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INVESTIGATION OF COVERAGE LEVEL AND THE AVAILABILITY OF GSM SIGNAL IN EKPOMA, NIGERIA

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ABSTRACT- This work presents the investigation of the coverage level and the availability of GSM signal in Ekpoma, Edo State, Nigeria. The RF Signal Tracker installed in four Tecno Y4 handsets equipped with four different sims of the available network providers referred to as Net A, Net B, Net C and Net D was used to measure the received signal strength at the various test points for a period of one year. The data was analyzed to determine the coverage level, the quality of service and the availability of the different network signals in the investigated environment. Forty- one test points within the service area were selected to give a comprehensive representation of Ekpoma. The investigation was carried out from May 2014 to April 2015. The result when compared with the international acceptable standard of RSSL (Received Signal Strength Level) revealed that Net B offered a better level of coverage and quality of service compared with Net A, Net C and Net D. It was also observed that Net A, Net C and Net D experience more periods of no – signal (no – network) and fluctuations of signals within the period of the investigation. In order to ensure a better coverage and a better quality of service, Net A, Net C and Net D need to increase the number of their Base Stations.

KEYWORDS: Global system for mobile communication (GSM), Base station, Mobile unit, Signal strength, Coverage level, Signal tracker.

I. INTRODUCTION

The three basic mechanisms of radio propagation are attributed to reflection, diffraction and scattering. All three of these phenomenon cause radio signal distortions and give rise to signal fades as well as additional signal propagation losses [1]. When establishing any radio or wireless system, it is necessary to consider the unique features of the propagation environment and also to have good knowledge about the parameters that give rise to signal loss. For accurate design, coverage of modem cellular networks and signal strength measurement will be considered as source of data, in order to provide reliable and efficient coverage locality [2].

The coverage area is the total area covered by a radiated signal from any global system for mobile communication (GSM) network provider. In a cellular system, the communication between the GSM radio station and the mobile phone is bi-directional. However, the system is designed so that if there is sufficient signal strength at the mobile phone from the Base station, then there is also enough signals from the mobile station to the base station [3,4]. A mobile phone is said to be in coverage, if the signal at the mobile phone from then Base station is sufficient to place and maintain a call [4,5]. Sometimes the mobile unit (MU) experiences no – network within this coverage area due to failure of a successful communication link between the base station (BS) and the mobile unit (MU). This may be as a result of the failure of the radiated signal by the base station to be successfully received by the mobile unit or inability of the base station to radiate signal as a result of a temporary problem.

A cellular network is a radio network distributed over land areas called cells. The area serviced by a transmitter is called a cell. Each small powered transmitter, also called a base station provides coverage to only a small portion of the service area. At least one fixed transmitting base station serve each cell. The combinations of these cells provide radio coverage over a large area [6]. The signal strength received by the mobile phone depends on the distance from the Base station and the prevailing environment. Base Station close to one another is assigned different groups of channels so that the interference between stations is minimized. By symmetrically spacing Base station and their channel groups throughout a service area, the available channels are distributed throughout the geographic region and may be reused as many times as necessary, so long as the interference between co-channel station is kept below acceptable levels [7,8]. When designing a cellular system, the signal strength plays a major role between the mobile phone and the base station, hence the base station is cited so as to provide enough signal to operate a mobile phone within its coverage area [9].

II. METHODOLOGY

The RF Signal Tracker software was employed in this work in conjunction with four phones equipped with the sims of four different network providers. A total of forty-one test points were assigned within the quarters that made up Ekpoma. These test points gave a comprehensive representation of Ekpoma. In each test point the received signal strength level (RSSL) of Net A, Net B, Net C and Net D were measured simultaneously for a period of one year to determine the coverage level, quality of service and availability of the GSM signal of each network.

A. Investigated Environment

Ekpoma is located in Edo state, south-south Nigeria. The town lies between latitude 6^0 $43^{'}$ and 6^0 $45^{'}$ North of the Equator, and longitude 6^0 $6^{'}$ and 6^0 $8^{'}$ East of the Greenwich meridian. It is at 333 meters elevation above sea level. Ekpoma town is the second most populated city in Edo state after Benin City, the state capital. It has an area of 502 km^2 and a population of 125,842 according to the 2006 census. Ekpoma is made up of the following quarters namely; Ujemen, Idumebo, Iruekpen, Ihumudumu, Ukpenu, Ukhun, Ujeolen,

Emaudo, Eguare, Emuhi, Uke, Illeh, Uhiele, Eghoro, Igor and Idoa [10]. All the quarters were considered in the investigation.

