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A Study of 5G Network: Structural Design, Challenges and Promising Technologies, Cloud Technologies

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Abstract: In the near prospect, beyond 4G has the major objectives or difficulty that need to be addressed are improved capacity, better data rate, decreased latency, and enhanced quality of service. To meet these demands, radical improvements need to be made in cellular network architecture. This paper presents the consequences of a detailed study on the fifth generation (5G) cellular network structural design, challenges and some of the solution for promising technologies that are supportive in improving the structural design and gathering the demands of users. In this comprehensive review focuses 5G cellular network architecture, huge various input many output technologies, and device-to-device communication (D2D). Next, to with this, some of the promising technologies that are addressed in this paper include intrusion supervision, variety sharing with cognitive radio, ultra-dense networks, multi-radio access technology organization, full duplex radios, and millimeter wave solutions for 5G cellular networks. In this paper, a universal possible 5G cellular set of connections architecture is proposed, which shows that D2D, small cell access points, network cloud, and the Internet of Things can be a part of 5G cellular network architecture. A comprehensive study is integrated concerning present research projects being conducted in different countries by research groups and institutions that are working on 5G technologies. Finally, this paper describes cloud technologies for 5G radio access networks and software defined networks.

Keywords: 4G, 5G, D2D, Ultradense Networks, Full duplex, IOT.

I.INTRODUCTION

At present and in the modern future, to accomplish the audacity and challenges of the modern future, the wireless based networks will have to move forward in different ways. Current technology element like high-speed packet access (HSPA) and long-term evolution (LTE) will be launched as a section of the improvement of modern wireless based technologies. However, the supplementary mechanism may also compose future latest wireless based technologies, which may access the evolved technologies. Example of this new technology mechanism is unusual ways of acquiring range and significantly advanced regularity ranges, the initiation of enormous antenna configurations, direct device-to-device communication, and ultra-dense deployments [1].

From the time when its beginning in the late 1970s, mobile wireless communication has a major approach from analog voice calls to present modern technologies expert of giving that high excellence mobile broadband services with end-user data rates of abundant megabits per second over broad areas and tens, or even hundreds, of megabits per second locally. The wide-ranging improvements in conditions of the ability of mobile communication networks, along with the instigation of new types of mobile devices such as smart phones and tablets, have shaped an explosion of new applications which will be used in cases for mobile connectivity and a consequential exponential growth in network traffic. This paper introduces our sight on the future of wireless communication for 2020 and beyond. In this paper, we illustrate the key challenges that will be encountered by future wireless communication while enabling the networking society. [2].

The thoughts of our future are a network society with abundant access to information and sharing of data which is available universally and every time for everyone and everything. To understand this imagination, new knowledge mechanism needs to be examined for the development of obtainable wireless based technologies. Current wireless based technologies, like the 3rd Generation Partnership Project (3GPP) LTE technology, HSPA, and Wi-Fi, will be including new technology mechanism that will be serving to gather the requirements of the future. However, there may be confident scenarios that cannot be adequately addressed along with the evolution of ongoing existing technologies. The instigation of completely new wireless based technologies will complement the current technologies which are needed for the long term realization of the networked society [2].

The remainder of the paper is organized as follows: In section II, we present the growth of wireless technologies. Section III gives the challenges of the 5G networks and section IV gives a detailed description of the proposed general 5G cellular network architecture. Section IV comprises of the detailed explanation of the emerging technologies for 5G wireless networks. Section V describes the promising technologies and its benefits. Section VI explains the cloud technologies for flexible 5G radio access networks. We conclude our paper in Section VII.

II. GROWTH IN WIRELESS TECHNOLOGIES

In networking, terminology wireless is the term used to describe any computer network where there is no physical wired connection between the sender and the receiver but rather than the network is connected by radio waves and microwaves to maintain communications. Transmitting and receiving voice and data using electromagnetic waves in open space.

G. Marconi, an Italian inventor, unlocks the path of current day wireless communications by communicating the letter 'S' along with a distance of 3Km in the form of three dot Morse code with the help of electromagnetic waves. Following this initiation, wireless communications have turned into a significant part of present day society. Since satellite communication, television and radio transmission has advanced to pervasive mobile telephone, wireless communications have changed the style in which society runs. The development of wireless begins here [2] and is shown in Fig. 1. It shows the budding generations of wireless technologies in terms of data rate, mobility, coverage, and spectral efficiency. As the wireless technologies are rising, the data rate, mobility, coverage, and spectral efficiency increases. It also shows that the 1G and 2G technologies use circuit switching while 2.5G and 3G use both circuit and packet switching and the next generations from 3.5G to now i.e. 5G are using packet switching. Along with these factors, it also differentiates between licensed spectrum and unlicensed spectrum. All the evolving generations use the licensed spectrum while the WiFi, Bluetooth, and WiMAX are using the unlicensed spectrum. A summary of the growth in wireless technologies is below:

FIGURE 1: Growth in wireless Technologies

FIGURE 2: Evolution of 1G to 5G Technology

A. 1G

The 1st generation developed in 1980's. 1 G was old analog system and supported the analog cell phone system data rate up to 2.4kbps. Major subscribers were Advanced Mobile Phone System (AMPS) first launched by the US, Nordic Mobile Telephone (NMT), and Total Access Communication System (TACS). It has a lot of disadvantages like below par capacity, reckless handoff, inferior voice associations, and with no security since voice calls were stored and played in radio towers due to which vulnerability of these calls from unwanted eavesdropping by third party increases[3], [7].

