (4G) network is the name given to an IP-based mobile system that provides access through a collection of radio interfaces [3]. A 4G network assures flawless roaming/handover and best connected service, merging numerous radio access interfaces into a single network that subscribers may use. With this characteristic, users will have access to different services, improved coverage, the convenience of a single device, one bill with reduced total access cost, and more trustworthy wireless access even with the failure or loss of one or more networks. At the moment, 4G is simply an initiative by R&D labs to move further than the restrictions, and deal with the problems of 3G (which is having trouble meeting its promised performance and throughput).

At the most common level, 4G architecture will comprise of three basic areas of connectivity: Personal Area Networking (such as Bluetooth), local high-speed access points on the network together with wireless LAN technologies and cellular connectivity. Under this shade, 4G calls for a wide range of mobile devices that support global roaming. Each device will be able to interact with Internet-based information that will be customized on the fly for the network being used by the device at that instant. To sum up, the roots of 4G networks lie in the idea of pervasive computing [4].

4G is being developed to accommodate the QoS and rate requirements set by forthcoming applications like wireless broadband access, Multimedia Messaging Service (MMS), video chat, mobile TV, HDTV content, Digital Video Broadcasting (DVB), minimal services like voice and data, and other services that make use of bandwidth. The meaning of 4G is to provide sufficient RF coverage, more bits/Hz and to interconnect all wireless heterogonous networks to provide seamless, steady telecom experience to user.

4G introduced new physical radio interface known as Evolved UMTS Terrestrial Radio Access (E-UTRA) and new packet –switching based core network called as Evolved Packet Core (EPC). IP-based network architecture, allows for seamless handovers for voice and data to GSM, UMTS or CDMA2000 technology.

1. Standards - **Long-Term Evolution Time-Division Duplex** (LTE-TDD and LTE-FDD) Mobile WiMAX standard (**802.16m standardized by the IEEE**
2. Speed - 100Mbps while moving and 1Gbps while stationary ,with the help of following features
3. IP telephony
4. OFDMA multi-carrier transmission and frequency-domain equalization (FDE) schemes
5. Smart antenna arrays for multiple-input multiple-output (MIMO) communications.
6. New frequency bands, wider channel frequency bandwidth
7. Multiplexing/Access Technologies - OFDM, MC-CDMA, LAS-CDMA and Network-LMDS
8. Bandwidth - 5–20 MHz, optionally up to 40 MHz

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9. Frequency Bands: - LTE standard covers a range of many different bands.
10. In North America, 700, 750, 800, 850, 1900, 1700/2100 (AWS), 2300 (WCS) 2500 and 2600 MHz are used (bands 2, 4, 5, 7, 12, 13, 17, 25, 26, 30, 41); 2500 MHz in South America;
11. 700, 800, 900, 1800, 2600 MHz in Europe (bands 3, 7, 20); 800, 1800 and 2600 MHz in Asia (bands 1, 3, 5, 7, 8, 11, 13, 40)
12. 1800 MHz and 2300 MHz in Australia & New Zealand (bands 3, 40).
13. Services - Mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, 3D television, and cloud computing, manage multi broadcast streams and handle quick-moving mobile phones , Digital Video Broadcasting (DVB), Dynamic information access, wearable devices. smooth handovers across heterogeneous networks and automatic roaming between different wireless networks

4G implementation variants:

The LTE standard supports only Packet Switching & is all IP Network. Voice calls in GSM, UMTS and CDMA2000 are circuit switched, so with the adoption of LTE, carriers will have to re-engineer their voice call network. However since it requires lot of infrastructure changes, three different approaches are

