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Past, Present and Future of Mobile Wireless Communication

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Abstract: *Revolutionary change in the Ways of communication between moving people at remote distance have given birth of different wireless communication techniques. These radical changes in technologies have been leaving behind the previous one with additional advantages and features. Mobile wireless has been developing gradually since the invention of radio ability to keep continuous contact with ships by Guglielmo Marconi. In this paper, we will have a small sight at the evolution of mobile wireless communication systems developed in the past few decades. Besides, we will discuss on the future aim of mobile wireless systems. Mobile wireless communication has stepped forward from First Generation (1G) to Second Generation (2G), Third Generation (3G) and Fourth Generation (4G) systems. These developments in mobile wireless communication systems aims at providing new features, greater quality of service, high data rates, enhanced efficiency etc. Mobile wireless system is approaching towards Fifth Generation (5G) systems.*

Keywords: *1G, 2G, 3G, 4G, 5G, FDMA, Millimeter Wave*

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I. Introduction

The transfer of data or information through free space as a form of electromagnetic wave without using any electrical conductor or wired mediums such as co-axial cable, twisted pair cable etc is termed as Wireless communication. Now-a-days mobile and wireless network provide secured communication path between users apart from a few meters to millions of kilometers. Due to maintain increasing needs we develop new systems and fast wireless network. Not only mobile network operators but also vendors have felt the significance of efficient networks through efficient design. Hence planning, installation, development and optimization of network has captured the main focus [1]. In 1895, Guglielmo Marconi used the wireless channel for the first time to send morese radio signals over more than a mile [2]. Based on wireless channel, mobile was invented by Martin Cooper in 1973 [3]. At the same year, Fluhr and Nussbaum proposed a cellular telephone switching plan. Since then a revolutionary change has been brought to the wireless communication methodologies to ensure more secured and high speed communication along with efficient network designing and increased capacity. The following sections of this paper describe the evolution of mobile communication 1G to the future generation i.e., 5G.

II. 1G Or The First Generation System

1G is the first generation of wireless telecommunication technology and works in the frequency band of 150 MHz [4]. In the 1980s, 1G technology was invented. Initially in the metropolitan area of Tokyo in japan, it was launched by NTT (Nippon Telegraph and Telephone) in 1979. The key technique behind 1G was frequency reuse technique where the same frequency is reused can be in nearby but not adjacent cells [5]. In a certain area more users can be supported by using the technique and it is possible by using a technique called FDMA. The technology used analog signals for voice transmission and had a speed up to 2.4 kbps. 1G was used in the following technologies: paging system, cordless telephone, private mobile radio, mobile satellite systems, mobile telephone systems, advance mobile telephone systems, push to talk and improved mobile telephone service. In various countries, different 1g standards were used such as Nordic countries, Eastern Europe and Russia used NMT (Nordic Mobile Telephone), United States used AMPS (Advanced Mobile Phone System), United Kingdom used TACS (Total Access Communications System) etc. [6].

III. 2G Or The Second-Generation System

2G is the Second-Generation wireless telecommunication technology, based on digital technologies. In 1991, 2G was launched in Finland. The digital mobile access technology such as TDMA and CDMA are used by 2G system. At first, TDMA divides signal in different time slots then CDMA allocates each user a special code to communicate over a multiplex physical channel. There are different TDMA technologies such as GSM (Global System for Mobile), PDC (Personal Digital Cellular), iDEN (Integrated Digital Enhanced Network), iS-136 [7]. Again, IS-95 is CDMA technology. 2G technology used digital signals for voice transmission and had a speed up to 64 kbps. It helps mobile batteries to last long because, the digital signals consume less battery power. Again, Digital coding improves the voice clarity and reduces noise in the line. The use of digital data service assists mobile network operators to introduce short message service (SMS) over the cellular mobile phones. 2G also provides services such as text message, picture messages, Multimedia message service (MMS), cordless telephone (DECT, PACS), Private mobile radio (TETRA), Wireless Local Loop (WLL) cellular systems (GSM, D-AMPS, PDC etc.), Mobile Satellite Systems (IRIDIUM, ICO, GLOBALSTAR) [10]. This technology offers greater security for both sender and receiver. All text messages are digitally encrypted, which allows for the transfer of data in such a way that only intended receiver can receive and read it. GSM was first 2G system and has origin from Europe. GSM is most admired standard of all the mobile technologies used in more than 212 countries, in the world. This technology makes international roaming very common between mobile phone operators, enabling subscribers to use their phones from different parts of the world.