Drawbacks of 1G:

- The main drawback of 1g technology is that it uses analog signals rather than digital signals, This is a less effective means of transmitting information, It is slower, and the signals cannot reach as far in terms of sheltered areas and such **2G** and **3G** signal is far more widespread.
- The analogue signals are more likely to suffer interference problems, It makes the use of the mobile phone with the analog signal more difficult, the newer brands of **2G** and **3G** technology are more highly recommended,1G mobile phones appears bulky and awkward by modern standards.
- 1G technology compares unfavorably to its successors in terms of the overall connection quality, it has low capacity, unreliable hand off, it offers poor voice links, it has no security at all since the voice calls were played back in the radio towers, So, these calls are susceptible to the unwanted eavesdropping by the third parties.

B. 2G

The 2nd generation was launched in late 1990's in finland.It uses digital signal with digital technology. Global Systems for Mobile communications (GSM) was the first 2nd generation system, primarily used for voice communication and having a data rate up to 64kbps. 2G mobile handset battery lasts longer because of the radio signals having low power. It also provides services like Short Message Service (SMS) and e-mail. Vital eminent technologies were GSM, Code Division Multiple Access (CDMA), and IS-95 [3], [7].

Drawbacks of 2G:

- 2g requires strong digital signals to help mobile phones work.
- If there is no network coverage in any specific area digital signals would weak.
- These systems are unable to handle complex data such as videos.

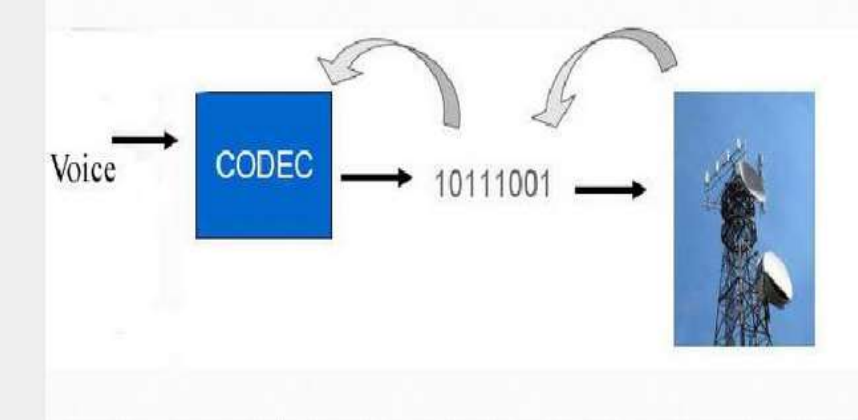

FIGURE 3: 2G with Digital Signal

C. 2.5G

2.5G technology between the 2G and 3G mobile telephony. It generally subscribes a 2nd generation cellular system merged with General Packet Radio Services (GPRS) and other amenities doesn't usually endow in 2G or 1G network. A 2.5G system generally uses 2G system frameworks, but it applies packet switching along with circuit switching. It can assist data rate up to 144kbps. The main 2.5G technologies were GPRS, Enhanced Data Rate for GSM Evolution (EDGE), and Code Division Multiple Access (CDMA) 2000 [3], [7].It also includes the feature of web browsing and camera phones.

D. 3G

The 3rd generation was recognized in late 2000. It imparts transmission rate up to 2Mbps. Third generation (3G) systems merge high speed mobile access to services based on Internet Protocol (IP). Away from transmission rate, the unconventional improvement was made for maintaining QoS. Additional amenities like global roaming and improved voice quality made 3G as a remarkable generation.

The major disadvantage for 3G handsets is that they require more power than most 2G models. Along with this 3G network, plans are more expensive than 2G [3], [7]. Since 3G involves the introduction and utilization of Wideband Code Division Multiple Access (WCDMA), Universal Mobile Telecommunications Systems (UMTS) and Code Division Multiple Access (CDMA) 2000 technologies, the evolving technologies like High Speed Uplink/Downlink Packet Access (HSUPA/HSDPA) and Evolution-Data Optimized (EVDO) has made an intermediate wireless generation between 3G and 4G named as 3.5G with improved data rate of 5-30 Mbps [3].

It includes the features of faster communication, highspeed web, videoconferencing, 3Dgaming, TV streaming, phone calls, mobile TV, more security.

Drawbacks of 3G:

- Expensive fees for 3G licenses services.
- It was a challenge to build the infrastructure for 3G.
- High bandwidth requirement.
- Expensive 3G phones.
- Very Large Cell Phones.

E. 3.75G

Long-Term Evolution technology (LTE) and Fixed Worldwide Interoperability for Microwave Access (WIMAX) is the potential of mobile data services. LTE and Fixed WIMAX has the latent to supplement the capacity of the network and provides a large number of users the facility to access a broad range of high speed services like on demand video, peer to peer file sharing and composite Web services. Along with this, a complementary spectrum is available which recognize operators manage their network very passively and offers better coverage with improved performance for less cost [4], [5], [6], [7].

F. 4G

4G is generally referred as the successor of the 3G and 2G standards. It is a combination of wi-fi and wi-max. It has the capability of providing 100Mbps-1 Gbps speed. A 4G system improves the prevailing communication networks by imparting a complete and reliable solution based on IP. Amenities like voice, data, and multimedia will be imparted to subscribers on every time and everywhere basis and at quite higher data rates as related to earlier generations. Applications that are being made to use a 4G network are Multimedia Messaging Service (MMS), Digital Video Broadcasting (DVB), and video chat, High Definition TV

content and mobile TV [2], [4],[5],[6].It includes the features of high QOS, high security, and high speed, and high capacity, lowcost per bit.

