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A Priori Study Of Multi Dwelling Unit Effect On 4G Mobile Network In Ilorin Metropolis

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***Abstract:** This research was geared towards studying the quality of experience (QoE) of the mobile signal received by mobile subscribers' occupants of multi-dwelling units in Ilorin metropolis. The study was done using three mobile signal parametric values of reference signal received power (RSRP) from base transceiver stations, signal packets throughput and latency and ping test success rates for each of the four major mobile vendors providing radio coverage within the Ilorin metropolis. The drive test was conducted along major routes that span across the ancient city's nook and cranny through the professional version and license RantCell network signal monitoring application installed on the android mobile phone. The gauging of the study of the multi-dwelling units on the major network service providers was computationally analyzed showing routes that are clustered in the multi-dwelling units depicted high average signal strength variation along the altitude while the GLO network depicted low latency and high throughput, followed by Airtel, 9mobile and MTN. However, MTN network was observed to be characterized by increased voice and internet traffic majorly along all the four measurement routes.*

***Keywords:** Multi-dwelling units, 4G network, Average Signal Strength and Mobile Subscribers*

I. INTRODUCTION

Diverse reasons and purposes prompt the incursion of rural settlers to the cities of Ilorin, whatever the rationale, this act has put on pressure on the available infrastructural facilities that are available within the metropolis, and the telecommunication carriers are not left out. Quality signal reception has been a long-term demand of mobile subscribers. Any cause of signal degradation within the Ilorin metropolis shall have a pronounced effect on the economy and well-being of the residents of the developing city due to the emerging e-economy. Also in the phases of recent infrastructural developments, the vehicles and trailer courts in the ancient city of Ilorin, mobile subscribers have noticed significant challenges. These include low data speed, high rate of drop calls etc. across all the major mobile carriers providing signal coverage(Babatunde et al., n.d.). This is predominant as mobile signals are known to exhibit wave-like properties of reflection, refraction, diffraction and polarization effects. In contrast, multi-dwelling units are characterized with objects that aid the wave-like properties of the mobile signals. The third and fourth generations (3G & 4G) of the universal mobile telecommunication service (UMTS) are presently the two most engaged services for the city residents. This generation of wireless network defined its set of telephony. This helps described the technological implementation of the system and possible challenges that may prompt the need for better and higher service by the users of the universal equipment. These standards show the major difference between the two sets of generations' networks in terms of speeds, latency and bandwidth management. However, the development of a new network generation comes with additional spectral utility features and qualities. So a 4G network is expected to provide a better Quality of Signal (QoS) than 3G. Still, a generation of networks operating at a high frequency will offer low signal coverage. However, high-

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speed packet access (HSPA) and throughput may result in the possibility of more antennas being needed to enhance the quality of experience (QoE) of the mobile subscribers (Park et al., 2009).

Modern wireless technologies target mobile users and ensure they have access to good QoS whilst in transit or roaming. In the event of rolling out a new mobile generation of mobile signal, coverage area estimation is one of the fundamental factors of network planning to be considered. The universal equipment users need and want to dictate the tone of features for the next possible generation of mobile architecture. These set the stage for theoretical analysis on spectral efficiency, followed up with the study and research of real-time factors that may lead to fading, multipath and attenuation of the mobile signals(*(PDF) Analysis of Mobile Networks Signal Strength for GSM Networks*, n.d.). Therefore, the necessity to study the effect of a multi-dwelling unit on the QoE of the subscribers becomes inevitable if considering the finance incurred on data, airtime and the possible interruption of vital business information and operation that may be altered.

