The Novel 5G Network Technology Deployment Considerations along Internet of Medical Things Program Support for Public Healthcare

Ugochukwu O. Matthew, Computer Science Department, Universidade Federal De Viçosa (UFV), Brazil, **matthew.ugochukwu@hafedpoly.edu.ng**

Jazuli S. Kazaure, Electrical Electronics Department, Hussaini Adamu Federal Polytechnic, Nigeria, **sakjazuli@gmail.com**

Nwamaka U. Okafor, School of Electrical and Electronic Engineering, University College Dublin, Republic of Ireland, **nwamaka.okafor@ucdconnect.ie**

Abstract- The research analysed the existing literature and made significant contribution in the perspective of the ongoing insinuations of electromagnetic radiation emitted from the novel 5G network technology installation. The electromagnetic spectrum (EMS) is the collection of frequencies of electromagnetic radiation (EMR) dispersed through the electromagnetic base station such as telecom mask. The ionizing radiation possesses an imposing quantum of electromagnetic energy to hit off electrons and ionize the electrically charged particles, while the non-ionizing radiation (NIR) does not acquire a sufficient amount of electromagnetic energy to ionize atoms or molecules. On the contrary , the research established that deploying Non-standalone 5G network along 4G network core on low , mid/high baseband does not emit radiation capable of destroying body cells. The novel 5G network technology was tested along SCENARIO 1, SCENARIO 2 and SCENARIO 3 to find out if 5G network does emit electromagnetic non-ionizing radiation capable of destroying body cells as already alleged .The paper discovered that deploying Non Standalone or Standalone 5G network on low, mid/high baseband does not produce dangerous effects on human health. The research finally submitted that deploying the Standalone 5G network on unmodulated ultra-high baseband (frequency >=20 GHz) produces non-ionisable, non-visible radiation regarded as wireless radiation capable of adverse health effect including heating up the human skin through polarization.

Keyword: :E-Healthcare , 5G Network Technology, Internet of Things , Internet of Medical Things, Electromagnetic Radiation , Wearable Body Sensor, Artificial Intelligence , Wireless Transmission

1. INTRODUCTION

The development in 5G network will superlatively be enhanced in Internet of Things (IoTs) technology, Internet of Medical Things (IoTMs), 5G Medical Robotic Innovations and Industrial service automations[2]. The global world will witness another computing paradigm characterized by 5G technology and IoTs enabled framework. The paradigm shift in the novel 5G network technology and IoTs will either make the global world or destroy the global world completely, the two things, one is bound to occur. The ionizing and non-ionizing electromagnetic rays emitted by the radio frequency electromagnetic field (RF-EMF) possessed several distinct energy level. As much as necessary concerns have been raised about 5G that some cities have cancelled or delayed the installation of the base stations on the premise of the electromagnetic energy emission[3]. To that effect, the members of the IEEE Future Networks Initiative that is assisting to consolidate 5G development and deployment, appropriated the reports and further issued a short paper titled "5G Communications Systems and Radiofrequency Exposure Limits". Above all, the report reviewed the current recommendations for RF-EMF exposure on the society wide space. Several concerns regarding 5G network considered negative influences on human health stem from its cell towers being uncommon architecture with respect to existing 4G and 3G cellular networks[4]. In the physical implementation, the 5G radio replacing a 4G radio at 750 MHz will have the same coverage as the 4G radio, assuming no modification to the implementable antenna. Although, several opponents insisted that 5G network must be proven safe before regulators should allow its deployments but logically, it is very impossible to prove anything with 100% certainty[5].

