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5G TECHNOLOGY: A REVIEW

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ABSTRACT

In the generation of cloud computing and prominent development of the devices the massive need for faster error free data transmission can become a reality with 5G networking system. While comparing the characteristics of the previous generations, this review of 5G technology, talks about the main features of 5G and its working principal. It also includes the advantages and drawbacks of the highly anticipated 5G technology. 5G mainly incorporates Massive MIMO networking, Nanotechnology and device to device communication mediums. It's been in development for awhile, but the 3GPP has officially standardized its first specification. The 5G was said to be the ultimatum in mobile wireless technology; where 6G is already in the works. The testing of 5G networks are about to happen throughout 2018.

KEYWORDS: Massive Mimo, Cloud Computing, Nanotechnology, LTE, D2d, Millimeter Wave.

INTRODUCTION

We live in the age of digitization. We have seen some astounding scientific advances and phenomenal growth in IT and telecommunication systems. We can almost do anything with our mobile phones and the existing 4G connections. The necessity of 5G i.e. the Fifth Generation Technology comes from the high demand more advanced data transmission and for "Ubiquitous computing paradigm" [1] to become a reality.

The fifth generation of wireless communication will develop from the 4G systems; it will help almost every industry such as education, health, travel (automobiles) and utility companies etc to grow.

5th generation technology can provide facilities like cloud connected camera, MP3 recordings, video player, large phone memory, audio player, tremendous data capabilities and unrestricted call volumes and infinite data broadcast and also bidirectional high bandwidth and finest Quality of Service (QoS) and quality of experience (QoE) etc. [3, 5, 13, 16, 21, 24]. Previous technologies such as UMTS (Universal Mobile Telecommunication System, cdma2000), Wi-Fi, WiMAX (Worldwide Interoperability for Microwave Access), LTE (Long Term Evolution) and also sensor networks, or personal area networks like Bluetooth and ZigBee are being heavily used [3, 5, 10].

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5G is a packet switched wireless system with wide area coverage and high throughput. 5G technologies use CDMA and BDMA (Beam division Multiple Access), LASCDMA (Large Area Synchronized Code-Division Multiple Access), OFDM (Orthogonal frequency-division multiplexing), MCCDMA (Multi-Carrier Code Division Multiple Access), UWB (Ultra-wideband), LMDS (Local Multipoint Distribution Service), and IPv6 that enables speed to be higher than 1 Gbps [4, 5, 10, 13, 18, 24]. But 5G will bring us perfect real world wireless or called "WWWW: World Wide Wireless Web" [1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 15, 18, 20, 24]. The 5G technology is set to be available in 2020 and will definitely take the world by storm with its levels of call volume and higher data transmission rates with 5G pushing over VOIP system [2]. It is yet to be standardized by 3GPP, WiMAX Forum or ITU-R [6, 8]. The more improved PDA(Personal Digital Assistant) system using 5G is definitely going to make our lives easier [2, 6, 7, 17].

LITERATURE SURVEY

Need for 5G, Concept of 5G, The fulfillment of the "any rate, anytime, anywhere, affordable" paradigm is arguably the most important challenge towards the 5G cellular networks, identify the key enabling technical concepts for 5G, technical aspects of 5g network, convergence architecture, mix bandwidth data path for 5G so that all wireless network, advanced radio access network, ran[1]. Basic concept of 5g network, 5g architecture, Beam Division Multiple Access (BDMA) for 5g, concept of BDMA [2]. The revolution from 1G-the first generation, 2G-the second generation, 3G-the third generation, and then the 4G-the fourth generation, 5G-the fifth second generation and comparison between them, 5g network architecture, need of 5g[3].Challenges in migration from 4g, Basic concept of 5g network, features of 5g technology, 5g architecture[4]. Evolution of wireless technologies, concept of 5g, needs of 5g, advantages of 5g network, exceptional applications, 5g network architecture, Master-Core technology, 5G-IU (5G Interfacing Unit), future enhancement [5]. Evolution of wireless technologies from 0g to 5g, concept of 5g networks, offerings of 5g network, need for 5g, features of 5g, key concepts of 5g, future scope of 5g [6]. Development from 1g to 4g, how 4g works, requirement of 5g, characteristics of 5g, Applications of 5G, universities and companies working on 5g, availability of 5g [7]. Features of 5g technology, key concepts of 5g, key challenges, 5g hardware and software, 5g mobile network architecture, applications, future scope[8]. Evolution of mobile technologies, 5g networks, design off 5g mobile network architecture, need of 5g, characteristics of 5g, applications of 5g technology, future scope [9]. Challenges in migration from 4g, key terms of 5g, structure of 5g, 5g architecture, visions and requirements for 5g network, key challenges, future scope [10]. Advancement from 4g, key concepts of 5g, features of 5g network technology, visions and requirements for 5g network, implementation, technology, future scope[11]. Concept of 5g wireless technology, 5g network technology, some other potential technologies [12]. Technical requirement in 5G, Enabling Technologies, Denser Multi-RAT HetNet, Direct Device to Device (D2D) [13]. Limitations of conventional cellular systems, Desideratum of 5G Networks, Challenges in the Development of 5G Networks, Architectures for the Future, 5G Mobile Cellular Networks, Implementation Issues in 5GNetworks, Methodologies and Technologies for 5G Network, Applications of 5G Networks, Real Demonstrations and Test beds for 5G Networks [14]. 5g Wi-Fi and 5g, features analysis between 5g and 5g Wi-Fi, superpower 5g over 5g Wi-Fi [15]. Internet growth in worldwide, evolution from 1g to 5g, Limitations of 4g, necessity of 5g, concept of 5g technology, 5G Technology Requirement, Features of 5G Technology [16]. Architecture of 5g, advance features of 5g, need of 5g, features in 5g, protocol stack of 5g [17]. Futuristic scenarios and

