International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August, 2019

Role of 5G Networks: Issues, Challenges and Applications

Arun Kumar Tripathi, Akash Rajak, Ajay Kumar Shrivastava

Abstract*: Due to revolutionary development in electronic and communication, mobile and handheld devices become the part of our daily life. As a result, volume of data traffic on Internet is increasing day by day. To provide unlimited, uninterrupted and content-rich services to these devices, the 5th Generation (5G) of network technology is emerged. 5G network can provide better Quality of Service (QoS) along with higher data rates than 4G network and have least latency. The paper appraisals various generations of wireless networks. Furthermore, it explores various challenges in implementation of 5G network and application areas of 5G network.

Keywords: **Latency, Internet of Things, Device-to-device communication, Smart Health, Smart farming.**

I. INTRODUCTION

To provide ubiquitous services to mobile devices the cellular system was came into existence. Now a-days, Industry and academia both are trying to develop better alternatives to provide high-speed bandwidth and real-time services to mobile devices. 5G enables next generation wireless network is able to provide better End-to-End (E2E) connectivity in on-demand fashion.

Analysis by Computer Information System Company (CISCO) state that mobile data traffic may increase up-to 4.8 Zettabyte (ZB) [1] per year by 2022, or 396 Exabytes (EB)/ month, while it was only 1.5 ZB/year or 122 EB/month in 2017. In another analysis by CISCO, it is projected that in 2020, approximately 50 billion smart deceives will be linked to Internet. Figure 1 shows growth of Internet of Things (IoT) enabled devices on Internet.

In the last decade, IoT has reformed the pervasive computing due to numerous application area such as smart city, smart agricultural, smart health etc. IoT paradigm encompasses a group of smart devices and sensor nodes. Sensor nodes monitors the predefined parameters and shares via Internet. In an analysis, it is found that billions of devices with on average six to seven devices per person by year 2020 [2]. In 2022, more than one trillion sensor nodes will be attached to the Internet. It is also expected that in next twenty years approximately forty-five trillion devices will be attach to the Internet. To provide uninterrupted services to these mobile devices is compelling to search alternative of 4G. It is an assumption that, a new generation of cellular is propose approximately in every Ten years. The last generation of cellular network, i.e. 4G network was introduce in 2011 and it is expected that 5G [3] network may standardize and deployed in 2020.

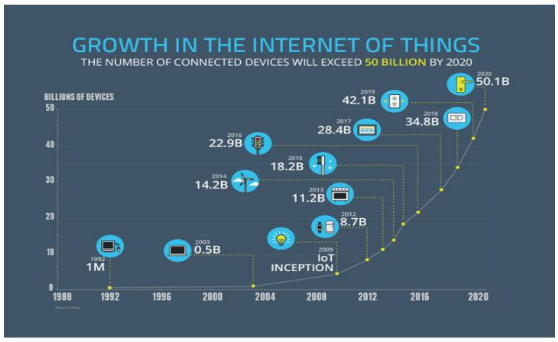

Fig. 1. Growth of IoT enabled devices on Internet

The scope of the 5G is not limited to the radio technology; it can also provide services to fixed host communication, cloud infrastructure, etc. The extension services of 5G mobile network improves the ecosystem of the telecommunication network and provide services to healthcare industry, agriculture industry, smart city project in an energy efficient manner. 5G builds foundation of digitalization from personal communication to the interconnection of society. Digitalization builds incredible prospects for mobile communication but suffers from severe challenges towards mobile communication technologies.

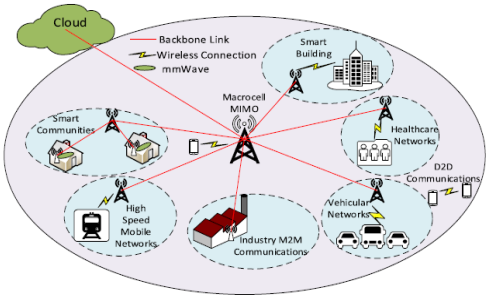

Fig. 2. Application area and technologies of 5G

To improve the performance innumerable technologies are applied to 5G systems, such as 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 Network (SDN) [8].