1. **Voice over LTE (VoLTE) :** VoLTE is based on the IP Multimedia Subsystem (IMS) network i.e. voice service (control and media planes) being delivered as data flows within the LTE data bearer. VoLTE has up to three times more voice and data capacity than 3G UMTS. Furthermore, it frees up bandwidth because VoLTE's packets headers are smaller than those of unoptimized VoIP/LTE.
2. **Circuit-switched fallback (CSFB :** In this approach, LTE just provides data services, and when a voice call is to be initiated or received, it will fall back to the circuit-switched domain. When using this solution, operators just need to upgrade the MSC instead of deploying the IMS, and therefore, can provide services quickly. However, the disadvantage is longer call setup delay.
3. **Simultaneous voice and LTE (SVLTE) :** In this approach, the handset works simultaneously in the LTE and circuit switched modes, with the LTE mode providing data services and the circuit switched mode providing the voice service. This is a solution solely based on the handset, which does not have special requirements on the network and does not require the deployment of IMS either. The disadvantage of this solution is that the phone can become expensive with high power consumption.

One additional approach which is not initiated by operators is the usage of over-the-top content (OTT) services, using applications like Skype and Google Talk to provide LTE voice services.

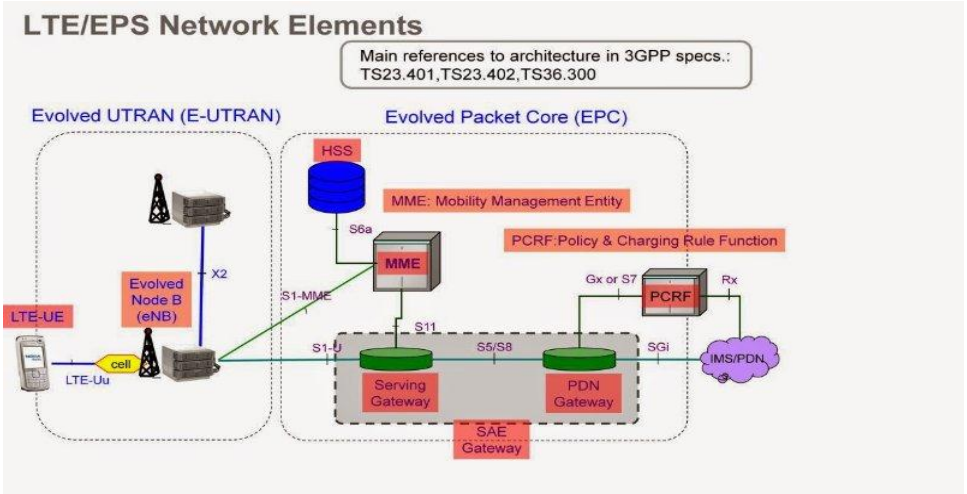

Fig. 5 Network components of 4(G)

VI. FIFTH GENERATION TECHNOLOGY (5G)

The 5G fifth generation of wireless mobile communication system is the wireless internet network which is maintained by OFDM, MC-CDMA, LAS-CDMA, UWB, Network-LMDS and IPv6. The 5G is also called as Real world wireless or (wwww) worldwide wireless web because it does not require

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restrictions. Physical layer and data link layer defines the wireless technology in 5G. These two layers indicate that the 5G technology is like Open Wireless Architecture (OWA) and the virtual multi-wireless networks are also maintained in the 5G technology mobile phones. To carry out this, the network layer is sub divided into upper network layer for upper terminal and lower network layer for interface and where all the routing is based in IP addresses and that should be different for each IP network in world wide. The application layer is for quality of service management over different type of networks. Bidirectional bandwidths, less traffic, uniform availability of network across the world, 25Mbps connectivity speed, data bandwidth higher than 1GB and low cost are the main features of 5G technology. It provides services:

1. Connected people & devices anywhere anytime. Its application will make world real Wi Fi zone.
2. Mobile IP address will be assigned as per the connected network and geographical position.
3. Radio signal at higher altitude as well.
4. Parallel multiple services, such as you can know weather and location while talking
5. You can control your PCs by handsets. Education will become easier. A student sitting in any part of world can attend the class.
6. Remote diagnostics is a great feature of 5G. - A doctor can treat the patient located in remote part of the world.
7. Monitoring will be easier − A governmental organization and investigating offers can monitor any part of the world. Possible to reduce the crime rate.
8. Visualizing universe, galaxies, and planets will be possible.
9. Possible, natural disaster including tsunami, earthquake etc. can be detected faster.

