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Dynamic Power Consumption in Base Transceiver Station in Urban and Rural Setting in Awka, Nigeria using Multi-Attribute Decision-Making Technique

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Abstract :
The goal of this paper was to lower base transceiver station (BTS) dynamic power consumption. A multi-attribute decision-making technique was implemented that reflects the stochastic nature of cellular networks and guarantees cost-effective traffic generation and improved BTS power consumption performance. Every related candidate or attribute that is taken into consideration to help reduce power consumption is given a utility function, and the candidate with the highest utility value is chosen to meet the target. The Utility function that the Technique selects is the weighted sum of the normalized attributes. In contrast to the works of other authors, which lowered consumption by 20%, the developed dynamic power consumption model cut consumption to 25.14 percent. The two BTS of interest were measured, and the results showed that Mgbakwu BTS has two Peak (Busy) Hour periods: in the morning, 9.55Erlangs from 7.30am to 8.30am, and in the evening, 10.7Erlangs from 8.30pm to 9.30pm. The BTS is located in a rural/residential area. The BTS measurement and analysis for the UNIZIK temporary site revealed that it is located in a commercial/business setting with a morning peak (busy) hour period of 19.1 Erlangs between 10 and 11 a.m. 14.6 Erlangs is the afternoon peak hour, which runs from 3.30 to 4.30 p.m. The traffic generated in the BTS under various load situations is reflected in the relevant Power Consumption for both BTS.

Keywords *– Base Transceiver Station, Dynamic Power Consumption, Cost-effective Traffic Generation, Multi-attribute decision-making technique*

I. Introduction

The Nigerian Telecommunications Limited (NITEL) was the only operator in Nigeria providing coordinated telecommunication services, supplying exclusively fixed or landline telephone and telex services, until September 21, 2001 [1]. Base transceiver stations (BTS) and transmission masts (towers) were installed in greater numbers as a result of the growing demand for new and dependable mobile services following Nigeria's deregulation of the telecom sector. The conventional understanding of BTS deployment makes the assumption that continuous operation is required to ensure Quality of Service (QoS) at all times and locations. With almost 50% of the total network power consumed, BTSs are the component of the cellular mobile network that uses the most energy [2]. In the context of today's globalization, telecommunications are vital to people's daily lives. Based on the traffic generated by BTS and the power consumption, a power consumption model was created. Energy efficiency was examined between different loads, such as low and high traffic, because the BTS has two components for power usage. Both the static power consumption, which is a power figure that is consumed in an empty BTS, and the dynamic power consumption, which varies depending on traffic and load, are covered in the first section. A portion of the dynamic power consumption adds to the static, depending on the load conditions. Only the dynamic power consumption in relation to traffic and load was taken into account in this work. After Nigerian telecommunications services were deregulated, private operators with disparate systems began to appear in the country in an unorganized fashion. By the end of 2002, subscriptions had increased, and system compatibility and quality of service (QoS) became a problem [3]. The number of BTS built in Nigeria has expanded as a result of growing demand in new and dependable services in the areas of Internet and mobile wireless communications.

Furthermore, in order to ensure QoS—such as low latency, delays, high throughput, seamless handoffs, call setup success rate, minimized interference and provide high reliability regardless of bandwidth availability and failure frequency etc.—wherever and at any time, the conventional notion of BTS deployment requires continuous operation [4], [5], [6], [7]. Currently, there are over four billion phone subscribers globally [8], which is equivalent to more than half of the world's population. The number of subscribers and various data applications, including voice over internet protocol (VoIP), video streaming, content downloading, gaming, and social media applications, are clearly driving up the power consumption of mobile wireless networks. In addition, wireless mobile communication network operators are installing more base transceivers (BTS) in their infrastructure, which is driving up energy consumption. Information and communication technology (ICT) accounts for about 600 Tera-Watt Hour (600TWh), or 3%, of the world's electrical energy consumption in recent years. By 2030, it is predicted that ICT energy consumption will reach 1,700TWh [9]. To lower the ICT sector's energy consumption and, at the same time, boost telecommunication system performance, innovative solutions must be developed. As a result, examining BTS power consumption as the primary energy consumed in wireless cellular networks has grown in importance as a research topic recently [10]. Precise knowledge regarding BTS Power Consumption and the impact of traffic/loads on the instantaneous BTS Power Consumptions can be very valuable in understanding the Power Consumption of a specific configuration of cellular networks. It was generally believed that variations in traffic and loads had an impact on BTS power consumption [11],[12]. The power consumption of the entire system must be tracked, evaluated, and an acceptable Energy Efficiency Evaluation (E3F) made public in order to quantify energy savings in wireless networks. Since wireless cellular networks make up a sizable portion of the ICT industry, examining a specific BTS's power consumption can help reduce the frequency with which BTS power analyses of the same configuration under actual traffic and load conditions are measured. For this reason, two BTS locations—one at the UNIZIK temporary site in Awka, Anambra State, and the other at Mgbakwu, a rural suburb of Awka, Anambra State, Nigeria—were utilized as case studies.

2.0 Theory of Power Saving Techniques in BTS

The analytical framework presented in [13],[14] can be used to create a hierarchical Energy Management System (EMS) that will allow neighboring BTS to share energy. The Global System for Mobile Communication (GSM), a Second-Generation network upgraded to a Third-Generation network, and the Universal Mobile Telecommunication System (UMTS), a Third-Generation network upgraded to a Fourth-Generation network (3G/4G) with a frequency band of 900MHz and 2100MHz, respectively, are two examples of new researches aimed at reducing Power Consumption in Wireless Cellular Access Networks [15];

i. **Component Level:** Research focuses mostly on the linearity and efficiency of the Power Amplifier (PA) at the component level. Efficiency can be increased by applying techniques like signal (envelope) tracking or the Crest Factor Reduction (CFR) method, as well as by using specially designed Power Amplifiers (PA) like the Doherty or special materials for PA transistors like high frequency materials like Silicon (Si), Aluminium Gallium Nitride (AlGaN), Gallium Arsenide (GaAs), or Gallium Nitride (GaN) [16]. In order to improve the efficiency of the PA, CFR is a technique that lowers the transmitted signals' Peak to Average Power Ratio (PAPR). By clipping, CFR lowers the output Peak to Average ratio and permits higher gain on the CFR's output. To improve linearity, the PA can employ a digital pre-distortion technique to cancel out distortion [15]. Using Digital Signal Processor (DSP) of Field Programmable Gate Array (FPGA) Architectures of Integrated Circuits (ICs), which are typically coupled to achieve efficiency, can lower the Power Consumption of Digital Signal Processing. The portion of the transceiver that manages all digital signal processing for a single transceiver is called the signal processing unit (SPU). The Direct Current Distribution Unit (DCDU) in BTS performs AC/DC conversion. Its efficiency can be increased even under conditions of high traffic and load by utilizing high efficiency converters. DCDUs are Rectifier Units that transform Alternating Current (AC) from Public Power Supplies or Generators into Direct Current (DC), typically between 44 and 52volts DC (from 220 V AC). Typically, the battery is supplied in banks of two cascaded to provide a DC voltage between 44 and 52 volts. The battery is in charging mode if the generator or public supply are operating. This indicates that the battery is in the float state. The air conditioning system uses the greatest power, which can be minimized by lowering the BTS models' operating temperature or by adding extra components as heat exchangers (extractors), smart fans, or heating modules [16]. Moreover, energy savings can be attained by the use of distributed BTS architecture, in which the Remote Radio Unit (RRU), also known as the Ratio Frequency Equipment, is positioned close to the antenna to reduce cable losses. The frequency used for radio transmission is called radio frequency (RF) [17].