The extension of existing 2G network is General packet radio service (GPRS) which have the capacity of launching packet based services with enhance the data rates. is used to This system is described by the term "Second and a half generation" as this technology is developed in between its predecessor, 2G, and its successor, 3G. GPRS provided data rates from 56 Kbps up to 115 Kbps by using database of HLR, VLR, AUC with HSCSD, GPRS and EDGE technologies [8]. It provides services such as wireless application protocol (WAP) access, multimedia messaging service (MMS) and for internet communication services such as e-mail and worldwide wireless web (WWW) access [11].

2.5G technology has enlarged the data rates for GSM evolution (EDGE) networks with the introduction of 8PSK encoding [8]. EDGE technology is an extended version of GSM EDGE which is preferred over GSM for its flexibility to carry packet switch data and circuit switch data. The EDGE technology is faster technology GPRS. For example, a typical text file of 40KB is transferred in only 2 seconds while the GPRS technology takes 6 seconds. EDGE is characterised by 3rd Generation Partnership Project (3GPP) which provides a potential three-fold increase in capacity of GSM/GPRS networks. Here, higher data rates (up to 236.8 Kbits/s) is achieved by switching to more sophisticated methods of coding (8PSK), within existing GSM timeslots [8]. The main advantage of using EDGE technology is any additional hardware and software installation is not needed.

IV. 3G Or The Third-Generation Systems

3G is the third generation of wireless telecommunication technology which is superseding previous generations. The international telecommunication union (ITU) formulated a plan to implement global frequency band in the 2000 MHZ range [9], which will support a single, ubiquitous wireless communication standard for all countries throughout the world with bandwidth of 15-20MHz used for High-speed internet service, video chatting. HSPA data transmission capabilities are able to provide with speeds up to 14.4Mbit/s on the downlink and 5.8Mbit/s on the uplink [5]. This technology was introduced in 2002. 3G evolution for CDMA systems lead to CDMA 2000. 3G progresses for GSM is IS-136 and PDC system leads to wideband CDMA (WCDMA). 3G technology provides users with wider range of more advanced services such as wide area wireless voice telephony, video calls, and broadband wireless data, mobile television, global positioning system (GPS) and video conferencing, WLAN, Bluetooth [7]. 3G has the following enhancements over previous technologies [5]:

- Enhanced audio and video streaming
- Several times higher data speed
- Video-conferencing support
- Web and WAP browsing at higher speeds
- IPTV (TV through the Internet) support

3G technologies have some other facilities such as Global Roaming Clarity in voice calls, fast communication, internet, mobile T.V, video conferencing, GPS, Video Calls, MMS, 3D gaming and multiplayer-gaming which is impossible by 2G technologies. The main goal of the 3G is to allow more coverage and growth with minimum investment.

3.5G uses a wireless telecommunication protocol named High-speed downlink packet access (HSDPA) which provides higher data transfer speeds. HSDPA is a packet-based data service in W-CDMA downlink and it provides data transmission up to 8-10 Mbit/s over a 5MHz bandwidth in W-CDMA downlink. Also for MIMO (multiple-input multiple-output) systems data transmission is up to 20 Mbit/s. 3.5G technologies acquirement

includes adaptive modulation and coding (AMC), multiple-input multiple-output (MIMO), hybrid automatic request (HARQ), fast cell search and advanced receiver design [5].

Another technology called High-speed uplink packet access (HSUPA) beyond the well-defined 3G technology is known as 3.75G. HSUPA will enlarge data rates and many consumer will be benefited from enhanced uplink speed. HSUPA will initially boost the UMTS / WCDMA uplink up to 1.4Mbps and in later releases up to 5.8Mbps [10].

