



The 5G Deployment and Health Implication: Review

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ABSTRACT

The study presents the 5g deployment and health implication: a review. The study entails holistic research into various studies involving 5g deployment and health implication. The new parameters of 5g were highlighted; they include Millimeter Wave (mmWave), beamforming, massive MIMO and micro Cell Network. This range of frequency deployed is Non-Ionizing Radiation (NIR), which implies that it does not change the human body chemistry, but it can increase the thermal effect. The Millimeter waves are affected by tall buildings and foliage and it required a series of closely place base station, called micro-cell and with an increase in rooftop antennas. Based on different studies reviewed, it is observed that 5g does not cause immediate health damage to the human body. However, the thermal effect could be associated with millimetre-wave frequency radiation, especially with prolong calls and usage of mobile devices. Finally, the effect of millimetre-wave frequency radiation for 5g has not been ascertained.

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INTRODUCTION

In recent time, mobile subscribers begin to raise concern about the health condition of using the mobile phone and with the proliferation of mobile communication Base Stations (BTS) spread around the urban cities. Often time, the subscribers are full of anxiety and uncertainty about the health safety level of mobile communication network transceiver radiation. The effect of mobile phone and BTS radiation on human health has become an area of interest to researchers globally, as a result of the enormous increase in this mobile technology worldwide and relative health hazard (Osahenvemwen, 2017). The

anxiety and uncertainty on how safe it becomes, with intend of rolling out of 5G which is the 5th generation of mobile networks. It is designed to meet the large growth in data demand and connectivity of today's modern society, the internet of things with billions of connected devices, and tomorrow's innovations. With the outbreak of difference pandemic ravaging the world such as the one that originated from Wuhan city in China, a virus breakout called coronavirus also known as "COVID-19" which took place in December 2019. This COVID-19, the pandemic spread around the world, killing thousands of people within a short period. The severity

of the COVID-19, the disease was attributed to the rolling out of 5G mobile networks leading to people resisting the installation of 5G in various counties (Ganesh, 2014). This study presents a holistic literature review. However, there is a need to clear the doubt of possible health effect among the subscribers with the deployment of the 5G mobile communication network.

The bombardment of photons from the initial state to another state through space is referred to as Electromagnetic Field (EMF) radiation. These photons are quantified with a variety

of different energy resulting in different types of electromagnetic spectrum radiations. The electromagnetic spectrum radiations are characterized by wavelength and frequency (in Hz) deployed in a mobile communication system.

Electromagnetic (EM) spectrum radiation contains a set of electromagnetic waves, from super-high frequency to low frequency. Figure 1; shows Electromagnetic (EM) spectrum radiation or energy in ascending frequency with a corresponding decrease in wavelength.