The novel 5G network technology presents several opportunities for the delivery of Healthcare in the current digital electronic society, characterized with the existence of IoTs[6]. The concept of Internet of Medical Things (IoMTs) had emerged as the key component of the IoTs innovation for Healthcare computing in the twenty first century digital extreme automation. The development in the enterprise 5G network infrastructures have necessitated billions of low bit rate and low-energy connected health monitoring devices, remote sensors and clinical wearables relying on the 5G backbone infrastructure and IoTs enterprise framework,[7]. The Doctors, Physicians and Healthcare service provider will essentially depend on the connected devices to collect , analyse and digitally transmit the patients' data among the parties that will effect decision making process. Under this situation, the data will be retrieved and processed in real time synchronism, permitting the Healthcare givers to cost-effectively examine all collected electronic information, derive insights and administer or adjust treatments,[8]. Moreover, the electronic synchronous data transmission will enable the clinicians, diagnostics, physicians and doctors authenticate the accuracy of every diagnosis carried out which will enhance the effectiveness of treatments performed on the patients,[9]. The 5G network infrastructures and Internet of Medical Things will grow in quantum for assisting patients who often does not like or is limited to bodily consultations with the Healthcare provider on a frequent schedules. The limiting considerations may arise from the cost of the consultations, time of the consultations, stigma, immobility and geographical location. The Healthcare giver can intelligently examine, consider, scrutinize and analyse the medical history of a patient and offer exceedingly customizable, individualized and personalized treatment package for the patient via a virtual environment,[10]. The 5G network infrastructures will enable the doctors to obtain updates on the patient's medical situation in real time and deliver helpful healthcare services remotely. The swift coming of 5G network technology contained opportunities and potentials to revolutionize Healthcare delivery, advancing speed and capacity while reducing latency,[11].

However, the 5G network technology adoption in electronic Healthcare computing is at infancy, the essentiality of the new network has superlative potential to the twenty first century E-Healthcare service delivery and Health Grid Computing. Several opportunities abound for transmitting large

medical images, expediting Tele-Health options and sustaining remote patient monitoring efficiency. Moreover, empowering further complex utilization of artificial intelligence (AI) and augmented virtual reality environment (AVRE) also enhances the suitability of electronic Healthcare adoption. The 5G network utilization will accelerate speedy transfers and communication on mobile devices use for e-Healthcare, [12]. While the 5G network technology projects key infrastructure that energizes smart devices and resolves around the core to the edge and creating secure, smarter data streams and enabling greater personalization,[13]. The Healthcare industries should comprehend the evolution of 5G network innovative landscape and related challenges before massive adoption. The Healthcare organizations are currently intensifying investment in Tele-Healthcare, offering high-quality video augmented reality (AR), the 5G technology will benefit patients and Healthcare providers realize quicker and efficient connection,[14]. The 5G network technology is deigned to advantage the growing network of Internet of Medical Things devices and several other enterprise-able Wearable Sensors available for remote patient monitoring,[15], allowing Clinicians, doctors , physicians keep in touch with very important signs, medication schedules and other data from the remote to personalize care. The business requirements for 5G network technology will permit several consistent connections to expedite data transfer option for Healthcare workers to quickly arrive at the decision for remotely located patients. To that effect, 5G network technology will be exceptionally significant in transferring arrays of images and that could pave ways for optical imaging tools like X-rays, Magnetic Resonance Imagings (MRIs) to be managed wirelessly. By extension, 5G network technology will be instrumental in championing emerging augmented and virtual reality tools for training and response feed loop in complex medical circumstances,[16]. Enthusiasm exist for 5G's network technology potentials to power Robotic Surgery tools that will eliminate proximity barrier and technical lag time between doctors and patients,[17].

