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SPEED AND RELIABILITY OF 5G NETWORK

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ABSTRACT

Everybody loves speed and moreover speedy internet, so it's no surprise that every major telecom in the world is working to make it even faster. Smartphones, watches, homes, and cars are increasingly requiring stable internet connections. In order to survive in the world where in every second the speed changes and where we urge for more and more technology, here comes the fifth-generation technology: 5G. In future, i.e., a world beyond 4G, some of the prime objectives that need to be fulfilled are increased capacity, improved data rate, decreased latency, and quality service. To meet these demands, large scale improvement in the cellular architecture of 5G is required. This paper basically lays emphasis on the 5th generation i.e., 5G cellular network architecture and some of the essential emerging technologies that can prove fruitful in humanizing the architecture and summiting the demands of users. This paper is contented with the details related to 5g with the prime focus on the massive multiple input multiple output technology and device-to-device communication (D2D). A general credible 5G cellular network architecture is being proposed with the guideline taken from the internet books and by the detailed study of the topic.

INTRODUCTION

The G in 5G stands for generation. and 5 is the advancement denoted through a number. Wireless phone technology technically entered with 1G, and in the early 1990s it upgraded to 2G when companies enabled people to send text messages between two cellular devices which fascinated the world. Eventually the world moved on to 3G, which imparted the liberation of making phone calls, send text messages, and browse the internet at excellent speed.4G enhanced many of the capabilities that were made possible only with the third generation of wireless. People could browse the web at lights speed, send text messages, and can make phone calls and they could even download and upload large video files without any issues and without long waiting. Then companies added LTE, abbr. for long term evolution, to 4G connectivity. LTE became the fastest and most consistent variety of 4G and it started competing with the technologies like WiMax in the market. Both technologies resulted in similar outcomes, but it was vital to create a standard for everyone to use. LTE did just that, by making 4G technology even faster and this laid the foundation of 5G. 5G will make it easier for people to download and upload Ultra HD and 3D video. So, we can say that there is advancement in the speed of living. It would be fascinating to imagine upgrading your data

connection from a backyard hose to a flames hose. The difference will be noticeable and worth appreciable.

The NEXT GENERATION MOBILE NETWORK ALLIANCES defines the following pre-requisite for 5G networks:

- Increased Data rates
- 1 Gb per second simultaneously to many workers on the same office floor
- SPECTRAL efficiency more enhanced as compared to 4G
- Coverage speed
- Signalling efficiency enhanced
- Legacy reduced significantly compared to LTE

A new-fangled mobile generation has appeared in roughly every 10 years since the first 1G system was introduced, Nordic mobile telephone in 1982. The first '2G' system commercially came into being in 1992, and the 3G system was started in the year 2001. 4G systems fully compliant with IMT Advanced were first made identical in 2012. The development of the 2G (GSM) and 3G (IMT-2000 and UMTS) standards took a extended time of about 10 years from the official initiative of the R&D projects, and thus the development of 4G systems began in 2001 or 2002. The evolution of wireless has been shown in Fig. 1. It depicts the embryonic generations of wireless technologies in provisions of data rate, mobility, network coverage and spectral competency. As the wireless technologies are emerging at a thick range, the data rate, mobility, coverage and spectral efficiency increases. Even it shows that the 1G and 2G technologies uses circuit switching while as 2.5G and 3G uses together circuit and packet switching whereas the next generations from 3.5G to till now i.e., 5G are using packet switching. Along with these factors, it also clears out the difference between licensed spectrum and unlicensed spectrum. All the budding generations make use of licensed spectrum while the Wi-Fi, Bluetooth and WiMax are using the unlicensed spectrum.