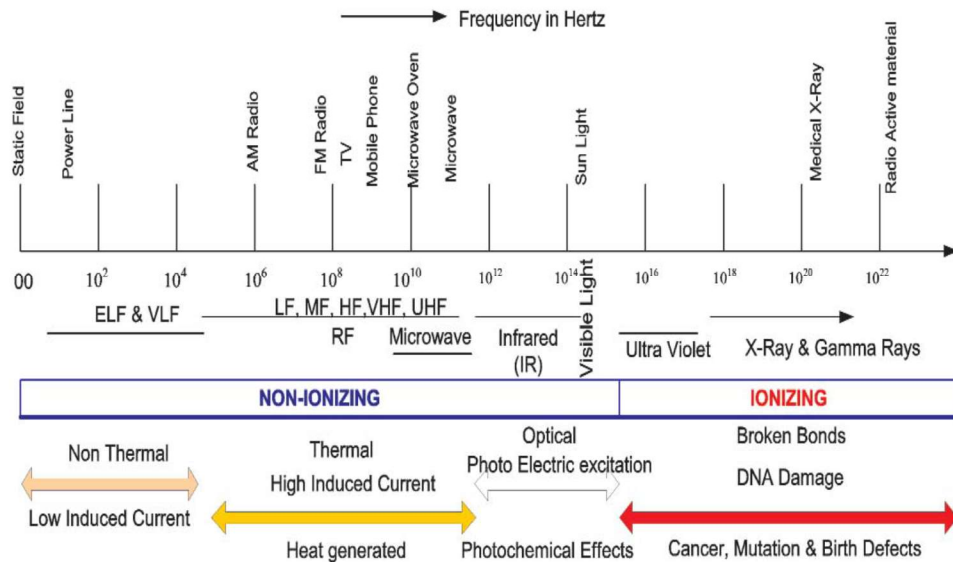


Figure 1: Electromagnetic (EM) Spectrum

1. Medium Frequency (MF), High Frequency (HF), Very High Frequency (VHF), Ultra High Frequency (UHF) and Microwave (MW) and Millimetre-wave (mmWave) (30 kHz to 300 GHz) shows in Figure 1.
2. Infrared (IR) light, Visible light and Ultraviolet (UV) light (above 300 GHz).

The Electromagnetic (EM) Spectrum includes frequencies between 3 kilohertz (kHz) and 300 Gigahertz (GHz). The initial

cellular communication networks 1G network was operated at a frequency of 850 MHz and 1900 MHz. While the 2G and 3G networks are accomplished with frequency bands of 2100 MHz. The development of 4G gave room 1.7/2.1 GHz, 2.3 GHz, 2.5 GHz, 600 MHz, 700 MHz frequency bands. The 5G network is faster than the 4G networks, it operates at higher frequencies band spectrum called millimetre wave (mm-Wave).

Millimetre waves deploy frequencies band from 28 to 300 gigahertz, they are

referred to as millimetre because their wavelengths vary between 1 and 10 millimetres, compared to radio waves which are in centimetres. Millimetre waves lie between the microwave and infrared waves and it is affected by building and

foliage. In Figure 2, the Millimeter waves required a close base station due to a shorter wavelength. The base stations are of reduced height such as light poles and rooftop due to lesser power associated with the transceiver.

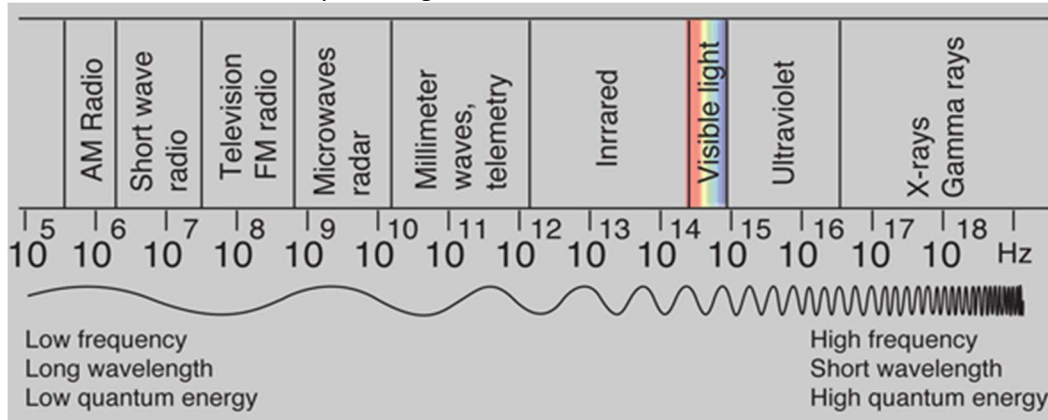


Figure 2: Frequency band Spectrum

Table 1: Parameters of both Microwaves and Millimeter Waves

S/N	parameters	Microwaves, Radar	Millimetre Waves, Telemetry
1	Frequencies	1.6-30 GHz	30-300 GHz
2	Wavelengths	187 - 10 mm	10 - 1 mm
3	Quantum energies	$0.66 \times 10^{-5} - 0.12 \times 10^{-3} \text{ eV}$	$0.12 \times 10^{-3} - 0.12 \times 10^{-2} \text{ eV}$

The expected 5G is accomplished with various improve data rate, Internet of Things (IoT), high data processing rate, industrial automation etc. The dream of smart cities and physical infrastructures are managed through the 5G network. The 5G network should be able to work reliably and securely in high-density areas like factories, airports and urban centres (Mohammad, 2015).