The sudden escalation of COVID-19 pandemic exerted human bodily and human inventiveness, resourcefulness, imagination, creativity and skills beyond its limits leading to development of several 5G networked technology empowered robots to response to healthcare challenges,[18]. While the patients flood emergency departments in all the Hospitals, Rehabilitation centres and Healthcare facilities around the world, the Healthcare experts are struggling to respond to the escalating situations globally. The International Group on Robotic Experts have made advancements on some electronic Inventions and Techno-innovative Mobilization in response to COVID-19[2]. The experts in the field of Artificial Intelligence Robotics have argued that COVID-19 may perhaps drive new developments in Robotics Technologies which could pave way for more effective Diagnosis, Screening and Patient care. However , Healthcare Robotic Machines could take over hospital disinfection entirely, providing continuous sterilization of high-touch areas with Ultra-Violet(UV) light,[19]. The scientists believed that the activities of COVID-19 will catalyse Robotics Inventions for Public Healthcare adoption and digital society automation. As part of its effort to contain the spread of COVID-19 global pandemic, China used 5G Patrol Robots developed by Guangzhou Gosuncn Robot Co., Ltd using Advantech technology to monitor mask wearing and body temperatures in public places. In the wake of the outburst of COVID-19, providers of Smart City IoTs products and services Guangzhou Gosuncn Robot Co. upgraded its 5G-powered Police Patrol Robot with new capabilities to assist Front-Line Police officers in conducting Disease Prevention Inspections[2]. The manual measurement of body temperature exposes public safety personnel to potential Health Risks at this consequential time. The 5G Robots were equipped with high resolution cameras and infrared thermometers capable of scanning the temperature of 9 people simultaneously within a radius of 5 meters apart,[20].

2. RESEARCH FINDINGS

The contemporary Ericsson Consumer Lab report disclosed the end user and manufacturer's perceptiveness of the influence of 5G network technology on present and the upcoming Healthcare services and its revolution throughout anticipatory, routine and post-operative care considerations across economy sectors[1]. In this research, the 5G network technology and its Business Potential were analysed on the account that the 5G network infrastructure that accompanied the industrialized digitalization in eight essential world-wide modernism will provide justification upon which adoption of the 5G technology will anchor. In the healthcare service sector , the prediction of USD 76 billion returns on investment amount to opportunity in 2026 for operators addressing healthcare transformation with regards to 5G network technology ,[21]. To enable this transformation to occur, partnership, teamwork, collaboration and synergy between distinctive players are highly necessary. The Healthcare administrators across the innovative industrial sectors often prioritized telecom operators and placed them topmost when matters of partnerships are debated above App Developers and Pharmaceutical Companies. The technological revolution of the healthcare sector presents abundant opportunities for telecom operators to infiltrate the investment terrain and introduce businesses that favour the entire investment and business ecosystem. However, the Healthcare and Homecare are of the opinion that telecom operators may perhaps provide system integration together with the App and Service Development in conjunction with their responsibilities as network providers.

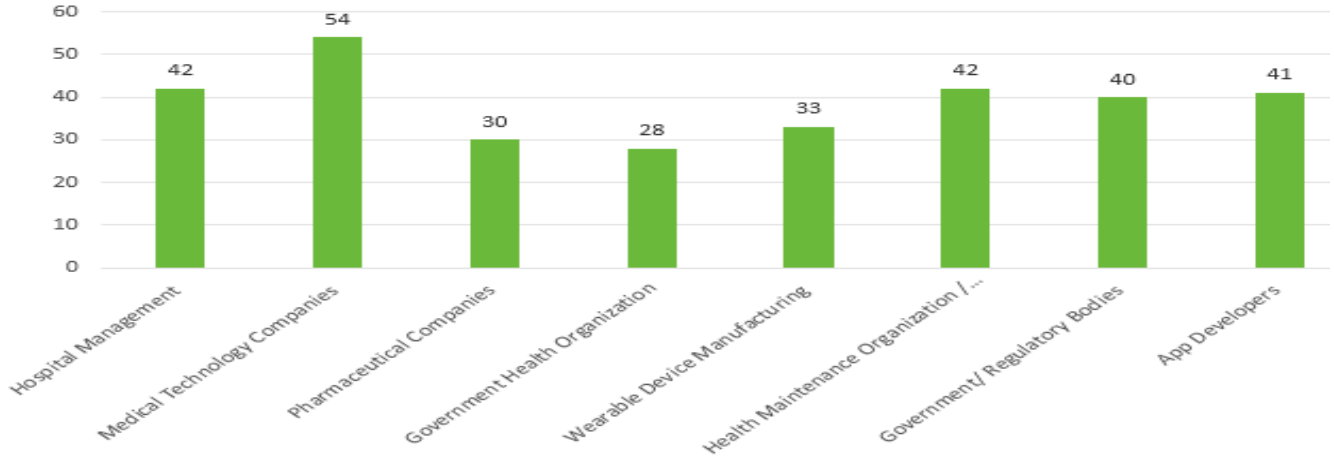


Figure 1: 5G Healthcare, Telecom Operators attractive partners in the Healthcare Ecosystem[1].