V. 4G Or The Fourth Generation Systems

4G is a concept of inter-operability between different sorts of networks and well-known for high speed data transfer. It is a successor to 3G and 2G families of standards. In March 2008, the ITU-Radio (ITU-R) communications sector specified a set of requirements for 4G standards, named the International Mobile Telecommunications Advanced (IMT-Advanced) specification which has set peak speed requirements for 4G service at 100 megabits per second (Mbit/s) for high mobility communication and 1 gigabit per second (Gbit/s) for low mobility communication [11]. The 4G system not only provides voice with other 3G services but also provides ultra-broadband network access to mobile devices. The limitations and problems of 3G system have removed by 4G system. On June 2009, IPv6 is accepted as a 4G standard. In 3G technology, we can access the internet through our mobile phone with the help of various technologies, like Wi-Fi, Wi-Max, GPRS, EDGE, WAP and Wi-Bro [5]. But the problem is when you are accessing the internet through your mobile phone within the help of any of these technologies and you move to place where inter-operability between different networks, you are stuck. Again, if you are using 4G, you can access the net through any of these technologies even while moving from one place to another. 4G consist of a range of mobile technologies such as long term evolution (LTE) Standard based on the GSM/EDGE and UMTS/HSPA, 3GPP, MIMO smart antenna technology, orthogonal frequency division multiplexing (OFDM), 802.16e - worldwide interoperability for microwave access (WiMAX), 802.20 - mobile broadband wireless access (MBWA). 4G wireless technology refers to the word "MAGIC" which stands for Mobile multimedia, Global mobility solutions over every where, integrated wireless and customized services [7].

VI. 5G Or Future Generation Systems

5G (5^{th} Generation) is a generalized term for future generation mobile communication. The frequency band of 5G is 30 GHz to 300 GHz. This is also known as Millimeter-wave (mm-wave). Currently 5G has not been started to be used widely yet. No particular standard or specification has been carried out yet. Though it has been kept public by the ITU-R wireless standardization authorities [10]. It is expected that mm-wave band will perform with higher level of perfection in mobile communication networks. Now a days, mobile usage is not restricted to conversation and texting, rather it also serves for diverse applications. Country's development and increase in people give rise to the demand for a speedier mobile network. Existing frequency bands are about to face the saturation to cope with this demand. So, 5G is the only alternative and available option to fulfil the demand. In case of interoperability among existing radio networks, 5G acts as an all-IP based network model [12]. The all-IP based model is now termed as AIPN. It is predicted that AIPN will fulfil the future demand of the flourishing mobile souk. New services like online marketing, e-banking, portals, e-governance, e-health and so many other services will be available for mobile users through cloud computing resources (CCR) [13]. Users can store data online, access data from anywhere and take server services, security services, software services and so many services through CCR. In turns, cloud computing enhances flexibility of data manipulation, enhances resource security, reduces the cost of software licencing and server maintenance cost. A major portion of mm-wave suffers from different types of attenuation and propagation losses. The band around 38 GHz, 60 GHz and 80 GHz faces comparatively lower losses. Besides, 60 GHz band does not require any licencing. So licencing cost is saved and high data rate is ensured at this band. Noteworthy developments have been carried out in mobile communication from 1G to 5G. The 5G-mm-wave network is assumed to provide services at a reasonable price along with attractive new features. Since 5G has not been standardized yet, it requires a lots of developments. The 5G is expected to provide with the following attractive features.

Key features of 5G [14]:

- Enhanced coverage range and higher data rate availability at cell edge.
- Numerous concurrent paths for data transmission and hand over.
- G provid5es support for interactive multimedia, voice, video, Internet, and other broadband services which are more effective and more attractive and have bidirectional accurate traffic statistics.
- A probable mobility data rate of over 1Gbps with a large broadcast capacity to 65,000 connections at a time.
- Better security features and also better cognitive radio/Software Development Radio (SDR).
- Higher system level spectral efficiency.

- Worldwide wireless web (WWWW), wireless-based web applications that include full multimedia capability beyond 4G speeds.
- Several Artificial Intelligence aided applications at high bandwidth with multiple sensors enabled mobile devices.
- 5G technology offer high resolution for crazy cell phone user and bi-directional large bandwidth shaping.

VII. Conclusions

Mobile communication has gone through a lots of evolution and is about to face more change in frequency band, technology and standards. Every change in mobile communication comes with more attractive new features. This evolution of mobile communication still has a long way to go and much more features to be served.

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