ii. **Link level:** The Transmission Technique on the Air Interface has the ability to save energy at the link level. The link level here takes into account potential Sleep Modes of various BTS, wherein some can be turned off for a predetermined amount of time. Cell Wilting and blooming approaches can be used to boost the Energy Efficiency of the BTS provided by sleep models. By gradually lowering the BTS Transmit Power, a technique known as "cell wilting" or "progressive switch-off" can be used to prevent call drops or any disruption of ongoing calls or sessions. Cell blooming, also known as progressive switch-on, is a technique that prevents denial of service and cell dropouts by gradually increasing the BTS's power to its typical goal amount. The design of BTS sleep-and-wake-up-transients was done using a gradual BTS switching-OFF and ON method. Nevertheless, research indicates that these brief periods do not significantly affect the energy savings realized from sleep mode operations [18].

iii. **Network level:** One of the most popular methods for lowering power consumption at the network level is Dynamic Management of Network Resources, which enables the complete BTS to be turned off during periods of low traffic or load. When this occurs, nearby BTS are required to cover the traffic and load of the BTS that are switched off [19]. Coordinated Multipoint Transmission and Reception, Antenna Tilting, Multi-chip relaying, and Dynamic Transmit Power Selection can all be used in conjunction with this shut-down [20]. Nonetheless, some programs are predicated on the potential for energy or power savings through collaboration amongst rival operators offering services in the same coverage area, such as cities (co-location). The plan is for one Operator to fully deactivate its BTS during periods of low traffic or load, while the second Operator's BTS continues to accept subscribers from both Operators. A 20% reduction in power consumption is possible using this method [21].

2.1 Power Consumption in Information and Communications Technology (ICT)

When operating from an angle, the information and communications technology sector consumes around 600 Tera-Watt Hour (TWh), or 3% of the global total electrical power. It is predicted that by the end of 2030, this number will have increased and will be 1700TWH [9]. Only 10% of the total power consumption in wireless access technologies is related to mobile stations or mobile terminal users; the remaining 90% is absorbed by network equipment, of which two third is used by base transceiver stations (BTSs) [22]. Communications equipment consumes one third of the total power in ICTs. Furthermore, due to its rapid expansion, ICT Network has emerged as a significant player in the wireless communication industry. The need for better base terminal equipment is being driven by the daily increase in subscribers in the field of wireless cellular access technologies. It is becoming increasingly crucial to rely on renewable energy resources at specific coverage areas, primarily in remote locations, to decrease maintenance costs and provide sustained QoS and efficient power consumption. Figure 1 makes it evident that the BTS's operation and maintenance department as well as the cooling (air conditioning) system components need a significant amount of power. The feeder lines (Optic Fibre Cables, or OFC) in the BTS consume a significant amount of power, which is needed for radio signal transmission. Rectifier units, PAs, DSP units, and other electronic equipment also contribute to the total power consumption [22].

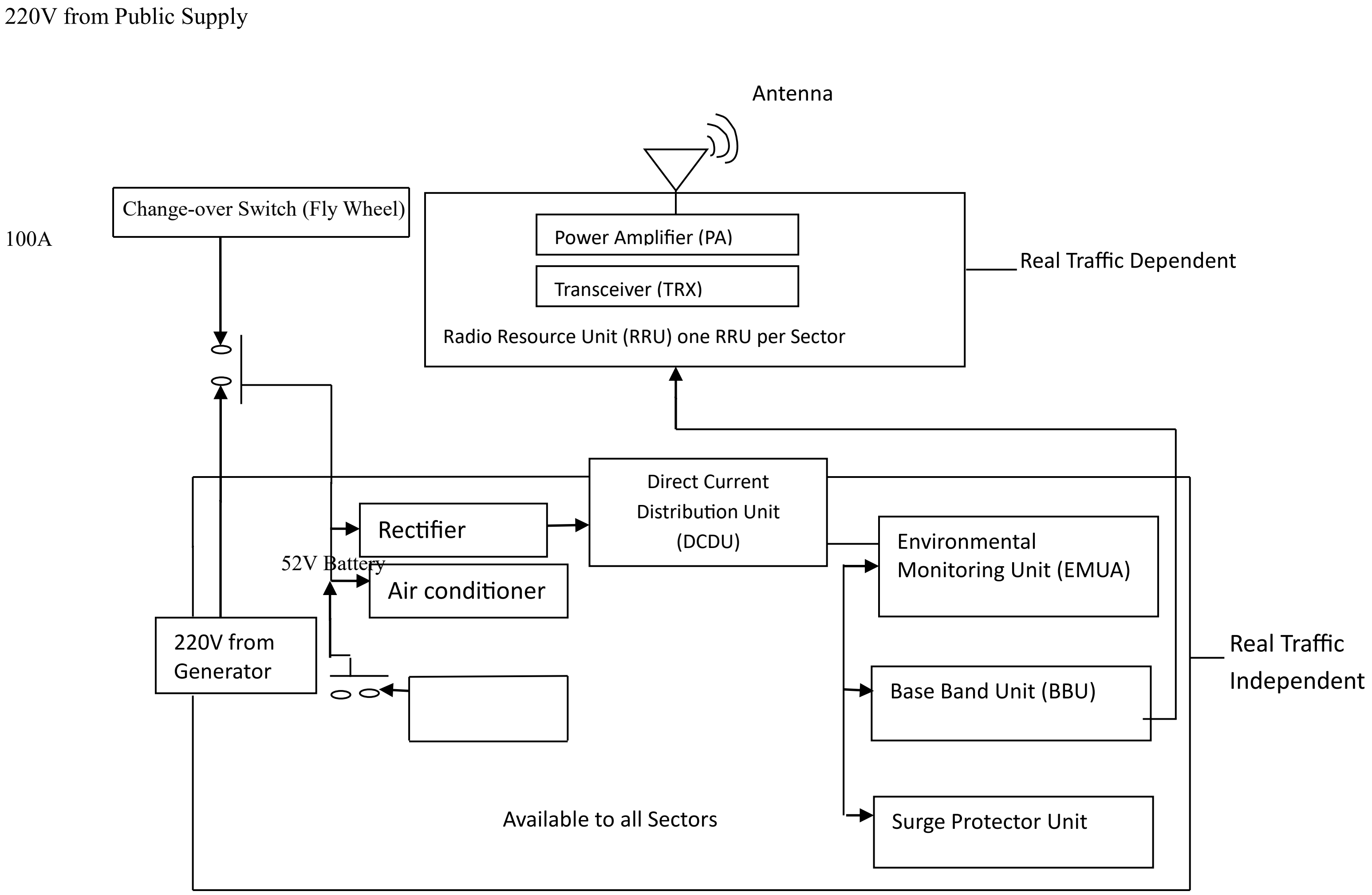

Figure 1: Components of a BTS Power Supply: Source – [22]

The transmission carrier power, which carries or conveys traffic to the intended destination, is of interest in this case. The effect of traffic intensity on BTS power consumption demonstrates that BTS power consumption changes instantly based on traffic and load [22].

