International Journal of Scientific Research and Engineering Development-– Volume 5 Issue 4, July- Aug 2022

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

5G Mobile Technology: A Look at the Opportunities and Recent Challenges

Rohit Shaw[1], Anamta Khan[2],Anirban Bhar[3], Shyamapriya Chatterjee[4]

[1]B. Tech student, Department of Information Technology, Narula Institute of Technology, Kolkata, India.
Email: rshaw9602@gmail.com

[2]B. Tech student, Department of Information Technology, Narula Institute of Technology, Kolkata, India.
Email:anamtakhan3434@gmail.com

[3]Assistant Professor, Department of Information Technology, Narula Institute of Technology, Kolkata,India.
Email:anirban.bhar@nit.ac.in

[4]Assistant Professor, Department of Information Technology, Narula Institute of Technology, Kolkata,India.
Email:shyamapriya.chowdhury@nit.ac.in

----------**********----------

Abstract:

5G stands for fifth generation wireless technology. Three key characteristics of this most recent cellular technology are its increased speed, decreased latency, and capacity to connect many more devices at once. In order to survive in the world where in every second the speed changes and where the urge is for more and more technology, here comes the Fifth-Generation technology: 5G. Some of the most important goals that must be achieved in the future, or in a world beyond 4G, are higher capacity, improved data rate, lower latency, and quality service. Large-scale improvements to the 5G cellular architecture are necessary to meet these expectations. This essay focuses primarily on the fifth generation. The design of the 5G cellular network and some of the most important upcoming technologies may help to make the architecture more livable and meet user requests.The paper is contented with the details related to 5g with the prime focus on the massive multiple input multiple output technology and device-to-device communication (D2D). This paper main aim is to highlight some of the most recent enhancements made towards the 5G mobile system and discuss its future research objectives.

Keywords **—5G Wireless Technology, MIMO Technology, Network Architecture, Internet of Things, Device-to-device communication, Cloud computing**

----------**********----------

I. INTRODUCTION

Through research and invention, wireless communication technology has developed and evolved greatly over time. The ability to connect numerous wireless technologies, networks, and applications at once has arrived. The most recent technology is 5G. The "G" in 5G stands for "generation," while the number 5 represents the technological improvement. The newest generation of wireless communication networks is known as 5G, or fifth generation wireless. Beyond the current 4G standard, it is the next significant stage in mobile telecommunications standards. High bandwidth and extremely low latency needs were the key driving force behind this study.With 5G, we can link many types of high-speed devices, moving away from networks that are just designed for mobile devices. People will find it simpler to download and upload Ultra HD and 3D content thanks to the main benefits of 5G. High connection densities, reduced latency, better mobility support, and high throughput are all characteristics of 5G. It

enables voice, video, Internet, and other broadband services in addition to interactive multimedia. New spectrum in the millimetre Wave bands has been assigned to 5G in order to satisfy its increasing throughput requirements. Multiple Input Multiple Output (MIMO) will be used in 5G to dramatically boost network capacity [1]. In response to the development of the Internet of Things and the surge in demand for access to video and services over wireless broadband, the transition to the 5G wireless communication standard has been made [2].Although the launch of 5G isn't anticipated until 2022, an increasing number of businesses are already making investments and developing 5G goods. Companies including Intel, Qualcomm, Nokia, Ericsson, BT, Verizon, AT&T, and Samsung are leading the development of the new mobile wireless standard.

The Next Generation Mobile Network Alliances defines the following pre-requisite for 5G networks:

- Increased Data rates.
- 1 Gb per second concurrently to many employees on the same workplace level.
- SPECTRAL efficiency is improved more than 4G.
- Coverage speed.
- Signalling efficiency enhanced.
- Compared to LTE, legacy usage decreased noticeably.

Instead of focusing on faster Internet connection speeds, 5G aims to be more capable than current 4G LTE. It will support more mobile broadband users per area unit, allow for the consumption of gigabytes of data per second, and have lower latency to improve connectivity and security for a large community.

II. EVOLUTION TO 5G NETWORK

First generation (1G):The first 1G cell phone, which uses analogue technology and functions just like a landline phone, was introduced in the 1970s and 1980s. It suffers from a variety of issues, including short battery life, poor voice quality, and missed calls. The fastest speed possible in 1G was 2.4 Kbps.