Revised Manuscript Received on October 30, 2019.
* Correspondence Author
Arun Kumar Tripathi*, Department of Computer Applications, KIET Group of Institutions, Ghaziabad, India.
Akash Rajak, Department of Computer Applications, KIET Group of Institutions, Ghaziabad, India.
Ajay Kumar Shrivastava Department of Computer Applications, KIET Group of Institutions, Ghaziabad, India.

Internet Engineering Task Force (IETF) has not standardized 5G. It is just at the very beginning stage. Figure 2 shows application area and technologies used in 5G.

The rest of paper is organized as follows: Section 2 deals with evolution of wireless generation and technologies. Section 3 explores issues and challenges in 5G network. Section 4 deals with application areas for 5G networks. At last, the paper is concluded in section 5.

II. EVOLUTION OF WIRELESS TECHNOLOGIES

In this section, a brief discussion about various wireless generations [9], [10] are discussed.

A. First Generation Networks (1G)

First Generation (1G) of wireless networks was standardized in initial 1981 for voice communication. It was able to handle data transfer speed up-to 2.4kbps. The most popular 1G-access technologies were Advanced Mobile Phone System (AMPS), Nordic Mobile Phone System (NMTS), Total Access Communication System (TACS) etc. Analog signals were responsible to carry out voice in 1G. It suffers from various issues such as low graded signal quality, low capacity, less secure and unreliable handoff.

B. Second Generation Networks (2G)

Second Generation (2G) of wireless networks was standardized in 1990. It was primarily used for voice communication and able to handle data transfer speed up-to 64kbps. It was also able to data communication with limited speed. The most popular 2G-access technologies were Global Systems for Mobile communications (GSM), Code Division Multiple Access (CDMA) and IS-95. 2G technology was also able to send text messages, picture messages, and MMS Multimedia Messaging Services (MMS). It is also able to provide secure point-to-point communication i.e. only intended receiver could receive and read the message. 2G was suffering from some of the critical issues such as low data rate, limited capacity of cells, higher handover latency, limited mobility etc. also the 2G enabled phones have limited facilities.

C. Extension to Second Generation Networks (2.5G)

It was an extension of second-generation wireless systems. It introduces packet-based switching technique known as General Packet Radio Services (GPRS). Furthermore, it is able to provide better communication by use of packet switching and circuit switching techniques along with services provided by 2G. It is able to handle data transfer speed up to 144kbps. The most popular 2.5G-access technologies were GPRS, Code Division Multiple Access-2000 (CDMA2000) and Enhanced Data Rate for GSM Evolution (EDGE).

D. Third Generation Networks (3G)

Third Generation (3G) of wireless networks was standardized in 2000. The basic objective to design 2G was voice communication and high-speed data transfer up to 2Mbps. The most popular 3G-access technologies were Wideband Code Division Multiple Access (WCDMA), CDMA2000 and Universal Mobile Telecommunications Systems (UMTS) technologies. To utilize benefit of 3G smartphone based specific applications were developed to handle video calling, online games, email service, social media services such as Facebook and Orkut etc.

E. Extension to Third Generation Networks (3.5G)

It was an extension of 3G wireless networks and standardized in 2008. It was primarily designed to improve data rate of present 3G networks and able to handle data transfer speed up to 3.6Mbps. The most popular 3G-access technologies were HSDPA (High Speed Downlink Packet Access) and HSUPA (High Speed Uplink Packet Access). 3.75G system was proposed as an improved version of 3G network. The technology used in it was, High Speed Packet Access Plus (HSPA+). The technology used in it was known as Long-Term Evolution technology (LTE) and Fixed Worldwide Interoperability for Microwave Access (WIMAX). These technologies are able to provide high-speed services such as on demand videos, composite web services, social media services etc. to multiple users simultaneously. Although 3G technology brings a radical change in the field of communication but suffers from expensive implementation, compatibly issue with 2G systems, heavy radiation of magnetic waves affects our brains etc.