3.0 Methodology

3.1 Development of a Multi-Attribute Decision Making Technique to minimize Power Consumption in Networks.

When building the developed model, the following characteristics that will reduce or save power consumption in a BTS were taken into account:

- There is possibility of Wake/Sleep mode in the Network
- There is Cell Wilting/Blossoming Techniques
- Adequate dimensioning in the BTS to ensure Traffic during Peak Hours does not exceed installed Capacity (Minimize Call Drop)
- That an overflow or alternative route exist to cater for Traffic surge
- That the Network has Quality Transmission Link (Backbone)
- That the Network Power Consumption is reasonable without incessant interruptions
- A Co-Location arrangement exists where two BTS could be housed in same building

- That a serving BTS can transfer Traffic to a Co-located BTS in case of shut downs

In this research, we use a Multiple Attribute Decision Fusion Model based on the Intuitionist Fuzzy Sets (MADF-IFS) Model to provide a specific application situation that is likely to worsen energy wastage and decrease power consumption. Figure 2 displays the MADF-IFS Model in BTS Power Consumption.

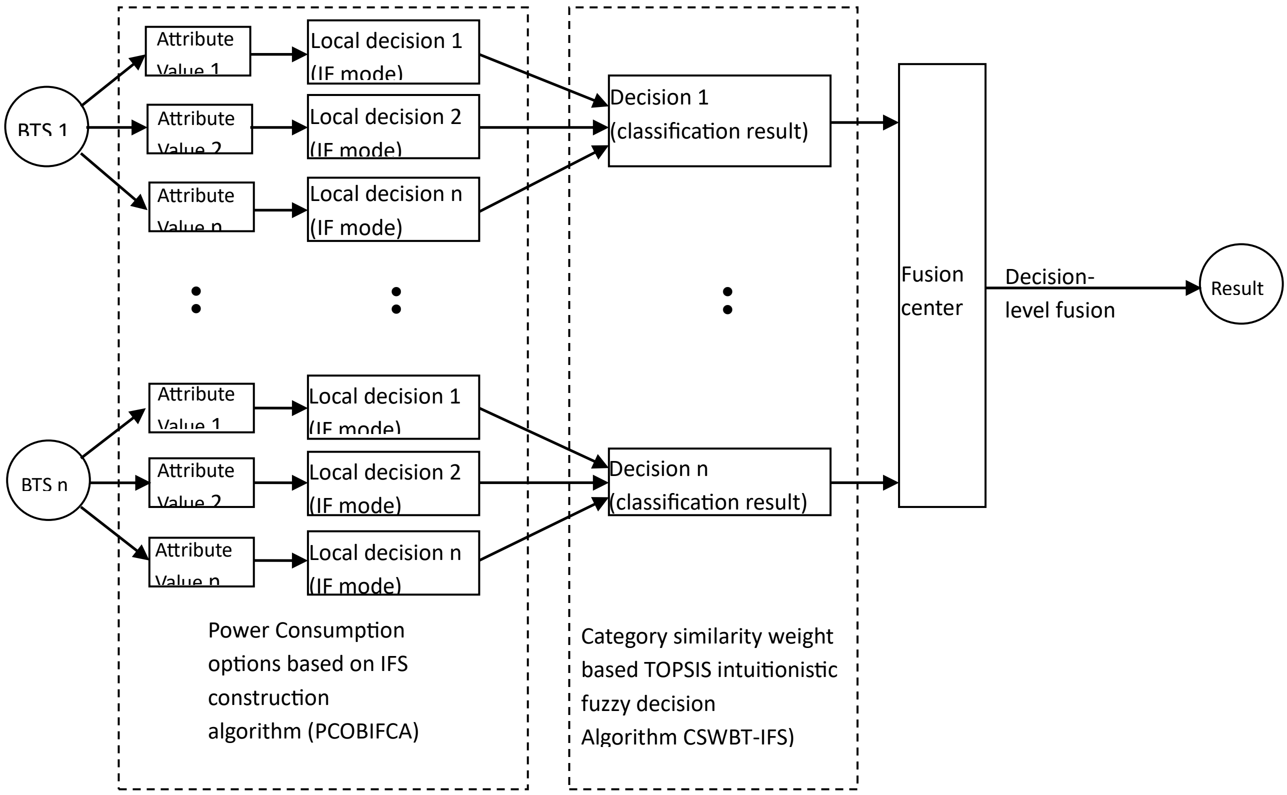

Figure 2: MADF-IFS Model in BTS Power Consumption

Following the Data Acquisition procedure, each BTS converts each attribute value into a set of IF values, or the target's membership degree for all conceivable categories in each attribute, in accordance with the algorithm. The Category Similarity Weight-Based Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) intuitionist Fuzzy Decision (CSWBT-IFS) Algorithm is then used by each BTS to combine the IF values into a single categorization decision. The combined decisions are then forwarded to Fuzzy Construction (FC). The FC reduces Power Consumption in the target BTS by combining the local judgments it has received to arrive at a final outcome determined by Fusion Rules. In order to confirm that quality signals are propagated throughout the network and that the service provider is providing QoS services, the test-bed of the 4G network under examination was characterized. An extensive on-site power consumption measurement was conducted at fully operational BTS Cell sites at UNIZIK temporary Site, Awka and Mgbakwu Rural Community in Awka North Local Government Area; both locations being high Capacity and low Capacity BTS, respectively, in order to investigate the interdependence between BTS Power Consumption and real Traffic/Loads. Measurements of power consumption were conducted using various transceiver configurations and BTS architectures for GSM900 and UMTS 2100 wireless cellular access technologies. Measurements were conducted over the course of two weeks, from July 02, 2022, to July 15, 2022, with averages being recorded for characterization reasons. A particular remark was made regarding the traffic created in both BTS: every 30 minutes, the relevant traffic equipment is scanned 50 times by the Basic 6.0 Simulator in the Direct Route Traffic Recorder (DRTR) in the BTS. All that the DRTR is, is a meter counter that tracks occupancy and shows you when Stepping is taking place on the routes and junctors.

3.2 Transmitted and Received Traffic

The Agilent 89600 Vector Signal Analyzer was utilized to monitor traffic, with a receiving antenna placed in close proximity to the transmitting node (see Figure 3 for the setup). This configuration emulates the BTS and functions as the DRTR, scanning the equipment fifty times every thirty minutes. The same instrument was also used to confirm received traffic, but this time the receiving antenna was situated near the sink. The Direct Route Traffic Recorder (DRTR) records and displays, through software, the waveforms received by the antenna in the time and frequency domains as well as the Traffic/Load.