Table 1: 5G Healthcare, Telecom Operators & partners

INNOVATIVE SECTOR	UTILIZATION RATIO (%)
Hospital Management	42
Medical Technology Companies	54
Pharmaceutical Companies	30
Government Health Organization	28
Wearable Device Manufacturing	33
Health Maintenance Organizations (HMO) / Healthcare Insurance Companies	42
Government/ Regulatory Agencies	40
App Developers	41

The prioritization of the key sector and 5G network technology utilization is illustrated in Figure 1 and in table 1. At present, 42% of the 5G network technology utilization is focussed on Hospital management, 54% of the 5G network technology utilization is concentrated on Medical Technologies Companies , 30% of the 5G network technology utilization is focussed on Pharmaceutical Companies , 28% of the 5G network technology utilization is focussed on Government Health Organization , 33% of the 5G network technology investment is utilized on Wearable Device Manufacturing, 42% of the 5G network technology investment is utilized on Health Maintenance Organizations & Healthcare Insurance Companies, 40% of the 5G network technology investment is utilized on Government/Regulatory Agencies while 41% of the 5G network investment is utilized on Application Development.

3. DISCUSSION OF FINDINGS

This research recognized the 5G network technology potentials in healthcare industry, innovative sectors and mobile technology together with the effects of non-ionizing, non-visible radiation regarded as wireless radiation previously documented in several literature. This current paper observed that very significant laboratory experimentations performed to date with respect to 5G wireless transmission are not planned to identify the more severe effects on the real-life health issues and operating environment in which the radio network wireless radiation systems operate. Although, numerous experimentations do not conceive pulsing and modulation of the wireless radio carrier signals. Substantial number of researches do not explain some effects of toxic stimuli such as chemical and biological effects accompanying the ultra-high frequency wireless radiation/transmission. This current paper offered evidence that the novel 5G mobile network technology have capability to destroy body cells under certain unmodulated high broadband deployment. In the current research, the novel 5G network technology was tested and deployed under three scenarios (SCENARIO 1, SCENARIO 2 & SCENARIO 3). With respect to "**Scenario 1-The Non-standalone (NSA) 5G alongside 4G in similar mid/low bands"**. In this Scenario, both 4G and NSA 5G radios are deployed in similar mid/low-band frequencies which implies that both 4G and 5G network technology have very similar coverage areas. **Scenario 2 – The Non-standalone (NSA) 5G alongside 4G in low/mid bands and 5G in high bands**. In this Scenario, the 4G is deployed in low frequencies, whereas NSA 5G is deployed in high frequencies, which implies that 5G network cell coverage areas will be lesser compared to 4G, particularly for the uplink transmission. Several telecom operators will prefer to deploy 5G network in this manner to take advantage of substantial innovative capability and exceedingly high-ranking throughput that the broader spectrum in higher-frequency bands affords. The 5G network technology radios are still built upon 4G network technology framework and subsisting core and transport network assets are recycled.

