



A Relative Survey on Wireless Mobile Technology

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Abstract—In today’s Internet age everything has gone wireless. The world has shifted its pattern from long cables to no cables. Mobile wireless technology is rising in swiftpace with superior techniques. This technology has made incredible growth in the last fifteen years. The fast development of the mobile generations was for the reason of supporting as many mobile devices as possible that could advantage the users at anytime and anywhere in terms of common realistic applications such as internet access, location based services, video-on-demand, video conferencing system, mobile financial services, mobile entertainment services and many more applications. The users can use these applications at anytime and anywhere through wireless mobile communication. Starting from the scratch to today’s latest approach under discussion, this paper presents a survey for the mobile generations in the wireless communication field in order to emphasize and contrast the issues and challenges that are concerned in each generation and also in order to be aware of how solutions and improvements were successfully performed to these issues starting from the previous generations along to the next generations and finally till the present existing generation.

Keywords— 1G, 2G, 3G, 4G, 5G, GSM

I. INTRODUCTION

This paper primarily talks about the development of the wireless mobile technology in computer networks since the time it was first introduced. Architectural and realistic facts of each phase of the development are discussed with their merits and demerits. In this research work, we present the detail analysis of the different generations of the mobile communication networks. First Generation (1G) mobile phone networks were the most basic cellular systems to build up, and they relied on a network of distributed transceivers to communicate with the mobile phones. Second Generation (2G) mobile telephone networks were the reasonable subsequent phase in the growth of wireless systems after 1G, and they introduced for the first time a mobile phone system that used solely digital technology. Third Generation (3G) mobile phone networks are the newest phase in the progress of wireless communications technology. Important characteristics of 3G systems are that they support much higher data communication rates and offer increased ability, which makes them appropriate for high-speed data applications as well as for the conventional voice calls. Fourth Generation (4G) is known as beyond 3G, stands as an acronym for Fourth-Generation Communications System. It is used to depict the next step in wireless communications. 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 (WWW).

II. EVOLUTION OF MOBILE CELLULAR NETWORKS

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

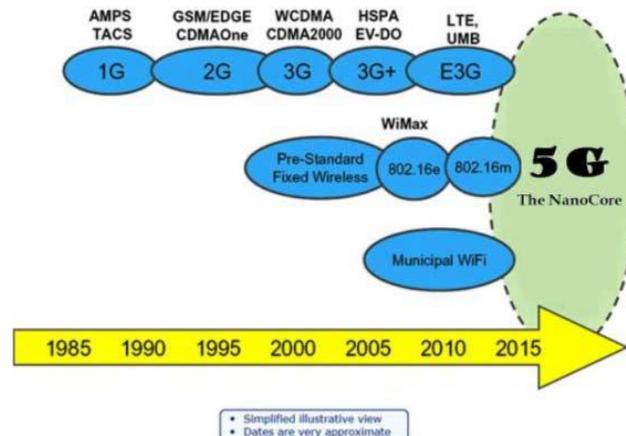


Fig. 1 Block Diagram of Evolution of Mobile Generations

III. ZERO GENERATION TECHNOLOGY (0G – 0.5G)

A. 0G

0G refers to pre-cellular mobile telephone technology in 1970s. These mobile telephones were typically mounted in cars or trucks, though briefcase models were also made. Mobile radio telephone systems preceded modern cellular mobile telephony technology. Since they were the predecessors of the first generation of cellular telephones, these systems are sometimes referred to as 0G (zero generation) systems. Technologies used in 0G systems included PTT (Push to Talk), MTS (Mobile Telephone System), IMTS (Improved Mobile Telephone Service), AMTS (Advanced Mobile Telephone System), OLT (Norwegian for Offentlig LandmobilTelefoni, Public Land Mobile Telephony) and MTD.

B. 0.5G

0.5G is a collection of technologies with enhanced features than the basic 0G technologies. These early mobile telephone systems can be distinguished from previous closed radiotelephone systems in that they were available as a marketable service that was part of the public switched telephonenetwork, with their own telephone numbers, rather than part of a blocked network such as a police radio or taxi dispatch system. These mobile telephones were typically mounted in cars or trucks, though briefcase models were also made. Normally, the transceiver (transmitter-receiver) was mounted in the vehicle trunk and attached to the "head" (dial, display, and handset) mounted near the driver seat. They were sold through various outlets, together with two-way radio dealers. The main users were loggers, construction foremen, realtors, and celebrities, for basic voice communication.

