

NIEEE'S EXPERTS INSIGHT: 5G TECHNOLOGIES Vs COVID-19

Preamble

The Nigerian Institute of Electrical and Electronic Engineers (NIEEE) was established in 1984 as group of registered Electrical Engineers. Today, there are 28 Chapters across the country with thousands of its members within and outside the country. NIEEE housed all the specialties of Electrical Engineering. In order to deliver our mandates effectively, NIEEE is constitutionally structured into 3 broad subdivisions of Electrical Engineering, namely: Power Engineering, Telecoms & ICT and Instrumentation & Control Sections. As a professional body with 36 years track record of professional excellence, we observed the growing intensity of global discussion (including Nigeria) linking 5G mobile wireless technology to coronavirus pandemic. The Institute has taken note of the growing concerns particularly the impact of 5G operations on public health and wish to state as follows:

Introduction

Record shows that new technologies of mobile networks are commercially launched every ten years (generation). For example 1G, 2G, 3G (IMT-2000), 4G and now 5G (IMT-2020) were released in 1980, 1990, 2000, 2010 and 2020 respectively. The increasing demands from telecoms consumers are shaping the development of wireless industry. It is true that necessity is the mother of invention. The fifth generation of mobile networks (5G) is expected to connect people, things, data, applications, transport systems, cities and homes in smart networked communication environment. According to ITU, the usage visions that characterized (drivers) 5G services are (a) less than 1 millisecond ultra-reliable & low latency communications (URLLC), (b) up to 20 Gbps enhanced mobile broadband data speed (eMBB) and (c) over 1 million connected devices per km² massive machine type communications (mMTC). These requirements triggered a giant leap in the development of backend technologies to bring 5G visions into reality. The six foundational technologies to bring 5G dreams into reality are: millimeter waves (mm waves), small cell network, massive MIMO optimization, Beamforming, non-orthogonal multiple access (NOMA) and mobile edge computing (MEC). Thereby making 5G a platform for many wireless technologies to co-exist. 5G will enhance technologies behind IoT, artificial intelligence, smart city, smart home, self-driving cars, remote operations, machine learning, etc.

COVID-19 and 5G Network

Every new generation of mobile networks has its excitements and skepticism. At the advent of 1G, some scary stories went into the airwaves that mobile phones are not for the poor. At another time it was cancer, later brain tumour, etc. Before December 2019, 5G was probably the hottest topic, maybe due to new level of mobile internet expectation. As the world was waiting for the 5G bride to be unveiled in 2020, the pandemic story of coronavirus diseases (COVID-19) went into the airwaves and suddenly became another hot topic. The two parallel topics gained global attention at the same time, yet not related.

5G signals are transmitted over the radio waves, not by sneezing or handshake or any other ways coronavirus can be transmitted. 5G signals are not bio agent, hence, cannot be transmitted using transmitting station. As experts we cannot link coronavirus pandemic to 5G mobile communication network. There are cases of coronavirus spread in countries without 5G networks. While the spread of coronavirus is a threat to life and global economy, evolution of 5G will digitally transform industries such as healthcare, energy, finance services, transportation, entertainment, manufacturing, agriculture, supply-chain management, etc.

5G Radio-frequency Spectrum

ITU and GSMA earmarked the following sub-bands spectrum for 5G services, namely, (a) below 1 GHz, called lower-band; (b) 1 to 6 GHz, called mid-band and (c) above 6 GHz, called upper-band. Except in very rare cases, the lower and mid bands spectrum were already licensed and densely occupied by live 2G, 3G and 4G networks. The upper band spectrum remained the only option for 5G services, of which 26 GHz, 28 GHz and 40 GHz frequency spectrum are most favoured candidates. The required spectrum bandwidth for 5G services are abundantly availability on these bands. This is the reason behind the global adoption of mm waves' spectrum band called new radio for 5G services (5G NR). However, mm waves signals are disadvantaged with very weak propagating energy resulting to short coverage distances, e.g. 50 to 200 meters. Due to the short distances, more number of distributed micro-base stations are required in a 5G network than that of present 3G and 4G put together.

5G NR Technologies and Health Concerns

World Health Organization (WHO) defines Health as a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity. Staying alive and in good health have become major concerns of all. Virtually all the major concerns about 5G networks hover around safety radiation from mm waves networks. Typical radio frequencies of 1G, 2G, 3G, 4G and 5G are 150 MHz, 1800 MHz, 2100 MHz, 2500 MHz and 38000 MHz respectively. This comparatively high frequency difference between 5G NR and its predecessors drew the attention of non-technical stakeholders. In telecoms industry, successor technology does not supplant the predecessor technologies, until when it becomes very necessary to decommission the oldest generation network. While existing generation technologies persists on their respective frequencies, evolving technologies are compelled to consider higher frequencies with vacant abundant bandwidth.

