5G TECHNOLOGY: AN ASSESSMENT OF THE OPPORTUNITIES AND CHALLENGES IN AN EMERGING NIGERIAN SOCIETY

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ABSTRACT

No country wants to be left behind in the tech war as there may be far-reaching consequences in military, health, and well-being, industrial applications, technology, banking, financial services, urbanization, and other facets of private and national life. For an emergent country like Nigeria, the cost of being left behind is enormous and may mean the continuous peril of underdevelopment wrought by over-dependence on other nations for essential services. This paper provides perspectives on sectors where the deployment of the 5G telecommunication network could be a swift driver of an emergent Nigeria. It also highlights the particular challenges facing the deployment of the 5G technology in Nigeria. The study adopted the use of secondary sources to obtain relevant preexisting data to facilitate the research objectives. Restrictions in movement necessitated this approach to curtail the spread of the Coronavirus. The research findings revealed the enormous multi-sectorial benefits of deploying the 5G technology in an emergent Nigeria and the inherent challenges. It is envisaged that the ideas highlighted in the study findings would provide useful guidance for policy directors in the quest for a better emergent Nigeria.

KEYWORDS

5G Technology, Nigeria, IoT, Opportunities, Challenges

1. INTRODUCTION

Ever since human civilization came into existence, we had a principal need to communicate in our society. At present, we have the mobile as the latest communication system. Communication and wireless technologies have had rapid and significant growth over the last 4 decades due to numerous advantages not only in Economic Sectors but also in many other sectors. This need created interest in E&TC engineers to develop an efficient mobile communication system keeping in mind four parameters: speed, bandwidth, latency & Reliability.

In the 1980s, the First-Generation Mobile Networks (1G) were introduced. The 1G signaling systems were designed based on analog system transmissions. Some of the most popular standards set up for the 1G system were Advanced Mobile Phone System (AMPS), Total Access Communication Systems (TACS), and Nordic Mobile Telephone (NMT). The major disadvantages of 1st generation wireless systems are poor voice quality, poor battery quality, and large phone size. In the early 1990s, the Second-Generation Mobile Networks (2G) based on Global System for Mobile Communications (GSM) was launched. 2G is the starting point toward wireless digital communication. The main concern of the new system was covering the problems with the security weakness of analog communication systems. Another novelty in designing GSM was using digital modulation to improve voice quality but the network offers limited data

service. The 2G carriers also began to offer additional services, such as paging, faxes, text messages, and voicemail. An intermediary phase, 2.5G was introduced in the late 1990s. It uses the General Packet Radio Services (GPRS) standard, which delivers packet switched data capabilities to existing GSM networks. It allows users to send graphics-rich data as packets. The importance of packet-switching increased with the rise of the Internet and the Internet Protocol (IP). The Third Generation Mobile Systems (3G) is proposed in the 2000s to provide high-speed Internet access to allow mobile phone customers to use video and audio applications. One of the main objectives of designing the 3G system was to standardize on a single global network protocol instead of the different standards adopted previously in Europe, the U.S., and other regions. 3G phone speeds deliver up to 2 Mpbs, but only under the best conditions and in stationary mode. Moving at a high speed can drop 3G bandwidth to a mere 145 Kbps [1]. The Fourth Generation Mobile System (4G) offered in the 2010s promised for providing transmission rates up to 20 Mbps. The concept of Quality of Service (QoS) got more attention in the 4G system. It is promised to accommodate QoS features in the 4G system. QoS will allow telephone carriers to prioritize traffic according to the type of application using bandwidth and adjust between different telephone needs at a moment's notice. High-quality video and audio streaming over end-to-end Internet Protocol are the most attractive of 4G. There are two important standards in 4G technologies; Worldwide Interoperability for Microwave Access (WiMax) and Long-Term Evolution (LTE). 4G is currently used in many countries all over the world [2]. There are two primary limitations to the performance of the 4G mobile communication systems: time and location. The new 5G technology, with 28 and 38 GHz mm-wave frequencies, addresses these limitations [3].

