

## Analysis of Variation in Electromagnetic Radiations across Selected Service Providers and Mobile Equipment in Osogbo, Nigeria

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### ABSTRACT

*Dynamic increase in amount of electromagnetic emissions into the environment is raising public concern over the likely health risks associated with wireless devices. Many studies have evaluated the potential links between mobile phones radiations and adverse health effects on human (neural activities, physiological effects, hearing, vision, memory, concentration, sleep and other functions which can be associated with headache). This paper investigated, with the aid of Spectran HF-4040 analyzer, the variation in electromagnetic radiations across various network service providers and mobile equipment. Major network service providers in Nigeria; Mobile Telephone Network (MTN), Globacom Limited (Glo) Airtel Networks Limited (Airtel) and Emerging Markets Telecommunication Services (EMTS) Ltd trading as 9Mobile, were considered in terms of their radiation levels. Mobile equipment such as; iphone 7, Samsung A2, Tecnopouvoir 2 and Infinix Hot S were deployed with the spectrum analyzer. The results showed that mobile equipment radiates, and its value is a function of the model of mobile equipment deployed along with service provider's equipment and network technology. The radiation may pose health risk or constitute environmental nuisance. It is therefore recommended that the probable injurious effects of mobile technology radiations should be averted by taking necessary precautionary measures such as using mobile phone of comparatively low specific absorption rate (SAR), using earphone or loudspeaker whenever possible, deployment of radiation blocker or pouch or special headphones that reduce SAR, and public enlightenment programmes on precautionary measures for phone users is thus essential.*

### 1. INTRODUCTION

Mobile phone technology has swiftly advanced and been exploited throughout the universe. As important as this technological front, the necessity to examine certain essential possible threats cannot be over emphasized. Number of cell phone users is rapidly increasing, however, the cultural knowledge required of proper phone usage is at the lowest ebb. Apparatus of mobile technology emit radiations, a non-ionizing form from their antennas. The portions of human body close to the antennas can absorb this radiation, and the long term effects may not be unsurprising. Generally, study on the impact of emission from handset and

other wireless electronic devices on human health has been a matter of attention globally, due to increased mobile phone usage all over the world. Moreover, as a matter of fact, the rampant usage of mobile phones has raised several anxieties about its probable effects on human wellbeing. The radiations from cellular phones are electromagnetic radiation emitted in the frequency range of 880–2200 Hz, thus, possible of being absorbed by the human body (Sajedifar *et al.*, 2019).

The rush and dynamic growth in mobile communication technology, the warm welcome given to it by uninformed populace, and the possible health impairments that may arise from human romance of this technology raised concerns and interest among researchers. Majorly, researchers are concern of the level of radiations of mobile communication technologies as well of possible associated health risks. Depending on the aim of a researcher and available resources, variables such as phone model, phone antenna type, service provider technology, connection network technology, signal reception strength, BTS distance and some other variables may contribute to the level of radiation experienced in a mobile phone (Agrawal *et al.*, 2009; Sajedifar *et al.*, 2019).

For mobile radiations, two critical assignments are before humanity for serious attention: “what are the effects of radio waves on human health?” and, more specifically, “what health risks are related to the utilization of cell phones, mobile radios, microwave radios, microwave ovens, broadcast radio and television transmitters, power lines and X-rays?” Nevertheless, many studies reported worldwide have tried to assess potential linkage between harmful health effects and mobile phones radiations (Jalal, 2014; Abdelati, 2015). In 2011, International Agency for Research on Cancer (IARC), an agency of the World Health Organization (WHO), categorized wireless radiation as Group 2B - possibly carcinogenic. This implies that there may possibly be some risk of carcinogenicity, thus, further investigation into level of radiation into the environment, the long term, and weighty use of wireless devices is required.