Whenever a 5G network connection has been authenticated, the Client device will link up with both the 4G network to switch on the control signalling that will assist the 5G network to deliver the fast data connectivity even to the existing 4G network technology capability, making 5G network act in complement with the existing 4G network. **Scenario 3 – The Stand-alone (SA) 5G in low, mid or high bands.** In this scenario, SA 5G is implemented in an arrangement with low, mid and conceivably high bands. The 5G network radios will be implemented as standalone units with highly reliable connectivity to a core network accomplishing the newest 5G Core requirements which implies that development and performance will far exceed the NSA 5G network. It is expected that telecom operators will implement SA 5G network at the start in low bands as well as mid and possibly high bands in order to deliver superior coverage areas. The major argument is whether 5G network technology does affect human body cells? The answer is yes but the condition upon which such effects can occur is when SA 5G network is deployed on high bands (Frequencies above 20 GHz). The Ultra-High Frequency (UHF) electric fields affects the human cells in a similar manner other material made up of charged particles are induced. Whenever electric fields induced a conductible particles, they prompt transmission of electromagnetic charges on the body of the conductible material. This will permit electric charges to flow through the body to the ground (earth). Ultra-high frequency magnetic fields induced circulation of currents in the surrounding human body. The quantum of these electromagnetic charges is influenced by the magnitude of the external magnetic field. Magnetic fields warming is the major organic consequence of the electromagnetic fields of radiofrequency emitted from 5G network installation especially at a very high baseband frequencies. In microwave ovens for instance, the concept is utilized to warm up food at varied frequencies. From the current research, the levels of electromagnetic frequency fields to which individuals are naturally unmasked under 4G network and 5G network technology in SCENARIO 1, SCENARIO 2 and SCENARIO 3 are very

negligible to alter human body dipolar chemistry. The heating consequences of the radio electromagnetic waves from 5G network technology deployment has formed the fundamental basis for current research. On the several findings of the research, deploying 5G network technology under the ultra-high baseband above 20 GHz will produce effect similar to figure 2, heating up of the body tissues due to electromagnetic field inducement (polarization) since human body is dipolar in nature[2].

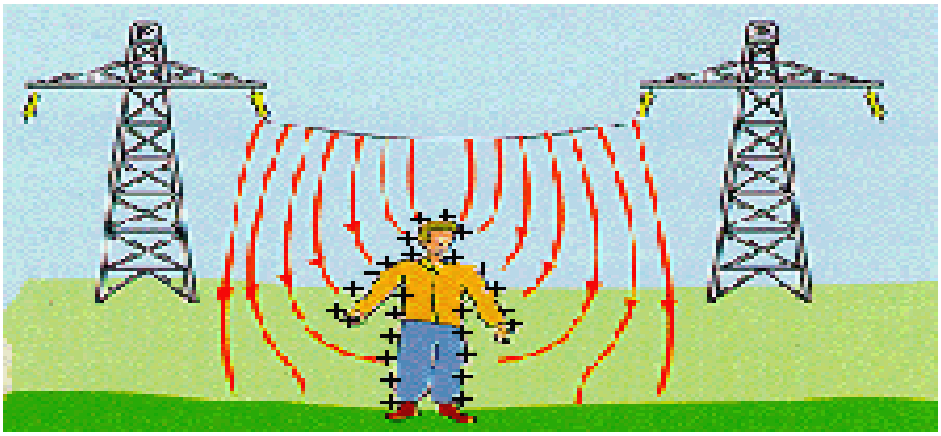


Figure 2: Health hazard of deploying 5G Network at Ultra High Frequency >=20GHZ

4. THE FUTURE RESEARCH FOCUS

The 5G network technology will make it possible for immediate connectivity to numerous devices, the Internet of Things and ubiquitous connected computing world. The 5G emerging technology will be responsible for speed, low latency and connectivity enhancement that will facilitate a new generation of applications, business ecosystem and improved healthcare assurance. The future research is expected to consolidate on the existing architectural framework for 5G network technology in the perspective of improved global investment network on the following agenda:

Consolidation of Scenario 1, Scenario 2 and Scenario 3: From the current research, technological investment around the aforementioned Scenario will improve the current high-tech digital society without considerable effect on human health.

Massive Machine to Machine (M2M) and Human to Machine (H2M) Interactions: The Internet of Things, Internet of Medical Things (IoMTs) and extreme automation requiring connecting several billions of devices with little or no human intermediation to the extent of incredible imagination. This will necessitate investment and business opportunity that will potentially revolutionise modern industrial extreme automation and applications including Healthcare, Transport and Logistics, Agriculture, Mining& Industry, Manufacturing and Business Communications.