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5g compliance, research group and their work, developments towards 5g technologies [18].5G Mobile Network Architecture, 5G waveform background, 5G concepts, 5G technology requirements, need of 5g[19]. Software-Defined Networking (SDN) for 5G, Cloud Computing, Internet of Things (IoT) for 5G, Mobile Access Networks for 5G [20]. EVOLUTION OF MOBILE TECHNOLOGY, Features of 1G, Limitations of 1G, Features of 2G, Limitations of 2G, Features of 3G, Limitation of 3G, Features of 4G, Limitation of 4G, 5G Architecture, advantages of 5g [21]. Evolution of wireless technologies, 5g Cellular Network Architecture, Beam Division Multiple Access (Bdma) For 5g [22]. Architecture & Working of 5g, Comparatively Study of 4g And 5g, Features of 5g Technology, Challenges In 5g Cellular Wireless Network, Emerging Applications [23].

WORKING PRINCIPLE & RELEVENT DISCUSSION

5G is one of the most discussed technologies in this decade.5G is the fifth generation telecommunication and wireless network standard which will be capable of handling greater data rates and network adaptable services, it efficiency. 5G networks will offer scalable and promises a smarter, faster and efficient network. This new system expected to be launched in early 2020s. Researches shows that a massive growth in the traffic volume for the past five years. This trend will continue approximately 12 to 18 times higher rate by year 2020. There will be 50 billion wirelessly connected devices by 2020. The next generation networks will be capable of handling 10 times more simultaneous connections than current 4G version. It will offer ultra high definition multimedia experience and remote access to many real time services.

COMPARISON OF GENERATIONS

Mobile communication has become more popular in last few years due to fast revolution in information and telecommunication technology. This revolution is due to very high increase in telecommunication users. This revolution is from 1G-the first generation, 2G-the second generation, 3G-the third generation, and then the 4G-the fourth generation, 5G-the fifth second generation.

This new technology would be mainly used to ensure backward compatibility, backhauling telecom networks rather than end user access. 4G is currently offering speed that is theoretically closer to Gigabit Ethernet whereas 5G will provide multiple Gigabit access. The table given on next page shows the comparison between the 5 different technologies [3].

LTE

M2M (Machine-to-Machine) Communication Legacy cellular networks have been developed to support high data rate and reliable communication. M2M environments are, however, very different from cellular networks, because low data rates and long latencies are desirable. The basic purpose of M2M communication is to transmit sensed data of small size with loose time constraints. To meet the characteristics of M2M communication, there are two categories of Radio Access Technologies (RATs) according to spectrum resources: cellular IoT and lower-powered wide-area network (LPWN). Cellular IoT involves modifying the legacy cellular network to accommodate IoT communication using licensed bands. The third-generation project partnership (3GPP) standardized long-term evolution machine-to-machine (LTEM), which optimized the IoT protocol over the LTE system since Release 12. LTE-M reuses LTE PHY channels. LTE-M includes cover age enhancement, cost reduction, and improved battery life. Furthermore, it is able to cooperate within the legacy LTE network. However, it has a limitation in fulfilling all requirements of IoT communication because the nature of the LTE system is not suited for low

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data rates and long-range communication. Therefore, 3GPP is currently study in gand standardizing a narrow band radio interface called narrow band (NB) IoT. This technology started as a clean state standard to fulfill the requirements of IoT environment. NB-IoT reuses LTE core networks; thus, rapid deployment is possible in the market with only software modifications. In addition, NB-IoT supports various operation modes including in-band, guard-band, and standalone. NB-IoT requires only a narrowband carrier of 200kHz with frequency division multiple access (FDMA) in uplink and orthogonal frequency division multiple access (OFDMA) in the downlink for 200, 000connections [21].

Table 1.Comparison of Generations [Ref. 3]

FEATURES	1G	2G	3G	4G	5G
TIME-LINE	1970-1980	1990-2004	2004-2010	2010-Now	By 2020
Bandwidth	2kbps	64kbps	2Mbps	1Gbps	≥1Gbps
Technology	Analog Cellular Technology	Digital Cellular Technology	CDMA 2000, UMTS, EDGE	WiMax LTE Wi-Fi	WWWW (as proposed)
Service	Voice Calling	Packetized data, digital voice calling, SMS	Integrated high quality audio, video & data	Dynamic information Access, wearable devices	Wearable devices with AI
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit, Packet	Packet	All Packet	All Packet
Core Network	PSTN	PSTN	Packet Network	Internet	Internet
Milliseconds(ms)	>>1000	300-1000	100-500	<100	Almost 1(theoretical)
Drawbacks	Poor spectral efficiency, major security issue	Limited data rates, difficult to support demand for internet	Real performance fail to match type, failure of WAP for internet access	Battery use is more, Required complicated and expensive hardware	high battery usage -

NANOTECHNOLOGY

Nanotechnology is the application of nanoscience to control process on nanometer scale between 0.1 to 100nm.The field is also known as Molecular Nanotechnology (MNT) where MNT deals with control of the structure of matter based on atom-by-atom and molecule by molecule engineering. Nanotechnology is considered as the next industrial revolution, and the telecommunications industry will be radically transformed by it in a few years. As the future applications will require more memory and computing power to offer higher data rates, current technologies cannot resolve these challenges. Fortunately, nanotechnology could provide effective solutions for power efficient computing, sensing, memory enlargement, and human machine interaction. Nanotechnology has shown its impact on both mobile as well as the core network as follows. The mobile device has become more than a communication device in modern world; computation and communication