Second Generation (2G):The first digital system for 2G, which offered an improvement over 1G in mobile voice communication, was made available in 1991. Concepts for the Global System for Mobile (GSM) and Code-Division Multiple Access (CDMA) were also covered. The fastest speed available with 2G was 1 Mbps.

Third Generation (3G):Users saw faster system performance and download speed after switching from 2G GSM frameworks to 3G universal mobile telecommunication system (UMTS) frameworks when conducting continuous video conversations. The first mobile broadband technology created to combine telephony with some multimedia was 3G. High-speed packet access (HSPA/HSPA+) was the technology used in 3G. MIMO was utilised in 3G to increase the wireless network's power, and packet switching was used for quick data delivery.

Fourth Generation (4G):It only applies to mobile broadband. Information rates in digital mobile communication were seen to increase from 20 to 60 Mbps in 4G [3]. It utilises WiMAX and LTE technologies and offers larger bandwidth up to 100 MHz. It first debuted in 2010. LTE-A of the fourth generation (4.5G): It is a more developed variant of 4G LTE. MIMO technology is used by LTE-A to combine multiple antennas for both transmitters and receivers. LTE-A is three times quicker than conventional 4G thanks to MIMO technology, which allows several signals and antennas to operate at once. Improved system limits, fewer application server delay, and wireless access to triple traffic (Data, Voice, and Video) were all provided by LTE-A. LTE-A provides speeds of more than 42 Mbps and up to 90 Mbps.

Fifth Generation (5G):The digital transformation is supported by 5G, which is a significant advancement over all prior mobile generation networks. Three new services, including Extreme

mobile broadband, are available thanks to 5G. (eMBB). It offers various features, including virtual reality and augmented reality (AR/VR) media, high-speed internet connectivity, higher bandwidth, moderate latency, and UltraHD streaming videos. Massive machine-to-machine communication (eMTC) offers broadband and long-range machine-to-machine communication at a very cost-effective price with low power usage. For IoT applications, eMTC offers a high data rate service, low power, and wider coverage with less complicated devices through mobile carriers. Traditional mobile network architecture is unable to provide the low-latency, ultra-high reliability, and rich quality of service (QoS) that is offered by ultra-reliable low-latency communication (URLLC).Industry 4.0, smart grids, intelligent transportation systems, remote surgery, vehicle to vehicle (V2V) communication, and other on-demand real-time interactions are all possible with URLLC. In addition to being quicker than 4G, 5G allows for remote control operation over a dependable network with no delays. Up to 20 Gbps of down-link throughput is offered. In addition, 5G is based on the Internet protocol version 6 (IPv6) protocol and enables 4G WWWW (4th Generation World Wide WirelessWeb) [4]. With exceptionally fast speed, high throughput, low latency, improved reliability and scalability, and energy-efficient mobile communication technology, 5G offers unlimited internet connection at your convenience, anytime, anywhere [5]. The two primary categories of 5G are 6 GHz and millimetre wave (mmWave) 5G.

III. WORKING PROCEDURE OF 5G

Like all current cellular networks, 5G networks will have cells that are separated into sectors and use radio waves to transmit data. Each cell has a wired or wireless connection to the network backbone. The unlicensed frequencies currently utilised for Wi-Fi could be utilised for 5G data transmission. A more intelligent, quick, and effective network is promised. In comparison to 4G, 5G is intended to offer far greater speeds, more capacity per sector, and significantly lower latency. The cell is segmented into micro and pico cells to improve network efficiency [6].Due to its promise of gigabit-per-second data rates whenever, anywhere, 5G will usher in a new era in mobile technology. Every mobile phone will have an IPv6 address on a 5G wireless network, depending on the environment and network in use. Instead, then being operator- or service-centric like in 3G or 4G, 5G relies on the user-centric network idea of the World-Wide Wireless Web (WWWW) [7]. The WWW will be able to support services and applications while connecting the entire globe. The newest technologies, including as cognitive radio, the Internet of Things, nanotechnology, and cloud computing, are all included in 5G.