F. Fourth Generation Networks (4G)

Fourth Generation (4G) of wireless networks was standardized in 2010. 4G has designed to handle data transfer speed up to 300Mbps along with Quality of Service (QoS). In 4G, the use can watch online High Definition (HD) video and can play online games. The most popular 4G-access technologies are Voice over LTE network VoLTE (use IP packets for voice). 3G Partnership Project (3GPP) is presently standardizing Long Term Evolution (LTE). It reduces latency for critical applications and provides secure mobility. It also supports IoT enabled devices to interact in an efficient manner. Like 3G, 4G also costlier in terms of hardware and implementation. For communication, it requires high-end multifunctional devices, which should be compatible with 4G technology.

3G and 4G systems mainly focuses delivery of contents to mobile devices rather than efficient delivery. 5G of wireless network is able to provide services to billions of devices with latency close to zero. It is expected that 5G will be standardized in 2020. 5G can handle data transfer speed up to 10Gbps along with QoS. Higher speed allows watching online Ultra High Definition (UHD) video and playing on line games

III. ISSUES AND CHALLENGES IN DEVELOPMENT OF 5G NETWORK

Challenges are the inherent part of the new development. The primary objective of 5G is to provide high-speed mobile broadband and better throughput along with ultra-low latency, high reliability and security in comparison to 3G or 4G networks.

A. High Data Rates and Increased Network Capacity along with Energy Optimization

5G has a complex infrastructure. Within a smaller geographical region, it requires a large number of Base Station (BS) to install. It will increase high data transfer rate and reduce the energy consumption, although it will increase the cost of network. To achieve high-speed, Cognitive Radio Networks (CRN) and Massive Multiple Input and Multiple Output (mMIMO) [11] architecture will be deployed. To increase the efficiency mMIMO uses a large number of antenna in comparison to communicating devices. The mMIMO uses frequency range 30-300 GHz and wavelength 1-10 mm.

B. High Data Rates, Network Capacity expansion with Energy Optimization Full Duplex Communication Channel

4G network uses half-duplex [6] communication i.e. there are two separate channels one for uploading and another for downloading. On the other hand, 5G is designed for full duplex communication i.e. it will access same channel for access and backhaul. Although it will increase link capacity, save the frequency spectrum and economically better, but practical implementation is very difficult due to interference. Therefore, it also requires a mechanism to cancel the impact of interference.

C. Environmentally Friendly

4G Radio Network (RN) is consuming approximately 70-80% of total power. This leads to emission of CO_2 in a large amount and creates a negative impact on environment. A various solutions are proposed in 5G for the same. It includes Cloud-Radio Network (CRN), Visual Light Communication (VLC), millimeter wave (mmWave) communication, D2D communication, Massive Multiple Input and Multiple Output (mMIMO) architectures to make 5G environmental friendly.

D. Low Latency and High Reliability

The roundtrip latency of 4G network is around 15 milliseconds (ms). It is assumed that 5G network will has extremely low latency and result in, will has lower packet loss and improve the reliability of network. To achieve this, efficient caching [12], mmWave, mMIMO architecture can be incorporated in 5G network

E. Network Performance Optimization

The 5G network will have extremely low latency. It will directly affect the quality of service, end-to-end delivery, ease of connectivity, reliability etc., To improve QoS [5], delay bound QoS, intelligent equipment and load balancing schemes are incorporated.

F. High Mobility and Handover

5G network will based on small cell network architecture rather than Base Station (BS) centric architecture or more precisely device center architecture. The cell may microcell or picocell. These cells are connected through ideal or non-ideal backhaul architecture [13]. Due to smaller cell, there will be high mobility and handover [14-17].

G. Security and Privacy for Network and Mobile Hosts

The traditional mobile communication networks focus on communication services to individual customers whereas 5G focus on individual as well as industry-oriented services. The mobile IoT devices have need of less security whereas high-speed mobile services require high security. The major security challenges in 5G networks are Denial of Service (DoS) attack, hijacking attacks, signaling 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 attack etc.