Correcting the Misconceptions in the Airwaves

Telecoms industry is full of acronyms and in some cases, similar terminologies may have different interpretation. For example, Allotment, Assignment and Allocation may sound the same, but they have different interpretation in telecoms ecospace. In telecoms, *bandwidth* and *data rate* are not the same, while the former depicts *size* the latter depicts *speed*. This is an aspect where experts' interventions becomes very important.

According to the latest edition of ITU-R V.431, the nomenclature of 300 – 3000 MHz, 3 – 30 GHz and 30 – 300 GHz are UHF, SHF and EHF respectively. The fact that 5G will operate on *extremely high frequency* (EHF) does not mean it will radiate extremely high power. It is a false imagination to think that if 2G network operates on 1800 MHz, then 5G network operating on 37000 MHz should radiate 20 times the power of 2G network, with the wrong assumption that the frequency is 20 times that of 2G. The fact that the data speed of 5G network promised to be ten times faster than that of 4G does not mean that the radiated power will be ten time of 4G. All these and many more are misconceptions that we need to correct as professionals. As a group of professional with authorities in radio communications engineering, we hereby correct these misconceptions about 5G mm waves' signals. The natural behavior of radio waves obeys *Newton's inverse-square law* of electromagnetic propagation, meaning that, each time the distance from the transmitter is doubled, then the received power at that point is reduced to one-fourth of the power at the transmitter. Similarly, the received power at three times away from the source becomes one-ninth the transmitted power. So the signal strength gets weaker very quickly as the distance from the source increases. The same law applies to light, because light is made up of electromagnetic energy like radio waves too.

Ionizing and Non-Ionizing Radiations

Since the 20th Century, man is exposed to artificial EMFs in addition to existing natural EMFs. *Ionizing radiation* occur when EMF signals carry enough energy to break molecular bonds and consequently damage the DNA, e.g. medical X-ray. On the other hand, *non-ionizing radiations* do not have sufficient energy to break molecular bonds. The non-ionizing radiations occupy the lower part of *electromagnetic spectrum*, while the ionizing radiations occupy the higher portion. Most common man-made sources of non-ionized radiations are electricity, telecommunications, radio and TV broadcasting antennas, etc. International Commission on Non-Ionizing Radiation Protection (ICNIRP) is the international watchdog on electromagnetic radiation rules. These rules are basically for safety and to limit human overexposure to EMF levels present in our environment. WHO officially recognizes and adopts the guidelines developed by ICNIRP. About 10 years ago, the intention to use *extremely high frequency* (mm waves) spectrum for 5G operations drew much health concerns. These concerns prompted ICNIRP to embark on a 7-year study to review its 1998 edition of EMF exposure limits guidelines. In March 2020, ICNIRP released a new set of guidelines tagged “Guidelines for Limiting Exposure to EMF (100 KHz to 300 GHz)”. The new guidelines provide better and more detailed exposure guidance in frequencies above 6 GHz, covering 5G’s mm waves spectrum and that of future technologies. It is worthy of note that the guidelines are product of thorough review of all relevant scientific literatures, workshops and an extensive public consultation process. ICNIRP iterated severally that 5G technologies will not cause harm as long as the guidelines are adhered to.

EMC Test of 5G Equipment

Electromagnetic compatibility (EMC) test will prevent the use of unlawful radiation equipment in the nation’s network. It is a global practice for equipment model sample is subjected to EMC test by the country’s regulatory body before such telecoms device or equipment are imported. This is to ensure that the radio system of the equipment will operate within its EM environment without causing intolerable disturbance to its environment. This exercise is done by benchmarking the operational parameters of the equipment with relevant standards. Incidentally, EMC tests is less talked about in the news, despite the efforts of highly skilled technical personnel working behind the scene. The nation’s telecoms regulator has excellent tracked record on this. Notwithstanding, 5G era of IoT and M2M communications, will witness a barrage of EMC requests that will require new state of the art automated EMC test system to cope with. Unhindered 5G deployments require extremely complex device-based testing system.

Standards for 5G Technologies

The development of standards for 5G is principally steered by ITU (from regulatory perspectives) and 3GPP (an alliance of seven telecoms SDOs). ITU is UN’s agency that was found in 1865 and responsible for ICT & Telecommunications. ITU’s standards for 5G networks (christened *IMT-2020*) started in 2012 but the final product that will address perspectives is expected to be consummated sometimes this year. On the other hand, *Release 16* from 3GPP has just been postponed till June this year. The specifications will cover the systems, network and radio aspects of 5G services. While the final document detailing the specifications are being awaited sometime this year, earlier volume of recommendation approvals are substantial enough for trials and pre-commercial activities as currently observed in some countries.