II. OVERVIEW OF A MULTI-DWELLING UNIT

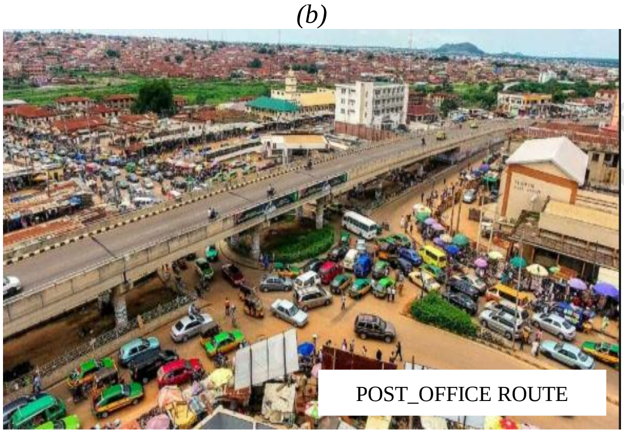
Figure 1: A Sample view of Multi Dwelling Unit

Telecommunication and radio propagation researchers have engaged in various studies and analytical researches on the QoS from mobile vendor and QoE obtained by the subscribers of mobile carriers. This is to provide possible and/or alternative solutions for seamless and efficient mobile connectivity and ensure the subscribers get what they demand from mobile signal operators. On the other hand, it ensures the telecommunication companies get a return on investment for the provision of the mobile signal and offers recommendations on the development of the dwelling unit spread and its ruin on the condition of the network's connectivity (Emmanuel, n.d.). In one-of-a kind research, where t*he comparative study of mobile signal received by mobile subscribers was investigated, in Oleh, Delta State, mobile signal measurements were taken at different sample points randomly selected within the town, intra and inter networks calls were put to test for 3 minutes (180sec) of call durations, and the received signal strength (in dBm) and Cell identification (CID) of the various network operators were recorded using an installed Net-monitor software in a Tecno phantom A3 Andriod phone for a month and the (ante meridiem and post meridiem) times were noted, finally results indicate that MTN has the best quality of signal strength and service followed by AIRTEL, GLO and ETISALAT respectively*. (Nwabueze C. N. *et al, 2016*). *So, it can be inferred that, quality network coverage and spread are factors of good preplanning, planning and post planning of the network rollout. This is because mobile network requires continuous monitoring and maintenance by the vendors to ensure the subscribers got what they bargain* (Song & Shen, 2011). *This is in line with the ambition gazette in the Third Generation Partnership Project (3GPP) of the Long Term Evolution (LTE), where the air interface protocol will be designed to optimal stage for high speed packet access (HSPA) as stated in* (Renni M, *et al*). *Although it must be kept at bay the compliance of vendors on the* exposure limits recommended by ICNIRP (International Commission on Non-Ionizing Radiation Protection), to ensure that users of radio network are not subjected to radiation risk despite the efforts of the mobile vendors to satisfy the service need of the subscribers AAA(*Nishirth D. T. et al*). Another importance service in radio network architecture is the drop call rates, in (Sharma & Sharma, n.d.), the research made used of Key Performance Index to analyze the speech circuit and packet data channels which analytically proved that existing mobile network can be optimized using optimization tools likes TEM'S, MapInfo and fine parameter tuning (*Tems_Investigation.Pdf*, n.d.). The study also provides details on how mobile operators can maintain signal coverage level, improve quality and increase capacity of mobile signal coverage to allow for wireless communications among a specific geographic area, in that case, base stations of mobile communication networks and services must be deployed to allow sufficient radio coverage to every users of mobile equipment for seamless connectivity between the PSTN (public switched telephone network) and the numerous wireless base stations and finally among entire wireless subscribers in the networks system. (Othman, n.d.). This practice is to increase the mobile wireless capacity as described in (*Mobile Wireless Capacity.Pdf*, n.d.), where the economic and technical challenges associated with deepening wireless networks to meet the growing demand was discussed and methods of capacity expansion were classified into three general categories: the deployment of more radio spectrum; more intensive geographic reuse of spectrum; and increasing the throughput capacity of each MHz of spectrum within a given geographic area. Description of several basic methods to deepen mobile wireless capacity has occupied research space to date and has led to the development of the fifth generation (5G) network. The deployment of the multiple input multiple output (MIMO) antenna system is promising in the actualization of the 5G (Casillas et al., n.d.).