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are ready to serve the user in an intelligent way. Mobile devices together with the intelligence, embedded in human environments, will create a new platform that enables ubiquitous sensing, computing, and communication. With nanotechnology mobile phones can act as intelligent sensors that have applications in many industries, among them transportation, communications, medicine and safety. The core network requires high speed and a reliable capacity to manipulate and interoperate increasing number of heterogeneous access technologies. At present, nanotechnologies are used in Digital Signal Processing (DSP) Fabrication, introducing new perceptions in DSP designing that increases the overall system speed & capacity. Apart from this it has its own impact on sensor as well as security. This is considered as a most significant in telecommunication [5]. The term nanotechnology was introduced in 1974 by Norio Taniguchi at the Tokyo International conference on production engineering. Nanotechnology is the next industrial revolution and the telecommunications industry will be radically transformed by it in a few years. Impact of nanotechnology has been on both mobile and on core network. Perfection in security and the better impact on the sensor makes the nanotechnology the most significant in its row. This is considered to be most significant in telecommunication. Atom-by-atom and molecule -by-molecule based control of the structure of matter. The telecommunication industry will radically get changed into the latest Nanotechnology in little year time [22]. Putting the effect in both mobile and in addition core network system is the method of operation of the nanotechnology. Flawlessness in security and the better effect on the sensor makes the nanotechnology the most critical in its column. Presentation of the Graphene's transistor is the development to be accomplished. A transistor which is been assembled utilizing the new material by name Graphene, mostly comprises of a type of graphite that comprises of a solitary layer of carbon atoms which has been orchestrated as honeycomb example. The specific structure will help the electrons to go through it rapidly and gives more noteworthy proficiency than the regularly existing handset chip material Mobile phones improved with the carbon nanotube will be presented soon which comes under the nanotechnology. Other primary up and coming functionalities are microscopic microphones, liquid lenses linked with global positioning system satellites connected with worldwide situating satellites are the exceptionally firm and most recent thought of electronic noses and some more. Getting maximally touchy to the sounds we need and in the meantime, insignificantly delicate to the sounds we don't need will be made conceivable by the utilization of numerous amplifiers. This will effectively chop down the capable of being heard commotion via telephone. Liquid Lenses points is the reasonable thought in which the static focal points which we are utilizing these days will be supplanted with Intelligent lenses which will have the sense to stay concentrate on what we are going for and this will adequately clear a path to lessen the jitter [23].

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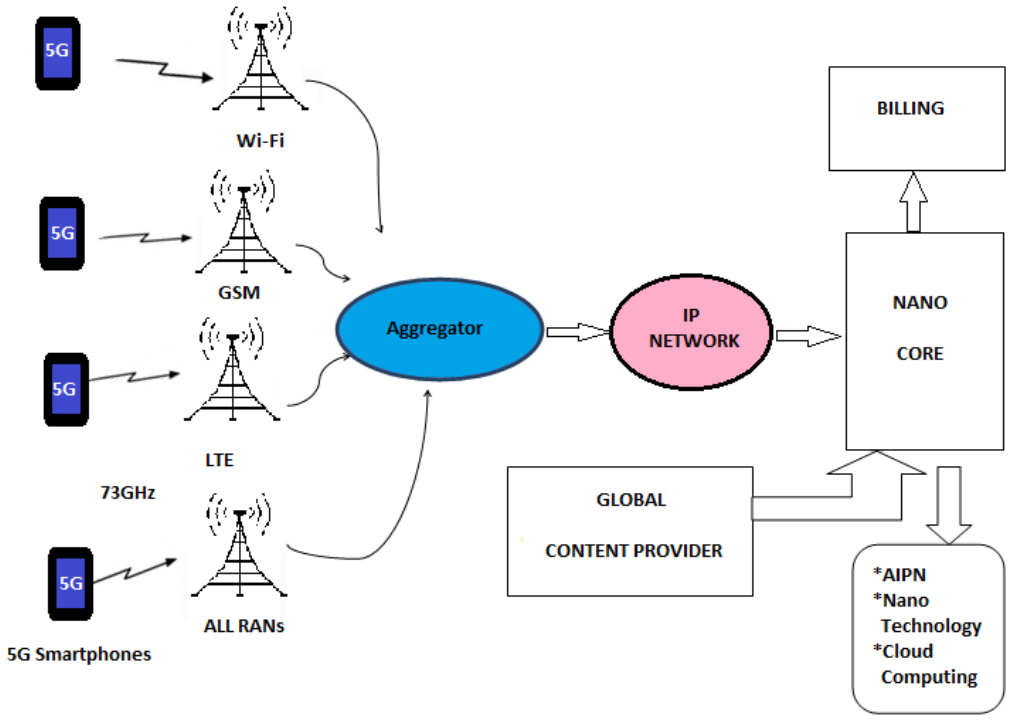

Figure 1.Architecture of 5G Network [Ref. 25]