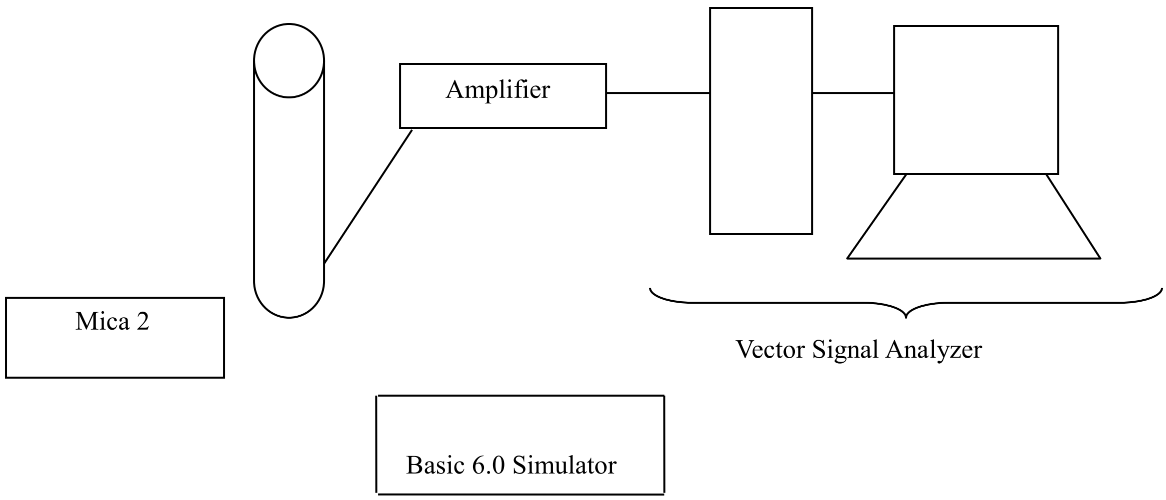

Figure 3: Equipment Set-Up for Tracking DRTR Counter in BTS – Researcher

3.3 Measurement Environment

Awka Urban was located using the Google Map Location Finder and the site coordinates (Figure 4); the beacons for Mgbakwu BTS and UNIZIK Temporary site are displayed in Figures 5 and 6, respectively. The entire scenario under consideration comprises of a BTS site with three sectors positioned at various azimuths to cover the designated Area. Utilizing a predetermined GPS clock, the sites are synchronized. The diameter of the cell is roughly 350 meters.

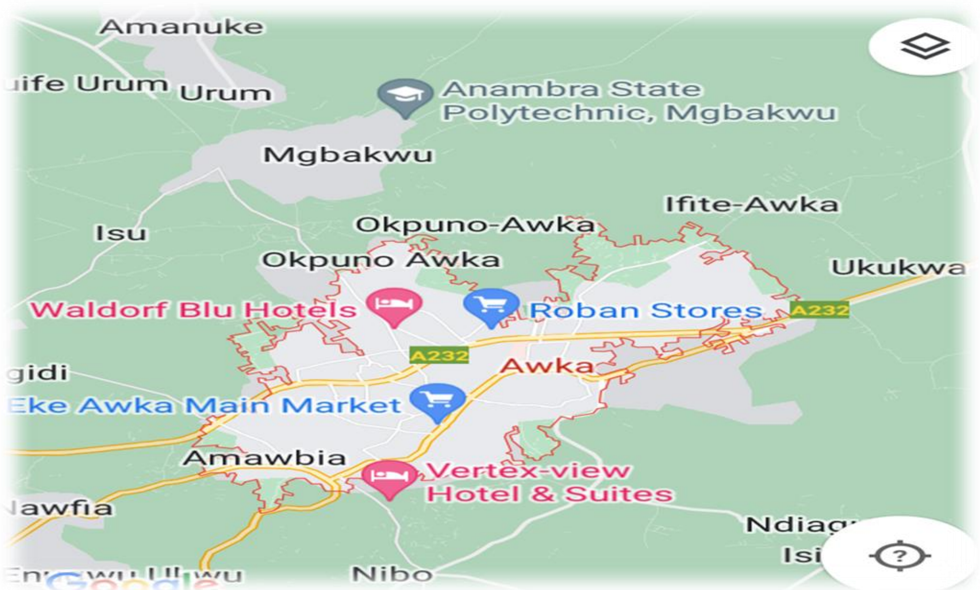

Figure 4: Google Map– Awka Urban and surrounding Rural Communities

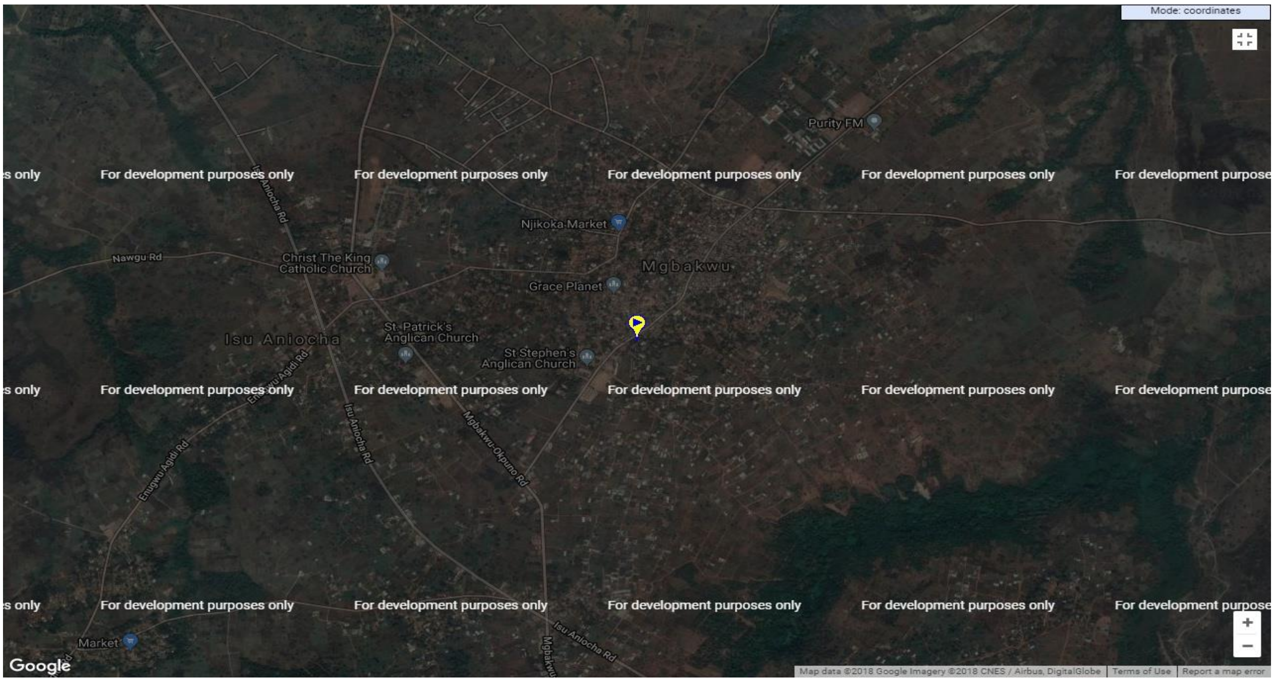

Figure 5: Google Map of BTS at Mgbakwu.