This paper is mainly classified into following sections:

- Evolution of generation
- 5G cellular network architecture
- Emerging technologies for 5g wireless network
- Conclusion

A sequential summary of all the generations has been given below:

A. 1G

1G (or 1-G) refers to the very first generation of wireless telephone technology (mobile telecommunication). The 1st

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generation was announced in initial 1980s. With data rate up to 2.4kbps. The subscribers were Advanced Mobile Phone System (AMPS), Nordic Mobile Telephone (NMT), and Total Access Communication System (TACS). The setbacks of first generation were below par capacity, reckless handoff, inferior accent associations, and with no safety measures, since audio calls were accumulated and played in radio towers due to which weakness of these calls from not so needed connections i.e., noises from the third-party increases. The main difference between the two mobile network system (1G and 2G), is the medium of encoders i.e. The radio signals which 1G networks uses are basically analog, while 2G networks are digital. We are aware of the fact that both the systems use digital signalling to connect the radio towers (which pay attention to the handsets) to the rest of the telephonic networks, the tone of voice itself during a call is programmed to digital signals in 2G whereas when we are talking about 1G, its modulation is done and that to on higher frequency, classically 150 MHz and up. This inherited advantage of digital over that of analog resulted in the replacement of 1G over 2G

B. 2G

2G (or 2-G) is short-term for second-generation wireless telephone technology. The three key benefits of 2G networks over their predecessors' generations were that:

- Phone conversations were digitally encrypted;
- 2G systems were considerably more competent on the spectrum allowing greater mobile phone penetration levels.
- 2G introduced data services, and gave rise to SMS text messages.

2G technologies enabled the various mobile phone networks with the services such as picture messages, text messages, and MMS (multimedia messages) All text messages sent over 2G are digitally encrypted as said above, allowing for the transfer of data in such a way that only the intended receiver can receive and read it i.e. more advanced than the 1G in terms of privacy.

C. 2.5G

It is generally a 2nd generation cellular system subscription combined with General Packet Radio Services i.e., GPRS and other amenities which doesn't commonly endow in 2G or 1G network. It can get high with data rate up to 144kbps system frameworks, but it applies both packet switching and circuit switching. GPRS, Enhanced Data Rate for GSM Evolution mainly known as EDGE, and Code Division Multiple Access i.e., CDMA 2000 were the man 2.5G technologies.

D. 3G

Then, came the introduction of 3rd generation which was established in late 2000. It imparts the world with transmission rate up to 2Mbps. The main purpose of Third generation (3G) system was to merge high speed mobile access to services based on Internet Protocol (IP) and it was successfully accomplished. Aside from transmission rate, avant-garde improvement was made for maintaining QoS. Supplementary facilities like global roaming and improved audio quality made 3G as a noteworthy and qualitative generation. The major annoyance for 3G handsets is that, they grab more power than most 2G models. Looking from the market point of view, 3G network plans are more expensive than 2G. 3G involves the utilization of Wideband Code Division Multiple Access i.e., WCDMA, Universal Mobile Telecommunications Systems (UMTS) and Code Division Multiple Access (CDMA) 2000 technologies, along with the introduction of the evolving technologies like High-Speed Uplink/Downlink Packet Access (HSUPA/HSDPA) and Evolution-Data Optimized (EVDO) which has made an intermediate wireless. 3G telecommunication networks prop up services that offer an information transfer rate of at least 200 kb/sec. Generation between 3G and 4G named as 3.5G provides an improved data rate of 5-30 Mbps

E. 3.75G

Long-Term Evolution technology (LTE) and Fixed Worldwide Interoperability for Microwave Access (WIMAX) is the outlook of mobile data services. LTE and Fixed WIMAX have the potential to complement the capability of the network. It also provides a substantial number of users, the facility to access a broad range of high-speed services approximating on stipulate video, peer to peer le sharing and fused Web services.

F. 4G

4G is the fourth generation (4th) of wireless mobile telecommunication technology, succeeding 3G and even more fascinating. A 4G system must provide capabilities defined by ITU in IMT. Advance 4G is generally referred as the progeny of the 3G and 2G standards. Presently, the standardization of Long-Term Evolution (LTE) advanced
as forthcoming 4G standards along with Mobile Worldwide Interoperability for Microwave Access commonly called WIMAX is done by 3rd generation partnership project (3GPP). A 4G system improves the customary communication networks by imparting complete and reliable solution based on IP. Facilities like voice, data and multimedia will be given to the users every time and everywhere basis and at quite elevated data charge as related to earlier generations. Applications which use a 4G network are Multimedia Messaging Service (MMS), Digital Video Broadcasting (DVB), and video chat, High-Definition TV content and mobile TV.