B. Measurement Condition

Measurements were carried out daily except on Sundays from May 2014 to April 2015 within any time of the day. However, to ensure fairness to all the network operators, all measurements for each network operator were taken simultaneously at each test point. The measurements taken were considered at three different periods namely May 2014 – August 2014 during the raining season, September 2014 – December 2015 period of which rain begins to subside and January 2015 – April 2015 during dry season.

C. Measurement Procedure

The measurement setup is shown in Figure 1. A tecno Y4 handset equipped with a RF signal tracker is used to measure the received signal strength level (power received) at different test points from the base station. The software comprises of a scale which represents the power received in dBm. For every test point in the environment investigated, the power received from the Base stations for Net A, Net B, Net C and Net D respectively were taken simultaneously and compared with the international acceptable standard of the Received Signal Strength level (RSSL). The measurements were taken from May 2014 to April 2015.

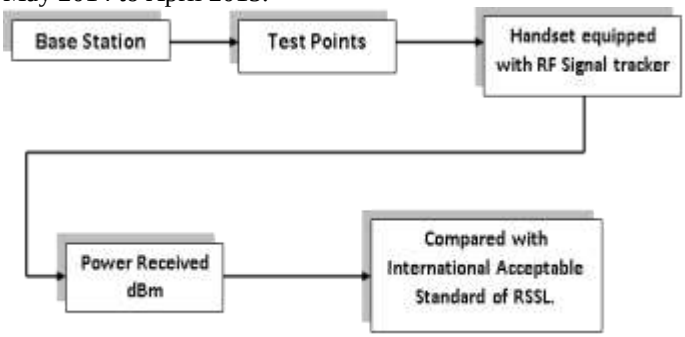

Fig. 1: Schematic Diagram showing Measurement setup.

D. Data Collection and Presentation

The different test express junction, along Benin – Auchi road. (2) Iruekpen – Abia road, along Benin – Auchi road. (3) Iruekpen junction, along Benin – Auchi road. (4) Iruekpen road, by Iruekpen post office. (5) Iruekpen – Sabo by-pass. (6) Iruekpen general Hospital. (7) Abia – Ujemen by-pass. (8) Supreme hotels junction, by Ujemen primary school. (9) Eghoro village, off Ujemen – Idumebo. (10) Oriafo junction, opp. PHCN office, Idumebo. (11) Ihumudumu community town hall, Iseleloa. (12) G-2 junction, Ihumudumu. (13) Judges quarter junction, Ihumudumu road. (14) Alli square round about. (15) Ujeolen secondary school. (16) Ezekiel College of Theology, Ujeolen. (17) College of medicine, AAU (18) Uke primary school, Uke town. (19) 1-T4 junction by Benin – Auchi road. (20) AAU library, main campus. (21) Mariere hostel junction, main campus. (22) Faculty of Law, main campus. (23) Faculty of Engineering & Technology, main campus. (24) Ukpenu junction, along Benin – Auchi express road. (25) Borehole junction, along Benin – Auchi express road. (26) Opoji junction. (27) Akahia, Uhiele. (28) Ukpoke, St. Paul's Anglican Church. (29) Idumegan, Ehanlen primary school. (30) Evbuakhuala village.(31) Illeh primary school by St. matthew's Anglican Church. (32) Evbuakhuala – Illeh road. (33) Ikeokogbe, by Asemblies of God church. (34) Ukun road, by Supreme hotels junction. (35) Market square round about. (36) Mount carmel school, road 9. (37) Faculty of Agriculture, Emaudo Campus. (38) Emaudo secoundary school. (39) Emuhi market square, Emuhi (40) Ukpenu – Emuhi road. (41). Ukpenu – Emuhi junction, by St. John's Anglican church, Ukpenu. The respective serial number of each test point is used to identify each test point as shown in Table 1.

Table 1 shows the average RSSL for May 2014 – August 2014, September 2014 – December 2014, January 2015 – April 2015 and average RSSL for the total period of the investigation.

points are;

(1) Iruekpen – Abia

Table 1: Average RSSL for the Different Periods of the Investigation.