Figure 1 shows a trend in cell phones and their development in the future. The journey is continuing to the Fifth Generation Mobile System (5G) to achieve the huge promises made by 5G in terms of high data rates up to 10 Gbits/s, lower latency times compared to LTE (1ms), signaling efficiency, spectral efficiency and network coverage improvement, and greater network coverage density which includes the massive number of wireless sensor network devices, low power consumption and much more. It is a big step forwards on this road and no one knows if this step makes the human achieve the peak of wireless communications or still there is a long way ahead. Table 1 shows the technologies and bandwidths for 2G, 3G, 4G, and 5G networks respectively.

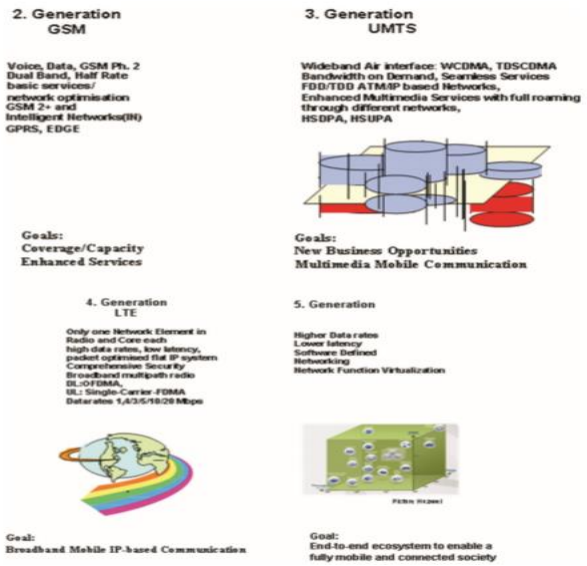

Figure 1. Digital mobile networks evolution towards 5th Generation [4]

Table 1. Technologies and bandwidth for 2G, 3G, 4G, and 5Gtechnologies

Generation	Year	Standard	Technology	Bandwidth	Data-rates
2G	1991	GSM, GPRS, EDGE	Digital	Narrowband	<80-100Kbits/s
3G	2001	UMTS, HSPA	Digital	Broadband	<2Mbit/s
4G	2010	LTE, LTE advanced	Digital	Mobile broadband	xDSL like experience 1hr HD mobile in 6 minutes
5G	25-2030	-	Digital	Ubiquitous connectivity	Fiber-like experience 1hr HD mobile in 6 minutes

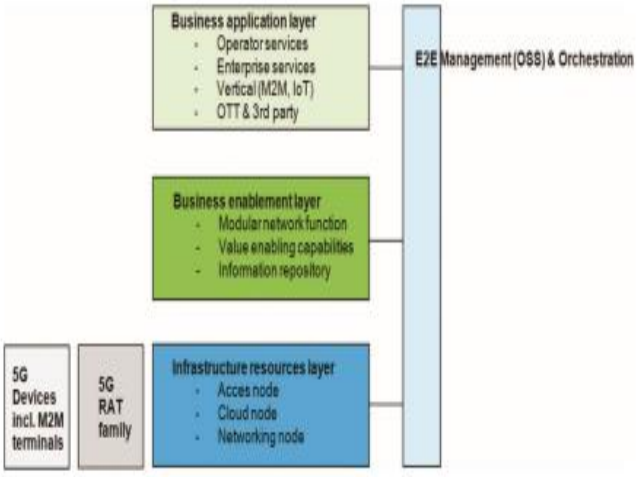

Figure 2. 5G architecture envisioned by [4].

5G networks will operate on a range of radio spectrum bands. In addition to the traditional sub-3 gigahertz (GHz) bands (where additional spectrum will be allocated in the 700-megahertz (MHz) band to mobile communications), 5G will exploit higher frequencies of radio spectrum in the millimeter wave range (roughly 20 to 300 GHz) which can provide greater bandwidth, although over shorter distances(The 2015World Radio Conference, WRC, decided to place the issue of high-frequency radio spectrum for 5G on the agenda for the next WRC in 2019.) Nevertheless, most commentators agree that sharing by different operators of currently authorized and licensed bands, as well as unlicensed bands, will be necessary to make the most efficient use of the spectrum. Devices and network base stations will employ multiple antennae (known as multiple input/multiple outputs or MIMO antennae) that allow multiple simultaneous connections to be set up to increase bandwidth, minimize errors and optimize data speed.