Earlier investigation claimed that for more than ten years of technology usage, emission from mobile phones possibly increases the threat of brain tumor at the adjacent of the head being exposed to mobile phone over the period (Keshvaer and Lang, 2006). Hadell and Carlberg (2009, 2014) and Hardell *et al.*, (2013) reported the likelihood of the danger of brain cancer doubling in adults with abuse of mobile phone, and even, five-times among youngsters. Recently, WHO stated that the repeated contact with Electromagnetic Field (EMF) can be harmful and in fact aid as the foundation for electromagnetic weaponry. Mobile phone radiations may interact with body tissues to produce internal electric and magnetic fields, thus, causing thermal effect in the body with close proximity to handsets over particular time duration (Behari, 2012). Report from previous research has it that the head temperature may increase by up to 0.6°C while using a mobile phone (Hirata and Shiozawa, 2003).

A broad assessment of related scientific literature shows that prolonged exposure to radiations may lead to biological effects which may result in serious health issues, learning deficiencies and lingering disease (Sage and Burgio, 2018). Some reports proposed a likely linkage between cell phone usages and reduction in semen quality. Potency and procreative impairment is quite regularly documented in men with harm to the DNA of sperm and weakening of the testis. Agrawal *et al.* (2009) discovered that the usage of mobile phones had harmful impact on the quality of semen in 361 men attending an infertility clinic. Fejes *et al.* (2005) revealed that the period of possession of mobile phone relates negatively with semen quality in 371 men. These discoveries have been verified, though in a lesser number of men (13 and 27, respectively) (Davondl and Brossner, 2002).

Radio frequency emissions which infiltrate through human body from cellular phone are measured in terms of Specific Absorption Rate (SAR). This specific absorption rate means the power absorbed by human from cellular phone over a certain volume of body tissue (Kusuma *et al.*, 2011). For cellular phones, SAR varies from 0.12 to 1.6 watts/kg of body weight and it's directly proportional to body conductivity. SAR is affected by dielectric value of human body, and really much dependent on its orientation, human-body and recurrence rate of exposure. The conductivity,  $\sigma$ , and relative permittivity,  $\epsilon$ , of human tissues are the factors

responsible for both optimum radio frequency communication and dosimetry (Behari, 2012). The permittivity and conductivity are frequency dependent (Kusuma *et al.*, 2011).

Quite a lot of international authoritative bodies are in charge of regulating safe SAR limit being exposed onto human tissues, one of which is International Commission on Non-Ionizing Radiation Protection (ICNIRP) in Europe. ICNIRP normalizes safe bound of SAR of 2 W/kg over 10 g sample of body tissue (ICNIRP, 2009). Other countries following this control are Japan, Brazil and New Zealand. In the United States Federal Communications Commission (FCC) set SAR limit of 1.6 W/kg over 1 g of body tissues (Kong and Li, 2018). Canada, Australia and Taiwan are also abiding to the present standard (Husni *et al.*, 2013). In Malaysia, the authoritative body of Malaysian Communication and Multimedia Commission (MCMC) put their safe SAR limit regulation of mobile phone by following the ICNIRP standards (Husni *et al.*, 2013).

Owing to the alleged health implications of mobile phones as a major source of electromagnetic radiation, this study thus, aimed at investigating variation in electromagnetic radiations across selected service providers and mobile equipment in Nigeria. This is to get users sensitized on the properties of the radiations, the possible long term effects, and necessary precautionary measures to avoid possible hazards associated with continuous exposure to the said electromagnetic radiation. Sajedifar *et al.* (2019) investigated emission as a function of network technology, calling mode and battery charge level among other variables. Measurements were made on 2G technology in calling mode, called mode and talking mode at battery charge levels of 1, 5, 10, 15, 20, 30, 50, 60, 70, 80 and 100%. It was observed that maximum electromagnetic waves were obtained only in calling mode when the used mobile phone was on 1% battery charge and when being fully charged (100%). However, the study showed no statistical significant difference in radiations in called and talking modes.

This work, thus, considered some variables left out in Sajedifar *et al.* (2019). Factors such as phone model and service provider technology are therein incorporated in this study. Phone models such as iPhone 7, Samsung A2, Infinix Hot S and Tecno Pouvoir 2 were experimented on major service providers (MTN, Glo, Airtel and 9mobile) in Nigeria.