Test Points	AVERAGE RSSL FOR MAY 2014 – AUGUST 2014 (dBm)				AVERAGE RSSL FOR SEPT. 2014 – DEC. 2014 (dBm)				AVERAGE RSSL FOR JAN. 2015 – APRIL 2015 (dBm)				AVERAGE RSSL FOR MAY 2014 – APRIL 2015 (dBm)			
	Net A	Net B	Net C	Net D	Net A	Net B	Net C	Net D	Net A	Net B	Net C	Net D	Net A	Net B	Net C	Net D
1.	-61	-67	-85	-73	-57	-85	-57	-67	-62	-69	-79	-75	-60	-74	-74	-69
2.	-65	-72	-72	-80	-74	-81	-60	-73	-79	-83	-76	-75	-73	-79	-69	-75
3.	-79	-73	-72	-80	-74	-81	-60	-73	-79	-83	-76	-75	-77	-79	-69	-75
4.	-83	-69	-103	-75	-81	-93	-87	-77	-79	-78	-94	-76	-81	-80	-95	-76
5.	-88	-72	-101	-78	-91	-75	-80	-79	-74	-70	-91	-81	-84	-72	-91	-79
6.	-63	-93	-79	-91	-65	-91	-69	-91	-107	-94	-64	-92	-78	-93	-71	-93
7.	-65	-81	-91	-69	-63	-71	-73	-67	-60	-81	-92	-71	-63	-78	-85	-68
8.	-75	-65	-91	-69	-63	-71	-73	-67	-60	-81	-92	-71	-66	-72	-85	-68
9.	-61	-71	-61	-71	-65	-51	-51	-63	-65	-76	-64	-75	-64	-66	-59	-66
10.	-61	-77	-97	-95	-85	-63	-79	-75	-72	-76	-82	-87	-73	-72	-86	-82
11.	-84	-66	-85	-76	-94	-80	-91	-82	-107	-74	-76	-95	-95	-73	-84	-80
12.	-73	-75	-85	-67	-73	-51	-57	-81	-71	-73	-73	-64	-72	-66	-72	-76
13.	-53	-61	-91	-85	-67	-71	-51	-79	-65	-78	-74	-79	-62	-70	-72	-81
14.	-63	-65	-85	-63	-77	-80	-65	-87	-74	-68	-94	-81	-71	-71	-81	-79
15.	-93	-63	-91	-77	-69	-74	-78	-74	-82	-74	-84	-80	-81	-70	-84	-75
16.	-71	-63	-97	-83	-77	65	-85	-83	-76	-68	-75	-76	-75	-65	-86	-83
17.	-75	-68	-87	-84	-76	-70	-82	-76	-80	-76	-74	-83	-77	-71	-81	-79

18.	-89	-71	-97	-91	-84	-78	-94	-79	-82	-73	-89	-94	-85	-74	-93	-83
19.	-82	-68	-94	-94	-79	-72	-90	-65	-87	-84	-94	-83	-83	-75	-93	-75
20.	-97	-67	-101	-95	-87	-68	-79	-95	-94	-67	-77	-96	-93	-67	-86	-95
21.	-84	-69	-77	-78	-94	-81	-77	-87	-81	-68	-81	-87	-86	-73	-78	-84
22.	-79	-71	-89	-75	-65	-74	-68	-75	-80	-57	-65	-81	-75	-67	-74	-75
23.	-55	-55	-83	-85	-67	-59	-95	-78	-65	-70	-76	-84	-62	-61	-85	-80
24.	-69	-57	-85	-77	-74	-54	-94	-79	-62	-63	-74	-80	-68	-58	-84	-78
25.	-53	-78	-85	-53	-61	-67	-78	-82	-55	-61	-69	-76	-56	-69	-77	-72
26.	-62	-68	-80	-69	-55	-65	-87	-80	-59	-78	-68	-84	-59	-70	-78	-76
27.	-59	-51	-85	-75	-58	-55	-83	-74	-61	-94	-72	-79	-59	-67	-80	-74
28.	-103	-97	-97	-101	-94	-88	-90	-79	-94	-97	-92	-87	-97	-94	-93	-86
29.	-69	-83	-91	-67	-72	-79	-88	-95	-86	-69	-87	-95	-76	-77	-89	-86
30.	-73	-67	-91	-87	-70	-69	-87	-96	-87	-78	-89	-91	-77	-71	-89	-93
31.	-81	-77	-91	-71	-83	-75	-85	-89	-80	-85	-104	-94	-81	-79	-93	-83
32.	-103	-93	-107	-89	-95	-78	-94	-106	-94	-87	-86	-86	-97	-86	-96	-99
33.	-61	-75	-85	-89	-85	-85	-57	-83	-72	-76	-94	-105	-73	-79	-79	-85
34.	-101	-75	-85	-79	-85	-71	-51	-63	-79	-68	-86	-80	-88	-71	-74	-68
35.	-107	-63	-91	-65	-89	-83	-75	-85	-84	-75	-79	-71	-93	-74	-82	-78
36.	-107	-73	-97	-85	-85	-85	-77	-85	-86	-74	-86	-69	-93	-77	-87	-85
37.	-97	-63	-91	-85	-85	-82	-71	-77	-81	-70	-94	-78	-88	-72	-85	-80
38.	-85	-75	-86	-79	-76	-79	-80	-79	-80	-69	-87	-79	-80	-74	-84	-79
39.	-87	-94	-89	-99	-79	-77	-83	-93	-86	-80	-80	-94	-84	-84	-84	-95
40.	-71	-65	-91	-69	-95	-65	-69	-79	-75	-72	-94	-90	-80	-67	-85	-76
41.	-76	-84	-81	-85	-75	-69	-72	-70	-81	-75	-79	-85	-77	-76	-77	-75