Table 2: Features of 5G

Generations	5G
Start from	2015
Data capacity	Higher than 1Gbps
Technology	Ipv6
Standard	Ip-broadband LAN/WAN/PAN and WWW
Multiplexing	CDMA

Switching	All packet
Services	Dynamic information access wearable devices with AI capabilities
Main network	Internet
Handoff	Horizontal and Vertical

The 5G mobile communication system was test-launched in Abuja, Nigeria in November 2019 by MTN -the largest telecommunications network in Nigeria. This was the first 5G trial in West Africa; it followed a successful trial conducted by MTN South Africa in June 2018. The demonstration highlighted the deliverables of the 5G wireless communication network which includes swift automation and rapid immersive entertainment [5].

This paper explores perspectives on the sectorial transformations derivable from the deployment of the 5G telecommunication network in an emergent Nigeria as well as the inherent challenges thereof. It also highlights the methodology wherein the premise for conclusions is drawn and recommendations are proffered.

2. MATERIALS AND METHODS

The study deployed the use of secondary sources to obtain relevant preexisting data to facilitate the research objectives. This approach was necessitated by restrictions in movement to curtail the spread of the Coronavirus. Consequently, online sources were adequately explored. This research method has severally been validated by scholarly [6]-[10]

The research population included scholarly works and news articles purposively selected. They light up the discourse on 5G and Its prospects and challenges in the contemporary Nigerian setting. Newspapers (online), magazines, academic journals, textbooks, radio, and television are good sources of secondary data in conducting research. The study utilized qualitative research using keywords search to find relevant information for the study. Keywords such as 5G, and Prospects of 5G technology on the economy, agriculture, security, power generation, and the propaganda of the correlation between 5G and Covid-19 were used to generate data that were analyzed and presented using discourse analysis.

3. RESULTS/DISCUSSION

The 5G (Fifth Generation) wireless communication network also known as IMT 2020 has been designed with huge capability and requirements for today and future need. It has enormous potential to deliver very many benefits of technology to Nigeria. These include swift automation and rapid immersive entertainment. This is a clear departure from 3G and 4G networks. Hence, the technology could not have come at a better time. 5G when successfully deployed in Nigeria, will improve the broadband leading to faster downloading and uploading of contents; encouraging financial inclusion, faster healthcare service delivery, and smarter transport system, and appliances. The preceding highlights the prospects and challenges of 5G technology deployment in an emergent Nigeria.

3.1. The Opportunities of 5G in an Emerging Nigerian Society

Delivering the full 5G experience has the prospect of enhancing many existing used cases and creating new ones that cannot be fulfilled using current technologies. The forecast is that mobile data traffic will grow by around 50% annually between 2017 and 2023 (11 times growth). Key drivers will be extensive network coverage and the reduction in prices of both devices and services.

Also, driven by the rapid rise in access to relevant video content, new players who provide and aggregate local content finding initial success in larger markets including Nigeria and South Africa. The increase of mobile data traffic in Africa is driving operators to look at opportunities to optimize their network capacities, including complementing capacity via Wi-Fi networks.

Furthermore, the development of the expert human capacity to innovate on services and the creation of awareness in the consumer domain of new and innovative services should be undertaken by the 5G eco-system stakeholders.

Decisions on where, when, and how operators deploy 5G are not only driven by commercial considerations but also by the availability of spectrum, network equipment, and devices.

3.1.1. Enhance Public Safety and Security (PSS)

Nigeria is plagued by a myriad of security challenges. Recent international indices indicate that Nigeria is the most insecure country in Africa and the third most insecure country in the world. The dimensions of insecurity in Nigeria are multifaceted and continue to increase unabated. The manifestations of insecurity in Nigeria range from armed bandits' attacks, tribal and religious militia terrorist attacks, bombings, kidnapping/hostage-takings, destruction of property, armed robbery, youth restiveness, and cattle rustling to mention but a few [11]. Data reports by International Organization on Peace Building and Social Justice (PSJ) revealed that within the first half of 2020, at least 2538 persons have been killed, 802 kidnapped and 487 persons injured across Nigeria [12]. This data though empirical is very conservative considering how challenging it is to gather data that depicts the true scenario as it is. This is due to fear, traumatization, and lack of trust by the victims or close relatives who could have given appropriate and copious information on the rate and frequency of the mishaps. The insecurity paranoia continues to haunt most inhabitants of Nigeria. Sadly, it is already fast dawning on them that government cannot effectively guarantee the security of lives and properties. Most Nigerians perceived the government as not only being impotent to curtail the growing menace of insecurity but worst still complicit in perpetuating the insecurity. The state security agents who are saddled with the responsibility of the security of lives and property which include- the police, state security agencies, the military, immigration, and prison service have all by their inaction performed abysmally in the discharge of their duties. To the extent that every effort mobilized by the government is largely adjudged as a deceitful cosmetic arrangement to conceal complicity. Thus, the government security apparatus is largely unreliable and untrustworthy.