The 5g mobile communication network has some unique characteristics as follows;

1. Beamforming
2. Millimetre Waves
3. Massive MIMO
4. Small Cell Network
5. Improved user experience
6. high speeds
7. lower latency

8. the activation of the Internet of Things (IoT)

The 5G use extra frequencies in the microwave spectrum band such as low- (0.6 GHz – 3.7 GHz), mid- (3.7GHz – 24 GHz), and high-band frequencies (24 GHz and higher) for low latency. The demand for faster, efficient communication and improved QoS gave room to the 5G (Bhavika, 2017). This new generation is being proposed to power the Internet of Things (IoT). The IoT promises us convenient and easy lifestyles with a massive 5G interconnected telecommunications network, however, the expansion of broadband with a shorter wavelength of Electromagnetic (EM) spectrum radiation highlights the concern that health and safety issues remain unknown. Controversy continues from current 2G, 3G and 4G wireless



technologies straying into 5G technologies on how safe is this technology to human and the environment. With the higher frequency deployed by 5G, the subscriber is worried about their physical and mental health perspectives (Alfonsina, 2010). Based on this ongoing anxiety from the subscribers arising from the development of 5G has resulted to review related studies.

METHODOLOGY

This study is on the 5G deployment and Health Implication: Review, which various authors were considered. The acronym 5G stands for “fifth generation” cellular communication. The “G” is deployed to describe the generations of mobile communication technology that have been or will be introduced. 5G uses millimetre-wave which can enhance peak speeds and low latency. The demerit of high-band frequency associated with 5G is that it has a low coverage area and the building penetration is poor. The millimetre waves (MMW) region of the electromagnetic spectrum, extending from 30 to 300 GHz in terms of frequency (corresponding to wavelengths from 10 mm to 1 mm shows in Table 1.

Millimeter Waves Health Implication

This aspect of the study is focused on the millimetre waves and health implication by reviewing various research works on this area as follows.

Harvey *et al.* (2019), presents a study that highlights the requirement of military local area network and the deployment of higher band mm-wave can enhance the peak data rate and simultaneously realized covertness. The military adjusting covert communication domains to accommodate fast movements of network nodes, fluctuating output power parameters and dynamic environmental conditions. Alfonsina (2010), also presents a study on Millimeter Waves (MMW) from frequency radiation spectrum, from 30

to 300 GHz with a corresponding wavelength from 10 mm to 1mm. Eastern European countries, deployed MMW in non-invasive medicine against different types of diseases such are gastroduodenal ulcers, cardiovascular disorders, traumatism and tumour. Outside traffic application and military deployment, it could be used in high resolution and high data rate in a communication network.

Cindy (2018), presents a study on environmental pollution caused by different types of electromagnetic field radiation. It can be compared to common toxic exposures however the effect from electromagnetic field radiation will be problematic and impossible to the resolved epidemic. This electromagnetic field radiation can result in a hazard that can be on the increase due to synergistic toxic exposures and other common health risk behaviours. The effect from the electromagnetic field radiation will witness a non-linear due to the first generation to have cradle-to-grave lifespan exposure to man-made microwave (RF EMR) radio frequencies. It will take years and decades before the actual health implication of electromagnetic field radiation will be known. The rolling out of new technology, the question of public health and precautionary approach in advancing new wireless technologies most been considered.

