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Electromagnetic Radiation Reduction from Ultra-Dense Network Using 5G Mobile Phone in a Coordinated Multipoint Environment

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Abstract- ***Technological advancement gave birth to Ultra-Dense Networks whereby there is massive deployment of micro base stations within and around the coverage area of macro base station or at the edge of the cell in order to increase the signal strength and network throughput. This leads to very high traffic density in densely populated area especially in crowded city and hotspot areas. However, Coordinated Multi-Point environment is based on transmission and/or reception at multiple separated sites to actively manage the interference for the users, with a particular emphasis on cell-edge users. This exposed many users to too much dose of electromagnetic radiation absorbed and also increased the general population exposure to different health hazards emanated from transceiver's electromagnetic radiation. Therefore, electromagnetic radiation reduction becomes one of the major concerns to secure the future life of mobile network users especially in an ultra-dense network area. One of the major equipment radiating electromagnetic radiation is mobile transceiver and is commonly used by both literate and illiterate, young and old, in the local, national and international levels. Base on this, Radio Frequency meter was used in measuring the radiation levels from different mobile transceiver. During call seeking, the electromagnetic radiation from transmitting mobile phones is very high while the radiation from the receiving mobile phone is very low but the radiation levels are the same for both transmitting and receiving mobile phones during call entablement and call conversation. This is essential for general-public safety and effective protection from health hazard associated with radiation exposures.***

Keywords- ***Coordinated Multipoint, Electromagnetic Radiation, Environment, Ultra-Dense Networks***

I. INTRODUCTION

Electromagnetism is a subdivision of physics which deals with electromagnetic force that happened between electrically charged particles but Electromagnetic refers to the electrical and magnetic forces produced by an electric current [1]. Therefore, Electromagnetic radiation simply refers to the energy that travel through space/air [2]. which does not need material medium for propagation. There are two types of radiation, they are ionizing and non-ionizing radiation. We have different types of electromagnetic emission such as X-rays and gamma rays, ultraviolet radiation, infrared waves, microwaves, visible light, radio waves. The radiations that have enough drive to ionize atoms that can disorganize molecules inside the cells and can result in the impairment of tissue is called Ionizing radiation while the radiations that are essential to life is called non-ionizing radiations, but too much dosage will cause tissue impairment, [3].

The upper frequencies of Electromagnetic Radiation (EMR) are x-rays and gamma rays and the lesser frequency of electromagnetic radiation are ultraviolet (UV), Infrared (IR), microwave (MW), Radio Frequency (RF) and tremendously low frequency (LF) and they are forms of non-ionizing radiation. Electromagnetic (EM) wave is known by its wavelength, λ and frequency, f. EM waves of frequencies ranges from 3KHz to 300GHz are generally use for communication, such as microwave, radio, television, radar and mobile phone [4].

Ultra-Dense Network (UDN) is employed by massively positioning Micro Base Stations (MiBS) within the coverage zone of Macro Base Station (MaBS) most especially at the edge of the cell. This helps to increase the speed and the required capacity, thus raise the signal strength at the reception besides network throughput. It is commonly use in telecommunication industries. Small cells have two important purposes: one, it provides one or both coverage and performance according to [5]. At the

macro-cells' edge, wherever downlink throughput is typically low and uplink throughput even suffers most, network users can maintain a good quality signal service by connect directly to that cell. Two, is using Coordinated Multi-Point (CoMP), which entails the use of many base stations collaborate together by transmitting and/or receiving at the same time aiming to decrease the chance of electromagnetic radiation upsurge.

Therefore, Coordinated Multi Point (CoMP) is built on one or both transmission and reception of signals at various detached locations within the network area. This increases the reliability of the signals by keenly control the interference at the users' end, with specific stress on cell edge of the users through improved coordination among the multiple separated sites. In this 5G networks, very high traffic density in densely populated area especially in crowded city and hotspot areas is one of the key requirements, [6]. Therefore, the reduction of EM radiation turns out to be one of the main worries to secure the lifetime of the system users in an ultra-dense network area.