5G technology has the following advanced features [8, 9]:

- Device-centric, distributed, programmable, and cloud-based architecture
- High data rates
- 1 to 10 Gbps connections to end points
- 1 millisecond end-to-end round-trip delay
- Low battery consumption
- Better connectivity irrespective of location
- Larger number of supporting devices
- Lower cost of infrastructure development

MIMO Technology Network Architecture:

For wireless systems, Multiple-Input Multiple-Output (MIMO) technology is crucial. Multiple signals can be sent and received simultaneously over a single radio channel. Massive MIMO is a development of MIMO technology utilised in the 5G network, where base stations are connected to hundreds of thousands of antennas to boost throughput and spectral efficiency. Massive MIMO employs many transmit and receive antennas to boost spectral efficiency and transmission rate. Massive MIMO can perceive data from various sensors with low latency, large data rate, and greater reliability when combined with beamforming and massive multiplexing techniques. Massive MIMO will help in transmitting the data in real-time collected from different sensors to central monitoring locations for smart sensor applications

like self-driving cars, healthcare centres, smart grids, smart cities, smart highways, smart homes, and smart enterprises. The 3GPP, an umbrella group of leading telecommunications standards development organization, has proposed 5G NR (New Radio) as a new global standard for air interface of 5G Networks. 5G network will based on small cell network architecture rather than Base Station (BS) centric architecture or more precisely device centre architecture. The cell may microcell or picocell. These cells are connected through ideal or non-ideal backhaul architecture. Due to smaller cell, there will be high mobility and handover. The system model for 5G mobile systems is depicted in the Fig 1. It is an IP-based paradigm enabling interoperability between wireless and mobile networks.

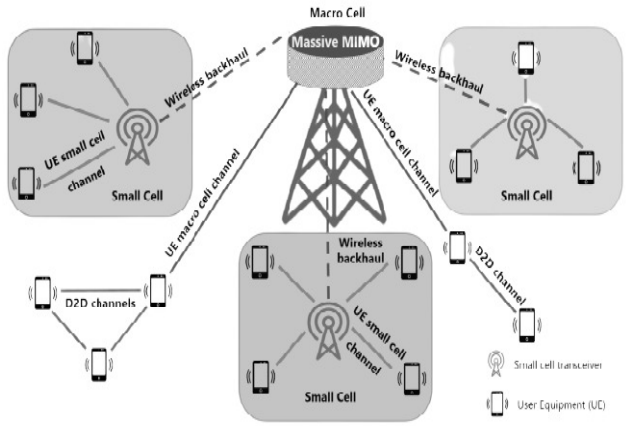

Fig 1: MIMO Network and Architecture

The system consists of various independent, autonomous radio access technologies as well as a user terminal, which is essential to the new architecture. Each terminal views its respective radio access technology as the IP connection to the wider Internet. However, each Radio Access Technology (RAT) in the mobile terminal should have a unique radio interface. For instance, in order for this architecture to function, all four of the mobile terminal's accesses — or unique interfaces — must be active at the same time if we wish to have access to four distinct RATs. The 5G wireless network works as a fibre optic internet connection. The 5G new radio is now using several frequency bands (NR). The term "millimetre wave" refers to the region of the radio spectrum with frequencies between 30 GHz and 300 GHz and wavelengths between 1 and 10 mm. Around the world, 5G is now being assigned frequencies between 24 GHz and 100 GHz. Unused UHF frequencies between 300 MHz and 3 GHz are also being used for 5G in addition to millimetre wave. Both the terminal and the RMTC can choose from a variety of access systems thanks to interoperability process-criteria and processes.

Internet of Things (IoT):

Instead of connecting people, an IoT network does such. It can be used for a variety of things, including farming, industrial automation, smart retail, supply chain management, project management, and disaster relief. By delivering more bandwidth and quicker speeds through wireless networks to enable a greater number of devices to coordinate and communicate at faster speeds, 5G is particularly positioned to handle the issues posed by IoT. IoT will link a variety of things, including devices, sensors, appliances, objects, and applications, to the internet. Several data points will be gathered by these applications from numerous gadgets and sensors.