H. Data Volumes

The exponential growth in mobile users and IoT devices increases volume of data on Internet. 4G network may not be able handle such huge volume of data. 5G network is able to capable to handle large amount of data between end devices with the help of optimized architecture.

I. Device-to-device (D2D) Communication

D2D [18] communications is mostly outside from the territory of present cellular networks. These direct links directly communicate without involving base station in communication. The walkie-talkie is the example of this but for communication a narrow spectrum is available and hence a bandwidth is available to communicate. The 5G system enables multi-RAT (Radio Access Technologies) system for seamless communication. The D2D communication may be single hop or multi-hop. 5G allows D2D communication using LTE-Advanced, LTE Advanced Pro. Figure 3 shows a high-speed D2D communication model in 5G.

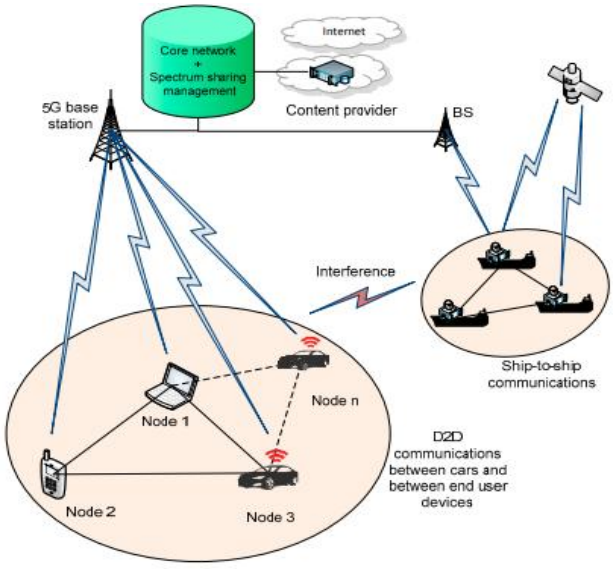

Fig. 3 D2D communication model in 5G

IV. APPLICATION AREA OF 5G NETWORKS

It is presumed that 5G will be up to 100 times faster than present cellular system with lowest latency and quality of services. The future application area may include:

A. Immersive Entertainment

As the number of users on Internet are increasing exponentially, it is difficult to provide live high definition videos to end users due to limited bandwidth capacity of 4G network and it is near to impossible to deliver ultra-high definition videos. 5G network be able to support the immersive entertainment [19] anywhere at any time due to low latency and big bandwidth offered by it. 5G is able to project live virtual reality streams of sports, adventures, real world images on smartphone or head mounted display (augmented reality). Figure 4, shows head mounted Immersive Entertainment device.

Fig. 4. Head mounted Immersive Entertainment device

B. Environmental Monitoring

Monitoring the changes in environment is one of the most critical challenge to the world. Living being suffer from sudden change in the climate due to unknown natural and environmental disasters, e.g., storm, flooding, drought, T-sunami etc. Sensor nodes [20] are fix at remote location to monitor the environment [21] and 5G network transmits the information immediately. By this, we can save life of living being. Recently, we have seen lost due to tsunami in Jakarta, Indonesia. Figure 5 shows measuring of environmental data with the help of sensor nodes.

Fig. 5. Measuring of Environmental Data

C. Smart Agriculture

Indian agricultural system is based traditional technique. Smart Agricultural [22] is a modern technique to monitor and automate the agricultural system to increase the quantity and quality of agricultural products. Smart agricultural system gathers real-time information about crop with the help of sensor nodes installed in the field. 5G is capable to share up-to-date information measured by sensor nodes. The information may be analyzed using Fog or Cloud computing and send to the specific user to whom it is valuable. The smart faming has number of application areas such as water management, injection of fertilizers, soil amendment, livestock safety and maturity monitoring, crop status, drilling, seeding and spraying, temperature, humidity, etc. In association with the Department of Telecommunications (DoT), Samsung had announced its plan of commencing the First large-scale 5G trials in the India Figure 6, shows smart agriculture system using 5G network

Fig. 6. Smart Agriculture System with 5G network

D. Smart Metering

In existing metering system, an analog or a digital electricity meters are mounted at consumer place. It measures the consumption of electricity based on power used by electric equipment. These meters can be tampered very easily even without a trace. It indirectly affects economy of country. Smart meter [23] is an advanced technique to measure the consumption of energy. It records the frequency and voltage in real time fashion and communicates the recorded information to the central system using wireless media. The information consists of timestamp, Unique ID (UID) of meter, current reading of meter, maximum power supplied by meter etc. Smart meter allows controlling and balancing of the load remotely i.e. increase or decrease the load on demand. 5G is capable enough to provide services smart metering system in real time fashion.