Early examples for this technology are:

- 1) The Autoradiopuhelin (ARP) launched in 1971 in Finland as the country's earliest public commercial mobile phone network.
- 2) The B-Netz launched 1972 in Germany as the country's second public commercial mobile phone network (but the first one that did not require human operators anymore to connect calls).

IV. FIRST GENERATION TECHNOLOGY (1G)

1G refers to the first generation of mobile communication system which was started in 1974 and completed in 1984. 1G was developed on earlier stages to communicate with the mobile phones through the network of distributed transceivers. Analog System was the earliest mobile wireless communication system used in 1G, which was based on an Advance Mobile Phone Service (AMPS) technology. AMPS system was based on frequency modulation radio system using Frequency Division Multiple Access (FDMA) with 30 KHz as the channel capacity and frequency band was 824-894 MHz it allows only voice calls. Its speed is up to 2.4 Kbps [1].

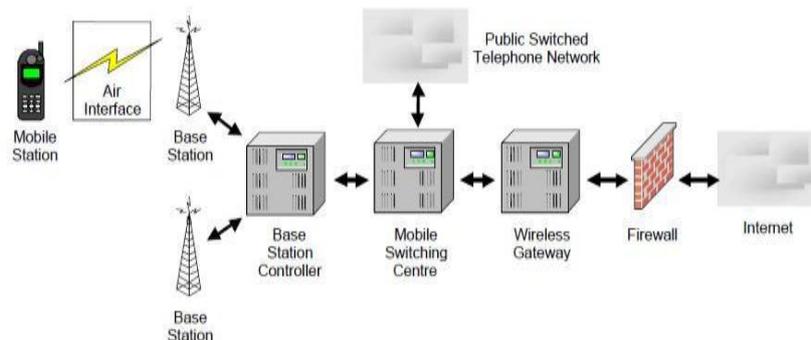


Fig. 2 Architecture of Advance Mobile Phone Services (AMPS)

There are some limitations in the 1G mobile communications. Firstly, it has no data service that can change the voice into digital numbers. Secondly, the global roaming service was not available. Thirdly, it contains an analog system in such a way that only voice is carried by these systems. In the matter of fact, the major difficulty that was held in the 1G is that there was only one channel which carries the data from one caller (source) to another (destination). More clearly, the available radio spectrum was not efficient for the space of channels. In other words, the first caller (source) will have to wait for a reply from the other caller once the voice is received. This means that the two callers are not able to hear each other concurrently since the number of calls was limited. As a result, such calls can be only performed once. This process refers to which is called "Frequency Division Multiple Access" FDMA [2]. This problem could be solved by having more than one channel (two channels or more) where one channel will have to be concerned about carrying the voice and the other channel will have to be concerned about carrying the data of the voice. As a result, a digital system is necessary for such tasks. More specifically, the frequency modulation technique was used to broadcast the signals of these voice calls.

V. SECOND GENERATION TECHNOLOGY (2G - 2.75G)

A. 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 Radiolinja (now part of Elisa

Oyj) in 1991. GSM service is used by more than 2 billion people across more than 212 countries and territories. The ubiquity of the GSM standard makes international roaming very ordinary between mobile phone operators, enabling subscribers to use their phones in many parts of the world. 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 makes use of a CODEC (Compression-Decompression Algorithm) to compress and multiplex digital voice data. Through this technology, a 2G network can group more calls per quantity of bandwidth as a 1G network. 2G cellphone units were normally smaller than 1G units, since they emitted less radio power. Some profit of 2G were Digital signals involve consume less battery power, so it helps mobile batteries to last long. Digital coding improves the voice clearness and reduces noise in the line. Digital signals are considered environment friendly. The use of digital data service assists mobile network operators to bring in short message service over the mobile phones. Digital encryption has provided privacy and security to the data and voice calls. The use of 2G technology requires strong digital signals to help mobile phones work. If there is no network coverage in any specific area, digital signals would be weak.