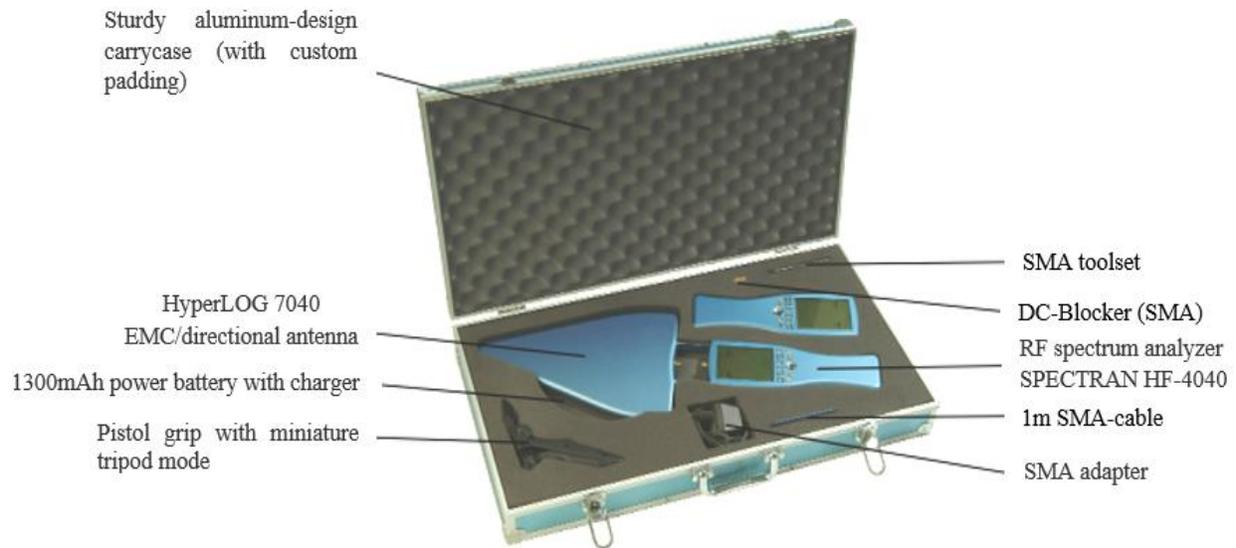
## 2. METHODOLOGY

With the aid of Aaronia HF-4040 Handheld RF Spectrum Analyzer, the variation in electromagnetic radiations across major network service providers in Nigeria were measured. The spectrum analyzer is of frequency range 100 MHz to 4 GHz and typical level range of -90 dBm to 0 dBm. Its lowest sample time is 100 ms and typical accuracy of  $\pm 3$  dB. The filter bandwidth of the analyzer is (RBW) mini: 100 kHz and (RBW) Max: 50MHz. The analyzer is of high performance digital signal processor (DSP) and incorporated with HypeloG 7040 EMC antenna.

Major network service providers such as MTN, Glo, Airtel and 9mobile were considered in terms of the radiation types and values. The radiations were observed at idle mode and call mode for the various mobile equipment and service providers considered in the course of the research. Calls were put across to respective subscriber identity module (SIM) cards of the selected service providers while the radiations were measured. Mobile equipment including iPhone 7, Samsung A2, Tecno Pouvoir2 and Infinix Hot S hosted the SIM cards during the experiment. However, SIM cards for all the service providers were, in turn experimented on all the mobile equipment. The radiations were measured and categorized as electric and magnetic units and bar plots of the values were obtained for necessary analysis. Measurements were taken repeatedly while those phone models were deployed as mobile stations.

For the measurement, the Spectran HF-4040 analyzer was configured to “custom” to set the required frequency. Other parameters configured in the experimental setup were: Sweep time – 10ms, Attenuation

– “Auto”, Count – 1, Level – 90dB and Antenna type – HL7040. Figures 1 and 2 present the overview of the Spectran HF4040 analyzer and its experimental setup for the measurement respectively.



**Figure 1:** Overview of Spectran HF4040 Analyzer



**Figure 2:** Experimental Setup for Spectran HF4040 analyzer

### 3. RESULTS AND DISCUSSION

The average values of the readings of magnetic and electric radiations are presented in Table 1. However, Figures 3 and 4 present the composite bar plots of the acquired magnetic and electric field radiations. It could be seen from Table 1 and Figures 1 and 2 that mobile phones do emit radiations into the environment. The radiations, magnetic field and electric field, are much concentrated around the mobile equipment, and its value is a function of the type of mobile equipment (phone) deployed as well as service provider.