Drawbacks of 4G:

- Obtaining the information from the people illegally becomes easier
- 4G technologies involve the possibility of some interference though not much, it is capable of being attacked (jamming frequencies) and the invasion of the privacy increased.
- The consumer is forced to buy a new device to support the 4G, New frequencies mean new components in the cell towers, higher data prices for the consumers, your current equipment cannot be compatible with the 4G network, it has different network bands for different phones. It is expensive & hard to implement.
- It consumes a lot of battery when in use, it consumes the data very fast & your battery becomes hot when it is used for a very long time (like a microwave).
- The 4G network needs complex hardware, 4G technology is still limited to certain specified carriers & regions but the number of cities which have 4G coverage is increasing by the day, it would take its own time for this network to be available in all the major cities of the world.
- 4G mobile technology is still fairly new but it will most likely have its initial glitches & bugs, which could be quite annoying for the user.
- 4G technology use many antennae & transmitters, you would experience much poorer battery life on your mobile, while on this network, So, and you would have to use larger mobile devices with more battery power to be able to stay online for longer periods of time.

G. 5G

4G will now be easily replaced with 5G with an advanced access technology named Beam Division Multiple Access (BDMA) and Non- and quasi-orthogonal or Filter Bank multi carrier (FBMC) multiple access with an exponential increase in the demand of the users, The concept behind BDMA technique is explained by considering the case of the base station communicating with the mobile stations.

In this communication, an orthogonal beam is allocated to each mobile station and BDMA technique will divide that antenna beam according to locations of the mobile stations for giving multiple accesses to the mobile stations, which correspondingly increase the capacity of the system [8]. An idea to shift towards 5G is based on current drifts, it is commonly assumed that 5G cellular networks must address six challenges that are not effectively addressed by 4G i.e. higher capacity, higher data rate, lower End to End latency, massive device connectivity, reduced cost and consistent Quality of Experience provisioning Feature of 5G wireless technology

- High resolution for crazy cell phone users.
- Bidirectional large BW.
- Less traffic.
- 25Mbps connectivity speed.
- Enhanced and available connectivity just around the world.
- Uploading and downloading speed of 5G touching the peak.
- Better and fast solution.
- More attractive and effective.
- High quality service based on policy to avoid error.
- Support virtual private networks.

Advantages of 5G:

- Data BW of 1 Gbps or higher.
- Globally accessible.
- Dynamic information access.
- Available at low cost.
- Technology to gather all networks on one platform.
- Possible to provide uniform, uninterrupted, and consistent connectivity across the world.
- Technological sound to support heterogeneous services (including private network).

Drawbacks of 5G:

G technology is researched and conceptualized to solve all radio signal problems and hardship of mobile world, but because of some security reason and lack of technological advancement in most of the geographic regions, it has following shortcomings;

- Technology is still under process and research on its viability is going on.
- The speed, this technology is claiming seems difficult to achieve (in future, it might be) because of the incompetent technological support in most parts of the world.
- Many of the old devices would not be competent to 5G; hence, all of them need to be replaced with new one — expensive deal.
- Developing infrastructure needs high cost.
- Security and privacy issue yet to be solved.

Applications of 5G:

- Wearable devices with AI capabilities.
- Pervasive networks.
- Media independent handover.
- Radio resource management.
- VOIP enabled messages.

III. 5G - CHALLENGES

Challenges are the inherent part of the new development; so, like all technologies, 5G has also big challenges to deal with. As we see past i.e. development of radio technology, we find very fast growth. Starting from 1G to 5G, the journey is mere of about 40 years old (Considering 1G in the 1980s and 5G in 2020s). However, in this journey, the common challenges that we observed are lack of infrastructure, research methodology, and cost.

The challenges of 5G are categorized into two types;

- Technological Challenges
- Common Challenges

Technological Challenges

- Inter-cell Interference: This is one of the major technological issues that need to be solved. There are variations in size of traditional macro cells and concurrent small cells that will lead to interference.
- Efficient Medium Access Control: In a situation, where dense deployment of access points and user terminals are required, the user throughput will be low, latency will be high, and hotspots will not be competent to cellular technology to provide high throughput. It needs to be researched properly to optimize the technology.
- Traffic Management: In comparison to the traditional human to human traffic in cellular networks, a great number of Machine to Machine (M2M) devices in a cell may cause serious system challenges i.e. radio access network (RAN) challenges, which will cause overload and congestion.

Common Challenges

- Multiple Services: Unlike other radio signal services, 5G would have a huge task to offer services to heterogeneous networks, technologies, and devices operating in different geographic regions. So, the challenge is of standardization to provide dynamic, universal, user-centric, and data-rich wireless services to fulfil the high expectation of people.
  Infrastructure − Researchers are facing technological challenges of standardization and application of 5G services.

- Communication, Navigation, & Sensing: These services largely depend upon the availability of radio spectrum, through which signals are transmitted. Though 5G technology has strong computational power to process the huge volume of data coming from different and distinct sources, it needs larger infrastructure support.
-
- Security and Privacy: This is one of the most important challenges that 5G needs to ensure the protection of personal data. 5G will have to define the uncertainties related to security threats including trust, privacy, cyber security, which are growing across the globe.

- Legislation of Cyber law: Cybercrime and other fraud may also increase with the high speed and ubiquitous 5G technology. Therefore, legislation of the Cyber law is also an imperative issue, which largely is governmental and political (national as well as an international issue) in nature.

FIGURE 4: Challenges of 5G

The Detailed Comparison Of Wireless Generations Is Shown In Table 1.

