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Research Paper

Comparative Analysis of Radiation Exposure from Single Service and Collocate Services Masts:AStudy of Damaturu in Yobe State of Nigeria

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ABSTRACT
Wireless communication (Global System of Mobile Communication [GSM]) enabled by mobile phone has seen rapid growth over the years in all part of the world. This growth is fastest in lowand medium income countries of Asia and Africa. In African Nations, such as Nigeria which has the largest mobile phone market with about 173 million subscribers and penetration rate of about 123%. This has given rise to the number of mobile communication masts erected in the country so as to meet up with bandwidth requirement. However, to limit the increasing need for erecting new masts, collocation has been adopted, leading to anincrease in number of antennas on a single mast or tower. Thus, the rate of radiation exposure is of great concern as it may affect human health. The radiation exposure (power density) and power receivedfrom these masts both single service and collocated service have been measured using high performance Spectran analyser HF6065 V4. The results of the measurements obtained for both type of towers are compared and are found to have met the safety guidelines stipulated by the regulatory body in the research area. Constant measurement of radiation exposure from BTS located within the populace and relocation and/ compensation of residents within 25 m radius from the masts was recommended to curtail future health hazards as BTS are upgraded.
KEYWORD*: collocation, exposure limits, power density, masts, mobile phone*

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I. INTRODUCTION

The telecommunication industry is experiencing robust growth on a global scale, and mobile phones are becoming an essential tool in modern society as they allow people to maintain constant and continuous communication without hampering their freedom of movement. Since the introduction of mobile phones in the world in the mid-1980s, there has been significant increase in the number of mobile phone users and installations of base stations [1]. Radio frequency (RF) and microwave radiation emission from mobile phone and mobile base station in highly populated cities and towns in Nigeria is a thing of concern to human health. The increase in the number of GSM subscribers and rise in the number of antennas at Base Transceiver Stations (BTS) has given rise to the non-ionizing radiation emission that can cause biological effects. For mobile network BTS antennas to operate as intended without adverse health effects, they must comply with Electromagnetic Compatibility (EMC) standards likewise with safety guidelines relating to exposure of non-ionizing radiation stipulated by Nigeria Communication Commission (NCC) guidelines [2].

There is ongoing discussion and several kinds of researches on whether the radiations from mobile phonesand BTSs cause any health effects. The International Commission on Non-Ionizing Radiation Protection (ICNIRP), the International Committee on Electromagnetic Safety (ICMS) and the World Health Organization (WHO) are assuring that there is no proven health risk and that the present safety limits protect all mobile phone users [3]. However, based on the available scientific evidence, the situation is not as clear as to whether mobile phone has health effect. There is a lack of human volunteer studies that would, in an unbiased way, demonstrate whetherthe human body responds at all to Base station radiations. The present available scientific evidence is insufficient to prove the reliability of the current safety standards [4]. Therefore, continuous research on BTS radiation effects is essential to improve the basis and reliability of the safety standards, especially in Africa

Nations and in particular Nigeria.Nigeria has about 173 million subscribers of mobile phone services with about 53, 460 BTS in operation. The increasing number of subscribers has equally given rise to the number of BTSrequired to meet bandwidth requirements. Recently NCC have declared that we need about 60,000 BTS to support this demand [5] [6]. The towers within the nation are owned by service providers and independent tower company. The two major tower solution providers in Nigeria are IHS towers and ATC Nigeria with over 16,500 and 5,300 towers across the nation respectively [7] [8]. The trend now is that most of this masts are owned by independent companies who lease them out to service providers, thereby reducing maintenance and running cost to service providers. In such a way, a tower can serve two or more different service providers, hence the collocate masts. This has now given rise to numbers of antennas at the BTS and in-turn has increase the rate of radiation emission. Therefore, continuous or routine measurement of radiation emission at the base stations is highly required in order to check compliance and to ensure the safety of this equipment to living populates [9]. The NCC has set out legal guidelines and requirements for infrastructure sharing and collocation [10]. These guide need to be fulfilled by all.

II. LITERATURE REVIEW

Over the years various studies have been presented in the area of radiation exposure of BTS and mobile phone radiations. An investigation into radiation power density of some selected BTSs of the four major telecommunication operators (MTN, AIRTEL, GLO and ETISALAT) in three different locations (Mando, Kabala,Costain and Malali) in city of Kaduna was reported by [11]. The technique deploy in this work are physical measurement and data analysis. The measurement was carried out using spectrum analyser of type SPECTRAN hf2025e with a frequency range of 700MHz to 2.5MHz. These measurements includes the received power in dBm and exposure limit in $\mu w/m^2$. The measurement were taking at various distances ranging from 25m to 200m at an interval of 25m. Results obtained indicates highest exposure of 4 $\mu w/m^2$ on AIRTEL and GLO BTSs at distance of 200m while that of MTN and ETISALAT records lowest radiation of 2.3 $\mu w/m^2$ and 2.4 $\mu w/m^2$ at a distance of 200m respectively. Based on the outcome of this investigation the radiation exposure of the marts in this areas are within the safety limit of 4.5 W/m^2 as stipulated in ICNIRP guideline.