MASSIVE MIMO

Massive MIMO has extensively applied in WIFI, LTE and so on. In theory, the more the number of antennas the higher will be the spectral efficiency and transmission reliability. In particular, when the number of transmit antennas and receive antennas are large; MIMO channel capacity will linearly increase approximately with the number of antennas in the minimum value. Therefore, with a large number of antennas and this provides an efficient pathway to greatly improve the capacity of the system. Due to limitations of space occupied by the multi-antenna, the implementation complexity of technical conditions, in the current wireless communication systems, the number of antenna transceiver multi-side configuration is not large, for example, the LTE system uses a maximum of four antennas, LTE-A system uses up to eight antennas. However, because of its enormous capacity and reliability gains, research related technology for large number of MIMO antenna system attracts the attention of researchers, such as in a cell, the research of multiuser MIMO system which the base station equips with greatly exceed the number of antenna of mobile station's. Massive MIMO can be achieved by some inexpensive and low power components. It makes a wide prospect in high frequency to implement mobile communication. There are some advantages such as increasing exponentially wireless spectrum efficiency, enhancing network coverage and system capacity, helping operators maximize the use of existing sites and spectrum resources. 3D-MIMO adds vertical dimension on the basis of MIMO. So it makes three-dimensional beam forming in space, and avoids the mutual interference. We can achieve multi-directional beam forming with massive MIMO [13]. The next level of the antenna technology has been arising in the form of MIMO (multiple inputs, multiple outputs). The MIMO is the advanced technology for wireless communication between antennas. This technology will use the multiple antennas at mobile station (transmitter) and base station (receiver).

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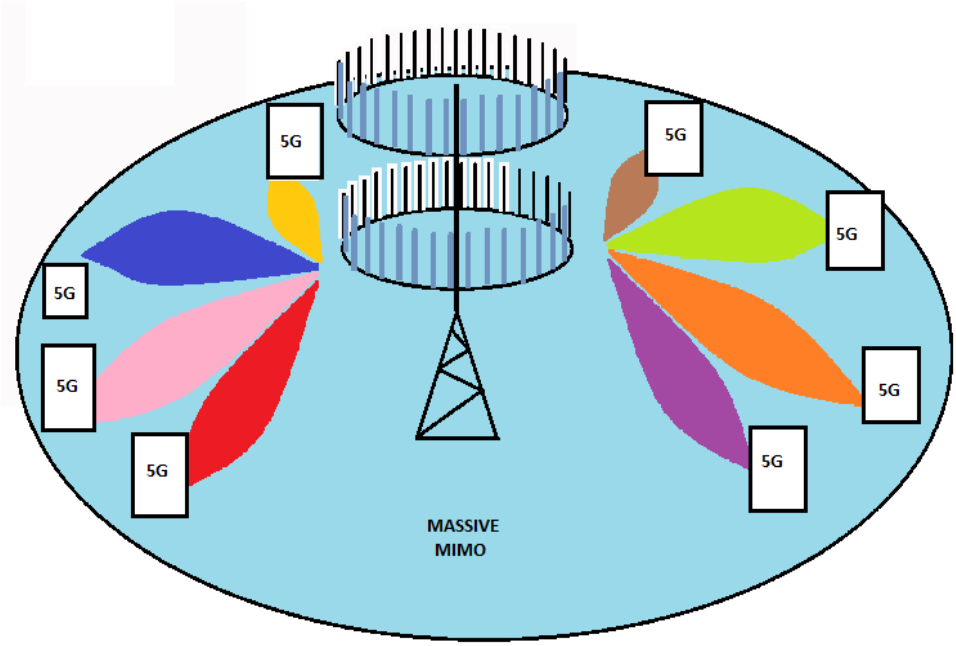

Figure 2.Massive MIMO [Ref. 25]

The communication circuits are combined for minimize errors and optimize data speed for antennas at each end. By using the single antenna at the source and destination that makes a problem into multipath effects. In wireless internet, it can cause an increase in the number of errors and reduction in data speed. This multipath effect can be overcome only by the use of two or more antennas along with the transmission of multiple signals at the source and the destination. The application of MIMO technology will be in the wireless local area networks (WLANs), for mobile communication, and in the digital television (DTV). The one of several forms of smart antennas technology is MIMO; SIMO (single input, single output) and MISO (multiple inputs, multiple outputs) technologies are also used [17]. A mobile user need to communicate inside or outside in Wireless cellular network architecture. The outside communication is done by an outside base station located at the middle of a cell. High penetration loss occurs When the inside users wants to communicate with the outside base station, the signals travel through the walls of the indoors, which alternatively reduce the spectral efficiency, data rate, and energy efficiency of wireless communications. Nowadays, Distinct outside and inside setups are used to overcome these challenges which reduces the penetration loss through the walls of the building and it will be implemented with the help of some standard technologies like massive MIMO technology, which uses geographically distributed array of antenna's. The term massive MIMO systems have come up with utilization of the advantages of large array antenna elements for huge capacity gains. Two stages for massive MIMO implementation-First, large antenna arrays which are aided with massive MIMO technologies gets attached with the outside base stations via optical fiber cables, and distributed around some hexagonal cell. The outside mobile users are basically attached with few number of antenna units but a large virtual antenna array can be built with cooperation, which will together form virtual massive MIMO links at base station. Second, large antenna arrays for every building will be placed from outside, to communicate with outdoor base stations using line of sight components. Communication with indoor users will be possible by installing the wireless access points inside the building which will be connected with the large antenna arrays via cables. This

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process improves the energy efficiency, cell average throughput, data rate, and spectral efficiency of the cellular system but at the same time increases infrastructure cost. Indoor communications (small range) having large data rates require technologies like Wi-Fi, Small cell, ultra-wideband, millimeter wave communications, and visible light communications [24].