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

IV. GENERAL NETWORK ARCHITECTURE FOR 5G CELLULAR

To analyze the study of 5G network in the market now, it is clear that the multiple access techniques in the network are almost at a still and requires unexpected improvement. Current technologies like OFDMA will work at least for next 50 years. Moreover, there is no need to have a change in the wireless setup which had come about from 1G to 4G. Alternatively, there could be only the addition of an application done at the fundamental network to please user requirements. This will incite the package providers to drift for a 5G network as early as 4G is commercially set up [8]. To meet the demands of the user and to overcome the challenges that have been put forward in the 5G system, a drastic change in the strategy of designing the 5G wireless cellular architecture is needed.

A general observation of the researchers has that most of the wireless users stay inside for approximately 80 percent of the time and outside for approximately 20 percent of the time. In present wireless cellular architecture, for a mobile user to communicate whether inside or outside, an outside base station present in the middle of a cell helps in communication. So for inside users to communicate with the outside base station, the signals will have to travel through the walls of the indoors, and this will result in very high penetration loss, which correspondingly costs with reduced spectral efficiency, data rate, and energy efficiency of wireless communications.

To overcome this challenge, a new idea or designing technique that has come in to existence for scheming the 5G cellular architecture is to the distinct outside and inside setups [8]. With this designing technique, the penetration loss through the walls of the building will be slightly reduced. This idea will be supported with the help of massive MIMO technology [9], in which geographically dispersed array of antennae are deployed which have tens or hundreds of antenna units. Since present MIMO systems are using either two or four antenna, but the idea of massive MIMO systems has come up with the idea of utilizing the advantages of large array antenna elements in terms of huge capacity gains.

To construct or assemble a large massive MIMO network, firstly the outer base stations will be fitted with large antenna arrays and among them, some are detached around the hexagonal cell and linked to the base station through optical fiber cables, aided with massive MIMO technologies. The mobile users present exterior are regularly fitted with a certain number of antenna units but with cooperation, a large virtual antenna array can be constructed, which together with antenna arrays of base station form virtual massive MIMO links.

Secondly, every construction will be installed with large antenna arrays from outside, to converse with outdoor base stations with the help of a line of sight components. The wireless access points inside the building are connected with the large antenna arrays through cables for communicating with indoor users. This will significantly improve the energy efficiency, cell average throughput, data rate, and spectral efficiency of the cellular system but at the expense of increased infrastructure cost [9].

With the beginning of such an architecture, the inside users will only have to connect or communicate with inside wireless access points while larger antenna arrays remained installed outside the buildings [8]. For indoor communication, certain technologies like Wi-Fi, Small cell, ultra wideband, millimeter wave communications, and visible light communications are useful for small range communications having large data rates. But technologies like millimeter wave and visible light communication are utilizing higher frequencies which are not conventionally used for cellular communications. But it is not an efficient idea to use these high frequency waves for outside and long distance applications because these waves will not infiltrate from dense materials efficiently and can easily be dispersed by rain droplets, gases, and flora.

Though, millimeter waves and visible light communications technologies can enhance the transmission data rate for indoor setups because they have come up with large bandwidth. Along with the introduction of new spectrum, which is not being conventionally used for wireless communication, there is one more method to solve the spectrum shortage problem by improving the spectrum utilization of current radio spectra through cognitive radio (CR) networks.

Since the 5G cellular architecture is heterogeneous, so it must include macrocells, microcells, small cells, and relays. A mobile small cell concept is an integral part of the 5G wireless cellular network and partially comprises of the mobile relay and small cell concepts. It is being introduced to put up high mobility users, which are inside the automobiles and high speed trains.

Mobile small cells are positioned inside the moving automobiles to communicate with the users inside the automobile, while the massive MIMO unit consisting of large antenna arrays is placed outside the automobile to communicate with the outside base station. According to user's opinion, a mobile small cell is realized as a regular base station and its allied users are all observed as a single unit to the base station which proves the above idea of splitting indoor and outdoor setups. Mobile small cell users have a high data rate for data rate services with considerably reduced signaling overhead, as shown in [8].

The 5G wireless cellular network architecture consists of only two logical layers: a radio network and a network cloud. Different types of components performing different functions constitute the radio network. The network function virtualization (NFV) cloud consists of a User plane entity (UPE) and a Control plane entity (CPE) that perform higher layer functionalities related to the User and Control plane, respectively. XaaS is the connection between a radio network and a network cloud.

In this paper, a general 5G cellular network architecture has been proposed as shown in Fig. 5. It describes the interconnectivity among the different emerging technologies like Massive MIMO network, Cognitive Radio network, and mobile and static small-cell networks. This proposed architecture also explains the role of network function virtualization (NFV) cloud in the 5G cellular network architecture. The concept of Device to Device (D2D) communication, small cell access points and the Internet of things (IoT) has also been integrated into this proposed 5G cellular network architecture. In general, this proposed 5G cellular network architecture may provide a good platform for future 5G standardization network [12].