Research relating to radiation exposure of mobile phone in relation to SAR value and long duration call and its impacts on human health was carried out in South Asia (Bangladesh) by [12]. The study was carried out using a structured questionnaire with respondents of 16 years and above across the eight (8) major cities of Bangladesh. Total numbers of respondents are 7650 with 3000 coming from general public, 2000 from students, 2500 from business men and only 150 from teachers. The outcome of the survey in relation to health symptoms claims: 24% experience headaches, 15% experience bad sleep, 10% experience ear aches, 16% experience short term memory loss, 8% experience hair loss and burning sensation, 6% experience blurring vision and 3% claimed no health effects. This report has also established the relationship between SAR value of mobile phone and health hazard. The result presented indicates that, SAR value is one of the factors to be considered when estimating the rate of health hazard resulting from radiation exposure. Based on the analysis of data obtained both users of mobile phones with high and low SAR value have claimed health symptoms.

Maximum power density of GSM signals in three major cities of Lagos, Abuja and Ibadan was presented in[9]. The study was carried out to evaluate the status of GSM band of 900 and 1800 which were the signal band in operation within Nigeria. The research was carried out with the aid of calibrated SPECTRAN HF-60105V4 hand held spectrum analyser coupled with an omniLOG 90200 antenna to measure the maximum power density of some selected BTSs within these cities. The measurement of maximum power density (worst case scenario of exposure) were taken between the hour of 900hr and 1500hr from 271 Base stations at a distance of 200m. For the GSM 900 band, the highest measured value ofsignal power density is 139.63$\mu W/m^2$ in Lagos, 162.90 $\mu W/m^2$ in Ibadan and 5411.26 $\mu W/m^2$ in Abuja. Thelevel of RF exposure due to GSM signals in the city of Abuja is about 5 times higher than that of Lagos and Ibadan. The land space in the central Abuja district is small and this has encouraged the installation of many base station collocations and the presence of so many radiating antennas in the city. However, the level of exposure in these cities are far less than the recommended reference levels of 4.5 W/m^2 for GSM 900 and 9.0 W/m^2 for GSM 1800 as stipulated in ICNIRP guidelines[9].

From the few literature reviewed, it is clear that there are health hazards associated with BTS and mobile phone usage. However, the studies are based on measurements of BTS operating onlysingle service provider. This study will considered both single service and collocated service,mast that are on collocation have more antennas compare to single service mast. For this, the radiation exposure can be high depending on the number of service providers operating within the shared facilities (collocated). Results obtained from the study will be analysed, and recommendations based on the outcomes will be provided for future work and referencing.

III. METHODOLOGY

The proposed research requires the method of data acquisition from measurements of radiation power density from selected BTSs, this will be conducted using the HighEnd EMC Spectrum Analyzer by taking reading at different distance ranging from 25m to 100m. The aim is to determine the rates of radiation exposure from some selected Base Transceiver Stations located within the populace in Damaturu town of Yobe State and their impact on human health. The following objectives are set to achieve these aims:

- Measurement of maximum power density ($\mu W/m^2$) of GSM signalsradiated from the BTS in all the locations (consideration will be given to highly populated locations)
- Measurement of the maximum and minimum power received (dBm) from each BTS considered above
- To ascertain the relationship between the power received and the power density of the GSM signal radiated from the BTS.

IV. MEASUREMENTS

The measurement of the power density and the exposure limits which are the two parameters used to access the limits of radiation exposure emanating from mobile communication tower was carried out using Aaronia AG SpectranAnalyzer HF-6065 V4 measurement device. The analyser provideshighEnd EMC and is suitable for measurements of the radiation exposurewith acceptable measurement accuracy of ± 2 dB. The HF6065 V4 measurement device was connected via calibrated 1 m subminiature A (SMA) cable to a HyperLOG measurement antenna supported by Aaronia "pistol grip" handle to allow independent movement of the antenna as shown in Figure 1. The maximum radiation exposure limit can easily be search via the independent antenna within the set radius of 100 m radially away from the tower. The settings of the device was then carried out in order to achieve results that is more precise and at the same time capture weaker signals. The sweep time was also set at higher value so as get a more precise result at the expense of more time between measurements.