The attendant effects of these security menaces include the ignition of fear and panic which is detrimental to the general wellbeing of the people, illnesses; low life expectancy; low quality of life, and even death. Economically, insecurity has led to the destruction of businesses, properties, and equipment; relocation, and closing down of businesses.

The deployment of 5G will support the fast-failing Security Architecture in Nigeria and provide advanced technologies for the deployment of smart public safety and security systems. Disaster and Emergency Management (DEM) solutions can support Public Safety agencies in achieving their aims of effectively managing natural or man-made emergencies by providing multimedia-based information over a reliable and high bandwidth 5G network, thereby preventing harm and providing protection to life, property, and nations. DEM offerings include National Level Emergency Response control rooms and Civil Warning solutions that ensure the right information gets to the right person at the right time, i.e.

a. Emergency Response – Managing 112/911/999 calls & alarms from the public & connected systems and providing actionable intelligence to field force agencies.
b. Civil Warning – Providing multi-media warning to the population in event of crisis or emergency using an integrated sensor, analysis, communications, and systems.
c. Situation Awareness – alarm/sensor fusion, management, and sharing as a decision and response support aid.

3.1.2. Support for Nigeria's Economy

Nigeria is the most populous country in Africa with a population of between 170-200 million and is highly endowed with numerous mineral resources. Nigeria is the fourteenth largest oil-exporting country in the world. Yet, the *Nigerian economy is appalling*. Nigeria is still considered to be a poor country with a Gross Domestic Product (GDP) of about $374.3 Billion. Nigeria is engulfed with socio-economic problems which have caused poverty and conflict in the country. The growth of the country is still hampered by consumptive cultures, weak institutions, and fragile political structures [13]

However, there is overwhelming evidence linking ICT investment in infrastructure and economic growth. Access to high-quality broadband services is based on networks that support rapid growth in internet traffic as well as competitive pricing. A rise in mobile broadband penetration can be linked to economic growth and job creation. Although there are no specific statistics to authenticate this claim, evidence abounds to the effect that broadband penetration is associated with increases in Gross Domestic Product (GDP), creationof jobs, increase in educational opportunities, and enhanced service delivery and rural development.

If the relevant frameworks are put in place, an assessment of the impact of broadband investment indicates that over 10 years, more than 400 000jobs can be created with over USD 8 billion contributed to a country's GDP. As an augmentation of current mobile technologies, 5G could consequently ensure significant economic advantages for a country's citizens. However, the characteristics in speed, reliability, and latency mean that 5G can potentially be a technology that can enable new markets, and development and can also transform current industries, as well as support socio-economic benefits. The economic impact of 5G is difficult to be determined for now, but there are views that 5G will enable new applications and services in several different sectors as well as open new avenues for revenue. Ericsson projected some of the 5G enabled revenues per industry as shown in Figure 3 [14]. The view is that the majority of infrastructure investment will be done by the mobile industry. Mobile Network Operators (MNOs), infrastructure manufacturers, and ICT service providers will have to play a crucial part in deploying 5G networks in Africa and the implication is that the deployment of Fifth Generation (5G) technologies will consequently promote the National Digital Economy for a Digital Nigeria that will improve the way Nigerians live and work.

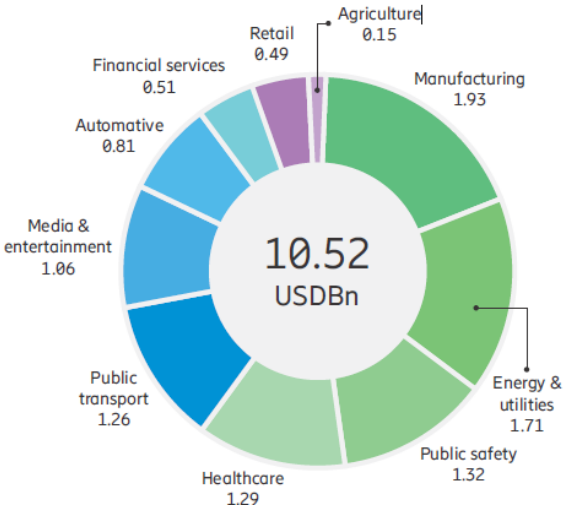

Figure 3:5G project Enabled Revenue [14]