Generally, the ease of wireless communication in certain and specific geographic areas is the paramount target of most wireless mobile vendors. Therefore, the Base Transceiver Station (BTS) need be deployed ideally to ensure efficient mobile signal coverage within the multi-dwelling unit as quality reference signal received power must ensure smooth handover from BTS to BTS and seamless exchange of Mobile Subscriber (MS) between BTSs (Halonen et al., 2003). Overall, the possible effect of multi-dwelling unit increment and congestion as depicted in Figure 2 need be given special consideration during pre-planning, planning, launching and post-planning of mobile radio network access (RNA) development.

(a)

(b)



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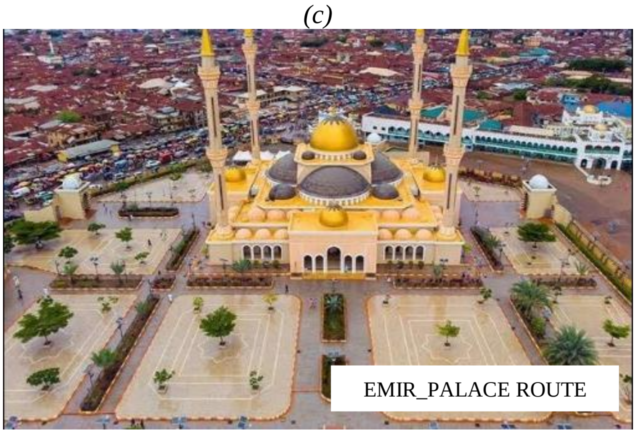

(d)

Figure 2: Major Routes and Locations where Measurement Campaign were conducted (a) GRA Ilorin Route (b) Taiwo_Airport Route (c) Post Office Route (d) Emir_Palace Route

S/N	Routes Name	Routes Features	Routes Span
1	GRA	This route is a two-lanes dual-carriage road that span from the Kwara State Library opposite Central Bank of Nigeria, through Government House Ilorin along Ahmadu Bello way to Tanke Junction, Fate-Basin roundabout, Kwara Shopping Mall to Fate-Zango roundabout, Ilorin. This route comprises storey buildings, which serve as offices majorly to the state government, private organization and are concentrated along the road while the few residential buildings were suburb some meters away from the main road.	1.5 km
2	Taiwo-Airport	This comprises a two lanes dual-carriage road that spans Taiwo Isale, through Queen Elizabeth roundabout diamond underpass to Ilorin International Airport. The route hosts one of the corporate commercial hubs of the state and is always busy with vehicular movement throughout the working hours.	2 km
3	Post Office	This route is also a dual-carriage road and it spans Fate-Zango round about through Maraba, Post Office Flyover, Challenge, A'Division Police Station to Offa Garage roundabout. This route is characterized with shops, motor parks and some motor premium spirit station along it way.	2.5 km
4	Emir Palace	This route is a dual carriage road and spans B'Division Police State Surulere through Baboko, Agaka, C' Division Police State, Emir Palace, Gambari and Ipata Market to UITH midwifery hospital. The route is characterized with ancient buildings, and vehicular movement due to markets being situated therein.	**2.5 km**

Table 1: Measurement Routes Descriptions

III. MEASUREMENT CAMPAIGN

Drive test measurement campaign technique was used for capturing three reference signals received power (RSRP), packet data throughput and ping test. These were used to investigate the effect of Ilorin multi-dwelling spread on the mobile signal reception by the subscribers. The professional