DEVICE-TO-DEVICE COMMUNICATION

D2D communication refers to a radio technology that enables devices to communicate directly with each other, that is without routing the data paths through a network infrastructure. While the conventional cellular architecture consists of connections from base stations to user equipment, 5G systems may well rely upon a two-tier architecture consisting of a macro cell tier for base station to device communication, and a second device tier for device to device (D2D) communications. The D2D communication is another technology that is to be use in the 5G which will depend on the two-tier architecture. D2D may even allow users to experience benefits in terms of smaller communication latency, increased data rate and reduced energy consumption. D2D communication high end user mobility will be considered, while communicating with directly terminal to terminal or sharing radio frequency connection to exchange data with reduce interference in communication [17, 24]. 5G is a full duplex system, at the same time devices can transmit and receive signals and reduce the time complexity. Network controlled device to device communication where the macro-cell base station performs control signaling in terms of synchronization signal configuration, providing uniqueness and safety management. This feature will utilize in 5G [12]. D2D communication allows close proximity UEs to communicate with each other on a licensed cellular bandwidth without involving a MBS or with a very controlled involvement of a MBS. The standards and frameworks for D2D communication are in an early stage of research [15].

CLOUD COMPUTING

Cloud computing is a technology that uses the internet and central remote server to maintain data and applications. In 5G network this central remote server will be our content provider. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with internet access. The same concept is going to be used in Nanocore where the user tries to access his private account form a global content provider through Nanocore in form of cloud. The development of cloud computing provides operators with tremendous opportunities. Since cloud computing relies on the networks, it shows the significance of networks and promotes network development. It also requires secure and reliable service providers, capabilities that operators have deep expertise in. Operators can enter the cloud computing market and create new value-added services and experiences by integrating industry content and applications in the digital supermarket model. This could make our user to obtain much more real-time application to utilize his 5G network efficiently. Secure and reliable service can be provided with the help of quantum cryptography. Cloud computing customer avoids capital expenditure for the Nanocore thereby also reducing the cost of purchasing physical infrastructure by renting the usage from a third party Provider(Content Provider). The Nanocore devours the resources and pay for what it uses [2, 5, 10, 23]. The 5G will be required to store the large amount of data and result in some traffic, to overcome this problem cloud computing is used. Cloud computing will provide an extra-ordinary backend for any application on mobile devices to access some of the resources like services, software, storage, computing power and etc. Cloud computing is

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mainly used for the user in the cloud, can be access the cloud service from any geographical location from any devices. The cloud computing used now should be more flexible and easy to access while using the advanced generation i.e, 5G. The data rate of mobile will be measured in the multiple of Gbps. By using this technology the more free space will be available for the user. The cloud computing will make the user to be free from the documents, apps, services to be carry with them[17].Cloud computing infrastructure provides on-demand, easy, and scalable access to a shared pool of configurable resources, without worrying about the management of resource. In this section, we will see cloud-based architectures or cloud-based radio access networks (C-RANs) for 5G networks. The basic idea behind any C-RAN is to execute most of the functions of a MBS in the cloud, and hence, divide the functionality of a MBS into a control layer and a data layer. The functions of the control and the data layers are executed in a cloud and in a MBS, respectively. Thus, a C-RAN provides a dynamic service allocation scheme for scaling the network without installing costly network devices. Specifically, a MBS has two main components, as: (i) a baseband unit (BBU, for implementing baseband processing using baseband processors), and (ii) a remote radio head (RRH, for performing radio functions). In most of the C-RANs, BBUs are placed in the cloud and RRHs stay in MBSs [15].

ADVANTAGES & DISADVANTAGES

ADVANTAGES

Although the 5G technology will not be fully developed anytime sooner before 2020, following are some of the general advantages that 5G will offer-

1. 5G will offer very high data rates, possibly more than 10Gbps, which may enhance the download and upload capabilities and user satisfaction [4, 25].
2. In 5G networking 5G millimetre waves will be able to transmit large amounts of data with latency of less than 1 ms leading to immediate connection establishment and release by 5G smart phones. Hence traffic load will be decreased in base stations [25].
3. With 5G a level of call volume and data transmission can be experienced. 5G technology will offer the services in Product Engineering, Documentation, supporting electronic transactions (e-Payments, e-transactions) etc [1].
4. The new 5G cell technologies can be used to hook your phone to your laptop for broadband Internet access; linking cameras, video players, MP3 recording, and much more.
5. To overcome path loss at higher frequencies Dynamic beam forming (smart beaming) can be used in 5G technology[5].
6. Due to improved 5G network architecture handoff will be smooth and will not have any effect on data transfer when mobile user changes gadgets.
7. Very high resolution and bi-directional large bandwidths for busy users [4].
8. 5G will also cater to remote diagnostics [4, 25].
9. 5G promises advanced billing interfaces, subscriber supervision tools and a transport class gateway with unparalleled consistency [4].
10. The 5G technology also supports virtual private network and the traffic statistics by 5G technology makes it more accurate [5].
11. 5G devices are comparatively less expensive than 3G and 4G devices [5].
12. 5G is expected to provide Finest Quality of Service (QoS) where All Networks can be gathered on a platform [1, 5, 25].
13. The 5G technology for large volume data distribution in Gigabit, which also maintains close ties to almost 65, 000 [4, 10].
14. 5G will reach higher system level spectral efficiency [6].

