International Journal of IT & Knowledge Management (ISSN: 0973-4414)
Volume 12 • Issue 2 pp. 207-213 Jan 2019 - June 2019 www.csjournals.com

Review of 5G Networks: Challenges and Applications

[1]Divya Shree, [2]Khushboo
[1]Assistant professor, CSE department, Uiet MDU,ROHTAK
[2]Assistant professor, Ece department, Uiet MDU,ROHTAK

Abstract: Mobile and portable gadgets have grown ubiquitous as a result of breakthrough developments in electrical and communication technologies. This results in a steadily rising tide of online data traffic. The 5th Generation (5G) of network technology has arisen to meet the need for seamless, high-bandwidth connectivity among all of these gadgets. In addition to faster data throughput and lower latency than 4G networks, 5G networks also promise improved Quality of Service (QoS). Several generations of wireless networks are evaluated in this research. It also delves into the many obstacles standing in the way of a fully functional 5G network and the many potential uses for such a system.
Keywords: Smart, Farming, Communication, Smart, Health.

I. INTRODUCTION

The cellular system was established to provide continuous service to mobile devices. These days, both businesses and universities are working on new ways to provide mobile devices access to fast data transfer rates and instantaneous services. To improve End-to-End (E2E) connection on demand, the next generation wireless network made possible by 5G is in a position to do so.

As reported by CISCO, mobile data traffic is expected to expand from its 2017 level of "1.5 ZB/year, or 122 EB/month", to a whopping 396 EB/month by 2022. By 2020, CISCO predicts, over 50 billion smart disguises will be online. The proliferation of Internet of Things (IoT)-enabled gadgets is seen in Figure 1.

IoT has transformed ubiquitous computing over the last decade as a result of its widespread use in fields as diverse as "smart city," "smart agriculture," "smart health," and many others. The Internet of Things (IoT) concept includes many computing and sensing nodes. Networked sensor nodes keep an eye on the fixed variables and report their findings online. Analysis shows that by 2020, there will be billions of devices, with each individual owning an average of 6-7 gadgets [2]. As of 2022, there will be more than a trillion sensor nodes connected to the web. A similar 45 trillion gadgets are predicted to be connected to the Internet in the following 20 years. There is strong need to look for alternatives to 4G in order to keep these mobile devices connected at all times. It's assumed that every ten years, a new generation of mobile technology will be proposed. In 2011, the fourth-generation (4G) cellular network was introduced, and by 2020, the first 5G [3] networks might be standardised and implemented.

5G's capabilities extend well beyond radio frequency transmission, including not just radio but also fixed host communication, cloud infrastructure, and more. 5G mobile network extension services strengthen the communications network ecosystem and provide services to the healthcare, agricultural, and smart city sectors in a way that minimises their energy consumption. From individual interactions to societal networking, 5G lays the groundwork for digitization. There are tremendous benefits and risks associated with mobile communication technologies that may be brought about through digitalization.

“Heterogeneous networks (HetNet) [4], massive multiple-input multiple-output (MIMO) [5], internet of vehicles (IoV) [6], device-to-device (D2D) communications [7], and software-defined networks (SDN)” [8] are only a few of the technologies deployed to 5G systems to boost performance.

In other words, 5G has not been standardised by the Internet Engineering Task Force (IETF). It's at its infant stages right now. As can be seen in Figure 2, 5G makes use of a wide variety of technologies.

II. ISSUESANDCHALLENGESINDEVELOPMENTOF5GNETWORK

The emergence of anything new always comes with its share of difficulties. In compared to 3G and 4G networks, 5G's major goal is to provide high-speed mobile broadband with improved throughput, ultra-low latency, and excellent dependability and security.

A. Energy-efficient high data rates and network capacity

When it comes to 5G, the infrastructure is complicated. Installation of a high number of Base Stations (BS) within a condensed area is labour intensive. Though it would raise network costs, the increased throughput will be worth it to decrease energy use. “Cognitive Radio Networks (CRNs) and Massive Multiple Input and Multiple Output (mMIMO)” [11] architecture will be used to accomplish this goal of high speed. mMIMO employs a high number of antennas relative to the number of communication devices to boost efficiency. The mMIMO operates at 1-10 mm wavelength and 30-300 GHz frequencies.