Ultra-Reliable Low Latency Communications: The low latency attribute of 5G network technology will enable real-time control of devices, industrial and 5G medical robotics, vehicle to vehicle communications, healthcare internet of medical things computing, safety systems, self-governing driving and safer transport networks. Low latency communications availability will unlocks emerging modern world providing remote healthcare services, procedures, and treatment options.

Improved Mobile Broadband: The upcoming and emerging technologies which include healthcare computing, telemedicine, virtual reality environment (VRE) and augmented reality (AR) will be supported and accessible to the community of users. The Virtual Reality will support connected new world experiences in healthcare sector in such a manner that had not been seen before. The 5G network technology will drive the smart cities, smart homes and smart schools, offering seamless opportunities for digital society automation.

5. RECOMMENDATION

To concentrate on the novel 5G network technology applications, there exist several issues the current digital society have to bear in mind above the preliminary development. In pursuant to cope with superior data rates, the operating frequency should be enlarged to a millimetre range to accomplish a broader bandwidth. However, the newest development in the mobile network technology, the novel 5G network will transform the healthcare industry on a global scale in the like manner that Wireless Fidelity (Wi-Fi) performed. Fundamentally, the novel 5G network capability will empower further robust Internet of Medical Things and home healthcare. Consequently, the current digital society will pay attention on 5G network technology and why it is suited to focus on healthcare technology and hospital logistics requirements in a connected digital world for securing patients' electronic medical records. The novel 5G network, the fifth generation innovative invention of cellular wireless technology that possessed the capacity to advance substantial linking capability and high-speed broadband connectivity of healthcare sector and industrial extreme automation. The 5G network retained potentials to empower the Internet of Medical Things (IoMTs) connectivity that will permit medical innovations through advancement in augmented reality (AR), virtual reality (VR), artificial intelligence (AI), remote medical learning, remote patient monitoring and help to connect all sector to the digital smart grid society. Patients Diagnostics and clinical operations will potentially be quicker and time saving on the promise of the novel 5G network innovation. Transmissions and retrieval of sensor data, images files and other network dependent contents will be easier due to low latency attributed to the novel 5G network technology. It is an opportunity for the healthcare services and devices connectivity, wearable body sensors, smart grid digital society, industrial 5G robots and Internet of things to flourish for a sustainable digital ecosystem.

6. CONCLUSION

Despite the fact that Wireless Fidelity (Wi-Fi) and traditional 4G network technology had improved healthcare automation and current digital society had experienced considerably adjustment in electronic health technology, the novel 5G

network technology will superlatively alter the current digital society healthcare expectation in manner that had not be conceived before. Adjusting latency significantly lower will support a second real-time communication in sending a live High Definition video link to an Emergency Medical Technician and Ambulance services (EMT) being the nomenclature that denoted a health care services for emergency medical attention. The EMTs have to do with clinicians, coached to act in response to emergency health development on essential medical matters, traumatic injuries and accident occurrences in which patient data need to be transmitted to the doctors via electronic means, the novel 5G network will enable the healthcare services to achieve a milestone.

REFERENCE

[1] O. Vermesan and P. Friess, *Internet of things-from research and innovation to market deployment* vol. 29: River publishers Aalborg, 2014.

[2] U. O. Matthew and J. S. Kazaure, "Chemical polarization effects of electromagnetic field radiation from the novel 5G network deployment at ultra high frequency," *Health and Technology,* pp. 1-13, 2021.

[3] M. Agiwal, A. Roy, and N. Saxena, "Next generation 5G wireless networks: A comprehensive survey," *IEEE Communications Surveys & Tutorials,* vol. 18, pp. 1617-1655, 2016.

[4] A. Srivastava, M. S. Gupta, and G. Kaur, "Energy efficient transmission trends towards future green cognitive radio networks (5G): Progress, taxonomy and open challenges," *Journal of Network and Computer Applications,* p. 102760, 2020.

[5] G. Chikermane and X. Jinping, "5G Infrastructure, Huawei's Techno-Economic Advantages and India's National Security Concerns: An Analysis," *ORF Occasional Paper,* 2019.