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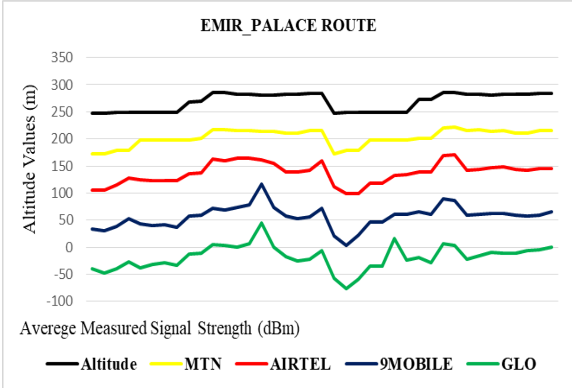
version of the license RantCell mobile test measurement application was employed for the mobile data capturing during the drive test. It was installed on Tecno Pouvrvior 3 plus with HiOS version 5.2 (P-P68-190821) and used as depicted in Figure 3. The mobile system's global positioning and station (GPS) was put on, and an average drive speed of 40 Km/h was maintained throughout the drive test to keep the Doppler effect constant. Fifteen iterations were used for data capturing along each route which span through a month during the After Meridian (AM) and Post Meridian (PM) time of the day. Data filtration and sorting were done before an average reference signal received power strength (dBm) was computed and recorded while both the packet data and ping tests concurrently run on the RantCell mobile application.

Figure 3: The Drive Test Measurement Campaign Set up

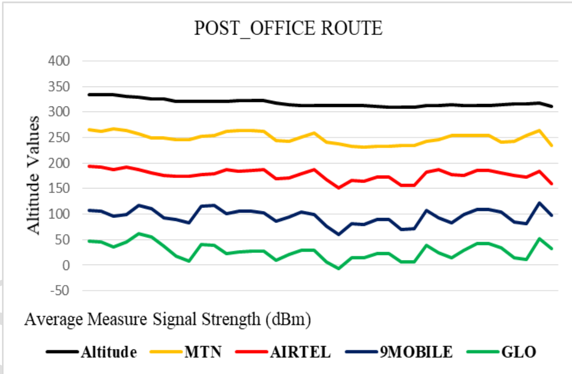
The mobile network for each of the vendor was set at 4G network preferred before the commencement of drive test.

IV. RESULTS AND DISCUSSIONS

The measurement points above the sea level (altitude values) were measured, the longitude and latitude of the measurement points captured concurrently with the mobile signal strength in (dBm) for each of the mobile vendor are as depicted in Figure 4 along the measurement routes.



(a)



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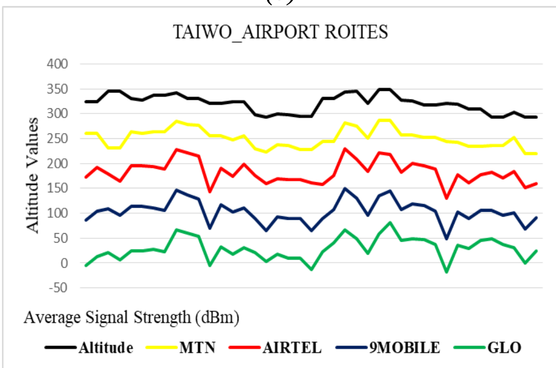

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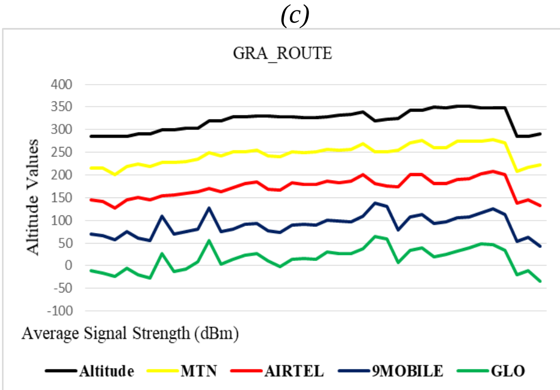

(d)

Figure 4: Altitude and Average Signal Strength Variation along (a) Emir_Palace Route (b) Post_Office Route (c) Taiwo_Airport Route and (d) GRA Route