Electromagnetic Radiation Reduction

Exposure to electromagnetic radiation by network users is based on the mobile network alertness of the user and capability to implement total influence on it. Two classes of exposure are professional and universal exposure, [7]. Occupational contact with EMR is the condition where employee unprotected from radiation as a result of their professional conditions. Universal exposure applies where people exposed to radiation as a result of series of radiations in an Ultra-dense network which we cannot even exercise control on [8]. As electromagnetic emission can be investigated using the amount of radiation engrossed by the mobile network users in form of Power Density (PD) emissions, Frequency radiations or Specific Absorption Rate (SAR). The quantity of radiation penetrates at exact place in the body from a mobile transceiver, such as the brain, is more efficiently quantify in terms of power density (PD) over a particular region, [9].

Mobile Transceiver also known as telephone transfers RF signal information to the nearby Base Transceiver Station (BTS) and the received signal information are transmit through BTS to the telephone using frequency marginally changed from transmitting radiofrequency signals as revealed in [10]. The frequency signals from BTS are unidirectional while the radiations from mobile transceiver are multidirectional. Therefore, the electromagnetic emission from a mobile transmitting station revolves round the users as obtainable in Figure 1, [10]. It demonstrates that radiation's pathways have weighty consequence on the bodily contact with the mobile transceiver and with the specific distance from transceiver phone.

Figure 1: Power density radiation of a mobile transceiver, [10]

The radiating pattern in mobile communication is in multidirectional paths as shown in Figure 1

Each time mobile transceiver is on, it connects to distinct frequency which is called the control channel which make the phone and BTS to communicate to one another, [2]. In the absence of this control channel, the mobile transceiver will communicate back to the users that is out of service or no network coverage, [5,7]. But if the mobile transceiver is inside the range of network coverage area, it will send a signal request to MSC to keep tracking the subscriber's location in the network database. Choosing of a frequency pair will be done with the help of MSC through the network subscriber used in the cell zone to initiate a connection. MSC connects to the telephone handset through the Control Channel to make demand for particular frequencies to be used, [8-10]. Furthermore, once the mobile transceiver and the tower switch those frequencies on, the network user is at that point automatically connected. Whenever the mobile transceiver user travels near the edge of the cell, the BTS experiences fading in the signal strength [3] and this shows that it is time for the handover to the nearest

cell by the control channel, [7]. In this situation, Multipoint connectivity is adopted to raise the system quantity of the user by linking the users to more than two cells at the same time.

Concept of 5th Generation (5G) Networks

The Fifth-Generation (5th G) mobile network is recognized as 5G networks and it is a new mobile wireless network that are in place after Fourth Generation (4G). First Generation (1G), Second Generation (2G) and Third Generation (3G) networks have been in place before Fourth Generation (4G) networks. 1G came to existence in December 1, 1979 from Nippon Telegraph and Telephone (NTT) in Japan and this was the first time a mobile cellular dialed the number. It was an analog mobile phone but too heavy to carry about by the users. It has frequency band of 50-150MHZ. This achievement could only transmit voice message with low quality from the mobile transmitter to the receiver [10]. In 1991, 22 years after the 1G technology, Finland launched a mobile network that confirmed the 2G mobile systems and it was officially called Group Special Mobile (GSM) to distinguish theirs from NTT technology. With 2G, there is additional advantages of text and picture messages with better quality voice transmission signal than 1G. General Packet Radio Service (GPRS) was presented to Global System for Mobile communications (GSM) in the middle of 1990s which made wireless internet first of its kind possible (Patrick and David, 2013). Additional GPRS to 2G was invented in the year 2000 and it was called 2.5G. The standard was enhanced by EDGE few years later which increase data rates for GSM advancement. The EDGE networks which were 2.75G were first launched in United State in the year 2003 and was faster than 2.5G networks [9]. The birth of 3G came into existence when the demand is increasing which 2.75G could not cater for. GSM and IS -95 standards organizations made partnership in 1998 to produce international standards that will define standards for future generations of mobile networks. One of their results was 3rd Generation Partnership Project (3GPP) in the year 2001 and it was used to develop the Universal Mobile Telecommunication System (UMTS) [2]. This remained the first global standard upgrading to GSM networks in 2001. Long Term Evolution (LTE) took over, towards the end of 3G. 3G was known with very great speed downlink access and very great speed packet access. Because of the limit bandwidth of 3G, 4G came to play in the year 2007 with high bandwidth. The transmission power capacity of 4G was empowered by Multiple Input Multiple Output (MIMO) Technology [6]. This technology gave room for more capacity and bandwidth than 3G. But with the network overloading which led to slow speed and drop connections especially in high traffic areas thereby reduced the functionality of 4G. With the technological advancement of mobile networks to overcome the challenges of 4G, the International Telecommunication Union (ITU) lunched its first draft of the requirements for 5G in 2015 [2, 4]. This 5G wireless network technology was started from USA in 2019 and it is to deliver higher data, more reliability, massive network capacity, higher speed and increase users' accessibility to full multiple signal strength [6]. One of the major key factors in 5G in Ultra-Dense Networks.