G. 5G

Huge consortiums of major global telecoms are already working to create worldwide values around 5G. Although most of those standards don't get solidified, experts yet expect it to be more compatible (with 4G and 3G) in addition to having some interoperability across the world. With an increment, in the demand of the users exponentially, 4G can now be easily replaced with 5G with a new advanced access technology named as Beam Division Multiple Access i.e. BDMA and or Filter Bank multi carrier abbr. as FBMC multiple access. The concept behind BDMA techniques can be explained by considering the case of the base station communicating with the mobile stations. An orthogonal beam is owed to each mobile station and by BDMA technique we

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can split that antenna beam according to locations of the mobile stations for openhanded multiple accesses to the mobile stations, which likewise increase the competency of the system and thus is the main process of this communication. An idea to swing towards 5G is based on present drifts; it is commonly assumed that 5G cellular networks can tackle six obstacles that are not well addressed by 4G i.e.

1. Higher capacity
2. Data rate higher
3. End to End latency has been lowered
4. Connectivity to massive device
5. Reduced cost
6. Consistent Quality

5G CELLULAR NETWORK ARCHITECTURE.

There are several obstacles in way for 5G designers. One of the most vital challenges is the physical paucity of radio frequency (RF) spectra owed for cellular communications. Moreover, these frequency spectra have been profoundly used, and there is no more auxiliary in the existing cellular bands. Further challenge is the operation of advanced wireless technologies comes at the tag of high energy consumption. Toting up to environmental concerns, it has been seen and reported by cellular operators that the energy which is consumed by the base stations contributes to over 70% of their electricity bill. To study 5G network in the market now, it is clear that the multiple access techniques in the network are almost at a halt and requires sudden upgrading. Current technologies like OFDMA are reported to work at least for next 50 years. Furthermore, there is no need of change in the technology. The wireless setup had come about from 1G to 4G. Alternatively, the addition of an application or we can say amelioration done at the elementary network for pleasing the user requirements is provoking the package providers to drift for a 5G network as soon as 4G is commercially set up. However, there was a widely agreement on the fact that as compared to the 4G network, the 5G network should achieve the below benefits over it:

1. 1000 times the system capacity
2. 10 times the spectral efficiency
3. Energy efficiency
4. Data rate.
5. 25 times the average cell throughput.

Drastic changes in the policy of designing the 5G wireless cellular architecture is needed to meet the difficulty of the user and to triumph over the challenges that have been put forward in the 5G system. In attendance wireless cellular architecture, for a mobile user to get connected or to communicate whether inside or outside, an outside base station is always present in the middle of a cell which helps in communication. The signals have to travel through the walls of the indoors, in providing communication between inside and outside base station which will result in very high penetration loss, along with the correspondingly costs with reduced spectral effectivity, data rate, and energy competency of wireless communications. To tackle this obstacle, a new idea for designing the 5G cellular architecture has come into existence i.e., to distinct the outside and inside setups. With the help of this designing technique, the loss due to the penetration through the walls of the building will be to some extent reduced. This scheme or we can say that this plan will be supported with the help of massive MIMO technology, in which the dispersed array of antennas are deployed geographically, which consists of many small units or it is made up of tens or hundreds of antenna units. Since at present MIMO systems are using either two or four antennas, but the idea of massive MIMO systems which has been introduced mainly lays emphasis on the utilizing the advantages of large array antenna elements in terms of huge aptitude gains. To erect or construct a large massive MIMO network, lastly, we have to fit the outside base stations with hefty antenna arrays and among them some are discrete around the hexagonal cell and connected to the base station through the fastest cables