B. 2.5G – GPRS (GENERAL PACKET RADIO SERVICE)

2.5G, which stands for "second and a half generation," is a cellular wireless technology developed in between its ancestor, 2G, and its descendant, 3G. The term "second and a half generation" is used to explain 2G systems that have implemented a packet switched domain in addition to the circuit switched domain.

"2.5G" is an informal term, invented exclusively for advertising purposes, unlike "2G" or "3G" which are formally defined standards based on those defined by the International Telecommunication (ITU).

GPRS could provide data rates from 56 kbit/s up to 115 kbit/s. It can be used for services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and for Internet communication services such as email and World Wide Web. GPRS data transmit is normally charged per megabyte of traffic transferred, while data communication via conventional circuit switching is billed per minute of connection time, independent of whether the user actually is utilizing the ability or is in an inactive state.

2.5G networks may support services such as WAP, MMS, SMS mobile games, and search and directory.

C. 2.75 – EDGE (Enhanced Data rates for GSM Evolution)

EDGE (EGPRS) is an acronym for Enhanced Data rates for GSM Evolution, which is a digital mobile phone technology which acts as a bolt-on improvement to 2G and 2.5G General Packet Radio Service (GPRS) networks. This technology works in GSM networks. EDGE is a superset to GPRS and can function on any network with GPRS installed on it, provided the carrier implements the essential advancements.

EDGE technology is an extended form of GSM. It permits the clear and fast broadcast of data and information. It is also named as IMT-SC or single carrier. EDGE technology was developed and presented by Cingular, which is now known as AT&T. EDGE is radio technology and is a part of third generation technologies. EDGE technology is favored over GSM due to its flexibility to transmit packet switched data and circuit switched data.

The use of EDGE technology has increased the use of blackberry, N97 and N95 mobile phones. EDGE transfers data in fewer seconds if we compare it with GPRS Technology. For instance a typical text file of 40KB is transmitted in only 2 seconds as compared to the transfer from GPRS Technology, which is 6 seconds. The biggest benefit of using EDGE technology is one does not need to install any further hardware and software in order to make use of EDGE Technology. There are no additional charges for exploiting this technology. If a person is an ex-GPRS Technology user he/she can use this technology without paying any additional charges.

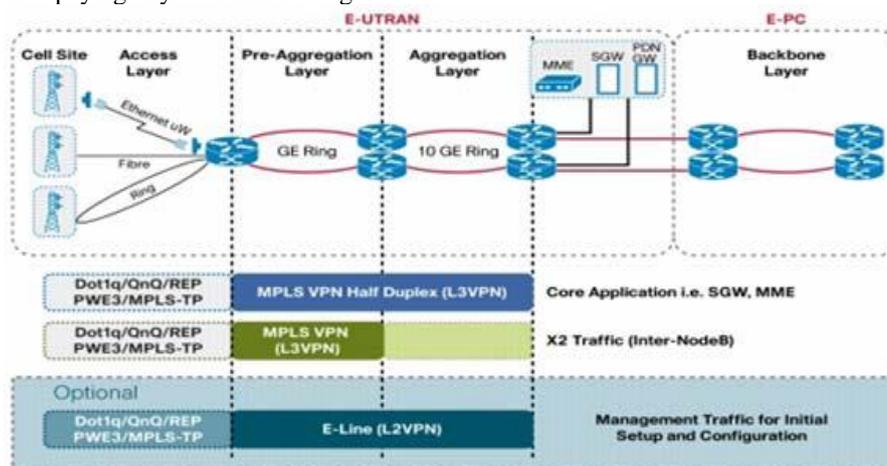


Fig. 3 2G Network Architecture

VI. THIRD GENERATION TECHNOLOGY (3G – 3.75G)

A. 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 widearea wireless voice telephony, video calls, and broadband wireless data, all in a mobile environment. 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.