3.1.3. Boost Energy and Water Supply

Smart and green energy and water supply management systems are two of the critical Industry services that will be enhanced by the 5G ICT ecosystem technologies. Transformation of the Utility sector and public services must be done in a manner to promote smart and effective utilization of the energy resources of a nation.

For example, in the Energy Sector, to increase the integration of renewable green energy solutions into the grid, and to help manage peak demand, utilities and municipalities are turning to smart energy solutions such as revenue and customer management, detecting technical and non-technical losses, smart metering and smart grid communications, as smart management of the consolidated multi-sourced energy supply of a country is becoming critical to the sustainable development of a nation.

Another key critical sector is Water Supply Management. In South Africa and the rest of Africa, water has already become a seriously scarce and critical resource. Hence, the use case of monitoring the water collection at the reservoirs and the monitoring of the water leaks in the distribution network through smart sensor networks and smart metering has also become a critical 5G IoT vertical use case in the emerging Nigerian market.

3.1.4. Enhance HealthCare Delivery System

Limiting the cost of healthcare and providing more effective care are the main challenges in this vertical. 5G is expected to bring new efficiencies, particularly in creating self-management capabilities and facilitating access to healthcare to minimize costs. This will partly be accomplished via m-Health, a general term used for the application of mobile phones and other wireless technology in medical care.

The most common application of m-Health today is the use of mobile phones and communication devices to educate consumers about preventative healthcare services. There are also many m-Health devices (for blood sugar testing, cholesterol, etc.) that can be utilized remotely, and uploaded via the mobile app to a clinic and/or hospital.

This particular application is very useful for patients in rural areas where the distance to the clinic and/or hospital are very far and can take those hours to get there.

Another key application is e-Health, which broadly refers to the use of information and communications technologies in healthcare. e-Health is an emerging field at the intersection of medical informatics, public health, and business, that aims to deliver health services and information through the Internet to reach people via mobile wireless technologies and broadband connections. 5G is expected to boost m-Health and e-Health applications in a major way to enable the introduction of additional services such as personalized or precision medicine initiatives with distributed, patient-centric approaches.

The integration of data across different networks and the aggregation of services across different domains will support various care models that include billing and care accounts where patients can better control their care and allocate financial resources as needed. 5G also has huge potential to enhance the capabilities of the surgeons by utilizing robots for remote applications. These applications can reduce health costs by allowing some patients to stay out of hospitals and care facilities and in their own homes. 5G technology requirements include ultra-low latencies and real-time sensing and perceptions for audio, vision, and haptics to enable these augmented or virtual reality applications. Hence, the healthcare areas that will be significantly enhanced by 5G technology include remote Health Monitoring, Remote Healthcare; and Remote Surgery.

Figure 4. The different components of the Interaction monitoring system [15]

3.1.5. Availability of Internet of Things (IoT) Opportunities

IoT provides an opportunity for mobile operators to bring new products and services to underserved markets, opening new possibilities for growth within the region. To unlock IoT's potential in Africa, Regulatory authorities, mobile operators, and stakeholders will need to work together. Failure to understand and fully develop the links across the various stakeholders in the ecosystem could stunt the growth of IoT in the region.

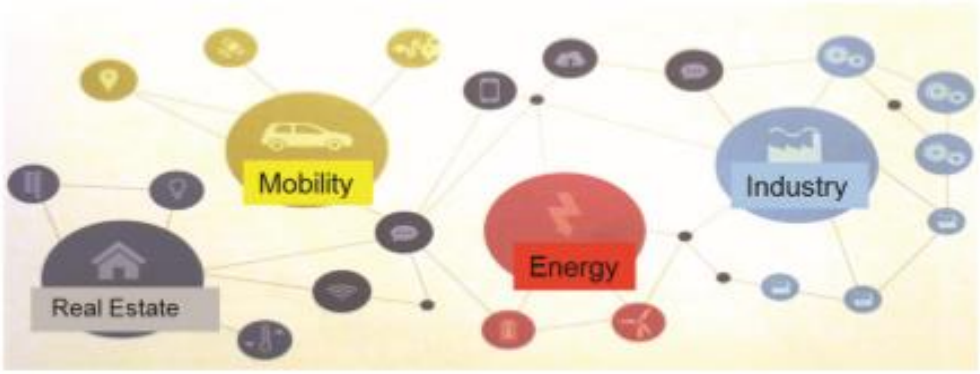

Figure5. New application areas for industries within 5G [16]