Concept of Ultra-Dense Networks

The concept of Ultra-Dense Networks (UDNs) is the key factor in 5G networks. However, UDNs are networks where the base station density radiation exceeds the users' density as a result of short inter-site distance [3]. Interference in UDN is predominant because all the Base Stations (BSs) will be at their peak of density radiation. UDN is identified as a network reaching every coverage area with maximum signal strength, [6]. We can list some significant features of UDNs from these definitions and observations: a network user can be within the coverage area of numerous cells. This means that users can be within coverage area of more than two cells in UDNs area, [8] interferences is critically high. With low inter cell space among the cells, transmissions may interfere between one another, resulting in the drop of the radio frequency signal concentration; several cells are not be in operation when there are no network users within their coverage area. To effectively control the interference at the mobile network user's end, the techniques of coordinated multipoint technology was adopted by all network providers to mitigate interference, [5].

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Concept of Coordinated Multipoint Environment

Coordinated Multipoint Environment is very familiar with 5G networks. Actually, Multipoint Environment (MpE) is an environment in which a specified Mobile Equipment (ME) obtain FR from more than three separate service points, [6] thereby have an assess to multipoint connection. The system is known as Multipoint Connectivity (MpC) and it comprises only single master cell (macro cell) and single secondary cell (micro cell) will be integrated within the master cell to cover the small areas with high radiation signal, [9].

Generally, as for multi-connectivity (MC), no final definition has been given because its standardization is only a draft yet [6]. In this research, multi connectivity was defined as the capability for a User Equipment (UE) to link to numerous access points simultaneously to improve the system output. These multiple access links can occur either within very similar frequency group, which is known as intra frequency MC, but in different frequency group, is known as inter frequency MC, as revealed in Figure 2.

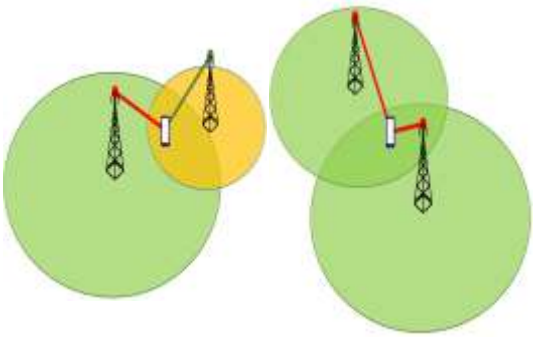

Figure 2: (a). Inter frequency MC (b). Intra frequency MC, [6].

In Multipoint Connection, the ability in link a user to micro cell is done through the help of macro cell and is depending on the ME distance to the cell. Although the users may have various information at their ends, particularly regarding to the electromagnetic radiation signals qualities having the verdict on the network signal gives room for an improved control of resources, more importantly once it comes to power density effectiveness. Major key Mobile Networking is telephone system. This is a combination of transmitter and receiver in a single package and is normally relates to wireless GSM. Its revolution began in August 2001 in Nigeria, with diverse brands and models that is use to transfer message in form of speech, picture and writing messages amongst transmitter and receiver. This drastically transformed the level of Information and Communications Technology (ICT) in Nigeria and thereby change the level of commercial activities in the nation for better. From the time when the GSM launched, mobile telephone system has significantly become the common system of voice communication in Nigeria. According to [4], Nigeria has currently termed as one of the wildest increasing GSM marketplaces in the realm of telecommunication because of the growth in communication market that has been so rapid.

