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AN OVERVIEW OF MASSIVE MIMO SYSTEM IN 5G

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Abstract: 4G is proving good speeds up to 1Gbps. Then why do we need anything more. The problem is that it is not able to provide real time applications. 5G is the name given to the next generation of mobile data connectivity. It will definitely provide great speeds between 10Gbps to 100Gbps and it will have enough capacity. But the thing that separated 5G from 4G is latency; the latency provided by 4G is between 40ms to 60ms, whereas in 5G it will provide ultra latency between 1ms to 10ms. The standards for 5G will be set till 2020 and it will be applicable by 2022/23. In this paper we have discussed about 5G and its advantages, a probable architecture for 5G and some challenges in 5G. The main technology that maybe used in 5G are massive MIMO, millimetre wave communication, device to device communication, beam division multiple access etc. In this paper we have discussed about massive MIMO, channel estimate in massive MIMO, beam division multiple access technique to be used in massive MIMO, antenna selection in massive MIMO, capacity and energy efficiency in massive MIMO. In future 5G is going to be a technology which will be invisible, I will be just there everywhere just like electricity. It is a very good area for research as standards and frequency band for 5G are yet to be standardised.

Keywords: Massive MIMO, Beam Division Multiple Access (BDMA), channel estimate, energy efficiency, antenna selection.

1. INTRODUCTION

Mobile networking is a wireless technology than can provide voice and/or data networking, through a radio transmission. Mobile phone is one of the most famous applications of mobile networking. In past circuit switching was used to transmit voice over a network, then we moved on to use both circuit-switching and packet-switching for voice and data, now presently we are using packet switching only, this is how spectrum has expanded from 1G to 4G [1]. Today and in upcoming future wireless networks need to be improved for meeting the demand for increased data rate, improved capacity, reduced latency and good quality of service. We are in the 4th generation of wireless communication, so now research is going on for developing new standards for the next generation beyond 4G i.e. 5G. With increasing demands of subscribers definitely 4G will be replaced by 5G with the help of some advanced technologies like massive MIMO, device-to-device communication, millimetre wave communication, Beam division multiple access in massive MIMO etc. The technologies used in 4G like High-Speed Packet Access (HSPA) and Long Term Evolution (LTE) will be used as a part of future advancement. For this advancement we may use different methods, It may happen that we may use different spectrum access technique, increased frequency range, deploying large number of antennas etc. [1]

This whole thing started in 1970s, till now the mobile wireless communication has come a long way from analog communication to today's modern digital mobile communication providing the subscribers with improved data rate of megabits per second over wide area and few hundreds of megabits per second in a local area. We are going on well toward next stepping stone in future i.e. 5G.It is predicted that 5G will be in operation by 2020, hence immense research in going on in this field. The world is imagining a future where there is no restriction to the access and sharing of information from anywhere by anyone.

2. WHAT IS 5G AND WHY DO WE NEED IT?

5G is the name given to the next generation of wireless connectivity. It will provide great speeds and a good capacity. We are in the 4G now, having speeds of up to 150Mbps in areas of double LTE connections, 300Mbps for LTE-A connections and Pocket-lint (the largest independent gadget news and reviews site in the UK) has predicted that the speeds will improve up to 1Gbps in 4G. This speed is more than enough, then why on earth we need something more, why we need 5G? it is sure that 5G will provide unbelievable speeds between 10Gbps and 100Gbps. But latency is the thing that is very important, in 4G it is between 40ms and 60ms. This is a very low latency but not able to provide real-time applications like in a multi-player game we want our server to respond very quickly when a button is pressed. When it comes to 5G, they have promised a ultra-low latency between 1ms to 10ms. Then in future we can actually watch a cricket or football or any conference actually live without any delay. 5G is a technology that will appear to be invisible; it will be just there like electricity. Management of the available bandwidth is very important for improving the capacity, one idea is that as not all devices need the same bandwidth, we may provide bandwidth according to the needs and hence improve the capacity.

Some of the key technologies to be used in 5G are massive MIMO, device-to-device communication, millimetre wave communication and some multiple access techniques like beam division multiple access (BDMA). Everything around us will be connected to network, the sensors network, the ad-hoc networks, our accounts, laptops, pc etc. Analysis tells that by the year 2020, every person in UK will have 27 internet connected devices and 50 billion connected devices worldwide. This is definitely going to happen in future and it is given the name internet of things and beyond this it is internet of everything [1]. The devices connected may be mobile phones, tablets, watches, smart cloths etc. some may require significant amount of data to be transferred back and forth, the others may just need small packets of data, hence depending on these bandwidth can be allotted for the improvement of overall capacity of the system.