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DISADVANTAGES

1. Need of skilled engineers and efficient designs.
2. Instalment and maintenance of 5G networking system will be costly.
3. Possibly having better performing and long-lasting batteries and high quality materials used in circuits will increase the cost of 5G smart phones.
4. 5G is yet to be released and is still under development; hence it will take time to even fully figure out some of the issues.
5. Coverage distance of up to 2 meters (in indoor) and 300 meters (in outdoor) can be achieved due to higher losses at high frequencies (such as millimetre waves). 5Gmm wave suffers from many losses such as penetration loss, attenuation due to rain, foliage loss etc.
6. It will take time for security and privacy issues to be fully resolved in 5G networks [25].
7. Radios, cell towers and satellites communicate using GHz ranges of radio frequencies. Early reports on the 5G network indicate that this network is going to transmit its data in the range of around 6 GHz. Unfortunately, this radio frequency range is already crowded by other signals, such as satellite links. With numerous types of signals operating in the range of 6 GHz, hence there might be an overcrowding of signals which can create issues like data interference and data loss [27].

APPLICATIONS OF 5G TECHNOLOGY

HIGH-SPEED MOBILE NETWORK

It can support 10 to 20 GBps of data download speed. High speed data can be simultaneously transferred. Low latency is one of its main features. Wi-Fi offloading and device to device communication techniques are suggested to enhance network performances further.

MULTIMEDIA

5G will offer a high definition virtual world on your mobile phone. Augmented reality and virtual reality requires HD video with low latency. 5G network is powerful enough to power AR and VR with amazing virtual experience.

INTERNET OF THINGS

Internet of Things will connect every object, appliances, sensors, devices and applications into Internet. Its applications will collect huge amount of data from millions of devices. 5G is the most efficient candidate for IoT due to its flexibility, unused spectrum availability and low cost solutions.

LOGISTICS AND SHIPPING

5G can be used for goods tracking, fleet Management, centralized database management and real-time delivery tracking and reporting.

SMART CITIES

Smart city application like traffic management, Instant weather update, energy management, smart power grid, smart lighting of street, crowd management, emergency response etc. can be done using 5G.

INDUSTRIAL IOT

Future industries will depend on wireless technologies like LTE and 5G for efficient automation of equipment, predictive maintenance, process tracking, shipping, logistics and energy management.

HEALTHCARE AND MISSION CRITICAL APPLICATIONS

People with chronic medical conditions will be benefitted from devices and real-time monitoring. Smart medical devices will continuously monitor patient's condition and activate alert during emergency. Hospitals will

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get alerts during critical situation and they can make necessary steps to speed up diagnose and treatment.

AUTONOMOUS DRIVING

In future, cars can communicate with smart traffic signs, surrounding objects and other vehicles on the road easily.

DRONE OPERATION

5G network will provide strong support with high speed wireless internet connectivity for drone operation. Drones are getting popular for multiple operations range

SECURITY AND PRIVACY

5G wireless technology is one the best solution for security and surveillance because of its higher bandwidth and unlicensed spectrum.

It will revolutionize the entire area where wireless network can be used for efficient and secure communication.

CURRENT RESEARCH GOING ON

MASSIVE MIMO

Massive MIMO has extensively applied in, LTE and so on. In theory, the more the number of antennas the higher will be the spectral efficiency and transmission reliability In particular, when the number of transmit antennas and receive antennas are large; MIMO channel capacity will linearly increase approximately with the number of antennas in the minimum value. Therefore, with a large number of antennas and this provides an efficient pathway to greatly improve the capacity of the system. Due to limitations of space occupied by the multi-antenna, the implementation complexity of technical conditions, the number of antenna transceiver multi-side configuration is not large in wireless communication system. The enormous capacity and reliability gains for large number of MIMO antenna system attracts the attention of researchers, such as in a cell, the research of multi user MIMO system which the base station equips with greatly exceed the number of antenna of mobile station's. Massive MIMO can be achieved by some inexpensive and low power components. It makes a wide prospect in high frequency to implement mobile communication. There are some advantages such as increasing exponentially wireless spectrum efficiency, enhancing network coverage and system capacity, helping operators maximize the use of existing sites and spectrum resources. 3D-MIMO adds vertical dimension on the basis of MIMO. So it makes three-dimensional beam forming in space, and avoids the mutual interference. We can achieve multi-directional beam forming with massive MIMO [13]. The next level of the antenna technology has been arising in the form of MIMO (multiple inputs, multiple outputs). The MIMO is the advanced technology for wireless communication between antennas. This technology will use the multiple antennas at mobile station (transmitter) and base station (receiver).The communications circuit are combined for minimize errors and optimize data speed for antennas at each end. By using the single antenna at the source and destination that makes a problem into multipath effects. In wireless internet, it can cause an increase in the number of errors and reduction in data speed. This multipath effect can be overcome only by the use of two or more antennas along with the transmission of multiple signals at the source and the destination. The application of MIMO technology will be in the wireless local area networks (WLANs), for mobile communication, and in the digital television (DTV).The one of several forms of smart antennas technology is MIMO; the others are SIMO (single input, single output) and MISO (multiple inputs, multiple outputs). Electronic made devices are connected to the network [17]. A mobile user need to communicate inside or outside in Wireless cellular network architecture. The outside