Myrtill (2019), presents a study that considered a higher frequency in the range 6–100 GHz, millimetre waves and possible health impact. The study reviews 94 relevant publications performing in vivo or in vitro investigations. From each study, these following parameters were highlighted; study type (in vivo, in vitro), biological endpoint, exposure (frequency, exposure duration and power density), result and quality criteria were determined. Based on the study 80% reveal that in vivo studies responses to exposure, while 58% of



the in vitro studies showed effects. Also, the responses affected all biological endpoints studied. There was no correlation between exposure duration, or frequency, power density and exposure effects. Meanwhile, non-thermal effects were not addressed with adequate and sufficient information. The issue of local heat developments on small surfaces, e.g., skin or the eye, and on any environmental impact should be addressed by researchers.

Bernardi (1997), deals with the interaction between a millimetre-wavelength plane wave and the human eye. The study deployed the Finite Difference Time Domain (FDTD) numerical technique, alongside photographic images of the human head to developed an eye model resulting in the FDTD-compatible eye model. Using Debye's dispersion equation, to obtained experimental data based on lower frequencies the resultant output showed the dielectric properties of the human tissues at millimetre wavelengths. The power distribution in the exposed eye has been calculated in both conditions of a closed and open eye, and the results have been compared with the limits settled by some of the most recognized safety standards for human exposure.

Stein (2019), presents the advantages associated with the deployment of a 5G mobile communication network using millimetre wave technology such are autonomic automobiles and "smart" home and cities. The disadvantage is about 30-100% in exposure to electromagnetic radiation on citizens while higher exposure is experienced inside homes deploying these devices. Children, pregnant women and babies should be protected from chronic exposure to electromagnetic radiation against their will. While electro

hypersensitive individuals would be forced to leave their homes and become refugees. In Brussels as well as other cities, 5G has been halted due to health concerns.

Osahenvemwen (2017) presents a study on the effects of radiation emitted from a base station and mobile phone on human beings. This study is to clear the doubt by mobile subscribers about the harmful nature of the mobile communication system. The study considered various electromagnetic radiations based on frequency spectrum (operated at frequency bands of 2100 MHz) emanating from mobile phones and base station. Various research works on this area were reviewed by different authors. It was observed that Non-Ionizing Radiation (NIR), does not change the human body chemical bond, but can cause molecules to vibrate leading to a rise in tissue temperature shows in Figure 3.

It was observed that electromagnetic radiation from both mobile phone and cell tower does not have significant effects on human health. But, prolong calls above 20 minutes duration using a mobile phone, resulted in dizzy sensation due to tissue temperature increases, after the call have been terminated within a few seconds it normalized to a normal health condition. Finally, to minimize dizzy sensation from long calls, subscribers are to deployed the recommended earpieces and remove them immediately after the end of the long call. This enables the subscribers to make long calls without the mobile phone having close contact with the ear (or head), for the prevention of electromagnetic radiation from hitting the head tissue which can lead to dizzy sensation (Osahenvemwen, 2017).