The Internet of Things (IoT) will provide the means for delivering innovative solutions to meet socio-economic challenges and will transform businesses to enable more growth in Africa. 5G is unarguably the base technology for the Internet of Things (IoT). Whilst Nigeria and South Africa will continue to increase the number of connected devices, IoT initiatives are seeing to advance in the rest of the region, especially East Africa. IoT is of increasing value to cities in Africa, with at least 55% of the urban population in the region living in informal settlements, and urbanization is rising. Smart City solutions, such as using IoT to curtail water scarcity in large informal settlements, to intelligent transport solutions, are increasingly being investigated to find answers to the challenge of urbanization. In agriculture, micro-insurance companies have deployed IoT devices to monitor weather patterns, e.g., providing small-scale farmers with insurance in Kenya.

3.1.6. Boost Agricultural Productivity

The Nigerian agricultural sector used to be one of the pillars of the country's economy and this was achieved sustainably. This is, however, a story in the past as agriculture is now relegated. Successive Nigerian governments have tried many ways and initiated lots of policies and programs which are aimed at restoring the country's agricultural sector to its pride [17]. The different ways, policies and programs put in place to promote investment and diversification in the agricultural sector have not been able to yield good or desired results. The huge potential for investment and export diversification to get the Nigeria agricultural sector to add to the economy as it does in before (the 1960s) has remained locked and untapped, because of several constrained and factors that must be addressed [18].

From a sustainable agricultural point of view, one of the main constraints in the agricultural system in Nigeria is the slow response to technology adoption when it comes to agricultural best practices. Hence the agricultural sector is bedeviled by low productivity, low return on investment, and rural poverty.

However, 5G technology deployed in connected farms and agriculture, will reducecosts, improves efficiency, and provides real-time data in amazing new ways. Consequently, agricultural production, agri-business opportunities, and models will expand in an emergent Nigeria through monitoring, tracking, mechanized automation, and automation control of environmental data and production information such as humidity, soil analysis, animal and vegetal feeding, rain, sun, and others.

The benefits will be that 5G will provide new ways to customize performance and eliminate inefficiencies by providing prompt reactions according to retrieved data and custom algorithms.

For instance, sensors will be able to be implemented throughout farms allowing for crops to communicate moisture and fertilization needs. The potential productivity gains, along with the ability to customize what, where, and how to plant down to areas of just a few square meters, could have huge implications for future sustainability.

3.1.7. Transportation

Road transport can become safer and more efficient as connected cars shareinformation in realtime with other vehicles; information from roadsideinfrastructure about a problem ahead can allow drivers to change routes quickly. Ultimately, cars may become smart enough and able to respond so quickly and reliably to networked data that they can be autonomous and drive themselves. Train travel can be more productive or entertaining as passengers traveling at 300km/h on high-speed trains through the countryside can work with full 5G network connectivity to their cloud computing resources or stream their own choice of high-definition movies.

Table 3. Summary of Emerging applications and services enabled by 5G [19]

Verticals	Drivers	Enablers	5G requirement
Education	Remote delivery Immersive experiences	Video streaming Augmented reality/ Virtual reality	Large bandwidth Low latency
Manufacturing	Industrial automation	Massive IoT networks	High connection d ensity Ultra-reliability Low power consu mption
Healthcare	Remote diagnosis and intervention Long term monitoring	Video streaming Augmented reality/ Virtual reality Embedded devices, advanced robotics	Low power High throughput Low latency
Smart Grid	Intelligent demand/ su pply control Powerline communicat ion	IoT sensors and networks	High reliability Broad coverage of network Low latency
Entertainment	Immersive gaming and media industry Multimedia experience at 4k, 8K resolution	Video streaming Augmented reality/Virtual reality	Large bandwidth Low latency
Automotive / Autonomous Cars	Collision avoidance Intelligent navigation a nd transportation syste ms	Vehicle-to-vehicle (V2V), Vehicle-to-infrastructure (V2I) and other intelligent trans port systems (ITS)	Large bandwidth a nd low latencies (< 5 ms) and high co nnection reliability (99.999%)
Smart Cities	Connected utilities, Transportation, Health care,Education and all amenities	Massive IoT networks Automation Cloud infrastructure Artificial intelligence	Large bandwidth High throughput High connection d ensity Low latencies