III. RESULTS AND DISCUSSION

According to the international acceptable standard of RSSL, a test point is said to have good coverage when the RSSL (dBm) at that test point is greater than -93dBm [11].

The average of the RSSL (dBm) taken for each test point and the coverage level (%) of each network provider are calculated from equations (1) and (2) respectively.

Average RSSL = $\sum$ RSSL / N ---------- (1)

CL (%) = NTPGC / TNTP × 100% ---------- (2)

Where N is the number of RSSL measured,

NTPGC is the number of test points with good coverage and

TNTP is the total number of test points.

Analysis of Coverage Level for May to August 2014

From table 1

TNTP is 41, which is the total number of test points for the period of the investigation.

Net A (NTPGC) = 33 Net B (NTPGC) = 38

Net C (NTPGC) = 32 Net D (NTPGC) = 36

∴ CL (%) for Net A = 33/41 x 100% = 80.46 %

CL (%) for Net B = 38/41 x 100% = 92.68 %

CL (%) for Net = 32/41 x 100% = 78.04 %

CL (%) for Net D = 36/41 x 100% = 87.80 %

The coverage level of Net A, Net B, Net C and Net D for the period of investigation are 80.46%, 92.68%, 78.04 % , 87.80% respectively.

Analysis of Coverage Level for September 2014 to December 2014

From table 1

TNTP is 41, which is the total number of test points for the period of the investigation.

Net A (NTPGC) = 36 Net B (NTPGC) = 39

Net C (NTPGC) = 37 Net D (NTPGC) = 36

∴CL (%) for Net A = 36/41 x 100% = 87.80 %

CL (%) for Net B = 39/41 x 100% = 95.12 %

CL (%) for Net C = 37/41 x 100% = 90.24 %

CL (%) for Net D = 36/41 x 100% = 87.80 %

The coverage level of Net A, Net B, Net C and Net D for the period of investigation are 87.80%, 95.12%, 90.24 % , 87.80% respectively.

Analysis of Coverage Level from January 2015 to April 2015

From table 1

TNTP is 41, which is the total number of test points for the period of the investigation.

Net A (NTPGC) = 36 Net B (NTPGC) = 39

Net C (NTPGC) = 35 Net D (NTPGC) = 34

∴CL (%) for Net A = 36/41 x 100% = 87.80 %

CL (%) for Net B = 39/41 x 100% = 95.12 %

CL (%) for Net C = 35/41 x 100% = 85.36 %

CL (%) for Net D = 34/41 x 100% = 82.92 %

The coverage level of Net A, Net B, Net C and Net D for the period of investigation are 87.80%, 95.12%, 85.36 % , 82.92% respectively.