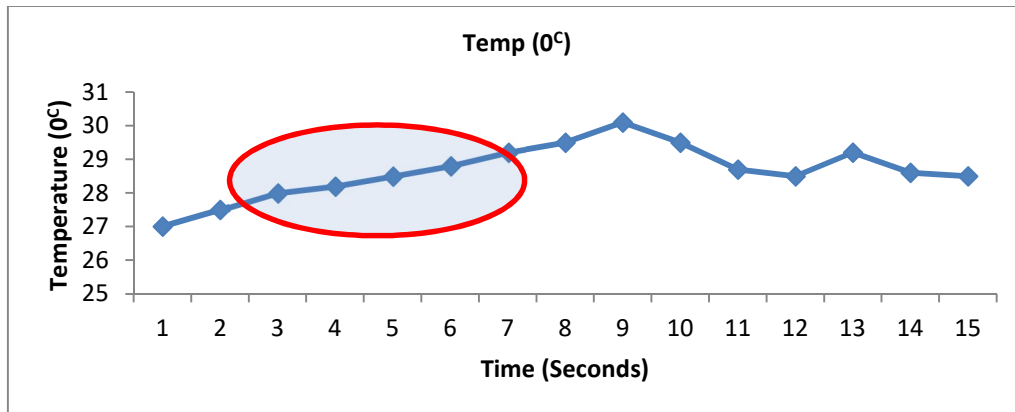


Figure 3: Temperature from Ring Mobile Radiation against Time

It was observed that there is an increase in temperature from the initial room ambient temperature of 27 °C to 30 °C. Also, it is observed a decrease in temperature; this was due to a diffusion process where a high concentration of temperature molecule move to less temperature region resulted in lower temperature.

Luca (2019), deals on 5G mobile communication networks which require dedicated radio channel access infrastructure. This 5G network has to create a controversy on public health and the safety of the new radio base stations. Five major health risk areas were considered, are; (i) links between insurgence of tumours and exposure to Electromagnetic Fields (EMFs) generated by 5G;(ii) the increase of radiation due to proliferation of 5G sites; (iii) health risks accomplished the emissions in the mm-Wave band adopted by 5G; (iv) the uncertainty around the 5G electromagnetic fields emission levels caused by the inadequate dedicated measurements tools; (v) and the impossibility to eliminate the previous thought and uncertainty determined by the inadequate measurement tools adequate for 5G mobile communication network. Based on the

review result, there is no incontrovertible scientific proof supporting any of the early mentioned five claims. Meanwhile, we need to iterate further investigations; we also remark a factual fabrication of fake news on the risks of 5G for public health, which may severely distort the perception of this technology by the population at large.

Subhash *et al.*, (2019), presents a major advantage of wireless technologies that have led to the industrial revolution in mobile communication. The deployments of higher frequencies of the electromagnetic spectrum can lead to health problem due to increasing public exposure. People raise a concern about the health and safety issues about 5G technologies radiation to remain unknown. In this paper, the harmful effect of 5G radiations is discussed for various verticals such as health, environmental issues, privacy, thermal etc.

Ting Wu *et al.*, (2015), deals with millimetre-wave frequency deployed in wireless communications, study on interactions between the human body and millimetre-wave devices are becoming important. This study gives regulatory requirements and provides a guideline for the usage of a 60 GHz transceiver. Also, the propagation characteristics of millimetre-waves were highlighted using the human



body, and four different models used to represent human parts and were considered to determine the thermal effects of millimetre-wave radiation on the body. Simulation results show that about 34% to 42% of the incident power is reflected at the skin surface at 60 GHz. It is observed that power density is not suitable to determine exposure compliance when millimetre-wave devices are deployed very close to the body. A temperature-based technique for the evaluation of safety compliance is proposed in this study.

In conclusion, the effects of 5G networks particularly at the new millimetre wave (mmWave) frequencies where the connection range is very short cannot change the human body chemistry. The Mm Wave radiation is Non-Ionizing Radiation (NIR) because the photon energy is not nearly sufficient to remove an electron from an atom or a molecule. Also, the same opinion was upheld by various researchers work reviewed. Also, the thermal effect will be probably generated due to the short wavelength and having to provide a continuous connection, adapting small cells will be distributed in clusters. Having in mind some parts of the human body example eye etc; possess a low blood temperature. However, the human body may probably witness a slightly thermal increase under prolong usage of these mobile communication devices.

CONCLUSION

The 5g which is the 5th generation of mobile communication network uses millimetre wave's frequencies from 30 to 300 gigahertz. This range of frequency is Non-Ionizing Radiation (NIR), which imply that it does not change the human body chemistry, but it can increase the thermal effect. Having in mind that the 5g is accomplished with Millimeter waves which are easily absorbed by foliage and buildings and will require many closely spaced Base

Stations BTS, called small cells and with an increased number of antennas. Based on different studies reviewed, it is observed the 5g does not cause immediate health damage to the human body. However, the prolonged effect from millimetre-wave frequency radiation for 5g has not to be ascertained.

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