Truly, these expansions have remained greatly alarming, as agreeing with the statistical data from the Nigerian Communications Commission (NCC), only 450,000 subscribers which also known as network users were identify with NITEL in 2001, but in August 2004, over seven million subscribers had been recorded by the GSM operators. In July 2018, they documented more than twenty-two million users according to [3]. The number increases to twenty-nine million at the end of 2022. The expectation now is that the number will increase to thirty-two million by the end of 2024 said [6], because of the volume of different programs involved with diverse generations from 1G networks to 5G networks through the network providers in Nigeria.

Mobile phone discharges radiation in form of power density which is grouped into the group of non-ionization [2]. The immense use of mobile phone brings the request on the health consequence of electromagnetic radiation from mobile network on the users since there is an international standard put in place by the International Communication Commission (ICC) and the subscribers love to discern the various measures that can be put in place to reduce the mobile transceiver emission which can caused mobile phone menaces. Massive use of this telephone in this present era in Nigeria has open many users to frequent dosage of power density and also opened the general populace to diverse health risks from phone's emission. Influx of diverse transceiver (phone) producers that manufacture diverse mobile phone prototypes with different qualities have also caused

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diverse health risks happening to users. Subsequently, it has increase anxiety on the quantity of the emission coming out of the telephones in this ultra-dense era, [5].

Mobile transceiver brands in Nigerian telecommunication market

Top ten (10) mobile phone brands using 5G networks in Nigerian Telecommunication Market approved by Nigerian Communication Commission, NCC which always available for mobile network users are Nokia; Tecno; Samsung; Huawei; Itel; Infinix; Gionee; iPhone; Oppo and Vivo brands.

II. METHOD

It's To activate the complete functionality of the telephone under study, a SIM card was injected into the mobile phone handsets and then activated. The contribution of Background Radiation (BGR) levels was accounted for by first measuring the BGR levels of the phones. Measurement PD of the test telephone was done a specified intervals of time under diverse exposure situations such as connection seeking, call establishment and call conversation. This latter consists of voice calling under different conditions such as weather, materials using for building and shielding materials (physical condition of the mobile transceivers). In defining the particular level of emission, the mobile transceiver was actuated and situated in a standard working condition. The RF meter quantify the increasing radiation. The procedure was repeated for each telephone at least thrice to assess consistency of the results. To assess the effect of mobile transceiver's shielding and weather conditions against the intensity of radiation, Nokia, Tecno, Samsung Galaxy, Huawei, Itel, Infinix, Gionee, Oppo, Vivo and Apple iphone all in different models were used. The intensity of radiation from the mobile transceivers were measured under these conditions and the results were compared with the respective standard radiation levels.

III. RESULTS

The results in Fig. 3 presented the radiation reduction levels results achieved from different mobile transceivers brands and models under test at different distances from the user and under different techniques and conditions using ICNIRP standard as our radiation limit because of the safety. We also determining suitable weather condition(s) and materials for electromagnetic radiation reduction using Ten (10) selected mobile phones. This selected mobile transceivers with 5G were placed in an ultra-dense networks area with all mobile network providers presented full signal strength. The measurement was taking place under different modes of operations. The Table 3.1 displays clearly the summary of the measurement and evaluation results.

Table 1: Radiation levels of mobile phones with different modes

Mobile Transceiver Mode.	Seeking for Connection	Call Establishment	Call Conversation.
Transmitting Mobile Phones.	Driving for Connection. (VHR).	Dialing (HR).	Dialer (LR).
Receiving Mobile Phones.	Routing for Connection. (VLR).	Ringing (HR).	Receiver (LR).

where;
VHR = Very High Radiation,
HR = High Radiation,
LR = Low Radiation,
VLR = Very Low Radiation.