On the average, MTN service provider has the least radiations for magnetic and electric: 18.44A/m, 2.64 V/m for I-Phone 7 as mobile station; 10.03A/m, 0.06 V/m for Samsung A2 Duo as mobile station,

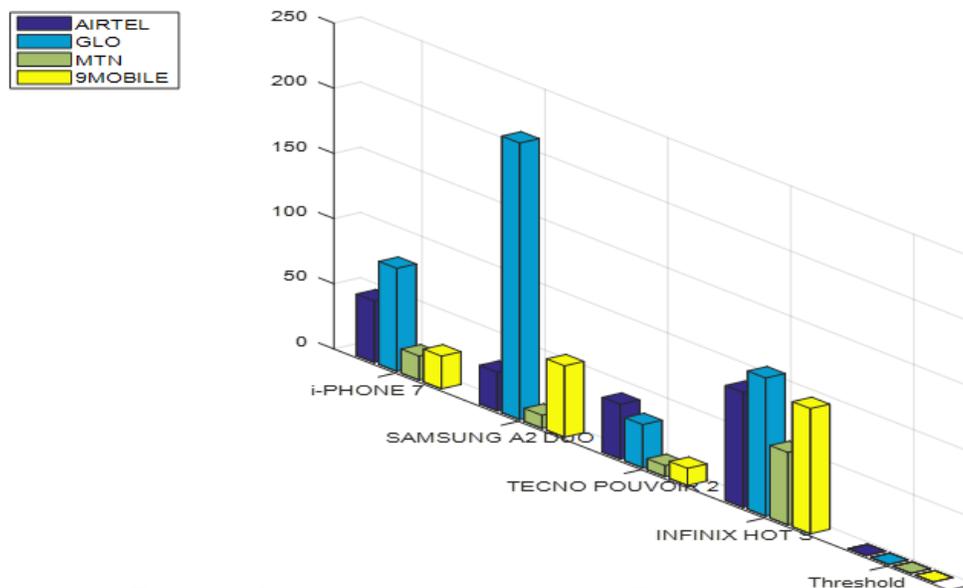
55.58A/m, 4.58 V/m for Infinix Hot S as mobile station, 8.44A/m, 1.78 V/m for Tecno Pouvoir 2 as mobile station. Conversely, the average radiation experienced, among the considered service providers, was highest in Glo network with values of 78.97A/m, 5.46V/m for I-Phone 7 as mobile station; 212.19A/m, 0.28V/m for Samsung A2 Duo as mobile station, 106.04A/m, 6.32V/m for Infinix Hot S as mobile station, 33.17A/m, 3.54V/m for Tecno Pouvoir 2 as mobile station.

Considering the mobile equipment, in term of electric field radiation, on average, Samsung A2 Duo as mobile station gave most fair electric radiation across the networks. The highest electric field radiation was, however, experienced when Infinix Hot S was deployed as mobile station. On the other hand, Tecno Pouvoir 2 as mobile station produced the least average magnetic radiation while the highest average value was given by Infinix Hot S when deployed as mobile station.