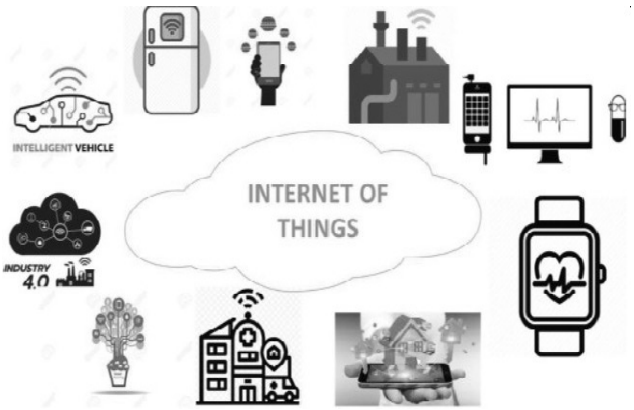

Fig 2: Internet of Things

5G will provide very highspeed internet connectivity for data collection, transmission,

control, and processing. The most effective technology for IoT is 5G since it is a flexible network with unused spectrum available and allows very low-cost deployment. But during the past ten years, IoT has gained tremendous popularity. Any Thing, Any Place, Any Time, Any Body, and so forth can be included in the IoT's dimensions and scopes. In order to create a global village and promote interoperability amongst items, standardisation is therefore required.

Device-to-Device (D2D):

Communication Most D2D conversations take place outside the current cellular networks' coverage areas. These direct links speak to one another directly, cutting away the base station from the conversation. The walkie-talkie is an example of this, however in order to communicate, a narrow spectrum is available, and as a result, a communication bandwidth is available. Multi-RAT (Radio Access Technologies) systems are made possible by the 5G network for seamless communication. Single-hop or multi-hop D2D communications are both possible. D2D communication utilizing LTE-Advanced and LTE Advanced Pro is possible with 5G. By recycling radio resources and granting network functionality to devices, D2D communication offers a number of benefits in terms of spectrum efficiency, power management, coverage expansion, and capacity development. D2D communication also offers brand-new services like traffic unloading, proximity-based commercial services, and public safety services. The handling of interference is the most difficult problem in D2D communication. D2D communication and a cellular network cannot coexist without effective interference management. The choice of mode is the other problem. For instance, when the network supports D2D mode, it is necessary to decide whether to use D2D and which event initiates the mode selection process. To boost network capacity and coverage expansion by a relay and power management, data offloading needs to be further researched.

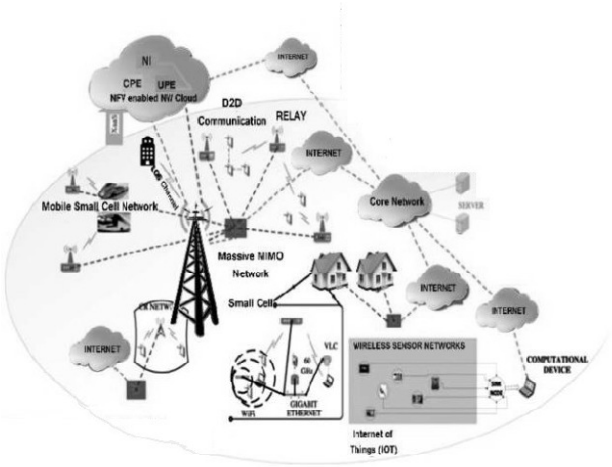

Fig 3: Device-to-Device Communication

Cloud Computing:

Large speed, low latency, and a high capacity to accommodate numerous real-time multimedia applications are some of 5G's key advantages. In order to process multidimensional, vast amounts of data, 5G is being designed as a smart wireless network architecture employing new models like SDN or NFV [10]. Due to its high data rate, high mobility, and centralised management services, cloud computing has emerged as one of the key reference designs for 5G networks. It can be used without the systems of the consumers being directly installed. Both academia and business are beginning to take cloud computing more seriously. The number of mobile devices is steadily rising as a result of technological advancement and the growing popularity of mobile services. The future of consumer technology will be cloud computing as the world migrates to small, low-powered gadgets. With computation-intensive affective computing, big data analysis, resource cognition-based emotion-aware feedback, and optimization of resource allocation under dynamic traffic load, the suggested system can handle the most recent technological advancements of 5G. These robots will need enormous volumes of processing data that one system just cannot maintain as they develop and become increasingly capable of real-time adaptation. The answer is 5G-enabled cloud

robotics, which connect robots on the ground to system intelligence in the cloud. In order to ensure consistent internet connectivity, remote computing, storage, data resources, data-driven intelligence, solid cybersecurity, and support for a sizable fleet of robots, the network delivers essential technology. The cloud, for instance, will serve as a central "brain" in hospitals of the future, coordinating a fleet of collaborative robots that will guide patients or administer medications.