Unlike IEEE 802.11 (common names Wi-Fi or WLAN) networks, 3G networks are wide area cellular telephone networks which evolved to integrate high-speed internet access and video telephony. IEEE 802.11 networks are short range, high-bandwidth networks mainly developed for data. Wi-Fi is the common name for a popular wireless technology used in home networks, mobile phones, video games and more. The notebook is associated to the wireless access point using a PC card i.e. wireless card. A videophone is a telephone which is capable of both audio and video duplex transmission.

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.

3G technology is much flexible, because it is able to support the 5 major radio technologies. These radio technologies work under CDMA, TDMA and FDMA.CDMA holds for IMT-DS (direct spread), IMT-MC (multi carrier). TDMA accounts for IMTTC (time code), IMT-SC (single carrier). FDMA has only one radio interface known as IMT-FC or frequency code. Third generation technology is truly reasonable due to the agreement of industry. This agreement took place in order to increase its acceptance by the users. 3G system is compatible to work with the 2G technologies. The aim of the 3G is to allow for more coverage and growth with minimum investment.

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 2.5G 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 higherspeeds;
- 5) IPTV (TV through the Internet) support.

B. 3.5G or 3G+ – HSDPA (HIGH-SPEED DOWNLINK PACKET ACCESS)

High-Speed Downlink Packet Access (HSDPA) is a mobile telephony protocol, also called 3.5G (or "3½G"), which offers a smooth evolutionary path for UMTS-based 3G networks permitting for higher data transfer speeds.

HSDPA is a packet-based data service in W-CDMA downlink with data transmission up to 8-10 Mbit/s (and 20 Mbit/s for MIMO systems) over a 5MHz bandwidth in WCDMA downlink. HSDPA implementations comprises of Adaptive Modulation and Coding (AMC), Multiple-Input Multiple-Output (MIMO), Hybrid Automatic Request (HARQ), fast cell search, and advanced receiver design.

C. 3.75G – HSUPA (High-Speed Uplink Packet Access)

The 3.75G refer to the technologies beyond the well-defined 3G wireless/mobile technologies. High Speed Uplink Packet Access (HSUPA) is a UMTS / WCDMA uplink evolution technology.

The HSUPA mobile telecommunications technology is directly connected to HSDPA and the two are complimentary to one another.

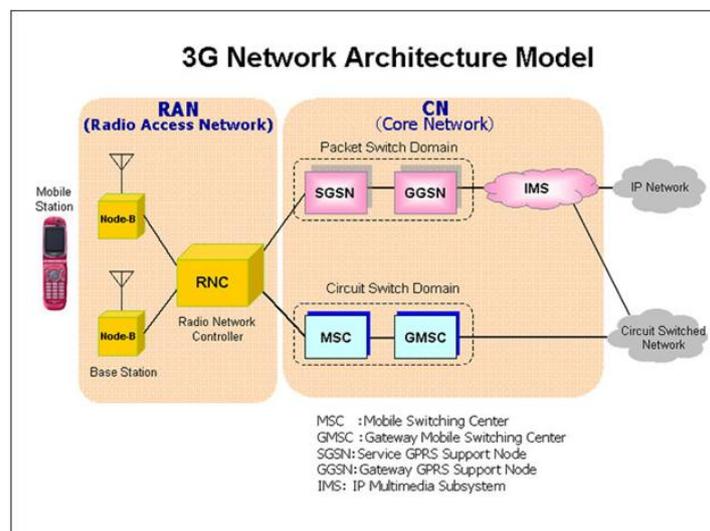


Fig. 4 3G Network Architecture

HSUPA will augment advanced person-to-person data applications with higher and symmetric data rates, like mobile e-mail and real-time person-to person gaming. Traditional business applications along with many customer applications will benefit from improved uplink speed. HSUPA will initially boost the UMTS / WCDMA uplink up to 1.4Mbps and in later releases up to 5.8Mbps.

VII. FOURTH GENERATION TECHNOLOGY (4G)

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 heterogeneous networks to provide seamless, steady telecom experience to user.