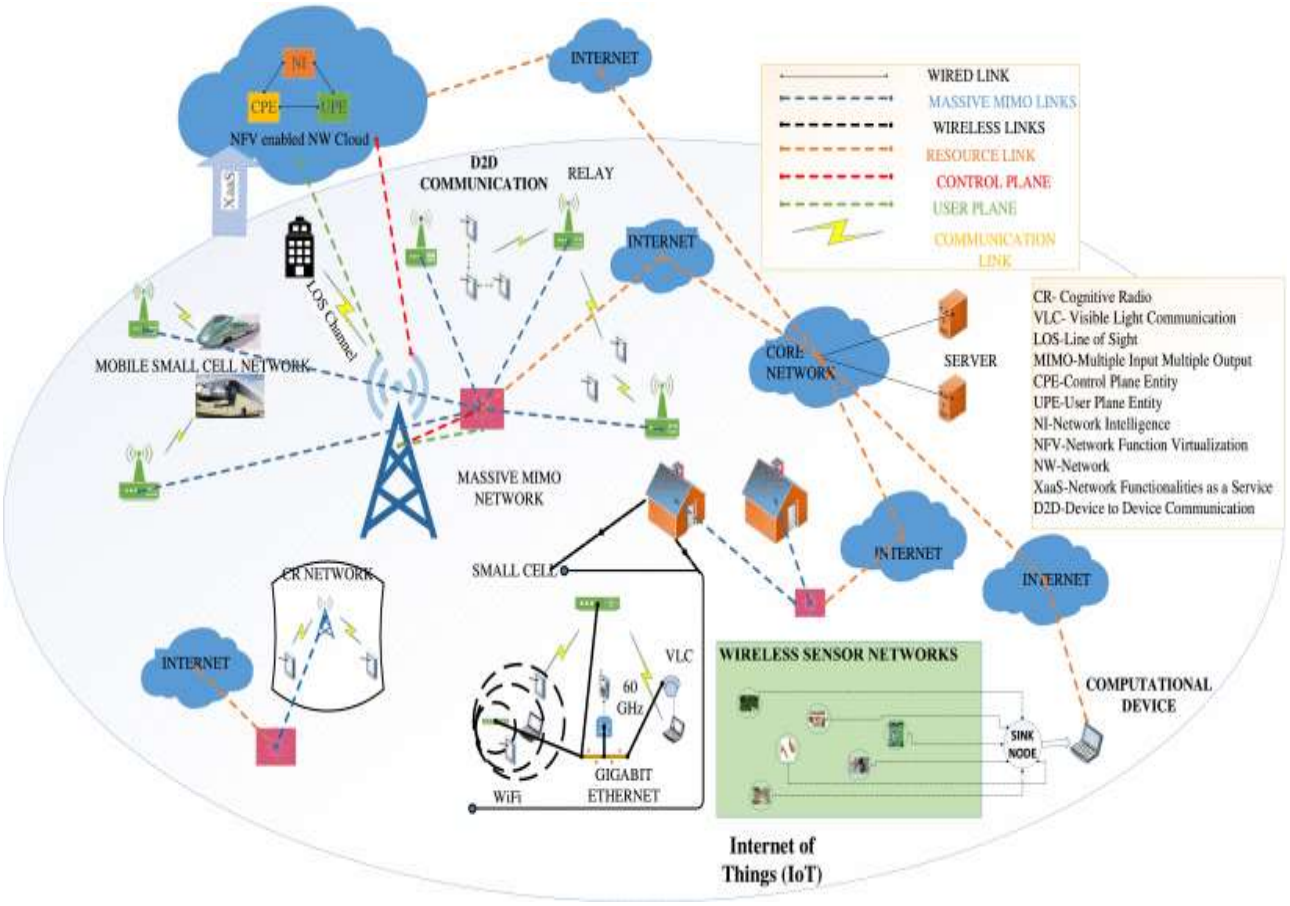

FIGURE 5: A general 5G cellular network infrastructure.

V. PROMISING TECHNOLIGIES FOR 5G WIRELESS NETWORKS

It is estimated that mobile and wireless traffic volume will raise a thousand-fold over the next decade which will be driven by the expected 50 billion connected devices connected to the cloud by 2020 and all need to access and share data, anywhere and anytime. With a hasty increase in the number of connected devices, some challenges appear which will be responded by rising capacity and by humanizing energy efficiency, cost, and spectrum utilization as well as providing better scalability for handling the increasing number of the connected devices. For the vision of all-communicating world relative to today's network, the overall technical aim is to provide a system idea that supports:

- 1000 times increased data volume per area
- 10 to 100 times increased the number of connected devices
- 10 to 100 times increased typical user data rate
- 10 times extended battery life for low power Massive Machine Communication (MMC) devices
- 5 times reduced End-to-End (E2E) latency

In this paper, we will envelop an extensive area of technologies with a lot of challenges arises due to a variety of applications and requirements of the user. To provide a common connected platform for a variety of applications and requirements for 5G, we will research the following technology components:

- Network dimension includes in view of the demand, traffic and mobility management, and novel approaches for efficient interference management in complex heterogeneous deployments.
- Spectrum usage includes considering extended spectrum band of operation, as well as operation in new spectrum regimes to provide a complete system concept for new spectrum regimes that carefully addresses the needs of each usage scenario.
- Radio-links includes the development of new transmission waveforms and new approaches to multiple access control and radio resource management.
- Multi-node and multi-antenna transmissions include designing of multi-antenna transmission/reception technologies based on massive antenna configurations and developing advanced inter-node coordination schemes and multi-hop technologies.

The following will integrate a subset of the technology components and provides the solution for the earlier components:

- Device-to-Device (D2D) communications refer to direct communication between devices allowing the local exchange of user plane traffic without going through a network infrastructure.
- Massive Machine Communications (MMC) will form the basis of the Internet of Things with a wide range of application fields including the automotive industry, public safety, emergency services and medical field.
- Moving Networks (MN) will enhance and extend linking together potentially large populations of jointly moving communication devices.
- Ultra-dense Networks (UDN) will be the main driver whose goals are to increase capacity, increase the energy efficiency of radio links, and enable better exploitation of under-utilized spectrum.
- Ultra-reliable Networks (URN) will enable high degrees of availability.