[6] M. M. Dhanvijay and S. C. Patil, "Internet of Things: A survey of enabling technologies in healthcare and its applications," *Computer Networks,* vol. 153, pp. 113-131, 2019.

[7] A. Mavrogiorgou, A. Kiourtis, M. Touloupou, E. Kapassa, D. Kyriazis, and M. Themistocleous, "The road to the future of healthcare: Transmitting interoperable healthcare data through a 5G based communication platform," in *European, Mediterranean, and Middle Eastern Conference on Information Systems*, 2018, pp. 383-401.

[8] P. K. D. Pramanik, S. Pal, and M. Mukhopadhyay, "Healthcare big data: A comprehensive overview," in *Intelligent Systems for Healthcare Management and Delivery*, ed: IGI Global, 2019, pp. 72-100.

[9] M. Abo-Zahhad, S. M. Ahmed, and O. Elnahas, "A wireless emergency telemedicine system for patients monitoring and diagnosis," *International journal of telemedicine and applications,* vol. 2014, 2014.

[10] M. I. Pramanik, R. Y. Lau, H. Demirkan, and M. A. K. Azad, "Smart health: Big data enabled health paradigm within smart cities," *Expert Systems with Applications,* vol. 87, pp. 370-383, 2017.

[11] P. K. D. Pramanik, A. Nayyar, and G. Pareek, "WBAN: Driving e-healthcare Beyond Telemedicine to Remote Health Monitoring: Architecture and Protocols," in *Telemedicine Technologies*, ed: Elsevier, 2019, pp. 89-119.

[12] P. Porambage, J. Okwuibe, M. Liyanage, M. Ylianttila, and T. Taleb, "Survey on multi-access edge computing for internet of things realization," *IEEE Communications Surveys & Tutorials,* vol. 20, pp. 2961-2991, 2018.

[13] Q.-V. Pham, F. Fang, V. N. Ha, M. Le, Z. Ding, L. B. Le*, et al.*, "A survey of multi-access edge computing in 5G and beyond: Fundamentals, technology integration, and state-of-the-art," *arXiv preprint arXiv:1906.08452,* 2019.

[14] M. A. Imran, Y. A. Sambo, and Q. H. Abbasi, *Enabling 5G Communication Systems to Support Vertical Industries*: Wiley Online Library, 2019.

[15] M. A. Lema, A. Laya, T. Mahmoodi, M. Cuevas, J. Sachs, J. Markendahl*, et al.*, "Business case and technology analysis for 5G low latency applications," *IEEE Access,* vol. 5, pp. 5917-5935, 2017.

[16] E. R. Barclay, "The nature of networks: an aesthetic model for the connected condition," 2019.

[17] S. Latif, J. Qadir, S. Farooq, and M. A. Imran, "How 5g wireless (and concomitant technologies) will revolutionize healthcare?," *Future Internet,* vol. 9, p. 93, 2017.

[18] T. L. Inn, "Smart city technologies take on COVID-19," *World Health,* 2020.

[19] M. A. Stibich, J. B. Wolford, A. N. Garfield, M. Rathgeber, and E. M. Frydendall, "Mobile ultraviolet lamp apparatuses having a reflector system that redirects light to a high touch area of a room," ed: Google Patents, 2019.

[20] B. Rizk, C. D. d'Aubigny, D. Golish, C. Fellows, C. Merrill, P. Smith*, et al.*, "OCAMS: the OSIRIS-REx camera suite," *Space Science Reviews,* vol. 214, p. 26, 2018.

[21] E. T. DATE, "The road to 5G networks," 2019.