B. High-speed data, network expansion, and energy optimization Full-duplex channel

There are two channels in a 4G network, one for uploading and one for downloading, thanks to half-duplex [6] communication. However, 5G is planned to use the same channel for both access and backhaul, allowing for full duplex transmission. Practical implementation is highly challenging owing to interference, but it will enhance connection capacity, conserve the frequency spectrum, and be economically superior. Because of this, a strategy to mitigate interference's effects is also necessary.

C. EnvironmentallyFriendly

The 4G Radio Network (RN) accounts for around 70-80% of overall power use. As a result, this causes substantial amounts of carbon dioxide to be released into the atmosphere, which has a deleterious effect on the natural world. 5G proposes a number of different approaches to this problem. To reduce its impact on the planet, 5G employs designs including the “Cloud-Radio Network (CRN), Visual Light Communication (VLC), millimetre wave (mmWave) communication, direct-to-direct (D2D) communication, and massive multiple input/output (mMIMO)”[12].

D. LowLatencyandHighReliability

Typically, a 4G connection will have a round-trip latency of 15 ms (ms). It is anticipated that the 5G network's very low latency would also lead to less packet loss and enhanced network dependability. Incorporating effective caching [12], mmWave, and mMIMO architecture into 5G networks may help accomplish this goal.

E. NetworkPerformanceOptimization

When using the 5G network, you'll experience almost no lag at all. It will have an immediate impact on things like service quality, speed of delivery, connection, dependability, etc. Delay-bound QoS, clever hardware, and load-balancing methods are implemented to improve quality of service [5].

F. HighMobility andHandover

Instead of relying on a Base Station (BS) centric design or, more accurately, a devicecentre architecture, 5G networks will be built on small cell network architecture. Cell size may range from microcell to picocell. Connecting these cells is either ideal or non-ideal backhaul architecture [13]. There will be a lot of movement and handoff because of the

smaller cells [14–17].

G. Security andPrivacyforNetworkandMobileHosts

When it comes to mobile communication, the older networks catered only to individuals, whereas the newer 5G networks aim to serve both consumers and businesses. The security needs of mobile IoT devices are far lower than those of high-speed mobile services. Denial-of-service (DoS) attacks, hijacking attacks, signalling storms, resource (slice) theft, security keys exposure, IMSI catching attacks, IP spoofing, scanning attacks, TCP level attacks, Man-in-the-middle attack, configuration attacks, penetration attacks, user-identity theft attacks, etc. are the most pressing security concerns for 5G networks.

H. DataVolumes

The amount of data on the Internet is growing exponentially as the number of mobile users and IoT devices proliferates. This massive amount of data might overwhelm the 4G network. Using an efficient design, 5G networks can transfer massive amounts of data between user devices.

I. Device-to-device(D2D)Communication

In most cases, current cellular networks don't cover the kind of space where D2D [18] conversations take place. These point-to-point connections bypass the need for a central relay station altogether. The walkie-talkie is a good illustration of this, however in order to communicate, only a small portion of the electromagnetic spectrum and, thus, a limited amount of data transfer capacity are made accessible. The 5G network makes it possible to use many radio access technologies (RATs) in tandem. It's possible for there to be several hops in the D2D connection, or it might be a single one. D2D communication via LTE-Advanced and LTE-Advanced Pro is made possible by 5G. A simplified representation of a 5G D2D communication paradigm that operates at very fast speeds.

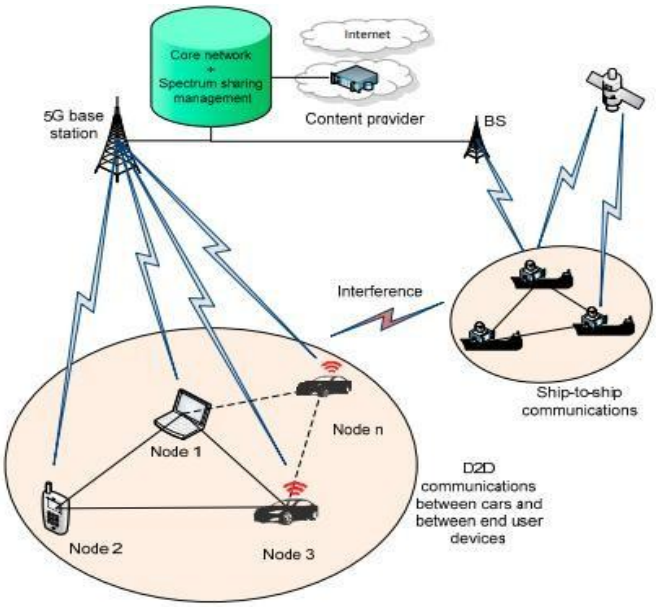

Fig.1:D2Dcommunicationmodelin5G

III. APPLICATIONAREAOF5GNETWORKS

Compared to the current cellular infrastructure, 5G is expected to be up to 100 times quicker, with lower latency and higher quality of service. Potential Future Fields of Application:

A. ImmersiveEntertainment

Providing live high-definition videos to end users is challenging owing to the restricted bandwidth capacity of 4G network, and delivering ultra-high-definition movies is next to impossible as the number of Internet users continues to grow dramatically. 5G's low latency and large bandwidth will enable it to allow immersive entertainment [19] at any time, in any place. Smartphones and HMDs will soon be able to broadcast live virtual reality streaming of sports, adventures, and real-world visuals thanks to 5G. (augmented reality). Immersive entertainment system, worn on the head.

B. EnvironmentalMonitoring

One of the world's greatest challenges is keeping track of environmental changes. Natural and environmental calamities such as storms, floods, droughts, Tsunamis, and so on cause abrupt shifts in climate, causing harm to all forms of life. The 5G network rapidly transfers data collected by sensor nodes [20] installed in faraway locations in order to keep tabs on the environment [21]. A live creature's life may be saved as a result of this. Losses related to the tsunami that hit Jakarta, Indonesia, very recently have been reported.

C. SmartAgriculture

Traditional methods form the backbone of India's agricultural system. Modern methods of monitoring and automating the agricultural system, known as "Smart Agricultural" [22] have been shown to boost both yield and quality of agricultural products. With the use of sensor nodes placed across the field, a smart agricultural system is able to collect data on the crop in near-real time. With 5G, sensor nodes may transmit real-time data in near real-time. Fog or Cloud computing can evaluate the data and communicate the results to the right person. “Water management, fertiliser injection, soil amendment, animal safety and maturity monitoring, crop status, drilling, planting and spraying, temperature, humidity, and so on are just a few of the many uses for smart farming. Samsung has declared its intention to begin the First large-scale 5G experiments in the India in conjunction with the Department of Telecommunications (DoT)”[23].

D. SmartMetering

There are two main types of electricity metres used in the current metering system: analogue and digital. Electricity consumption is quantified in terms of the amount of power required to operate various electric devices. Incredibly, these metres are simple to fool with and often leave no traces of their alteration. A country's economy feels its effects indirectly. An intelligent metre, or smart metre [23], is a cutting-edge tool for tracking energy use. It keeps track of the voltage and frequency in real time and sends that data back to the control unit through wireless connections. In addition to the time and date, the data also includes the meter's unique identification number (UID), the meter's current reading, the meter's maximum power output, and other similar metrics. The load may be increased or decreased on demand with the help of a smart metre, which also allows for remote load balancing. There is no need to wait for smart metre readings because to 5G's ability to provide services in near real time.

E. SmartWearables

Since 5G eliminates the need for these devices to have high-end, obscenely expensive CPUs, their lives are made much simpler. Having access to 5G will provide them with the computational power, and hence the lightning-fast speed and stable connection, that they need to do the user justice. It is predicted that the power of 5G and wearables [30] would be so great that the smartphone revolution will look puny in comparison. By keeping tabs on a wide range of essential metrics connected to human health, a technical research finds that wearable and artificial intelligence gadgets boost healthcare sector efficiency.

Fig.2:.SmartWearablewristwatchthrough5Gnetwork

F. SmartHome

The term "smart home" refers to a residence in which electronic devices such as lights, refrigerators, TVs, air conditioners, security systems, and so on are monitored and controlled remotely by means of an Internet-connected node, often a smartphone.

Fig.3:.SmartHomesconnectedthrough5Gnetwork

"Low-Power Wireless Personal Area Networks (LoWPAN)" is a mobile communication protocol used for controlling these appliances' Internet of Things sensor nodes [33, 34].