In this section, we recognize several technologies, ranked in superficial importance, which will be essential in future wireless standards.

A. Massive MIMO

Massive MIMO is a growing technology that has been upgraded from the current MIMO technology. The main objective of Massive MIMO technology is to extract all the benefits of MIMO but on a larger scale. The Massive MIMO system uses arrays of antenna containing few hundred antennas which are at the same time in one time, frequency slot helping many tens of user terminals. In general, massive MIMO is an evolving technology of Next generation networks, which is energy efficient, robust, and secure and spectrum efficient.

Massive MIMO depends on spatial multiplexing, which further depends on the base station to have channel state information, both on the uplink as well as on the downlink. In case of downlink, it is not easy, but in case of uplink, it is easy, as the terminals send pilots. On the basis of pilots, the channel response of each terminal is estimated. In conventional MIMO systems, the base station sends the pilot waveforms to the terminals and based on these, the terminal estimate the channel, quantize it and feedback them to the base station [10].

Following are the certain positives of a massive MIMO system:

i. Massive MIMO has the Capability that it can improve the Radiated Energy Efficiency by 100 Times and at the Same Time, Increases the Capacity of the Order of 10 or more:

The constructive of raise in capacity is because of the spatial multiplexing technique used in Massive MIMO systems. Concerning the upgrading of the radiated energy efficiency, it is because of the increase in the number of antennas, the energy can now be concentrated in small regions in the space. It is based on the principle of coherent superposition of wave fronts. After transmitting the shaped signals from the antennas, the base station has no role to play by confirming that all the wave fronts that have been emitted from the antennas possibly will add constructively at the intended terminal's locations and destructively elsewhere.

ii. Massive MIMO Systems can be put Together With the Help of Low Power and Less Costly Components:

Massive MIMO has come up with a transform with respect to concept, schemes, and execution. Massive MIMO systems use hundreds of less luxurious amplifiers in respect to expensive ultra-linear 50 Watt amplifiers because earlier are having an output power in the milliwatt range, which is much better than the latter which are generally being used in conventional systems. It is dissimilar to conventional array schemes, as it will use only a little antenna's that are being fed from high power amplifiers but having a notable impact. The most significant improvement is the removal of a large number of expensive and massive items like large coaxial cables.

With the use of a large number of antennas in massive MIMO technology the noise, fading, and hardware deficits will be averaged because signals from a large number of antennas are combined together in the free space. It condenses the limits on precision and linearity of every single amplifier and radio frequency chain and altogether what matters is their collective action. This will increase the robustness of massive MIMO against fading and failure.

The substantial development in the energy efficiency facilitates massive MIMO systems to work two steps of lower magnitude than with existing technology on the total output RF power. This is important because the cellular base stations are consuming a lot of power and it is an area of concern. In addition, if base stations that consume less power could be driven by renewable resources like solar or wind and therefore it is helpful to deploy base stations to the places where electricity is not obtainable. Along with this, the increased concerns of electromagnetic exposure will be considerably less.

iii. Massive MIMO Permits a Substantial Decrease in Latency on the air Interface:

Latency is the major area of concern in the next generation networks. In wireless communication, the main cause of latency is fading. This is happening at the base station and terminal, i.e. when the signal is transmitted from the base station, it travels through different multiple paths because of the occurrence is like scattering, reflection, and diffraction before it reaches the terminal.

When the signal through these multiple paths reaches the terminal it will interfere either profitably or violently and the case when following waves from these multiple paths obstruct destructively, the received signal strength reduces to a considerable low point. If the terminal is fixed in a desertion dip, then it has to wait for the communication channel to change until any data can be received.

iv. Massive MIMO Makes the Multiple Access Layer Simple:

OFDM provides each subcarrier in a massive MIMO system with the same channel gain. Every terminal can be provided with complete bandwidth, which reduces most of the physical layer control signaling terminated.

v. Massive MIMO Increases the Strength Equally Against Unintended Man Made Interference and Intended Jamming:

Congestion of the wireless systems of the civilian is a prime area of concern and poses a serious threat to cyber security. Owing to limited bandwidth, the distribution of information over frequency just is not possible. Massive MIMO offers the methods of improving the robustness of wireless communications with the help of multiple antennas. It provides with an excess of degrees of freedom that can be useful for canceling the signals from intended jammers. If massive MIMO systems use joint channel estimation and decoding instead of uplink pilots for channel estimation, then the problem from the intended jammers is considerably reduced.

B. Ultra Dense Networks

To meet the increasing traffic demands due to the increased number of users, densification of the infrastructure will be the prior aspect of 5G communications. Ultra-dense, heterogeneous networks will play an important role here. With the introduction of moving networks and ad-hoc social networks, the heterogeneous networks are becoming more dynamic. Though dense and dynamic heterogeneous networks will give rise to new challenges in terms of interference, mobility and backhauling. To overcome these challenges, there arises a requirement of designing new network layer functionalities for maximizing the performance beyond from the design of the existing physical layer.

In present networks like Long Term Evolution (LTE), there exist interference mitigation techniques like enhanced Inter-Cell Interference Coordination and autonomous component carrier selection. But these techniques are applicable only to nomadic and dense small cell deployments and have limited flexibility. So for 5G networks, the interference mitigation techniques should be more flexible and open to the variations as changes in the traffic and deployment are expected to occur more rapidly than existing networks.