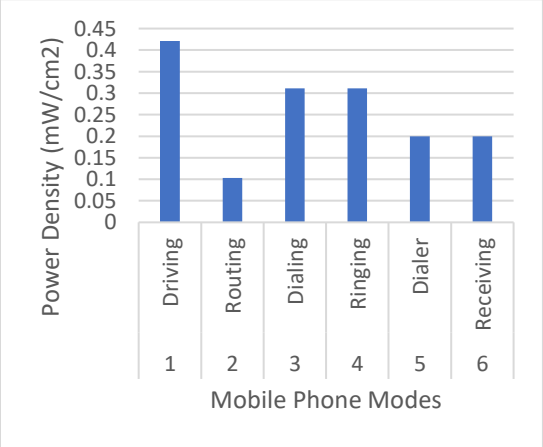

Figure 3: Mobile Phone Modes

Fig. 3 presents the overall radiation levels of mobile phones' mode of operations with very high and very low radiations in all mobile phones used when driving and routing for connection respectively. The radiation levels are all equal when dialing and ringing but with low radiation level when in dialer and receiver modes.

IV. CONCLUSION

In an ultra-dense network area, the research revealed the presence of different levels of EM radiations from mobile phones during seeking for connections but the same with all mobile phones during call establishment and conversation. Among all the materials used in a coordinated multipoint environment, it is clearly seen from Table 1 that the power density (and hence the EM radiation exposure on a user) reduce drastically when call conversation is ongoing from both ends.

REFERENCES

[1] Aaneet K. & Rasesh K. (2021). "Electromagnetic Radiation reducing in 5G networks & beyond using thermal Radiation mode" *IEEE Transaction on Vehicle, Technology.* Pp 6, 135-138.

[2] Abubakar Y., Abbas Z. & Yunusa Z. (2019). "Easy determination of Radiation Absorption in brain tissue from mobile phone using element method", Pp 9, 147-154.

[3] Ahmed M. T., Mohamed R. I., Faruque M. U., Khandaker D. & Andrew B. (2021). "Electromagnetic radiation reduction using novel metamaterial for cellular applications" *Radphyschem. 2021 Vol 178,* Pp *108976*

[4] Abdul-Al, M., Amar, A.S.I., Elfergani, I., Littlehales, R., Ojaroudi Parchin, N., Al-Yasir, Y., See, C.H., Zhou, D., Zainal Abidin, Z. & Alibakhshikenari, M. (2022) Wireless Electromagnetic Radiation Assessment Based on the Specific Absorption Rate (SAR): A Review Case Study. Electronics 2022, 11, 511.

[5] Agburu A. O. A., James G. B., Caleb A. A., Siyaka O. S., & Yunusa Y. S. (2022). "Performance Assessment of the Quality of Service of a GSM Network in Jigawa State Nigeria" *3rd International Conference on Applied Engineering and Natural Sciences, ICAENS.*Pp 236-142.

[6] Al- Zahrani A. Y., Yu F. R. & Huang M. (2022). "A joint cross-layer and co-layer interference management scheme in hyper-dense heterogeneous networks using mean-field game theory" *IEEE Transactions on Vehicular Technology, Vol. 65, Pp. 1522-1535.*

[7] Anita F. A. & Fredrick O. U. (2019) "Assessment of radiofrequency radiation levels of mobile phones and evaluation of specific absorption rate to tissues of human head layers" *FUW Trends in Science & Technology Journal, e-ISSN:* 24085162; p-ISSN: 20485170; Vol. 4 No. 3 Pp. 643 – 650.

[8] Aru O. E., Adimora K. C., & Nwankwo F. J. (2021). "Investigating the impact of 5G radiation on Human Health using Machine Learning". *Nigerian Journal of Technology (NIJOTECH) Vol. 40, Pp, 694-702, ISSN: 0331 – 8443.*

[9] Bashir M. A., Oyedum O. D., Tyabo M. A. & Muraina N. (2018). "Assessment of human exposure to RF radiation from mobile transceiver stations". *Physical science international journal* 18(3): 1-5, Pp 2010-2018.

[10] Bhatia C. (2021). "Impact of EMR produced by M/Phs and M/Ws on Human Health and Eyes" *International Journal of EMS & Application.* Pp 175-182.