Analysis of the Average Coverage Level from May 2014 to April 2015

The mean coverage level for each Network for the period of the investigation is calculated by taking the average of various coverage levels for the period. The mean coverage level for the four networks for the period of investigation is shown below;

Mean CL (%) for the different operators are;

Net A = (80.46 + 87.80 + 87.80)/3 = 85.35 %

Net B = (92.68 + 95.12 +95.12)/3 = 94.31 %

Net C = (78.04 + 90.24 + 85.36)/3 = 84.53 %

Net D = (87.80 + 87.80 + 82.92)/3 = 86.17 %

The graphical representation of the coverage level of the networks for the period of investigation is given in the following figures.

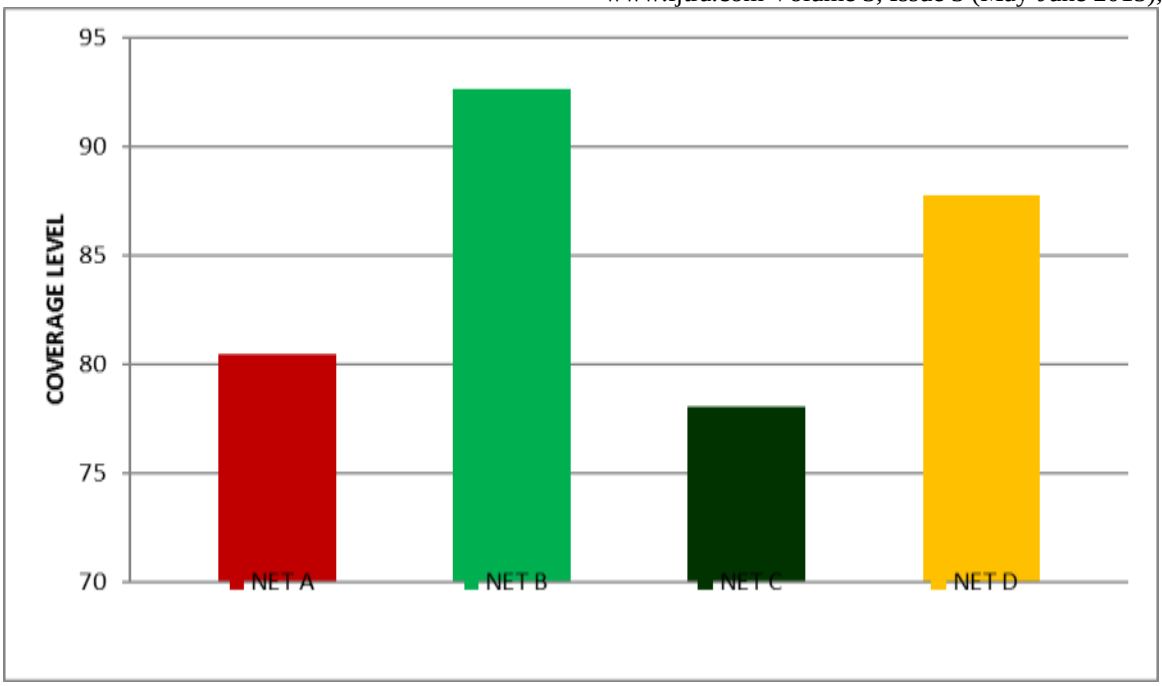

Fig. 2 Analysis of Coverage Level from May 2014 to August 2014.