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Highly filtered and sorted average signal strengths were plotted against the altitude variation values along the four routes as depicted in Figure 4. Firstly, it was observed that GLO signal varied mostly with the altitude variation values, while MTN and Airtel mobile signal varied least with the altitude variation values. Although moderate variation of mobile signal was noticed with 9mobile signal along all the measurement routes. These trends indicate that when the altitude values decrease, the average signal strength of GLO increases towards 0 dBm. However, routes that are characterized with more multi dwelling units spread like Taiwo-Airport and Emir_Palace routes show high variation of the average signal strength while routes with least multi dwelling unit spread like post-office and GRA routes show least variation in the altitude values and average signal strength variation.

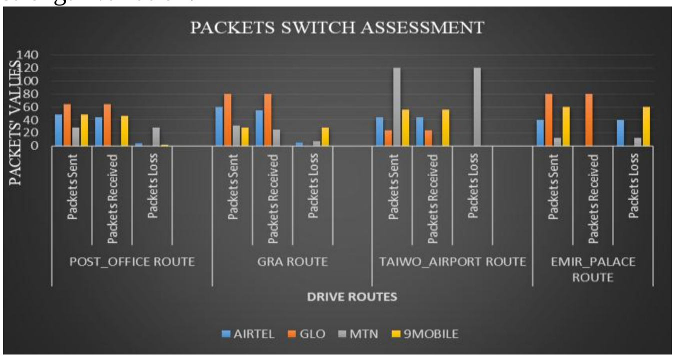
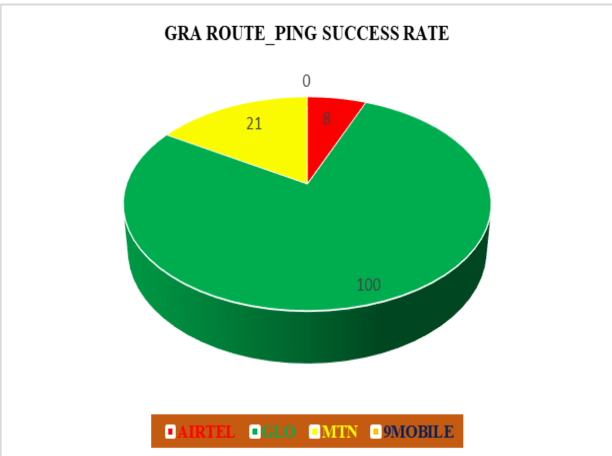
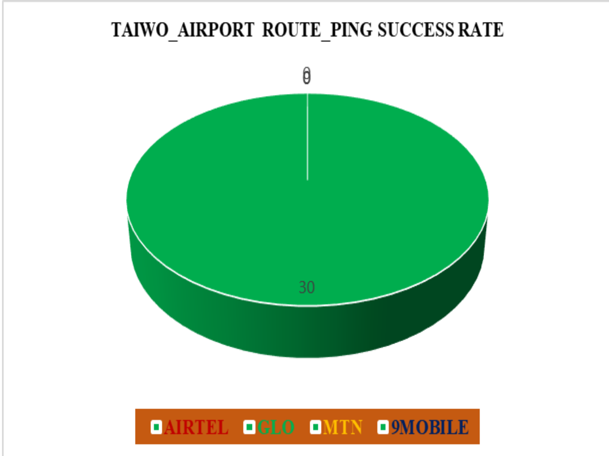
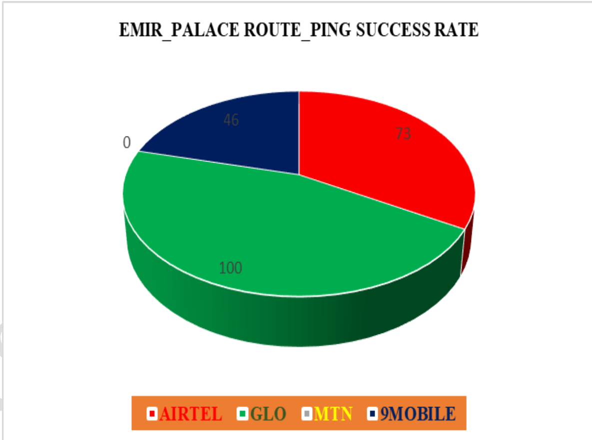