3.2. The Challenges of 5G in an Emerging Nigerian Society

Like any other technology advent, the 5G technology is not without its peculiar challenges. Here in Nigeria, some concerns heralded the advent of the attempt to commence the deployment process of the 5G technology. Some of these concerns are highlighted below:

3.2.1. Health Concerns

There are global health concerns that have been raised over the short and long-term effects of 5G on humans and the environment [20]. These concerns have been re-echoed here in Nigeria. In an appeal to the European Union, more than 180 doctors and scientists from 36 countries warned about the dangers of the 5G rollout, which will lead to an increase in involuntary exposure to electromagnetic radiation. Carlberg and Hardell raised concerns over the ability of the human skin to act as antennas and therefore respond to millimeter waves when they established that sweat ducts on human skin are helically-shaped tubes, overflowing using a conductive aqueous solution [14].

There are also concerns about the effects of 5G applications on the eyes as they would receive some degree of radiation, especially for near field exposures which could lead to a cataract of the eye. Chiaravigli*oet al* and Foster reported that 12% of respondents in a study in Europe were 'endearingly concerned' about exposure to wireless base stations, broadcast facilities, mobile phones, and other new technologies [21] [22].

Meanwhile, findings detailed in a study by Falcioni*etal* released after those carried out by the US Department of Health corroborated the health risks associated with radio base station emissions. The research precisely, reports an increase in the incidence of brain and heart tumors in Sprague-Dawley rats exposed to EMF generated by a radio base station [23].

However, in a 2014 study, the World Health Organization (WHO) stated that *"no adverse health effects have been established as being caused by mobile phone use."* WHO maintains that the radio waveband deployed in mobile phones is non-ionizing, meaning it lacks adequate energy to affect DNA which can lead to cellular damage [22]?The clear observation in all the studies is the lack of conclusivity and definitiveness about the expected health impacts of the 5G network. As is with most new technologies, there are always reservations about their impacts on one hand [24]

3.2.2. Epileptic Nigerian Power Supply System

The benefits derivable from 5G depend on the availability of a functional and consistent power supply system. The grid power supply system in Nigeria is not only underdeveloped but grossly inadequate. Currently, there are severe gaps in Nigeria's power infrastructure. Nigeria's installed power supply capacity is about 12,500 Megawatts (MW) but is only able to produce 7,000 MW, while less than 4,000 MW is shared among the over 180 million people living in the country [25]. This unfortunate scenario, portents a major challenge in the deployment and commercialization of 5G networks in Nigeria.

Although it has been suggested that the challenge of power supply can be lessened by the deployment of solar technology and inverters to cell sites [25], it yet raises the concern of the extra cost of installation and maintenance. At present, network companies complain about the huge cost of maintaining infrastructure in Nigeria on one hand while users have concerns about the affordability of data services [26]. Another concern connected to the use of solar power inverters as alternatives in the deployment of the 5G network is the challenge of security against theft and vandalism as a lot of these facilities can be damaged and stolen by vandals.

3.2.3. Religious Misconceptions in Nigeria

Religious views are highly upheld by most Nigerians. The two most popular religions are Christianity and Islam. It is commonplace in Nigeria to use religion as a medium of propaganda. With the advent of COVID-19, there have been several unverified theories that have attempted to link 5G to the outbreak of Covid-19 and religion has been used to fan the flames of this propaganda [27]. Worst still is the paucity of reliable scientific unanimity on the effects of 5G technology on health.

This vacuum has led to a public outcry against the deployment of the 5G network in Nigeria, the government and WHO has been accused of complicity and withholding secrets relating to the health implications of the 5G technology. On possible radiation emanating from 5G deployment, Bako Wakil, of the Nigerian Communication Commission (NCC) dismissed the claims, saying that the radiation from mobile devices is non-iodized, and as such, not harmful to the people. Hence, there is no sufficient empirical evidence to associate 5G with any serious health hazards [28].