In squat future, smart devices and small cell networks will be capable of providing the best wireless connectivity with minimum interference and less power consumption. Along with this, they should be rapidly adaptable to the changing requirements of devices and radio access network [11].

C. Multi Radio Access Technology Association

5G networks are becoming more heterogeneous. The main aspect that has attracted many is the integration of different radio access technologies. A typical 5G aided device should be manufactured whose radios not only support a new 5G standard like millimeter wave frequencies, but also 3G, various releases of 4G LTE, numerous types of WiFi, and possibly direct device to device communication, all across the different spectral bands. So, defining of principles and consumption of range to which base station or users will be a truly difficult job for the network.

Defining of the optimal user association is the prime area of concern which depends on the signal to interference and noise ratio from every single user to every single base station, the selections of other users in the network, the load at every single base station, and the prerequisite to apply the same base station and standard in both uplink and downlink for simplifying the operation of control channels for resource allocation and feedback. So, certain procedures must be implemented to overcome these issues.

D. Full Duplex Radios

For a long interval of communication period, it is implicit in the wireless system design that radios have to operate in half duplex mode. It means that it will not transmit and receive simultaneously on the same channel. Many scholars, academics, and

researchers at different universities and research groups have tried to undermine this assumption by proposing many designs to build in-band full-duplex radios.

But the realization to build full duplex radio has a lot of implications. The cellular networks will have to reduce their spectrum demands to half as only a single channel is used for achieving the same performance. As in LTE, for both uplink and downlink, it uses equal width separate channels for empowering radios to realize full duplex.

For communicating in the full duplex mode, the self-interference results from its own transmission to the received signal have to be completely removed. Let us consider the case of WiFi signals which are transmitting at 20dBm (100mW) average power with the noise floor of around −90dBm. So the transmit self-interference need to be canceled by 110dB (20dBm-(−90dBm)) to achieve the similar level as of the noise floor and reduce it to insignificant. If any residual self-interference is not completely canceled, then it will act as noise to the received signal, which in turn reduces SNR and subsequently throughput [].

VI. CLOUD TECHNOLOGIES FOR FLEXIBLE 5G RADIO ACCESS NETWORKS

1*)* Mobile Cloud Computing:
In the current time, mobile cloud computing has earned a lot of appreciation as it is a coalition of many computing fields. It offers computing, storage, services, and applications over the Internet. It also reduces cost; disconnect services from the existing technology, and offers flexibility in terms of resource provisioning. So mobile cloud computing can be clearly defined as an incorporation of cloud computing technology with mobile devices. This integration will make the mobile devices resource full in terms of computational power, memory, storage, energy, and context awareness.

Mobile devices will also act as resource providers .So the combined resources of the numerous mobile devices and other available stationary devices in the local area will be exploited. This method supports user mobility and identifies the potential of mobile clouds to perform collective sensing.

In cloudlet where a local cloudlet encompassed by numerous multi core computers with connectivity to the remote cloud servers is used by the mobile device to relieve its workload. Plug Computers having outline factor, diversity and low power consumption can be considered as good contenders for cloudlet servers. But these computers are ideal for small scale servers installed in the public organization because they have the similar general architecture as a normal computer and are less powerful, smaller, and less costly. Hence, these cloudlets should be installed in public areas like restaurants so that mobile devices can connect directly with the cloudlet instead of a remote cloud server to remove latency and bandwidth problems. A cloudlet enabling mobile devices to bypass latency and bandwidth issues while benefitting from its resources.

Mobile cloud computing follows the basic concepts of cloud computing. There are some specific requirements that need to be encountered in a cloud like an adaptability, scalability, availability, and self-awareness are discussed.

So mobile cloud computing should also fulfill these requirements. For example, a mobile computing cloud should be cognizant of its availability and dynamically plug themselves in, depending on the requirements and workload. An appropriate technique of self pretentious one's own quality is desirable for mobile users to proficiently take advantage of the cloud, as the internal status and the external environment is subject to change. Others facets like mobility, low connectivity and limited source of power also needed to be considered.

2) Radio Access Network as a Service:
Centralization is the prime objective of 5G mobile networks because processing and management will need to be flexible and adapted to the actual service requirements. This will lead to a compromise between the decentralized today's network and fully centralized cloud radio access network. This compromise is addressed by the radio access network as a service concept, which partly centralizes functionalities of the radio access network depending on the needs and characteristics of the network.

The Radio access network as a service is an application of the software as a service paradigm, so every function may be filled and circulated in the form of a service within a cloud platform. This will cause increased data storage and processing capabilities, as provided by a cloud platform accommodated in data centers. The following Fig. 13 shows the major characteristics of a radio access network as a service implementation similar to the basic characteristics of a cloud computing platform.