IV. CONCLUSION

The IT and electronics sectors are developing rapidly, with a primary emphasis on developing hand-held and miniature sensing devices. In particular, Internet of Things-enabled gadgets serve as sensor nodes in this system. For these gadgets to be able to talk to one another, a fast data network is needed. There is a huge gap between what users need and what 4G can provide in terms of speed and latency. This prompted businesses and academics to pitch 5G as a replacement for 4G. The capabilities of 5G networks are sufficient to satisfy market demands. The paper began with a short overview of the history of wireless technology. In addition, this article discusses a number of problems and solutions associated with putting 5G networks into action. Internet-of-Things devices may be used in a wide variety of settings. Thus, the rest of the article delves into the many uses for 5G networks.

REFERENCES

1. https://www.networkworld.com/article/3323063/internet/cisco-predicts-nearly-5-zettabytes-of-ip-traffic-per-year-by-2022.html.
2. https://www.huffingtonpost.com/entry/cisco-enterprises-are-leading-the-internet-of-things_us_59a41fcee4b0a62d0987b0c6.
3. Jessica Moysen, LorenzaGiupponi, "From 4G to 5G: Self-organizednetworkmanagementmeetsmachinelearning",ComputerCommunications,vol.129,2018,pp.248–268.
4. G.Bacci,E.V.Belmega,P.Mertikopoulos,andL.Sanguinetti,"Energyawarecompetitivepowerallocationinheterogeneousnetworks with QoS constraints", IEEE Trans. Wireless Commun., vol.14,no.9,2015,pp.4728–4742.
5. C. She, C. Yang, and L. Liu, "Energy-efficient resource allocation forMIMO-OFDM systems serving random sources with statistical QoSrequirement,"IEEETrans.Commun.,vol.63,no.11,2015,pp.4125-4141.
6. Inhyok Cha, Yogendra Shah, Andreas U. Schmidt, Andreas Leicher,andMichaelVictor(Mike)Meyerstein,"TrustinM2MCommunication," IEEE Vehicular Tech. Mag., vol. 4, no. 3, 2009, pp.69-75.
7. M. N. Tehrani, M. Uysal, and H. Yanikomeroglu, " Device-to-devicecommunication in 5G cellular networks: Challenges, solutions, andfuture directions", IEEE Communication Mag. , vol. 52, no. 5, 2014,pp.86–92.
8. Jeffrey G. Andrews, Stefano Buzzi, Wan Choi, Stephen V. Hanly,AngelLozano,Anthony,C.K.Soong,andJianzhongCharlieZhang,"WhatWill5GBe?",IEEEJournalonSelectedAreasinCommunications,vol.32,no.6,2014,pp.1065-1082.
9. T.Rappaport,WirelessCommunications:PrinciplesandPractice,Prentice-Hall, EnglewoodCliffs, NJ,1996.
10. ChangyangShe,ChenyangYang,andTonyQ.S.Quek,"RadioResourceManagementforUltra-reliableandLow-latencyCommunications," IEEE Communications Magazine, Nol. 55, No. 6,2017,pp.72-78.
11. S. Buzzi, C. I, T. Klein, V. Poor, C. Yang, A. Zappone, "A Survey ofEnergy-EfficientTechniquesfor5GNetworksandChallengesAhead," IEEE JSAC,vol.34,no.4,2016,pp.697-709.
12. D. Liu and C. Yang, "Energy efficiency of downlink networks withcaching at base stations," IEEE J. Sel. Areas Commun., vol. 34, no. 4,2016,pp.907–922.
13. D. W. K. Ng, E. S. Lo, and R. Schober, "Energy-efficient resourceallocationinmulti-cellOFDMAsystemswithlimitedbackhaulcapacity," IEEE Trans. Wireless Commun., vol. 11, no. 10, 2012, pp.3618–3631.
14. Arun Kumar Tripathi, R. Radhakrishnan and J. S. Lather, "Secure andOptimizedAuthenticationSchemeinProxyMobileIPv6(SOAS-PMIPv6) to reduce Handover Latency", International JournalofComputerNetworkandInformationSecurity,vol.9,issue10,2017,pp.1-12.
15. Arun Kumar Tripathi and Surendra Kumar Tripathi, "A QualitativeAnalysisofSecuredHandoverManagementSchemesforMobileIPv6enabledNetworks",InternationalConferenceonInnovativeApplications of Computational Intelligence on Power, Energy andControls withtheirimpactonHumanity(CIPECH-18),2018,pp.1-8.
16. Shweta Singh and Arun Kumar Tripathi, "A Comparative Study ofInternetProtocolsinMANET",InternationalConferenceonAdvancesinComputerSciences(ICACDS-16),Ghaziabad-India,vol.721,2016,pp:221-231.
17. Arun Kumar Tripathi and Shweta Singh, "A Comparative Analysis onInternetProtocolsinCloud-MobileEnvironment",InternationalJournal of Control Theory and Applications (IJCTA), vol. 9, issue 17,2016,pp.9161-9169.