Figure 1: Measurements of the power received with Aaronia AG SpectranAnalyzer (HF-6065 V4)

The measurements of the radiation exposure limits was taken at various locations for all the four service providersoperating in the selected research city, this includes: Airtel, Etisalat, Glo and MTN networks. The mobile communications towers within the research area areclassifiedbased on single service towersand shared infrastructure (i.e collocate towers). Two towers from each network providers and eight (8) towers that are on colocation run by ATC Nigeria and IHS TowerNigeria four from each. ATC Nigeria is leasing it service to Airtel and MTN in all the measured masts while IHS tower is rendering service to Etisalat and MTN. Measurements of power density and the exposure limits parameters for distance ranging from

approximately25m up to 100 maway from the towers were taken and recorded. All measurement were for GSM 900 type and readingswere taken several times at different point aimed at getting the maximum exposure from these towers. Due to different location of the antennas along the height of the masts, maintaining the same distance during the measurements from the towers would not necessarily give the maximum radiation emanating from these masts. For this, the set out parametermentioned earlier was utilised.

During the measurements the hold function is applied, this is to record only the highest value of the exposure limits, as the reading from the display keeps fluctuating. Enabling the hold function, keeps the display frozen and only changes if a much higher radiation is picked up. This is either moving the antenna or changing position and moving some distance. Though the effect of temperature has not been considered, however all measurement are at temperature of 30 ± 1 °C.

V. RESULTS AND DISCUSSIONS

From the measurements carried out, the results ofthe minimum and maximum radiation exposure (power density) and power received obtained are presented in Figures 2 to 4 for single service mast of four networks, ATC operated collocate and IHS collocated masts respectively.

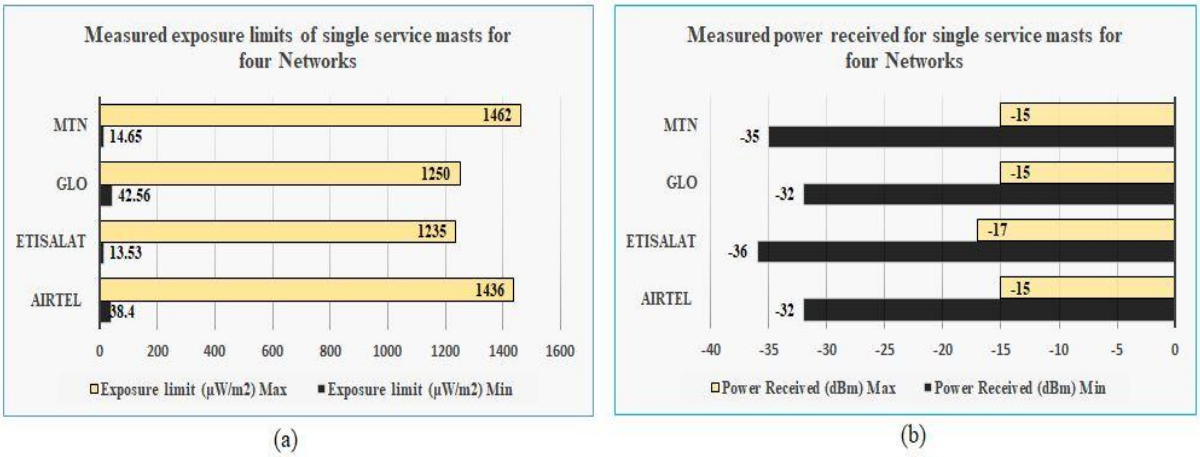

Figure 2: Measurements results of single service mast of four (4) networks: (a) Exposure limits (b) Power received