Mobile networks have been planned up to this point — for circuit- switched voice. Wireless networks were designed in a hierarchical fashion to aggregate, validate, handle and direct calls. A BSC aggregates calls from multiple base stations, assigns radio channels, allows handoffs between base stations and passes on calls to an even more centralized mobile switching center. As packet data networks came out, they were overlaid on the existing voice-centric architecture, using the BSC for the identical mobility management functions and adding the SGSN and GGSN in the case of GSM/UMTS and a PDSN in the case of CDMA to route and manage data sessions, as well as to connect to the Internet or suitable IP network. As data traffic is rising rapidly, this voice centric architecture has become cumbersome and harder to manage with too many network units. Flat network architecture eliminates that voice centric hierarchy from the network. Instead of overlaying a packet data core on the voice network, separate and much simplified data architecture can be put into practice that removes the multiple elements from the network sequence. BSC functions are divided between Base station and media gateway router. Base station will communicate directly via 3GDT (3G direct tunnel) with media gateway over WAN (Carrier Ethernet, MW, DWDM etc.). Some of the functions of BSC/RNC such as Radio resource management, Radio Bearer Control, and Dynamic allocations of resources will be handled by base stations, while functions such as Distribution of paging messages, Security will be managed by mobility manager, placed in Gateway router.

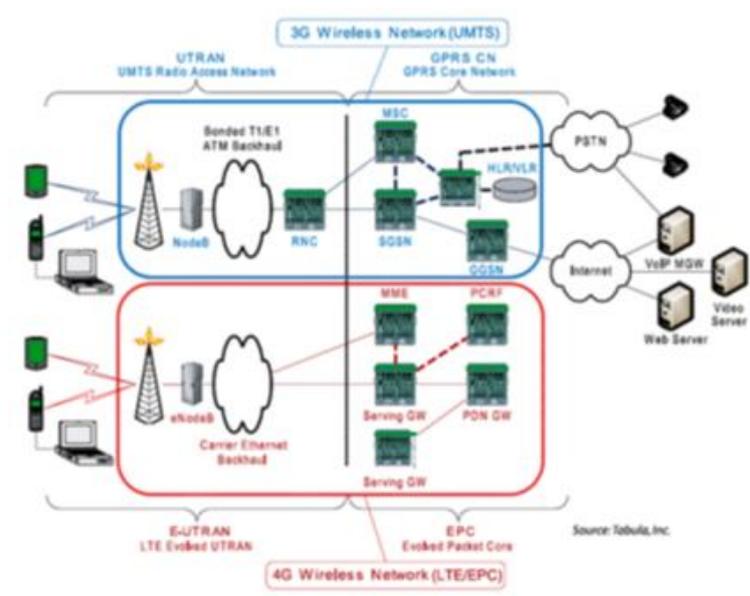


Fig. 5 4G Network Architecture

VIII. FIFTH GENERATION TECHNOLOGY (5G)

The 5G i.e. 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 www worldwide wireless web because it does not require 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 main drawback of the 5G technology is higher big rate. The big rate is controlled by using Open Control Protocol (OTP) [5]. This OTP is supported by transport layer and session layer in 5G networks. 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.

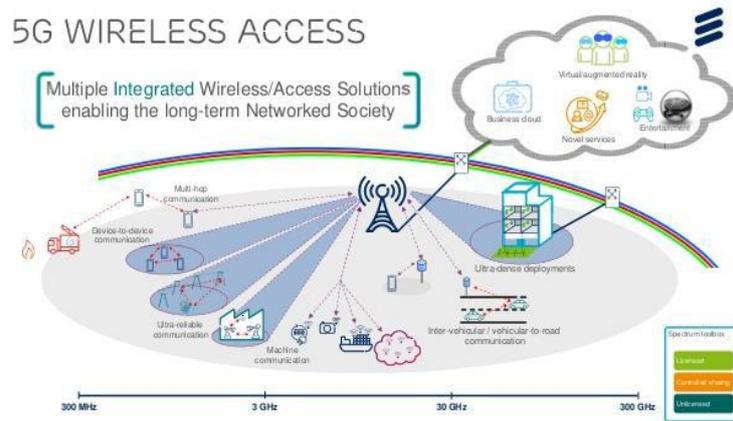


Fig. 6 Open Wireless Architecture

IX. COMPARISON OF 1G TO 5G TECHNOLOGIES

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+W/WWW
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

X. 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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