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communication is done by an outside base station located at the middle of a cell. High penetration loss occurs When the inside users wants to communicate with the outside base station, the signals travel through the walls of the indoors, which alternatively reduce the spectral efficiency, data rate, and energy efficiency of wireless communications. Nowadays, Distinct outside and inside setups are used to overcome these challenges which reduces the penetration loss through the walls of the building and it will be implemented with the help of some standard technologies like massive MIMO technology, which uses geographically distributed array of antenna's. The term massive MIMO systems have come up with utilization of the advantages of large array antenna elements for huge capacity gains. Two stages for massive MIMO implementation-First, large antenna arrays which are aided with massive MIMO technologies gets attached with the outside base stations via optical fiber cables, and distributed around some hexagonal cell. The outside mobile users are basically attached with few number of antenna units but a large virtual antenna array can be built with cooperation, which will together form virtual massive MIMO links at base station. Second, for every building their will be large antenna arrays from outside, to communicate with outdoor base stations using line of sight components. To communicate with indoor users the wireless access points being installed inside the building which will be connected with the large antenna arrays via cables. This will improves the energy efficiency, cell average throughput, data rate, and spectral efficiency of the cellular system but at the high rate of increased infrastructure cost. As larger antenna arrays remained installed outside the buildings, the inside users will only have to communicate with inside wireless access points. For small range communications (Indoor communication) having large data rates there are some of technologies like Wi-Fi, Small cell, ultra-wideband, millimeter wave communications, and visible light communications are very useful[24].

CLOUD COMPUTING

Cloud computing is a technology that uses the internet and central remote server to maintain data and applications. In 5G network this central remote server will be our content provider. Cloud computing allows consumers and business to use applications without installation and access their personal files at any computer with internet access. The same concept is going to be used in Nanocore where the user tries to access his private account form a global content provider through Nanocore in form of cloud. The development of cloud computing provides operators with tremendous opportunities. Since cloud computing relies on the networks, it shows the significance of networks and promotes network development. It also requires secure and reliable service providers, capabilities that operators have deep expertise in. Operators can enter the cloud computing market and create new value-added services and experiences by integrating industry content and applications in the digital supermarket model. This could make our user to obtain much more real-time application to utilize his 5G network efficiently. Secure and reliable service can be provided with the help of quantum cryptography. Cloud computing customer avoids capital expenditure for the Nanocore thereby also reducing the cost of purchasing physical infrastructure by renting the usage from a third party Provider(Content Provider). The Nanocore devours the resources and pay for what it uses [2, 5, 10, 23]. The 5G will be required to store the large amount of data and result in some traffic, to overcome this problem cloud computing is used. Cloud computing will provide an extra-ordinary backend for any application on mobile devices to access some of the resources like services, software, storage, computing power and etc. Cloud computing is mainly used for the user in the cloud, can be access the cloud service from any geographical

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location from any devices. The cloud computing used now should be more flexible and easy to access while using the advanced generation i.e, 5G. The data rate of mobile will be measured in the multiple of Gbps. By using this technology the more free space will be available for the user. The cloud computing will make the user to be free from the documents, apps, services to be carry with them[17].Cloud computing infrastructure provides on-demand, easy, and scalable access to a shared pool of configurable resources, without worrying about the management of resource. In this section, we will see cloud-based architectures or cloud-based radio access networks (C-RANs) for 5G networks. The basic idea behind any C-RAN is to execute most of the functions of a MBS in the cloud, and hence, divide the functionality of a MBS into a control layer and a data layer. The functions of the control and the data layers are executed in a cloud and in a MBS, respectively. Thus, a C-RAN provides a dynamic service allocation scheme for scaling the network without installing costly network devices. Specifically, a MBS has two main components, as: (i) a baseband unit (BBU, for implementing baseband processing using baseband processors), and (ii) a remote radio head (RRH, for performing radio functions). In most of the C-RANs, BBUs are placed in the cloud and RRHs stay in MBSs [15].

MILIMETER WAVE

Millimeter Wave Communication is used to satisfy requirement of increase in traffic and addition of different services, additional frequency band beyond what was previously assigned to 4G standard is required for. The use of millimeter wave frequency bands is necessary to overcome the problem of rare spectrum resources since it permits transmission at wider band widths than conventional 20MHz channel for 4G system. To resolve the use of millimeter wave frequency bands is must to overcome the problem of rare spectrum. Cells will automatically talk to each other to provide the best and most efficient service no matter where the user is. Larger cells will be used in the same way as they are now, with broad coverage, but urban areas will be covered by multiple smaller cells, fitted in lampposts, on the roofs of shops and malls, and in the pillars of building. Each of these will make the signal stabilized.[12] Millimeter waves, mm Waves Mm Waves is from 30GHz to 300GHz in frequency, 10 millimeter to 1 millimeter in wavelength. Mm Waves technology can support ultrahigh speed of transmission rate, narrow beam, flexible and controllable, and it can connect many devices. Mobile & telecom, consumer & commercial, healthcare, and others use Millimeter Wave technology. Smaller antennas which have small wavelength may achieve a very tight beam width, which makes re-using frequencies, network design and interference management much easier. The millimeter wave technology will provide more flexibility and transparency, it will carry out the signal to the network system Millimeter wave communication provides multi-gigabit communication services. It provides service of high definition television (HDTV), ultra-high definition video (UHDV). Bandwidth like 28 GHz band, the 38 GHz band, the 60 GHz band, and the E-band (71-76 GHz and 81-86 GHz) are the main focus of the researchers [17]. But there are some of the technologies like millimeter wave and visible light communication they requires higher frequencies which are not useful for cellular communications. But these high frequency waves are not efficient 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. As millimeter waves and visible light communications technologies come up with large bandwidth can improve the transmission data rate for indoor setups.

The spectrum shortage problem can be solved by improving the spectrum utilization of current radio spectra through cognitive radio (CR) networks [24].