Fig. 7. Smart Metering System with 5G network

A study in 2016, for the European Commission estimated that in Europe, smart meters with 5G data capabilities could provide annual benefits of €6.47bn in 2025, rising to €7.37bn in 2030 [24]. Figure 7 shows smart metering system using 5G network.

E. Smart Health

The recent developments and advancement in field of medical technology significantly improves the living standard people and makes them healthier. Still healthcare services [25] in the rural area are worst due to unavailability of doctors, medical information, and medical services. As a result, healthcare is one of critical issue in both urban and remote areas. 5G, robotics and artificial intelligence are able to provide healthcare services to patients from anywhere. The patient health can monitored with the help of virtual visits i.e. tiny sensor nodes may implanted or attached to wearable cloths and these nodes are able to monitor vital parameters such as blood pressure, sugar level, heartbeat, anxiety etc. on real time basis and sends the information to the hospitals and relatives on real time basis. These records will be available to physicians and medical professionals anytime and anywhere for investigation. 5G will not only cost efficient but also provide convenience and better and timelier medical outcomes. 5G can transmit large imaging files in efficiently. According to a research, it is estimated that telemedicine market may increase at compound annual growth-rate of 16.5% from 2017 to 2023 [26]. Telemedicine requires a high-speed data transmission network that may send real-time high-quality video wirelessly. 5G enables a high-speed connectivity among a series of connected sensor nodes, cloud-based storage and services. 5G will allow cloud-based storage of electronic medical records of individual patient. 5G system will allow continuous monitoring, predictive analytics, remote diagnosis and imaging, efficient management of these records, which may have medical images and video. Figure 8, shows smart health system using 5G network.

Fig. 8. Smart Health System with 5G network

F. Remote Object Manipulation

Remote object manipulation science [27] is in its childhood. It allows performing some actions / operation by an object at remote location. A non-living object such as robot performs the operation. This may include surgery, diffusion of bomb/mines, etc. According to the report, approximately 48% of patients are ready to accept remote robotic surgery, whereas 61% people believe that robotic surgery is very risky as it depends on Internet services. 5G network is capable to provide ubiquitous network for remote services. Healthcare industry, IoT industry and Military are main focusing area of 5G networks.

G. Internet of Vehicles (IoV)

Vehicular Ad-hoc Network (VANET) is a sub-class of Mobile Ad-hoc Network (MANET) [28] and Internet of Vehicles [29]. In VANET, the vehicles communicate with another vehicles, acknowledged as Vehicle-to-Vehicle (V2V) communication or fixed infrastructure Road Side Units (RSUs), acknowledged as Vehicle-to-Infrastructure (V2I) communication, continually to gather information about road conditions, traffic, congestions etc. A large number of vehicles are moving on the road and exchange up-to-date information the communication delay must be least. 5G is capable to exchange real-time information among vehicles connected through Internet. 5G is capable enough to provide services to Intelligent Transportation System (ITS) Figure 9, shows ITS enabled vehicles connected through Internet via 5G network.