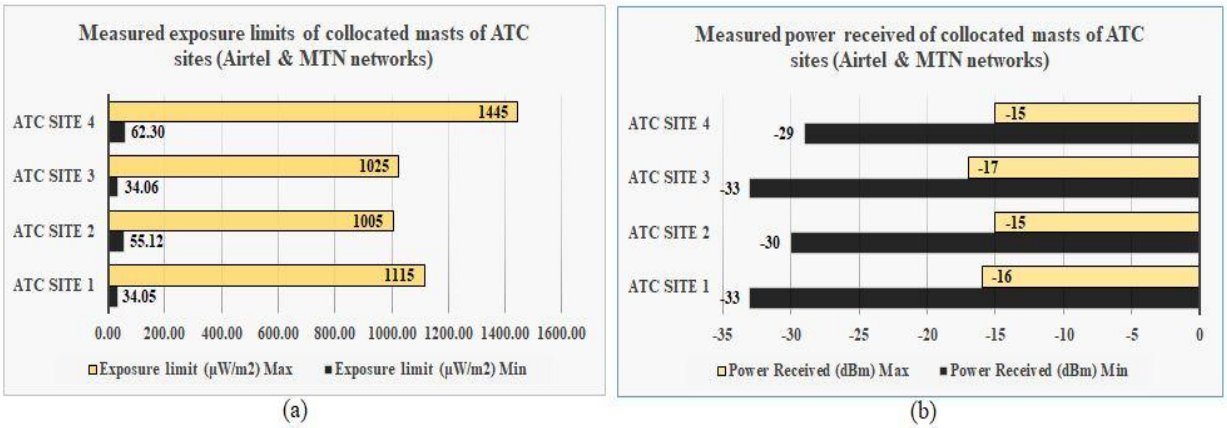

Figure3: Measurements results of collocated mast of ATC Nigeria operating Airtel and MTN networks (a) Exposure limits (b) Power received

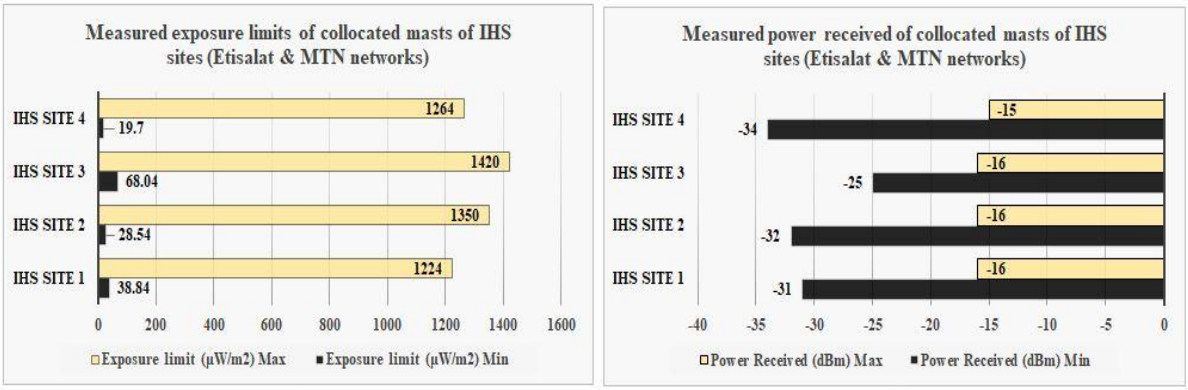

Figure4: Measurements results of collocated mast of IHS Nigeria operating Airtel and MTN networks (a) Exposure limits (b) Power received

The measured results shows that single service provider and collocated servicesmasts in all the measured sitesare operating within the stipulated guidelines.This can be the same in other cities depending on the topology and demography. From the results, the minimum and maximum radiation exposures for IHS collocate serviced towers are 19.70 $\mu W/m^2$ and 1420 $\mu W/m^2$for minimum and maximum received power of – 34 dBm and – 16 dBm respectively.While that of ATC serviced towers are 34.06 $\mu W/m^2$ and 1445 $\mu W/m^2$for -33 dBm and -15 dBm respectively. Similarly,in the case of single service the minimum and maximum radiation exposures are 13.53 $\mu W/m^2$(on Etisalat network) and 1462 $\mu W/m^2$(on MTN network) for minimum and maximum received power of – 36 dBm and – 15 dBm respectively..

With this, we can conclude that both type (single service and collated service)sites have met the safety guideline of maximum radiation limits of 4.5 $W/m^2$for the GSM 900 even though the number of antennas aremuch in collocate facilities. Results obtained equally shows no glaring difference between the two types of masts considered in terms of the exposure limits and power received from the BTS facilities. However, the radiation from collocated service comes from multiple antennas, a minimum of six (6) to (9) as against three (3) in most single service mast. This has therefore raise concern of the public health hazard in comparison with single services. In principle the collocate sites present a high risk of exposure due to multiple of radiations emanating from these antennas.

VI. CONCLUSION

Measurements of power density (exposure limit) and power received of masts for both single service and collocatedservice have been carried out. The study covers some selected BTSs located within populated areas in Damaturu town of Yobe state. The measured results of the radiation exposure for single service and collocate service are within the limit set by the regulatory body. However, based on the location of some of the masts and the multiple antennas radiating electromagnetic field, continuous exposure of these radiation over a long term is of concerned especially for houses located within 25 m radius of the masts. We therefore recommend a compensation to be proposed and/ relocation of such houses within the affected areas be made in addition to existing guideline.

Future work

From the study, we have seen how all the measured masts have met all the safety guidelines outlined by the regulator, on the other hand mobile phone in the Nigeria markets need to meet the SAR value requirements. For this our next study will examine both smart and normal mobile phone used by majority of the citizens.

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