ABOUT THE AUTHORS



Ugochukwu O. Matthew, presently is an academic scholar with Hussaini Adamu Federal Polytechnic, Nigeria in the Department of Computer Science with specialty in Artificial Intelligence, Biotechnology Researches on the effects of electromagnetic radiation (EMR) , Big Data Science, Cloud Computing, Internet of Things, Data Mining, Multimedia and E-Learning Education. A Member of Nigeria Computer Society (NCS) , Nigeria Institute of Management (NIM), International Association of Computer Science & Information Technology (IACSIT), International Association of Engineers of Computer Society (IAENG-CS) , Association for Computing Machinery (ACM) and also a member of Teaching & Education Research Association (TERA). Ugochukwu O. Matthew hold Masters in Computer Applications from Bayero University Kano, Nigeria and currently on Federal Government of Nigeria Postgraduate Scholarship Programme at Computer Science Department, Universidade Federal De Viçosa (UFV) Brazil. Matthew had authored and co-authored several research papers published in the International Journals and Local Journals of high academic significance including globally circulated text books, practical manuals and monographs. A widely travelled scholar, Matthew had reviewed Journals and a member of Editorial Committee of Journals Indexed by Scopus and Web of Science with vast intellectual contributions in academics and among the Learned Societies.

Engr. Dr. Jazuli Sanusi Kazaure is an Electrical Engineer and IT Professional. He is a registered Engineer with Nigerian professional bodies. He is an expert on electrical circuit designs, a consultant who supervises electrical projects in Nigeria. Jazuli is a certified Network Cabling Specialist in copper and fiber optic based systems and a certified instructor in Integrated System Voice and Messaging certified by C-Tech Inc. at Sparta, New Jersey, USA. Jazuli attended Technical School and read electrical installation as a trade; he obtained National Diploma, Higher National Diploma, Post Graduate Diploma and Master's Degree all in electrical engineering. Jazuli was awarded with a Degree of Doctor of Philosophy in Management Information Technology specialized on ICT Management Frameworks. Dr. Jazuli is an academician teaching in Polytechnic and University in Nigeria as well other Universities in West Africa. He started his teaching carrier from the lowest rank of Assistant Lecturer to the highest rank of Chief lecturer in Hussaini Adamu Federal Polytechnic Kazaure. He was a visiting lecturer at Jigawa State Informatics Institute, a visiting Senior Lecturer with Sule Lamido University Jigawa State University, a visiting Senior Lecturer with Maryam Abacha American University in Niger Republic, an External Examiner National Open University and Digital Bridge Institute of Nigeria. Dr. Jazuli held many academic positions in Hussaini Adamu Federal Polytechnic, among others are Head of Electrical Engineering Department, Director Center for Information Technology, Director College of Engineering, Deputy Dean Student Affairs and currently Director Academic Planning and Research Development. Dr. Jazuli published 20 journal articles, presented 20 conference papers and coauthored in 23 books. He supervised many National Diploma, Higher National Diploma and Degree projects as well Master's thesis. Dr. Jazuli is happily married with children.



Dr. Nwamaka U. Okafor is a lecturer in the Department of Computer Science, Federal Polytechnic Nekede, Owerri. She holds an MSc. in Computer Forensics and Cyber Security (Distinction) from University of Greenwich, London, United Kingdom. Her research interests span areas such as Internet of Things (IoTs), Artificial Intelligence (AI), Machine Learning, Data Analytics and Security. She is currently undertaking a PhD in the School of Electrical and Electronic Engineering, University College Dublin. Her research is supported by Schlumberger and TETFUND- Nigeria and is focused on the application of IoTs and AI in ecological sensing. She works under the supervision of Prof. Declan Delaney on the EPA funded SmartBog research project on Irish peatlands where she develops and deploys cost-effective IoT systems and AI solutions to corroborate remote and satellite-based surveillance. Nwamaka is a mentor and Judge in Technovation Girls, a member of the Elsevier's Advisory Panel and a member of the organizing committee for the Black in AI workshops. She is a recipient of several awards including the Schlumberger Faculty for the Future Fellowship Award, Google Women Techmaker, ACM Student Research Competition Award, Young Researcher, Heidelberg Laureate Forum and so on. She is a member of several academic bodies including International Association of Computer Science and Information Technology (IACSIT),Association for Computing Machinery (ACM), Nigeria Computer Society (NCS) and British Computer Society (BCS). She is happily married and blessed with children.