The key issues observed with the 5G rollout are the lack of synergy in awareness and sensitization between the network providers and government on one hand and the general public and stakeholders in the communication business on the other hand.

3.2.4. Low Spectrum and fiber infrastructure

Radio spectrum, backhaul, softwarization of core networks, and radio access networks will be vital in the early deployment of 5G networks, particularly where enhanced mobile broadband is concerned. Spectrum plays a critical role in realizing the full extent of the capabilities of the 5G technology. Thus, 5G's full socio-economic impact is dependent on access to a variety of spectrum resources, including millimeter-wave (mmWave) bands between 24 GHz and 86 GHz. The mmWave spectrum allows for the increases in bandwidth and capacity that numerous 5G applications require. It will play a key role in meeting the demand for many enhanced mobile data services as well as new wireless broadband use cases such as remote object manipulation, industrial automation, virtual and augmented reality, and next-generation connectivity for vehicles. These use cases will continue to increase the impact that mobile services have on societies and economies.

The existing bandwidth spectrum, 4G radio access network (RAN), and backhaul in Nigeria are grossly inadequate to facilitate the effective overhaul of the 5G technology, this position has also been collaborated by Bako Wakil, the Director, Technical Standard and Network Integrity of the NCC who admitted that the low fiber infrastructure, inadequate radio spectrum, backhaul, and softwarization as the major limitations to the deployment and commercialization of 5G on a large scale in Nigeria [29].

Hence, more spectrum bandwidth will be required to deploy 5G networks (than 4G) to the high-capacity requirements, increasing the need for spectrum. Thus, to deliver the dense coverage and high-capacity network required by 5G, wireless operators need to invest in the densification of their 4G radio access network (RAN) – particularly in densely populated urban areas – by deploying small cells. Small cells, while serving a much smaller geographical area than a macro cell, increase network coverage, capacity, and quality of service. The deployment of small cells is one way of boosting the capacity and quality of existing 4G networks while laying the foundation for commercial 5G networks.

4. CONCLUSION

The Fifth Generation (5G) is one of the crucial network technology standards that will pave the way for the 4th Industrial revolution (4IR). The technology is an advancement of existing mobile technologies (2G – 4G) with enhanced capabilities providing new and enhanced mobile communications services. Such enhancements include applications like the Internet of Things (IoT), Artificial Intelligence (AI), Robotics, Drones, Advanced Communication Systems, Cloud, 3D Printing, Mixed Reality, Simulation / Imaging, and Gamification. These will bring improvements in Manufacturing, Transportation, Public Services, Health, and Social Works, Agriculture, Energy, Logistics, Media and Entertainment, Mining and Quarrying, Machinery and Equipment, Automotive, Education, Information and Communication, Urban Infrastructure, Consumer experience, Sports, Semiconductor Technologies, etc. The deployment of 5G technologies in an emergent will be beneficial for socio-economic development. However, there are inherent challenges that need to be addressed. These include public awareness and the improvement of the power and fiber optic infrastructure in the country. These challenges can be swiftly overcome to pave way for this long-awaited revolution.

5. RECOMMENDATIONS

To kick-start ICT-enabled transformation and realize its benefits, policymakers need to take a broader, more coherent ICT policymaking approach. The key areas where governments can act to trigger ICT-enabled transformation include broadband and power supply infrastructural enhancement.

There is also an urgent need to mobilize robust Public-Private Partnerships (PPP): To facilitate the quick distribution of ICT-based solutions, governments must work with ICT companies through PPPs. These partnerships are needed between government, international organizations, and industry, to establish sustainable business models that support wide-scale ICT deployment.
There is also the need to accelerate innovation to develop new ICT applications. National policies should be designed such that they encourage the development of small-scale ICT industries, both locally and internationally, to operate within the country to provide solutions and applications designed for the local context.

Finally, various arguments indicate that no one understands the full capabilities of 5G and its long-term effect on living organisms and the environment. It is recommended that more tests be carried out in varying conditions to understand the tolerance limit of the technology, and for the government to be transparent in its public communication. The government should entrench the culture of transparency and community engagement in its telecommunication policy formulations and enactments as part of its public confidence-building endeavors.

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