5G Will Excite Cross-Sector Convergence

5G era will attract cross-sector cooperation and partnership due to cross-sector infrastructure sharing as a cost reduction option to enhance access connectivity. In order to enhance fast roll-out of 5G services, electricity grid, oil pipelines, rail lines and highways (*right of way*) will experience more fiber optic cables

network. We strongly recommend that all our roads and rails networks be equipped with self-sustaining cable ducts so that our transportation system can become intelligent. This cross-sector fiber deployment is the fundamentals towards our smart cities dream.

Fiber Optic Network

It is an illogical reasoning to believe that the lockdown directive was to create opportunity for secrete laying of 5G fiber cable network across the country. Fiber optic network is one of the oldest communication media in this country before the advent of 1G network. They complement the wireless networks. Hundreds of thousands small cell sites will be required for full fledge 5G network across the country. The nationwide 5G coverage may take many years to complete. So it is obvious that the tasks for many years cannot be completed within the few weeks of “stay at home” lockdown period. Fiber optic cable is safer, faster in data speeds delivery, more reliable and more energy efficient than wireless system. However, wireless network is faster to deploy than fiber network. Fiber optic cable does not emit electromagnetic radiation from the cable itself. As a matter of fact, most flavors and promises of 5G are best experienced on fiber optic networks. In anticipation of 5G and future technologies, modern housing estate developers have tapped into this vision (to add value to their properties), by constructing cable ducts network that terminates at each building within the estate.

Sample Tests of EMF Measurements on 5G Network

Since we are addressing health issues, we will deal with EMF results rather than network performance. There was no live 5G network in Nigeria at the time of our investigation. In order to benchmark theoretical standards with field measurement results, NIEEE’s RF team explored the results of EMF measurements in few countries where 5G networks are operational. We were unable to access 5G results in Wuhan and other several Chinese cities where early 5G trials took place. Our team eventually settled for the results obtained from UK 5G’s network and used as our case study. The choice of UK’s results is because Nigeria belong to the same Region–1 of the three global ITU-R geographical radio regions. Ofcom’s website showed the most recent technical report (February 2020) of EMF measurements conducted near 5G base stations in 10 major cities across UK. In all the measurements, the highest measured electric field value from 5G-enabled base stations was merely 1.5% of the recommended level in ICNIRP Guidelines. The highest contribution of 5G to the total emissions level observed was mere 0.039 % of the reference level. These confirmed that the EMF level of 5G networks are much lower than the current 3G and 4G networks.

Challenges of 5G Deployment

Despite the great economic potentials of 5G, there are some factors to consider and address, so that its deployment will not be stalled. They are: market maturity; public enlightenment; deployment timings; availability of 5G-enabled devices; huge CAPEX & OPEX; highly resilient physical & cloud-based infrastructures; physical & cyber security; building complex network, bringing 5G network indoor, etc. The radiated power losses in mm wave signals are very high, thereby making 5G NR signals are so weak and cannot travel far like signals from its predecessors’ networks. This is the challenge the network operators will face in addition to *capacity* and *coverage* preferences in the light of our varying population densities.

Conclusion

As professionals with authority in this subject, we stand by the side of conformance with globally approved radio communication regulations, standards, specifications and other guidelines developed for 5G networks. 5G NR has lot of bandwidth to deliver 5G visions, but cannot propagate far distances. 5G NR signals are not bio agent, and as such cannot be linked to coronavirus. There is no correlation between 5G and COVID-19, 5G has not been scientifically proven to be harmful. The international watchdog on radiation (ICNIRP) has released EMF exposure safety limits. The roll-out of 5G networks is still at infancy

stage globally. As a matter of fact there was no 5G deployment in Nigeria as at the time of this public notice. GSMA made it clear that 4G network coverage in Nigeria is still below the average line, while the 3G network is far below full nationwide coverage. NIEEE has highest regard for health and safety of person in all its activities. The Institute will continue to advise government organizations and educate the public on matters within the jurisdiction of electrical and electronic engineering profession. I hope that by this publication, the public is more informed and better enlightened. Henceforth, we will all be more responsible in information sharing.

Appreciation

I personally appreciate the efforts of every member of the **Independent RF Expert Group (IRFEG)** under the Chairmanship of the National Vice Chairman (Telecoms – ICT Section) of NIEEE, for putting this publication together within such a short time. As at the time of carrying out this task, these highly resourceful experts were geographically dispersed across three continents of the world. Notwithstanding, they were able to review about 100 recommendations, regulations, standards, technical reports and guidelines within such a short time. Thanks to all our engineers on duty to provide essential services and giving sustaining life to the economy of our great nation during the lockdown season. Our engineers in various sectors of the economy, such as telecoms, broadcasting, power, ICT, regulatory agencies, aviation, media, space agency, manufacturing, healthcare, banking, military, para-military, etc. I salute your valuable contributions toward the advancement of our mother land. I appreciate the submissions from all the 28 Chapters across the country. Thanks to all the standards development related agencies in Nigeria for keep our society safe.



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