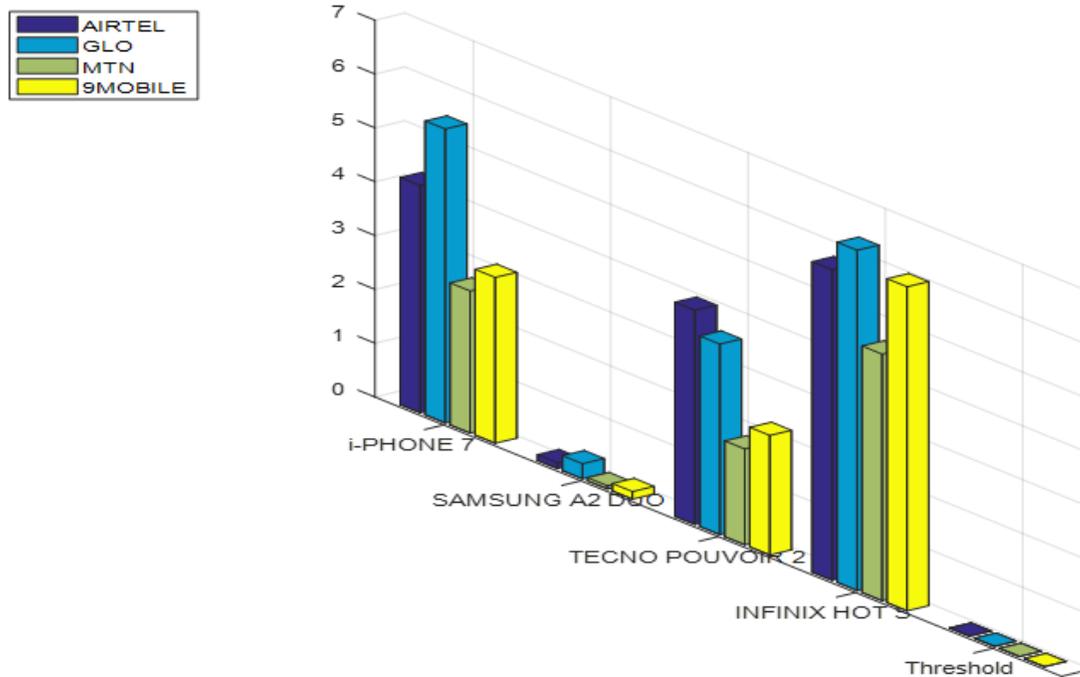
It was therefore observed, in the course of this research that mobile equipment do radiate, even at idle mode, when no call is in progress. The radiations are actually functions of some factors such as the service provider equipment, type of the mobile equipment (phone) deployed among others.

**Table 1:** Average Magnetic and Electric Radiations.

Network Provider	I-Phone 7 as Mobile Station		Samsung A2 Duo as Mobile Station		Infinix Hot S as Mobile Station		Tecno Pouvoir 2 as Mobile Station	
	Magnetic Field Radiation (A/m)	Electric Field Radiation (V/m)	Magnetic Field Radiation (A/m)	Electric Field Radiation (V/m)	Magnetic Field Radiation (A/m)	Electric Field Radiation (V/m)	Magnetic Field Radiation (A/m)	Electric Field Radiation (V/m)
1 AIRTEL	47.2	4.22	29.5	0.11	88.17	5.77	42.02	3.98
2 GLO	78.97	5.46	212.19	0.28	106.04	6.32	33.17	3.54
3 MTN	18.44	2.64	10.03	0.06	55.58	4.58	8.44	1.78
4 9MOBILE	25.10	3.08	54.7	0.14	96.02	6.02	13.10	2.22



**Figure 3:** Composite bar plot of Magnetic Field Radiation



**Figure 4:** Composite bar plot of Electric Field Radiation.

#### 4. CONCLUSION

The study has been able to examine the variation of electromagnetic radiations across service providers and with various mobile equipment models. The study established that the model of mobile equipment deployed and service provider mobile technology are among the variables that dictate the level of electromagnetic radiation experience in mobile network system. In all cases, mobile equipment do radiate even at idle mode, when no call is in progress, as they communicate at regular intervals with the operator's nearest antenna for information, update or instruction.

Based on the outcome of this research, it is therefore recommended that the probable injurious effects of mobile technology radiations should be averted by taking necessary precautionary measures such as using well thought-of mobile phone models of tested and recorded testimonial on health and safety (comparatively low SAR), keeping away mobile phones from the body by the use of earphone whenever possible, and minimizing self-exposure by optimizing the period of engagement when talking on mobile phones. Moreover, if possible, phone calls may be made on loudspeaker and electromagnetic radiation blocker or pouch or special headphones that reduce specific absorption rate (SAR) exposure can be employed. Conclusively, regular overhauling of base station equipment is recommended for the mobile operators, and observation of safety precautionary measures associated with mobile phone usage should be strictly adhered to by the mobile users.

In all, as prevention is better than cure, continuous and serious public enlightenment programmes are required for educating users of the practical precautionary measures that can be observed to avert the probable health risks related to the ever evolving mobile communication system.

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