Optical cables, mainly aided with gigantic MIMO technologies. The mobile users which are present outside usually contains certain number of antennae fitted in it but with collaboration, a large reel antenna array can be erected, which jointly with antenna arrays of base station form practical massive MIMO links. Secondly, we have installed every building with big antenna arrays from outside, for establishing communication with outdoor base stations with the help of line-of-sight components. The wireless access points which are there inside the building are associated or we can say connected with the giant antenna arrays through cables for communicating with users present indoor. This will significantly lead to the improvement in the energy efficiency, cell average output, data rates, and spectral competency or efficiency of the cellular system but at the outlay of amplified i.e., huge and levelled infrastructure cost. With the introduction of such architecture and such a advanced plan, the inside users will only have to connect or communicate within wireless access points while huge erected antenna arrays remained installed outside the buildings. For the communication which has to be established inside i.e., for indoor communication, certain technologies like Wi-Fi, Small cell, ultra-wideband, millimetre wave communications, and visible light communication (VLC) proves helpful for little range communications having great data rates. However, technologies similar to millimetre wave and visible light communication (VLC) are utilizing higher frequencies which are not typically used for cellular communications. But it is not a proficient idea to use these high frequency waves for outside and also for long distance applications or uses because these waves cannot be filtered from dense materials proficiently and can easily be dissipated by rain droplets, gases, and by some kind of ore. Millimetre waves and visible light communications technologies can develop the transmission data rate for indoor setups because they have come up with large bandwidth.

As we know that the 5G wireless cellular network architecture mainly comprises of only two logical layers i.e.

1. A radio networks
2. Network cloud.

Basically, different types of components which are performing different functions constitute the radio network. User plane entity i.e., UPE and a Control plane entity i.e., CPE both performs advanced layer functionalities related to

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the User and Control plane, respectively are generally the part of the network function virtualization (NFV) cloud. One of the terms related to this section is XaaS which is basically the connection between a radio network and a network cloud. In this paper, a general architecture of 5G cellular network has been proposed. So, what exactly we can say about XaaS is that it is the interconnectivity among the different budding technologies like Massive MIMO network, Cognitive Radio networks, and mobile and static small-cell networks. This anticipated architecture also tries to explains the function of network function virtualization i.e., NFV cloud in the 5th Generation cellular network architecture. The thought of Device to Device (D2D) communication, small cell access points and Internet of things i.e., IoT has also been integrated in this proposed 5G cellular network architecture. So, we can say that the proposed 5G cellular network architecture can be used as a platform for the standardization of upcoming 5G network in future. Since, there are numerous issues that need to be taken care of in order to apprehend the wireless network architecture in fastidious and 5G networks in all-purpose.

EMERGING TECHNOLOGIES FOR 5G WIRELESS NETWORKS:

In the next decade, it is expected that mobile and wireless traffic volume will increase a thousand-fold and this eventually will be obsessed by the anticipated 50 billion or much more connected devices connected to the cloud by 2020. Improving energy efficiency, increasing capacity, cost and spectrum utilization as well as offering better stability and scalability for handling the escalating number of connected devices are the remedial measure taken against various challenges when there is rapid increase in the number of connected devices. Today the world is upgrading at the lights speed and we relay more and more on technology through which we can communicate more speedily and for this the overall technical aim is to provide a system idea that supports:

- Increment in data volume per area by 1000 times.
- Number of connected devices should be increased by 10 to 100 times.
- 10 to 100 times increased typical user data rate.
- Extended battery life up to 10 times for low power Massive Machine Communication i.e., MMC devices.
- Also 5 times reduced End-to-End i.e., E2E latency.

In this paper, I have tried to touch all the generation of the evolution in internets and also, I have left no stone unturned in discussing the budding technologies along with their technical challenges which arises due to a variety.

CONCLUSION

In this paper, a comprehensive review has been done on the recital necessities of 5th Generation wireless cellular communication systems that have been denied in requisites of data rate, spectral efficiency, latency, capacity, energy efficiency, and Quality of service. In this paper, 5G wireless network architecture has been detailed along with massive MIMO technology, network function virtualization (NFV) cloud and device to device communication. In terms of better quality in future and increased data rate for the inside users and at the corresponding time reduces the pressure from the outside base station, certain short range communication technologies, like Wi-Fi, Small cell, Visible light communication (VLC) and millimetre wave communication (MVC) technologies, has been explained. Some key promising technologies and the upcoming generation step by step have also been discussed full the credible routine desires, like huge MIMO and Device to Device communication (D2D) in fastidious and intervention management, multi radio access technology ultra-dense networks, full duplex radios, millimetre wave communication (MVC) and Cloud Technologies in general with radio access networks, spectrum allocation with cognitive radio and software dined networks.

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