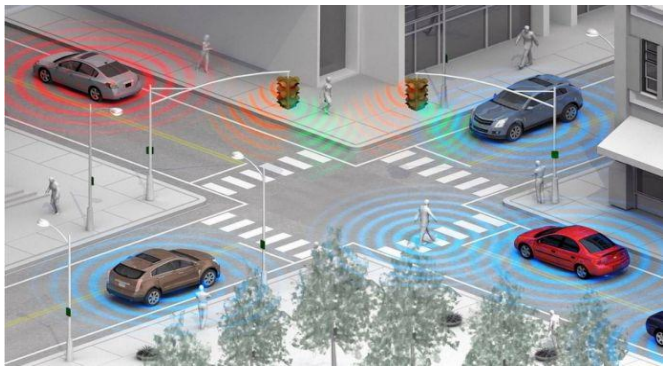

Fig. 9. Vehicles connected through Internet via 5G network

H. Smart Wearables

5G makes life easier for these gadgets, doing away with any requirement of top-end, overtly costly processors. 5G will lend them the required computing power and therein, the superfast speed and reliable connectivity that they need to do justice to the user. The combination of 5G and wearables [30] are expected to be so powerful that it will make the smartphone revolution seem like a miniscule advancement. In a technical report, it is found that wearable and artificial intelligence devices improve the performance of healthcare sector by monitoring various vital parameters related to health of human. Figure 10, shows smart wearable wristwatch with 5G network.

Fig. 10. Smart Wearable wristwatch through 5G network

I. Mobile Video Surveillance

Security is one of critical issue of smart cities. The security can by managed by mobile video surveillance [31].

It may be part of trains, metros, buses, taxis, transport vehicles, police cars, drones etc. 5G is able to provide real time update each movement of above.

J. Smart Transportation

Traffic congestion is one of major challenge to society now days. It indirectly affects the productivity of industries, creates environmental pollution and degrades the quality of life in society. 5G technology is able to collect huge amount of data real-time information from vehicles, drivers, road sensors and cameras installed at road side. It will help to manage traffic flow [32]. For example, it can manage the traffic signals light according to density of traffic and road usage and limit traffic to enter in congestion zone. Figure 11, shows an example of public transportation system connected through 5G network

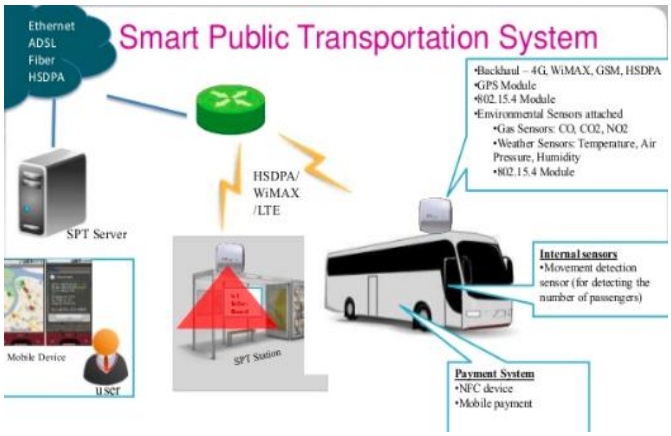

Fig. 11. Smart Transportation system connected through 5G

K. Smart Home

A smart home is a house in which most of the home appliance such as light, refrigerator, televisions, air conditioners, security system etc. are monitored and controlled through Internet a node in general a smartphone connected Internet.

Fig. 12. Smart Homes connected through 5G network

These appliances are equipped with IoT sensor nodes [33-34] and controlled using Low-Power Wireless Personal Area Networks (LoWPAN) mobile communication protocol. Figure 12, shows an example of smart home connected through 5G network.

V. CONCLUSION

Rapid development in IT and electronic industries focus on development of hand handled and tiny sensor devices. These sensor nodes especially IoT enabled devices form a network. A high-speed data network is required for communication among these devices. 4G is unable to meet the demand of bandwidth and latency. As a result, industries and researchers presented 5G as an alternative of 4G. 5G network are capable to meet industry requirements. Initially the paper briefly introduced various wireless generation. Furthermore, the paper various issues and challenges in implementation of 5G networks and its solutions are discussed. IoT devices have a numerous application areas. Hence, later on, paper explores the various application areas of 5G network.