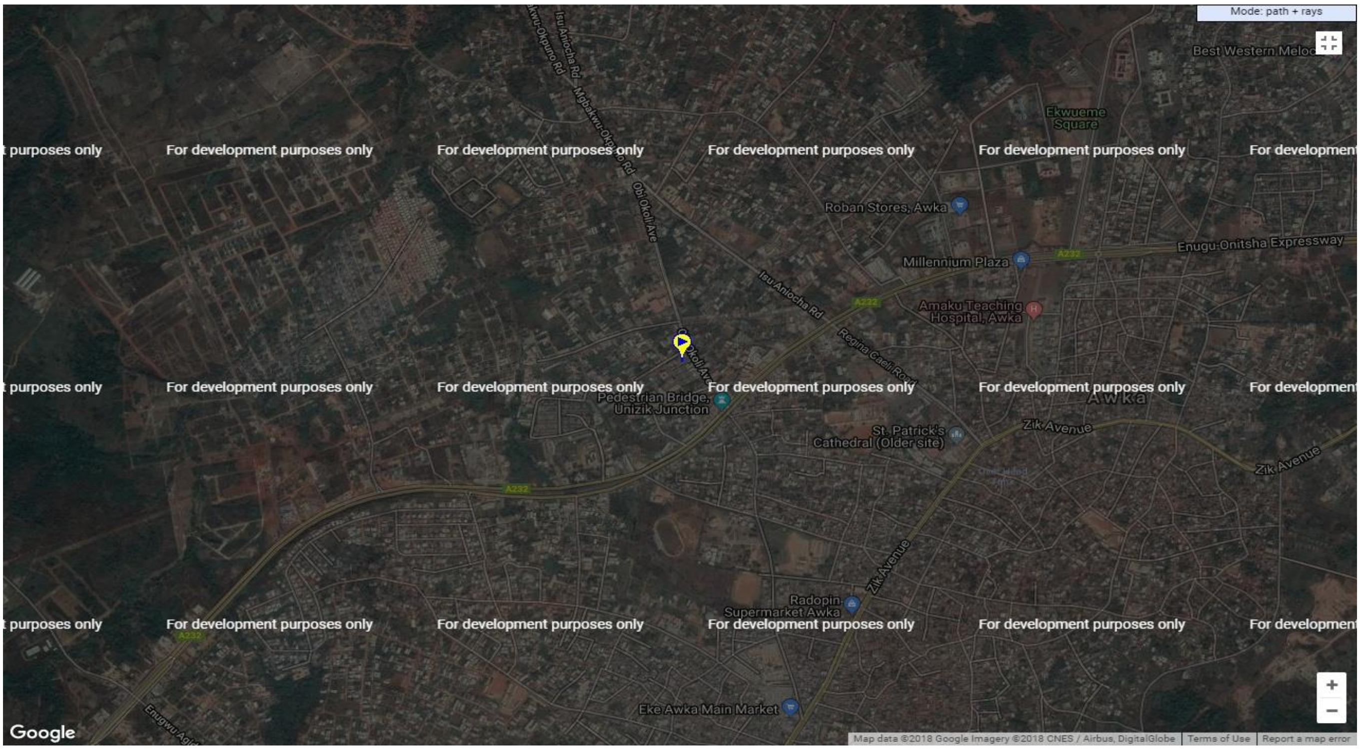

Figure 6: Google Map of UNIZIK Temporary Site BTS

4.0 Results and Discussions

4.1 Real time Measurement at UNIZIK Temporary Site Awka BTS and Mgbakwu BTS site at Awka North LGA, Anambra State.

Table 1: DRTR Average Traffic Occupancy (Counter) generated at UNIZIK temporary site BTS, Awka:

TIME of the Day (30 mins	00.00-	00.30-	01..00-	01.30-	02.00-	02.30-	03.00-	03.30-	04.00-	04.30-

interval)	00.30	01.00	01.30	02.00	02.30	03.00	03.30	04.00	04.30	05.00
Final Counter Initial Count	0 0	0 0	5 0	10 5	20 10	35 20	46 35	70 46	104 70	228 104

TIME (30 minutes interval)	05.00-05.30	05.30-06.00	06..00-06.30	06.30-07.00	07.00-07.30	07.30-08.00	08.00-08.30	08.30-09.00	09.00-09.30	09.30-10.00
Final Reading Initial Reading	360 228	373 360	808 373	1383 808	1882 1373	2165 1882	2442 2165	2897 2442	3735 2897	4577 3735

TIME (30 minutes interval)	10.00-10.30	10.30-11.00	11..00-11.30	11.30-12.00	12.00-12.30	12.30-13.00	13.00-13.30	13.30-14.00	14.00-14.30	14.30-15.00
Final Reading Initial Reading	5587 4577	6487 5587	7304 6487	8116 7304	8131 8116	8871 8131	9594 8871	10095 9594	10870 10095	11581 10870

TIME (30 minutes interval)	15.00-15.30	15.30-16.00	16..00-16.30	16.30-17.00	17.00-17.30	17.30-18.00	18.00-18.30	18.30-19.00	19.00-19.30	19.30-20.00
Final Reading Initial Reading	12296 11581	13021 12296	13757 13021	14372 13757	14477 14372	14677 14377	15273 14677	15717 15273	16107 15717	16452 16107

TIME (30 Minutes interval)	20.00-20.30	20.30-21.00	21.00-21.30	21.30-22.00	22.00-22.30	22.30-23.00	23.00-23.30	23.30-00.00
Final Reading Initial Reading	16687 16453	16825 16687	16939 16825	16989 16939	16989 `6989	16989 16989	16989 16989	16989 16989

At 12Midnight (00.00 Hours) the DRTR automatically resets to Zero and starts fresh occupancy for the new day.

Conversion of DRTR Traffic Occupancy generated at UNIZIK temporary site BTS to Erlang
For each 30minutes time interval: Deduct initial Counter Reading from Final Counter Reading and divide by 50 (DRTR Scanning time).

Illustration: By 16.00hrs to 16.30hrs (4p.m to 4,30pm);

The Reading in Erlang is: 13757 – 13021 = 736

Hence Erlang within the interval (16.00hrs to 16.30hours) is 736/50 =14.72E

The sequence is followed for the whole day from 00.00hrs.