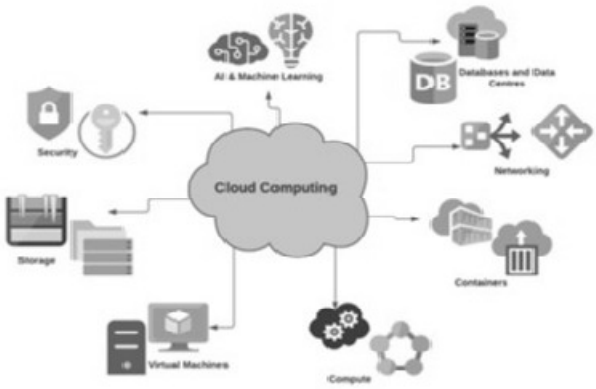

Fig 4: Cloud Computing

Cloud service providers will be able to easily and reliably connect with enterprise mobile customers thanks to 5G technology. Due to the increased computing power and machine-to-machine communication offered by 5G, access to virtual computers via phones will become widespread. Businesses using cloud computing will give mobile users more capabilities and alternatives, and hotspots will speed up, giving remote workers access to cloud services even in places with poor internet connectivity. There are numerous advantages to cloud communications, many of whose core functions will be enhanced by 5G.

IV. CONCLUSIONS

Arguably, the story of human progress over thousands of years is the story of evolution of technology over time. With each iteration, humans improve the tools at our disposal to enable a better quality of life. 5G standards are the next step in network evolution that will provide a much-needed impetus to emerging technologies that are awaiting deployment. The requirement of 5G will be massive IoT connectivity, virtual experience and media, and real-time communication. Smart cities and autonomous driving are the most important AI related domains that will be most effective by 5G. On the other hand, utilizing advanced big data analytics and machine (deep) learning algorithms in 5G will increase the stability of the robustness of the network where any predictions in a given network communication are required. This paper covers a detailed survey from multiple authors on different technologies in 5G wireless network architecture has been detailed along with massive MIMO technology, network function virtualization (NFV) cloud and device to device communication. It includes every form of cutting-edge feature, making it strong and in high demand in the near future. Before using 5G, there must be numerous experiments and tests. The development of 5G technology is still ongoing. It will cause a revolution in the mobile sector and has a promising future.

REFERENCES

[1] "5G,"Wikipedia,thefree encyclopediahttps://en.wikipedia.org/wiki/5G
[2] "5G Development with Matlab," https://www.mathworks.com/content/dam/mathworks/ebook/gated/5G_ebook.pdf
[3] Al-Namari, M.A.; Mansoor, A.M.; Idris, M.Y.I. A brief survey on 5G wireless mobile network. Int. J. Adv. Comput. Sci. Appl. 2017, 8, 52–59.
[4] Agiwal, M.; Roy, A.; Saxena, N. Next generation 5G wireless networks: A comprehensive survey. IEEE Commun. Surv. 2016, 18, 1617–1655.
[5] Buzzi, S.; Chih-Lin, I.; Klein, T.E.; Poor, H.V.; Yang, C.; Zappone, A. A survey of energy-efficient techniques for 5G networks and challenges ahead. IEEE J. Sel. Areas Commun. 2016, 34, 697–709.
[6] R. S. Sapakal and S. S. Kadam, "5G mobile technology," International Journal of Advanced Research in Computer Engineering & Technology, vol. 2, no. 2, February 2013, pp. 568-571.
[7] "How 5G technology works,"https://www.rfpage.com/how-5g-technology-works/
[8] D. H. Latha et al., "A study on 5th generation mobile technology – Future network service," International Journal of Computer Science and Information Technologies, vol. 5, no. 6, 2014, pp. 8309-8313.
[9] Eze, K. G., Sadiku, M. N., & Musa, S. M. (2018). 5G wireless technology: A primer. International Journal of Scientific Engineering and Technology,7(7), 62-64.
[10] Le, N. T., Hossain, M. A., Islam, A., Kim, D. Y., Choi, Y. J., & Jang, Y. M. (2016). Survey of promising technologies for 5G networks. Mobile information systems, 2016.