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, Lorenza Giupponi, “From 4G to 5G: Self-organized network management meets machine learning”, Computer Communications, vol. 129, 2018, pp. 248–268.
4. G. Bacci, E. V. Belmega, P. Mertikopoulos, and L. Sanguinetti, “Energyaware competitive power allocation in heterogeneous networks 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 for MIMO-OFDM systems serving random sources with statistical QoS requirement,” IEEE Trans. Commun., vol. 63, no. 11, 2015, pp. 4125-4141.
6. Inhyok Cha, Yogendra Shah, Andreas U. Schmidt, Andreas Leicher, and Michael Victor (Mike) Meyerstein, “Trust in M2M Communication,” IEEE Vehicular Tech. Mag., vol. 4, no. 3, 2009, pp. 69-75.
7. M. N. Tehrani, M. Uysal, and H. Yanikomeroglu, “ Device-to-device communication in 5G cellular networks: Challenges, solutions, and future directions”, IEEE Communication Mag. , vol. 52, no. 5, 2014, pp. 86–92.
8. Jeffrey G. Andrews, Stefano Buzzi, Wan Choi, Stephen V. Hanly, Angel Lozano, Anthony, C. K. Soong, and Jianzhong Charlie Zhang, “ What Will 5G Be?”, IEEE Journal on Selected Areas in Communications, vol. 32, no. 6, 2014, pp. 1065-1082.
9. T. Rappaport, Wireless Communications: Principles and Practice, Prentice-Hall, Englewood Cliffs, NJ, 1996.
10. Changyang She, Chenyang Yang, and Tony Q.S. Quek, "Radio Resource Management for Ultra-reliable and Low-latency Communications," 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 of Energy-Efficient Techniques for 5G Networks and Challenges Ahead," IEEE JSAC, vol. 34, no. 4, 2016, pp. 697-709.
12. D. Liu and C. Yang, “Energy efficiency of downlink networks with caching 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 resource allocation in multi-cell OFDMA systems with limited backhaul capacity,” IEEE Trans. Wireless Commun., vol. 11, no. 10, 2012, pp. 3618–3631.