18. PimmyGandotra, Rakesh Kumar Jha and SanjeevJain, " A survey ondevice-to-device(D2D)communication:Architectureandsecurityissues, Journal of Network and Computer Applications, vol. 78, 2017,pp.9-29.
19. MuhannaA.Muhanna, "Virtual reality and the CAVE: Taxonomy,interaction challenges and research directions", Journal of King SaudUniversity,ComputerandInformationSciences,vol.27,Issue3,2015,pp.344-361.
20. ArunKumarTripathiandAjayAgarwal,"AnApproachtowardsTimeSynchronizationBasedSecureProtocolforWirelessSensorNetwork",InternationalConferenceonNetworkedDigitalTechnologies(NDT-2010),vol.88,issue2,2010,pp.321-332.
21. MuhammadSaqibJamil,MuhammadAtifJamil,AnamMazhar,AhsanIkram,AbdullahAhmed,UsmanMunawar,"SmartEnvironmentMonitoringSystembyEmployingWirelessSensorNetworkson VehiclesforPollutionFreeSmartCities",ProcediaEngineering,vol.107,2015,pp.480-484.
22. GustavoSain,AnaMaríaLoboguerrero,CaitlinCorner-Dolloff,Miguel Lizarazo, Andreea Nowak, DeissyMartínez-Barón, NadineAndrieu, "Costs and benefits of climate-smart agriculture: The case oftheDryCorridorinGuatemala",AgriculturalSystems,vol.151,2017,pp.163-173.
23. YasinKabalci,"Asurveyonsmartmeteringandsmartgridcommunication",RenewableandSustainableEnergyReviews,vol.57,2016,pp.302-318.
24. https://www.engerati.com/transmission-and-distribution/article/communications-networks-technologies/5g-%E2%80%93-driver-next
25. A.Solanas,C.Patsakis,M.Contietal.,"Smarthealth:acontext-awarehealthparadigmwithinsmartcities,"IEEECommunicationsMagazine,vol.52,no.8,2014,pp.74-81.
26. https://www.beckershospitalreview.com/telehealth/global-telemedicin e-market-to-experience-16-5-annual-growth-rate-through-2023.html
27. H.Ashrafian, O.Clancy, V.Grover, A.Darzi, "The evolution of roboticsurgery:surgicalandanaestheticaspects",BritishJournalofAnaesthesia,vol.119,Supplement1,2017,pp.i72-i84.
28. Shweta Singh and Arun Kumar Tripathi, "A Comparative Study ofInternetProtocolsinMANET",InternationalConferenceonAdvancesin ComputerSciences(ICACDS-16),vol.721, pp.221-231.
29. LuigiAtzori,AlessandroFloris,RobertoGirau,MicheleNitti,Giovanni Pau, "Towards the implementation of the Social Internet ofVehicles", ComputerNetworks,vol.147,2018,pp.132-145.
30. J. Granjal, E. Monteiro, and J. S. Silva, "Security for the Internet ofThings:Asurveyofexistingprotocolsandopenresearchissues,"IEEECommun.Surveys Tuts.,vol.17,no.3,2015,pp.1294–1312.
31. Kun-chanLan,Chien-MingChou,Han-YiWang,"AnIncentive-BasedFrameworkforVehicle-BasedMobileSensing",ProcediaComputerScience,vol.10,2012,pp.1152-1157.
32. AgachaiSumalee,HungWaiHo,"Smarterandmoreconnected:Futureintelligent transportation system", IATSS Research, vol. 42, Issue 2,2018,pp.67-71.
33. H.M.Raafatetal.,"Fogintelligenceforreal-timeIoTsensordata analytics,"IEEEAccess,vol.5,2017,pp.24062–24069.
34. P.SethiandS.R.Sarangi,"InternetofThings:Architectures,protocols, and applications," J. Elect. Comput. Eng., vol. 2017, p. 25,2017,Art.no.9324035.