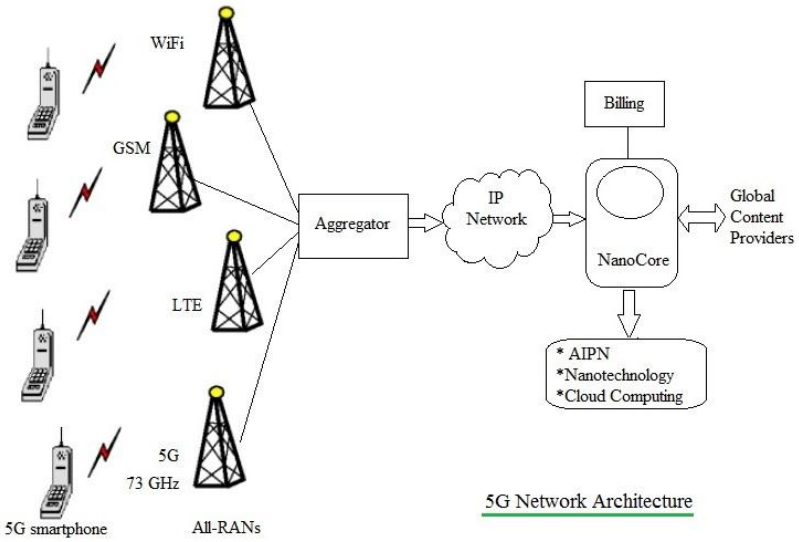

Fig. 6 Network components of 5(G)

VII. COMPARISON OF 1G TO 5G TECHNOLOGIES

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Technology	1G	2G/2.5G	3G	4G	5G
Deployment	1970/1984	1980/1999	1990/2002	2000/2010	2014/2015
Bandwidth	2kbps	14-64kbps	2mbps	200mbps	>1gbps
Technology	Analog cellular	Digital cellular	Broadbandwidth/ cdma/ip technology	Unified ip & seamless combo of LAN/WAN/WLAN/PAN	4G+WWWW
Service	Mobile telephony	Digital voice, short messaging	Integrated high quality audio, video & data	Dynamic information access, variable devices	Dynamic information access, variable devices with AI capabilities
Multiplexing	FDMA	TDMA/CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit/circuit for access network&air interface	Packet except for air interface	All packet	All packet
Core network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal& Vertical	Horizontal& Vertical

Fig 6. COMPARISON OF 1G TO 5G TECHNOLOGIES

VIII. CONCLUSION

Throughout this paper, we observe the performance of the previous wireless communication systems. In this study, it was discovered that some problems are still unable to solve such as endless problems of communications with poor coverage, bad interconnectivity and poor quality of service. The advent of 5G will change the field of communication field, bringing wireless experience to a completely new level. It will provide wealth of features. The mobile terminals of the 5G have more processing power and more memory on board. It is expected that the initial Internet idea of keeping the network simple as possible as well as giving more functionalities to the end nodes. It will become a reality in the fifth generation wireless system (5G). This technology helps to promote stronger links between people working in different fields creating future concepts of mobile communication, internet service, cloud computing and nanotechnology

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BIOGRAPHY

Mr. Pramod Kumar P is working as a Senior Assistant Professor in the Department of Computer Science & Engineering, SR Engineering College, Warangal, India. He received his M.Tech. Degree in Software Engineering with distinction at JNTU Hyderabad. Mr. P Pramod Kumar has taught primarily introductory Programming courses, courses in Mobile communication, and courses that focus on professional communication for over 13 years. His

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S Shwetha is working as a Assistant Professor in the Department of Computer Science & Engineering, Sumati Reddy Institute of Technology for Women, Warangal, India. She received her M.Tech. Degree in Software Engineering at JNTU Hyderabad, has 4 years of teaching experience. Mrs.S Shwetha research has been published in various international conferences and journals. His interested research area is Networking etc.