14. Arun Kumar Tripathi, R. Radhakrishnan and J. S. Lather, "Secure and Optimized Authentication Scheme in Proxy Mobile IPv6 (SOAS-PMIPv6) to reduce Handover Latency", International Journal of Computer Network and Information Security, vol. 9, issue 10, 2017, pp. 1-12.
15. Arun Kumar Tripathi and Surendra Kumar Tripathi, "A Qualitative Analysis of Secured Handover Management Schemes for Mobile IPv6 enabled Networks", International Conference on Innovative Applications of Computational Intelligence on Power, Energy and Controls with their impact on Humanity (CIPECH-18), 2018, pp. 1-8.
16. Shweta Singh and Arun Kumar Tripathi, "A Comparative Study of Internet Protocols in MANET", International Conference on Advances in Computer Sciences (ICACDS-16), Ghaziabad-India, vol. 721, 2016, pp: 221-231.
17. Arun Kumar Tripathi and Shweta Singh, "A Comparative Analysis on Internet Protocols in Cloud-Mobile Environment", International Journal of Control Theory and Applications (IJCTA), vol. 9, issue 17, 2016, pp. 9161-9169.
18. Pimmy Gandotra, Rakesh Kumar Jha and SanjeevJain, " A survey on device-to-device (D2D) communication: Architecture and security issues, Journal of Network and Computer Applications, vol. 78, 2017, pp. 9-29.
19. Muhanna A.Muhanna, "Virtual reality and the CAVE: Taxonomy, interaction challenges and research directions", Journal of King Saud University, Computer and Information Sciences, vol. 27, Issue 3, 2015, pp. 344-361.
20. Arun Kumar Tripathi and Ajay Agarwal, "An Approach towards Time Synchronization Based Secure Protocol for Wireless Sensor Network", International Conference on Networked Digital Technologies (NDT-2010), vol. 88, issue 2, 2010, pp. 321-332.
21. Muhammad Saqib Jamil, Muhammad Atif Jamil, Anam Mazhar, Ahsan Ikram, Abdullah Ahmed, Usman Munawar, "Smart Environment Monitoring System by Employing Wireless Sensor Networks on Vehicles for Pollution Free Smart Cities", Procedia Engineering, vol. 107, 2015, pp. 480-484.
22. GustavoSain, Ana María Loboguerrero, Caitlin Corner-Dolloff, Miguel Lizarazo, Andreea Nowak, Deissy Martínez-Barón, Nadine Andrieu, "Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala", Agricultural Systems, vol. 151, 2017, pp. 163-173.
23. YasinKabalci, "A survey on smart metering and smart grid communication", Renewable and Sustainable Energy Reviews, 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. Conti et al., "Smart health: a context-aware health paradigm within smart cities," IEEE Communications Magazine, vol. 52, no. 8, 2014, pp. 74-81.
26. https://www.beckershospitalreview.com/telehealth/global-telemedicine-market-to-experience-16-5-annual-growth-rate-through-2023.html
27. H.Ashrafian, O.Clancy, V.Grover, A.Darzi, "The evolution of robotic surgery: surgical and anaesthetic aspects", British Journal of Anaesthesia, vol. 119, Supplement 1, 2017, pp. i72-i84.
28. Shweta Singh and Arun Kumar Tripathi, "A Comparative Study of Internet Protocols in MANET", International Conference on Advances in Computer Sciences (ICACDS-16), vol. 721, pp. 221-231.
29. Luigi Atzori, Alessandro Floris, Roberto Girau, Michele Nitti, Giovanni Pau, "Towards the implementation of the Social Internet of Vehicles", Computer Networks, vol. 147, 2018, pp. 132-145.
30. J. Granjal, E. Monteiro, and J. S. Silva, "Security for the Internet of Things: A survey of existing protocols and open research issues," IEEE Commun. Surveys Tuts., vol. 17, no. 3, 2015, pp. 1294–1312.
31. Kun-chan Lan, Chien-Ming Chou, Han-YiWang, " An Incentive-Based Framework for Vehicle-Based Mobile Sensing", Procedia Computer Science, vol. 10, 2012, pp. 1152-1157.
32. Agachai Sumalee, Hung Wai Ho, "Smarter and more connected: Future intelligent transportation system", IATSS Research, vol. 42, Issue 2, 2018, pp. 67-71.
33. H. M. Raafat et al., "Fog intelligence for real-time IoT sensor data analytics," IEEE Access, vol. 5, 2017, pp. 24062–24069.
34. P. Sethi and S. R. Sarangi, "Internet of Things: Architectures, protocols, and applications," J. Elect. Comput. Eng., vol. 2017, p. 25, 2017, Art. no. 9324035.

AUTHORS PROFILE

Arun Kumar Tripathi received the B.Sc. (Electronics) degree from Dr. Hari Gour University Sagar and M. Tech. from Dr. APJ Abdul Kalam Technical University, Lucknow in Computer Science and Engineering and completed Ph.D. from National Institute of Technology, Kurukshetra in the field of security in PMIPv6. He has joined KIET Group of Institution, Ghaziabad in 2003 and presently working as Associate Professor. His area of interest is Mobile and Wireless Communication. He has published 38 papers in various International/National conferences and Journals. He is also reviewer of 03 SCI-indexed journals.

Akash Rajak is working as Associate Professor in KIET Group of Institutions, Ghaziabad, India. He is having 17 years of teaching and research experience. He completed Ph.D in computer science from Barkatullah University, Bhopal in the field of temporal data mining. He did M.C.A from U.T.D Campus, Dr. H. S. Gour University, Sagar (M.P) in 2002. Dr. Rajak published various research papers in reputed journals and conferences. His research interest includes AI and Data mining.

Ajay K. Shrivastava is working as Professor in KIET Group of Institutions, Ghaziabad, India. He is having 16 years of teaching and research experience. He completed Ph.D in computer science from Dr. H. S. Gour University, Sagar in the field of Embedded Systems. He did M.C.A from U.T.D Campus, Dr. H. S. Gour University, Sagar (M.P) in 2002. He is a member of various professional societies like IEEE, ACEEE, IACSIT etc. He is a member of the editorial boards of International Journals and Reviewer of the various journals and conferences organized by ACEEE.