Figure 5: The Packet Switch Rate along all the Four Measurement Routes for Cell Towers

Packets switch rates were measured for all the four measurement routes, to study the latency of each route base on the multi dwelling units spread along the measurement routes. In this regard, high packets of data were recorded along the Taiwo_Airport routes. This observation may be attributed to the concentration of banks and cooperate offices along the route, that required the use of high internet services. For instance, along the Taiwo_Airport route, Airtel, GLO and MTN show low latency while MTN has high latency. However, a critical scenario was observed along Emir_Palace route, only GLO mobile internet service shows low latency while MTN, Airtel and 9mobile depicted high latency. The other two routes of Post_Office and GRA routes depicted moderate latency for all the four mobile vendors' internet services.







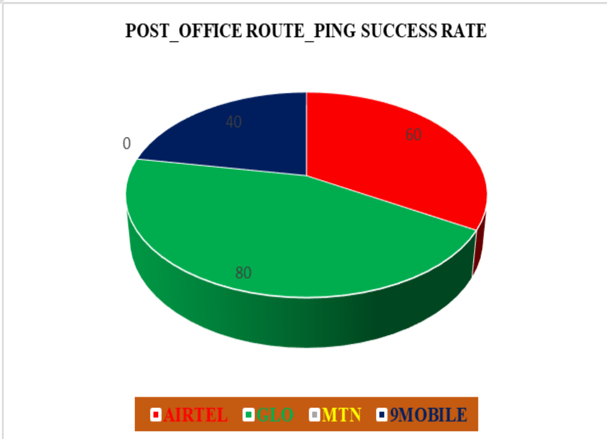


Figure 6: The Ping Success Rate Depiction for each of the Four Mobile Vendor along the Four Measurement Routes

To test for the reachability of a host on internet protocol, the pinging succes rate was employed for all the mobile vendor along the four measurement routes. For all the four measurement routes, GLO network showed high pinging success rate across all the major routes, followed by Airtel and 9mobile networks while MTN network pinging success rate was very poor along all the four measurement routes. The rate of pinging is a factor of the penetration power of mobile signal which depends on the spread of the multi dwelling unit. Therefore, GLO network has demonstrated high penetration power within the multi dwelling units spread due to good coverage and capacity.

V. CONCLUSION

Incoherent arrangement of multi dwelling units spread, across Ilorin metropolis now posed greater challenges to mobile signal reception within the metropolis and at this stage, the act may tend to subverting all the invested planned routine, time, energy and finance incurred for the provision of a voice and internet network services. The Emir palace route which was characterized with heavy human, vehicular traffics and incoherent spread of multi dwelling provides the most significant average signal strength to altitude variation. No doubt as radio signal diffraction and reflection are on the high with the two major markets situated in the metropolis.

Multi-dwelling units spread, whose occupants are elites, bankers and cooperate individuals as obtained in Taiwo_Airport, and GRA routes, all recorded high packets of data, this is in contrary to Emir palace route where voice channels were well covered by all the four major mobile vendors. Airtel, MTN and 9mobile provide poor reachability to the host on the internet protocol interface. In this regard, service may be conditioned based on needs of the majorities of the occupants of a multi dwelling unit, such that if the occupants of a multi-dwelling unit are data demanding, internet coverage should be provided at threshold values, and where voice is mostly demanded, speech channel capacity should be made available. This will save the mobile vendor for providing a service that may not be needed.

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