Table 2: Conversion of DRTR Occupancy of UNIZIK temporary site BTS, Awka to Erlang

TIME (30 minutes interval)	00.00-00.30	00.30-01.00	01..00-01.30	01.30-02.00	02.00-02.30	02.30-03.00	03.00-03.30	03.30-04.00	04.00-04.30	04.30-05.00
Traffic in Erlang (E)	0	0	0.1	0.1	0.2	0.3	0.22	0.48	0.68	2.48
TIME (30 minutes interval)	05.00-05.30	05.30-06.00	06..00-06.30	06.30-07.00	07.00-07.30	07.30-08.00	08.00-08.30	08.30-09.00	09.00-09.30	09.30-10.00
Traffic in Erlang (E)	2.64	0.26	8.7	11.5	9.98	5.66	5.54	9.1	16.76	16.84

TIME (30 minutes interval)	10.00-10.30	10.30-11.00	11..00-11.30	11.30-12.00	12.00-12.30	12.30-13.00	13.00-13.30	13.30-14.00	14.00-14.30	14.30-15.00
Traffic in Erlang (E)	20.2	18.0	16.34	16.24	0.3	14.8	14.46	10.02	15.5	14.22

TIME (30 minutes interval)	15.00-15.30	15.30-16.00	16..00-16.30	16.30-17.00	17.00-17.30	17.30-18.00	18.00-18.30	18.30-19.00	19.00-19.30	19.30-20.00
Traffic in Erlang (E)	14.3	14.5	14.72	12.3	2.1	4.0	12.3	8.5	7.8	5.64

TIME (30 Minutes interval)	20.00-20.30	20.30-21.00	21.00-21.30	21.30-22.00	22.00-22.30	22.30-23.00	23.00-23.30	23.30-00.00
Traffic in Erlang (E)	4.68	2.76	2.28	1.0	0	0	0	-0

For Daily Busy (Peak) Hour Period:

Add Two adjoining 30minutes Erlang readings and divide by Two. The Two adjoining consecutive 30 minutes interval with the highest reading is the Busy Hour for the Period, say Morning or Night.

Illustration:

From 00.00 to 00.30; Erlang = 0,

From 00.30 to 01.00: Erlang = 0; So, for One hr (00.00 – 01.00), Erlang = $\frac{0+0}{2}$ = **0E**

From 01.00 to 01.30: Erlang = 0.1, So, for One hr (00.30 – 01.30), Erlang = $\frac{0+0.1}{2}$ = **0.05E**

01.30 to 02.00: Erlang = 0.1; So, for One hr (01.00 – 02.00), Erlang = $\frac{0.1+0.1}{2}$ = **0.1E**

The sequence continues

..

From 08.00 to 08.30: Erlang = 5.54

From 08.30 to 09.00: Erlang = 9.1, So, for One hr (08.00 – 09.00), Erlang = $\frac{5.54+9.1}{2}$ = **7.32E**

From 08.30 to 09.00: Erlang = 9.1

From 09.00 to 09.30: Erlang = 16.76. So, for One hr (08.30 – 09.30), Erlang = $\frac{9.1+16.76}{2}$ = **12.93E**

From 09.30 to 10.00: Erlang = 16.84. So, for One hr (09.00 – 10.00), Erlang = $\frac{16.76+16.84}{2}$ = **16.8E**

From 10.00 to 10.30: Erlang = 20.2. So, for One hr (09.30 – 10.30), Erlang = $\frac{16.84+20.2}{2}$ = **18.52E**

From 10.30 to 11.00: Erlang = 18. So, for One hr (10.00 – 11.00), Erlang = $\frac{20.2+18}{2}$ = **19.1E**

From 15.30 to 16.00: Erlang = 14.5. So, for One hr (15.00 – 16.00), Erlang = $\frac{14.3+14.5}{2}$ = **14.4E**

From the foregoing, Daily Hourly Traffic in Erlang for UNIZIK Temp. Site BTS:

Morning Busy Hour Traffic: **19.1Erlang by 10.00am to 11.00am**

Afternoon Busy Hour Traffic: **14.61Erlang by 3.30pm to 4.30pm**

Table 3: DRTR Average Traffic Occupancy (Counter) generated at Mgbakwu BTS Awka North LGA, Anambra State:

TIME of the Day (30 mins interval)	00.00-00.30	00.30-01.00	01..00-01.30	01.30-02.00	02.00-02.30	02.30-03.00	03.00-03.30	03.30-04.00	04.00-04.30	04.30-05.00
Final Counter Initial Count	0 0	0 0	5 0	8 5	15 8	32 15	50 32	90 50	110 90	148 110
TIME (30 minutes interval)	05.00-05.30	05.30-06.00	06..00-06.30	06.30-07.00	07.00-07.30	07.30-08.00	08.00-08.30	08.30-09.00	09.00-09.30	09.30-10.00
Final Reading Initial Reading	192 148	300 192	610 300	905 610	1245 905	1800 1245	2200 1800	2600 2200	3080 2600	3100 3080
TIME (30 minutes interval)	10.00-10.30	10.30-11.00	11..00-11.30	11.30-12.00	12.00-12.30	12.30-13.00	13.00-13.30	13.30-14.00	14.00-14.30	14.30-15.00

Final Reading Initial Reading	3302 3100	3525 3302	3700 3525	3912 3700	4120 3912	4229 4120	4516 4229	4730 4516	4930 4730	5196 4930

TIME (30 minutes interval)	15.00-15.30	15.30-16.00	16..00-16.30	16.30-17.00	17.00-17.30	17.30-18.00	18.00-18.30	18.30-19.00	19.00-19.30	19.30-20.00
Final Reading Initial Reading	5215 5196	5310 5215	5621 5310	5923 5621	6112 5923	6300 6112	6433 6300	6618 6433	7000 6618	7529 7000

TIME (30 Minutes interval)	20.00-20.30	20.30-21.00	21.00-21.30	21.30-22.00	22.00-22.30	22.30-23.00	23.00-23.30	23.30-00.00
Final Reading Initial Reading	7932 7529	8544 7932	9000 8544	9200 9000	9255 9200	9255 9255	9255 9255	9255 9255

At 12Midnight (00.00 Hours) the DRTR automatically resets to Zero and starts fresh occupancy for the new day.

For each 30minutes time interval: Deduct initial Counter Reading from Final Counter Reading and divide by 50 (DRTR Scanning time).

Illustration: By 05.00hrs to 05.30hrs (5a.m to 5.30am);
The Reading in Erlang is: 192 – 148 = 44
Hence Erlang within the interval (05.00hrs to 05.30hours) is $\frac{44}{50}$ = 0.88E
Repeat the sequence as was done for UNIZIK BTS for the whole day from 00.00hrs.

Table 4: Conversion of DRTR Traffic Occupancy generated at Mgbakwu BTS to Erlang

TIME (30 minutes interval)	00.0 00.30	00.30-01.00	01..00-01.30	01.30-02.00	02.00-02.30	02.30-03.00	03.00-03.30	03.30-04.00	04.00-04.30	04.30-05.00
Traffic in Erlang (E)	0	0	0	0	0.3	0.34	0.36	0.8	0.4	0.76
TIME (30 minutes interval)	05.00-05.30	05.30-06.00	06..00-06.30	06.30-07.00	07.00-07.30	07.30-08.00	08.00-08.30	08.30-09.00	09.00-09.30	09.30-10.00
Traffic in Erlang (E)	0.88	2.16	6.2	5.9	6.8	11.1	8.0	8.0	9.6	0.4
TIME (30 minutes interval)	10.00-10.30	10.30-11.00	11..00-11.30	11.30-12.00	12.00-12.30	12.30-13.00	13.00-13.30	13.30-14.00	14.00-14.30	14.30-15.00
Traffic in Erlang (E)	4.04	4.46	3.5	4.24	4.16	2.18	5.74	4.28	4.0	5.32

TIME (30 minutes interval)	15.00-15.30	15.30-16.00	16..00-16.30	16.30-17.00	17.00-17.30	17.30-18.00	18.00-18.30	18.30-19.00	19.00-19.30	19.30-20.00
Traffic in Erlang (E)	0.38	1.9	6.22	6.04	3.78	3.76	2.66	3.7	7.64	10.58

TIME (30 minutes interval)	20.00-20.30	20.30-21.00	21.00-21.30	21.30-22.00	22.00-22.30	22.30-23.00	23.00-23.30	23.30-00.00
Traffic in Erlang (E)	8.06	12.24	9.12	4.0	1.1	0	0	0

For Daily Busy (Peak) Hour Period: Add the two adjoining 30minutes Erlang readings and divide by Two. The Two adjoining consecutive 30 minutes interval with the highest reading is the Busy Hour for the Period, say Morning or Night.