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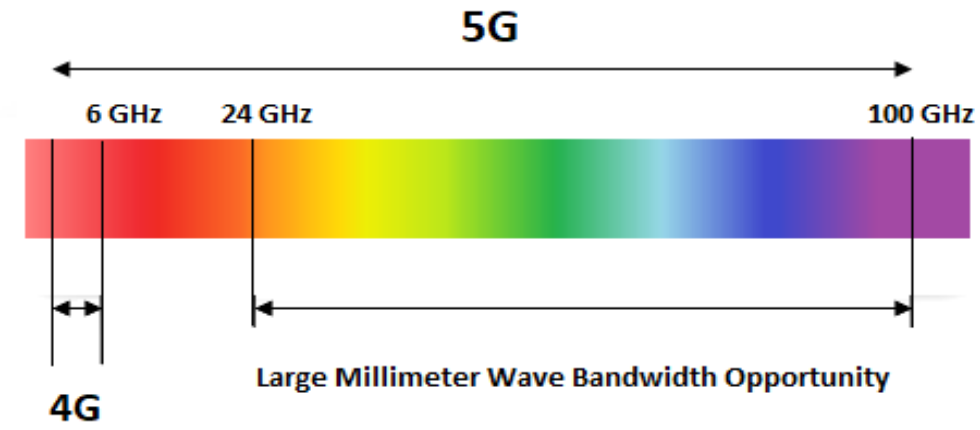

Figure 3.Millimeter Wave for 5G [Ref. 29]

DEVICE-TO-DEVICE COMMUNICATION

D2D communication refers to a radio technology that enables devices to communicate directly with each other, that is without routing the data paths through a network infrastructure. While the conventional cellular architecture consists of connections from base stations to user equipment, 5G systems may well rely upon a two-tier architecture consisting of a macro cell tier for base station to device communication, and a second device tier for device to device (D2D) communications. D2D offers smaller communication latency, increased data rate and reduced energy consumption. D2D communication offers high end user mobility, while communicating with directly terminal to terminal or sharing radio frequency connection to exchange data with reduced interference [17, 24]. 5G is a full duplex system, at the same time devices can transmit and receive signals and reduce the time complexity. Network controlled device to device communication where the macro-cell base station performs control signaling in terms of synchronization signal configuration, providing uniqueness and safety management. This feature will be utilized in 5G [12]. D2D communication allows close proximity UEs to communicate with each other on a licensed cellular bandwidth without involving a MBS or with a very controlled involvement of a MBS. The standards and frameworksforD2D communication are in an early stage of research [15].

ENERGY-EFFICIENT ARCHITECTURES FOR 5GNETWORKS

Energy efficient infrastructures are a vital goal of 5G networks. Researchers have proposed a few ways of reducing energy in the infrastructure. Rowell et al. considered a joint optimization o energy-efficiency and spectral-efficiency. Auser-centric 5G network is suggested in so that UEs are allowed to select UL and DL channels from different BSs depending on the load, channel conditions, services and application requirements. In a similar manner, decoupling of signaling and data is useful for energy saving; for example, a MBS may become a signaling BS while SBSs may serve all data requests. Thus, when there is no data traffic in a SBS, it can be turned off. A similar approach for decoupling of signaling and data is presented in. However, a UE gets connected to a SBS according to instructions by a MBS, and hence, it results in less energy consumption at UEs' side due to less interference, faster small-cells' discovery, and MBS-assisted handover. Hu and Qian provided an energy-efficient C-RAN architecture in a manner that RRHs serve almost a same number of UEs. They also present an interference management approach so that the power consumption of SBSs and MBSs can be decreased. Like Rowell et al. Hu and Qian also suggested that the association of a

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UE cannot be done based on entirely a DL channel or a UL channel, and a UE must consider both the channels at the time of association with a BS. Lin et al. suggested including an energy harvesting device (to collect energy) and a spectrum harvesting controller (to collect spectrum) at SBSs [15].

CONCLUSION

We already know the massive need of 5G in the future of mobile wireless networking; from the above review of 5G technology we can conclude that 5G will definitely enhance the data transmission rate at lower cost using 5G millimeter wave and incorporating IoT application, aiding to global connectivity. With the advancement in 5G technology Artificial Intelligent can work faster, making cloud computing smoother than ever. We need to overcome the overcrowding of radio frequencies in GHz range where already radio, cell towers operate and move the frequency range of 5G.We hope that this Paper helps to promote stronger links between people working in different fields creating future concepts of mobile communication, Internet services, Cloud computing, All IP network, and Nano technologies. We conclude that it is a great time to invest in start-ups. The 5G technologies include all type of advanced features which makes 5G mobile technology most powerful and in huge demand in near future.

FUTURE SCOPE

The 5G technology is an open platform. Its future scope is to use wireless technology in order to bring the best of the operating system. Its evolution will give a tough competition to laptops and PCs whole market value will be greatly affected. The new 5G technology is having high peak expectation and is much reliable. It offers high resolution at the same time. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will develop [4].It will have access to different wireless technologies at the same time, 5G technology offer high resolution for cell phone user and also we can monitor any place of the world from anywhere. There will be exciting amusement unbelievable services. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will evolve [5]. It will greatly enhance the Artificial Intelligence (AI) due to enhancement in the Nano Core as it will combine with it. The 5G mobile phones will have access to different wireless technologies at the same time.5G technology offer high resolution for cell phone user. We can watch TV channels at HD clarity in our mobile phones without any interruption. The 5G mobile phones will be a tablet PC. Many mobile embedded technologies will evolve [8]. The 5G technology has improved the wireless network. It is very efficient and less expensive, 5G technologies provide high resolution for the use of network to the mobile phone consumers [11, 12].

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