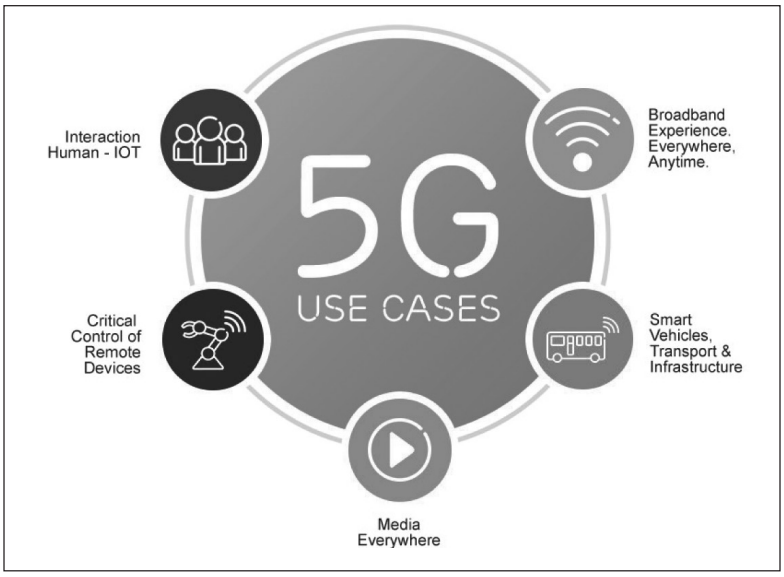

Figure 1. Things that will happen in future [1]

3. EVOLUTION OF 5G

First Generation (1G)-1981: The 1G was based on analog communication. They had poor traffic density i.e. only one call per channel, poor voice quality and they were insecure without any encryption.

Second Generation (2G)-1991: The 2G was based on digital communication with different standards

Division Multiple Access One), IS-136, and PDC (Pacific Digital Cellular). GSM was the most famous of all; it's being used even now. GSM used a frequency band between 900MHz and 1800 MHz, they developed a technology called SIM for authenticate a subscriber for identification and billing purposes, and for encryption of data.

Second to Third Generation Bridge (2.5G)-2000: In 2.5G the data was added along with voice. In between 2G and 3G a famous service called GPRS (general Packet Radio Service) was introduced, which provided services like send and receive e-mail and picture messages. They provide operation speeds up to 115kbps, which was increased up to 384Kbps by using EDGE (Enhanced Data rates for Global Evolution).

Third Generation (3G)-2003: 3G used a higher frequency bands and CDMA for data transmission with speeds up to 2Mbps and supported multimedia services like MMS. The famous standard in 3G was WCDMA (Wideband Code Division Multiple Access) which achieved speeds between 384Kbps and 2048Kbps. They continued using SIM authentication for billing systems and for encryption of data.

Fourth Generation (4G)-2007: 4G can provide speeds up to 150Mbps in areas of double LTE connections, 300Mbps for LTE-A connections and Pocket-lint (the largest independent gadget news and reviews site in the UK) has predicted that the speeds will improve up to 1Gbps in 4G., ad hoc networking model is used as a base as there is no need for a fixed infrastructure. The famous standards used are LTE-A (Long Term Evolution- Advance) by 3GPP and Wimax by IEEE. They provide latency between 40ms and 60ms.

Table 1
Difference between 1G, 2G, 3G, 4G, 5G [11]

Technologies / Features	***1G***	***2G/2.5G***	***3G***	***4G***	***5G***
Evolution	1970	1980	1990	2000	2010
Deployment	1984	1999	2002	2010	2015
Data Rate	2 kbps	14.4-64 kbps	2 Mbps	200 Mbps to 1 Gbps for low mobility	10 Gbps to 100 Gbps
Famous Standards	AMPS	2G: GSM,C]DMA 2.5G: GPRS, EDGE, 1xRTT	WCDMA, CDMA-2000	LTA, WiMAX	Not yet defined
Technology behind	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Undefined IP and seamless combination of broadband. LAN/WAN/PAN/ WLAN	Undefined IP and seamless combination of broadband. LAN/WAN/ PAN/WLAN
Service	Voice	2G: Digital Voice, SMS 2.5G: Voice+Data	Integrated high quality audio, video and data	Dynamic information access, wearable devices	Dynamic information access, wearable devices with AI capabilities
Multiplexing	FDMA	TDMA,CDMA	CDMA	CDMA	CDMA
Type of Switching	Circuit	2G: Circuit 2.5G: Circuit and packet	Packet	Packet	Packet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal and Vertical	Horizontal and Vertical
Core Network	PSTN	PSTN	Packet network	Internet	Internet

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