The One Hour interval that records the highest Value is the Busy Hour for the Day or Night.

Morning Busy Hour Traffic: **9.55Erlang by 07.30am to 08.30am**

Evening Busy Hour Traffic: **10.7Erlang by 8.30pm to 9.30pm**

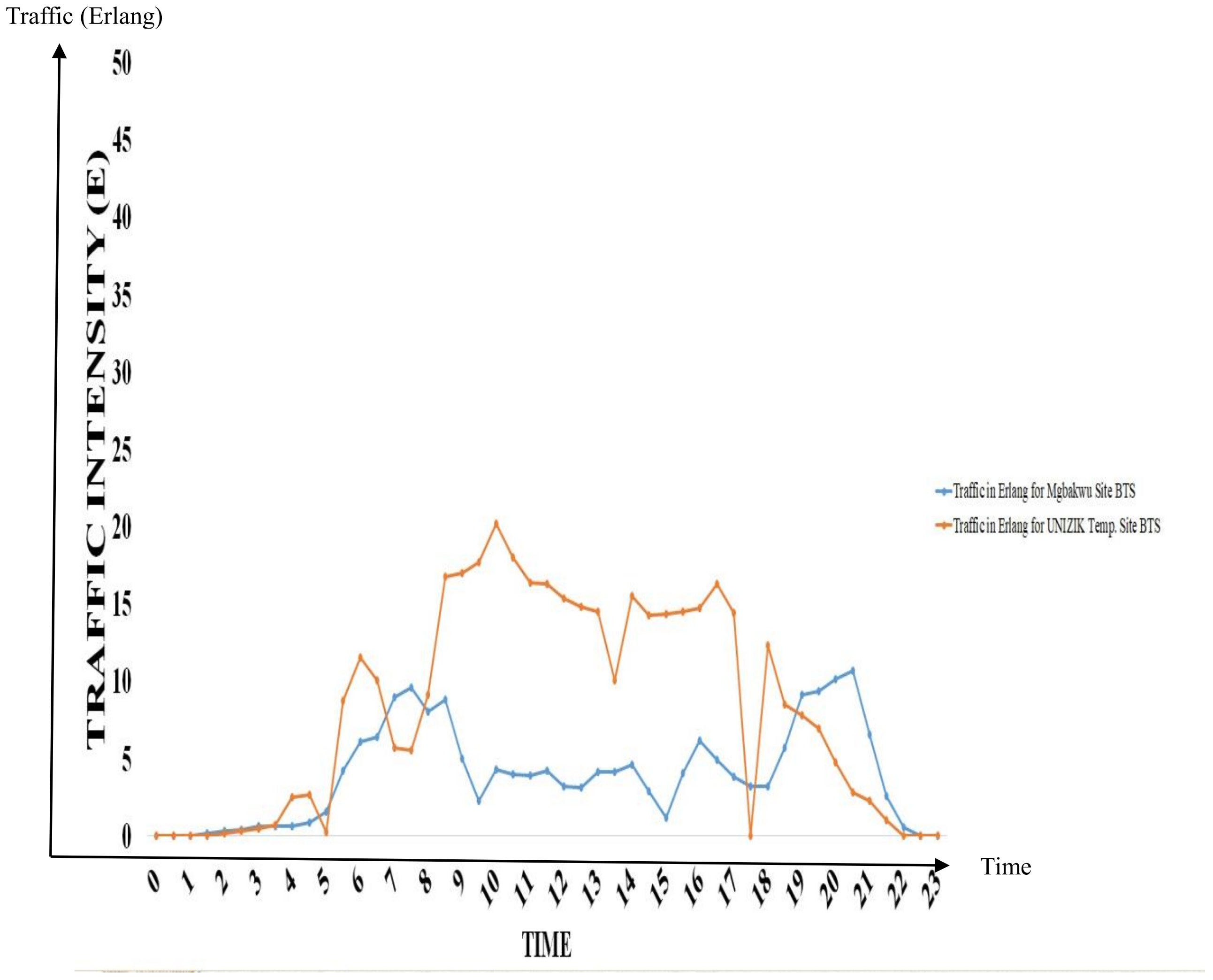

Figure 7: Excel Plot of Traffic generation at UNIZIK temporary site (Red) and Mgbakwu BTS (Blue).

Note: LEGEND: Upper Plot (Red) – UNIZIK Temporary site BTS

Bottom Plot (Blue) – Mgbakwu BTS

Recall Equation: P (t) = V x I (t)

Equipment (Traffic Independent) consumes between 1016W and 1087W.

Current = 100A (Rectifier Unit Fuse) and V = 52 (Battery), taking maximum ratings:

Hence Total BTS Power Consumption (PC) = 52 x100 = 5200W

Traffic Dependent Power Consumption Component = 5200 – 1016 = 4184W

Energy Efficiency for Dynamic Power Consumption is $(\frac{W}{m^2}) = \frac{4184}{(350)^2} = 0.034Wpm^2$

Reduction of Power Consumption by the Developed Model:

Efficiency of Power Consumption (Reduction) = 0.034 x 4184 = 142.256W

Dynamic Power Consumption Savings = 4184 - 142.256 = 4041.744W

Percentage Reduction (in comparison to Independent Power Consumption) = $\frac{1016}{4041.744}$= 0.25137 = 25.14%

This is a remarkable improvement compared to [17] that posted a reduction of 20%.

The Dynamic Power Consumption vis-à-vis Load conditions = Energy Efficiency x Traffic Load (Erlang) + Traffic Load (Erlang).