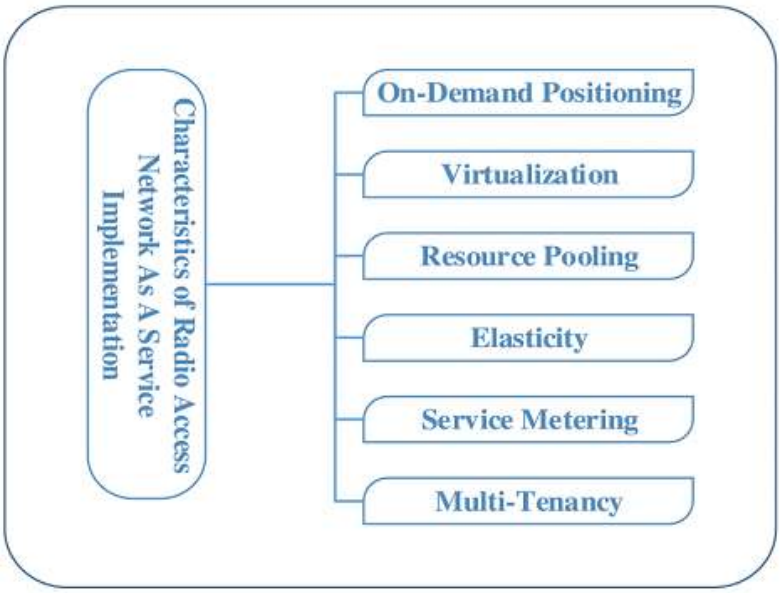

FIGURE 13: Radio access network as a service

3) Number of Machine (M2M) connections in mobile:
At the same time, the stake of machine to machine connections of the total number of connections in the mobile operator's networks will rise from the present 5% to 15% in 2018 and to 22% in 2022

A key trend relates to mobility, as broadband mobile usage, with more than 2.4 billion users globally (as of June 2012) is expected to be dominant over the coming years. For data traffic and machine to machine communications, an expected 40-fold increase between 2010 and 2015 is shown in Fig. 15 and a 1000 fold increase is predicted over a decade. This level of growth force the network operators to provide global broadband access to all types of heterogeneous and modified Internet based services and applications.

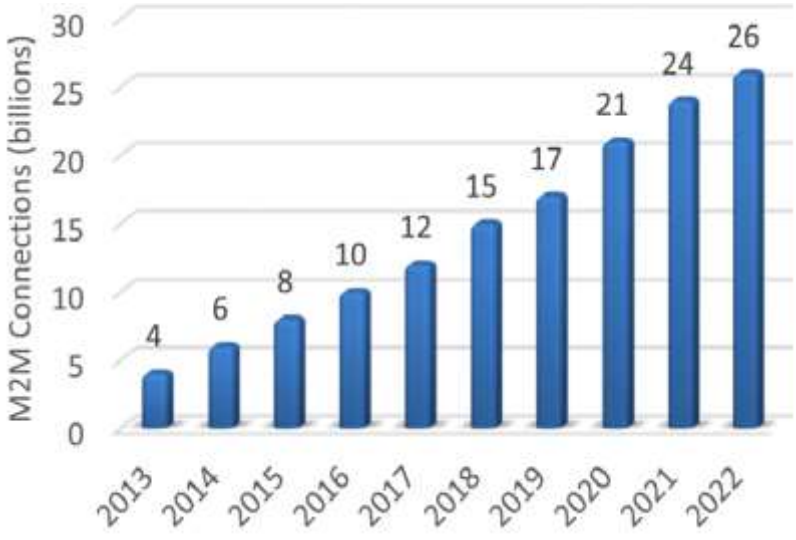

FIGURE 14: Machine to Machine (M2M) connections in mobile

VII. CONCLUSION

5G technology is going to be a new revolution in wireless system market.5G will promote the concept of the super core where all the network operators will be connected one single core and have one single infrastructure, regardless of their access technologies. Today wired society is going wireless and if it has a problem, 5G is answered. The new coming 5G technology Will be available in the market with affordable rates, high peak future and much reliability than preceding technologies. In this paper, a detailed survey has been done on the performance requirements of 5G wireless cellular communication systems that have been defined in terms of capacity, data rate, spectral efficiency, latency, energy efficiency, and Quality of service.
5G technology offers high resolution for passionate mobile phone consumer. We can watch an HD TV channel on our mobile phones without any disturbance. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will develop.

5G wireless network architecture has been explained in this paper with massive MIMO technology, network function virtualization (NFV) cloud and device to device communication. Certain short range communication technologies, like Wi-Fi, Small cell, Visible light communication, and millimeter wave communication technologies, has been explained, which provides a promising future in terms of better quality and increased data rate for inside users and at the equivalent time reduces the pressure from the outside base stations.

Some key emerging technologies have also been discussed that can be used in 5G wireless systems to fulfill the probable performance desires, like massive MIMO and Device to Device communication, ultra dense networks, multi radio access technology, full duplex radios, millimeter wave communication and Cloud Technologies in general with radio access networks and software defined networks. This paper may be giving a good platform to motivate the researchers for a better outcome of different types of problems in next generation networks.

VIII. 5G – FUTURE SCOPE

Several types of research and discussions are going on across the world among technologists, researchers, academicians, vendors, operators, and governments about the innovations, implementation, viability, and security concerns of 5G.

As proposed, loaded with multiple advances features starting from the super high speed internet service to smooth ubiquitous service, 5G will unlock many of the problems. However, the question is in a situation, where the previous technologies (4G and 3G) are still under process and in many parts yet to be started; what will be the future of 5G?

5G is the Fifth Generation technology. 5^{th} generation technology is designed to provide incredible and remarkable data capabilities, unhindered call volumes, and immeasurable data broadcast within the latest mobile operating system. Hence, it is more intelligent technology, which will interconnect the entire world without limits. Likewise, our world would have universal and uninterrupted access to information, communication, and entertainment that will open a new dimension to our lives and will change our life style meaningfully.

Moreover, governments and regulators can use this technology as an opportunity for the good governance and can create healthier environments, which will definitely encourage continuing investment in 5G, the next generation technology.
It has many advanced features potential enough to solve many of the problems of our mundane life. It is beneficial for the government, as it can make the governance easier; for the students, as it can make available the advanced courses, classes, and materials online; it is easier for the common people as well, as it can facilitate them the internet everywhere.

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