Illustration: Morning Busy Hour Traffic for UNIZIK temporary BTS site from 10an to 11am = 19.1E. Hence Busy Hour Power Consumption = (0.034 x 19.1) + 19.1 = 19.75

So, Load = 19.1, Power Consumption = 19.75

The same sequence and same procedure follow from 00.00 Midnight for the whole day as in Figures 8 and 9 below

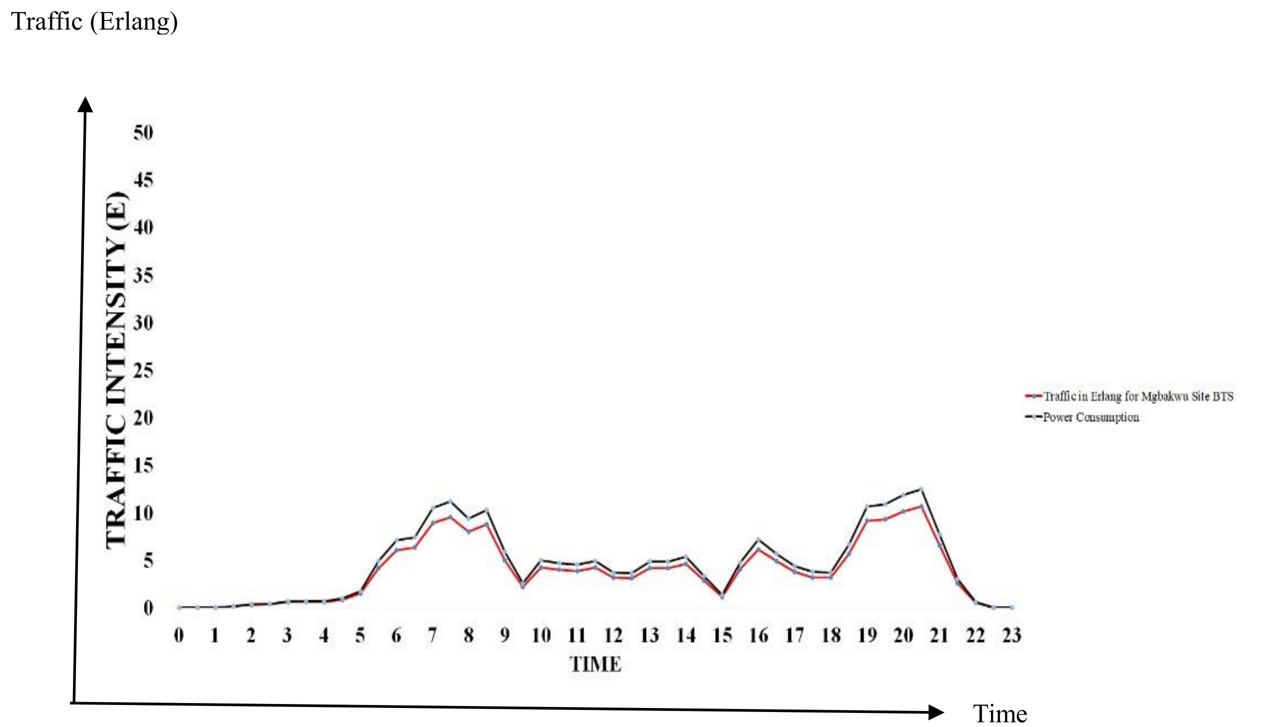

Figure 8: Traffic/Load and corresponding Power Consumption at Mgbakwu BTS in a Day

Note: LEGEND: Upper Plot (Blue) – Power Consumption

Bottom Plot (Red) – Traffic/Load

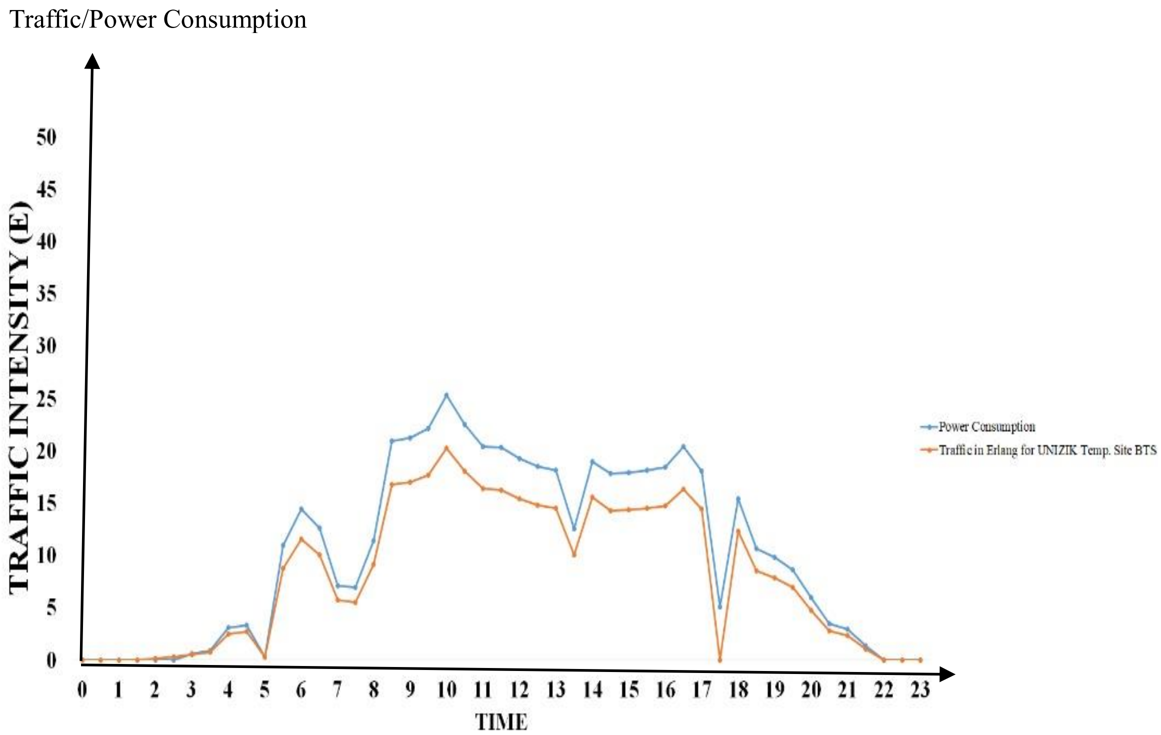

Figure 9: Traffic/Load and corresponding Power Consumption at UNIZIK Temporary Site BTS in a day

Note: LEGEND: Upper Plot (Blue) – Power Consumption

Bottom Plot (Red) – Traffic/Load

5.0 Conclusion

This research work was able to highlight the critical problems that hinder the offering of Quality Service in Telecommunications in Nigeria, especially the critical poor power situation in Nigeria.

With this in focus, solutions were proffered in identifying adequate dimensioning of equipment by calculating the Busy Hour periods of the BTSs and ensuring reduction in Power Consumptions with a view to improving the performance of Telecommunication infrastructure in Nigeria.

A Model for measuring Power Consumption under varying Traffic/Load conditions in BTS was developed. Real time Traffic generated at UNIZIK temporary site and Mgbakwu BTS confirm UNIZIK temporary site to be a Commercial/Business area with morning Busy Hour Traffic of 19.1Erlangs by 10.00am to 11.00am and afternoon Busy Hour of Traffic of 14.6Erlang by 3.30pm to 4.30pm. Mgbakwu was confirmed to be a Rural/Residential environment as it posted morning Busy Hour Traffic of 9.55Erlangs by 7.30am to 8.30am and evening Busy Hour Traffic of 10.7Erlangs by 8.30pm to 9.30pm.

From Power Analysis carried out in both BTS, it was observed that plots of Power Consumption followed the same pattern as Traffic generated in the BTS which confirms that Dynamic Power Consumption varies for both Low and High Traffic/Load in an existing BTS and Power Consumption Savings in the developed Model was 25.14% against other Authors that posted 20% Power Consumption Savings.

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