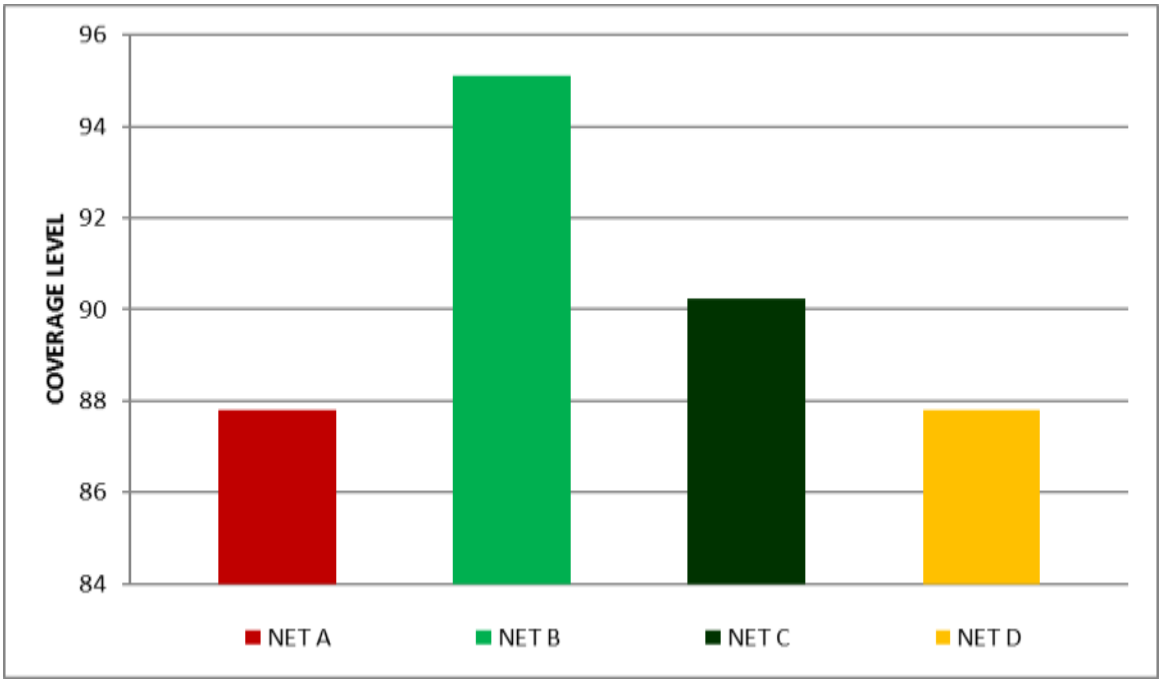

Fig. 3 Analysis of Coverage Level from September 2014 to December 2014.

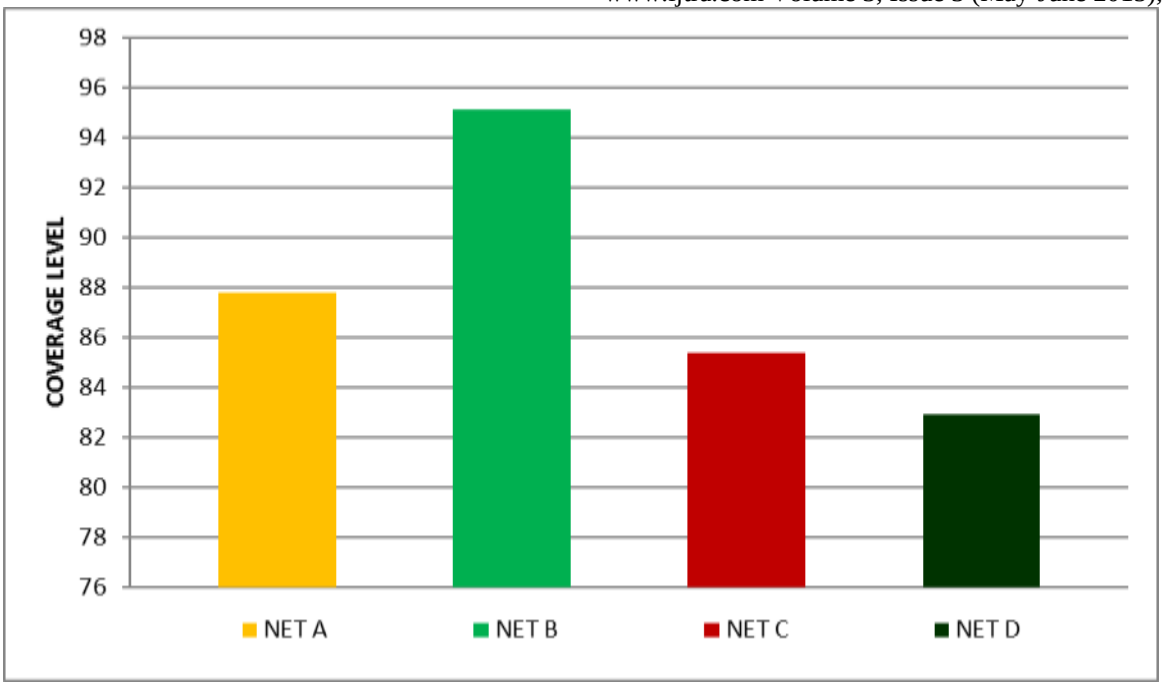

Fig. 4 Analysis of Coverage Level from January 2015 to April 2015.

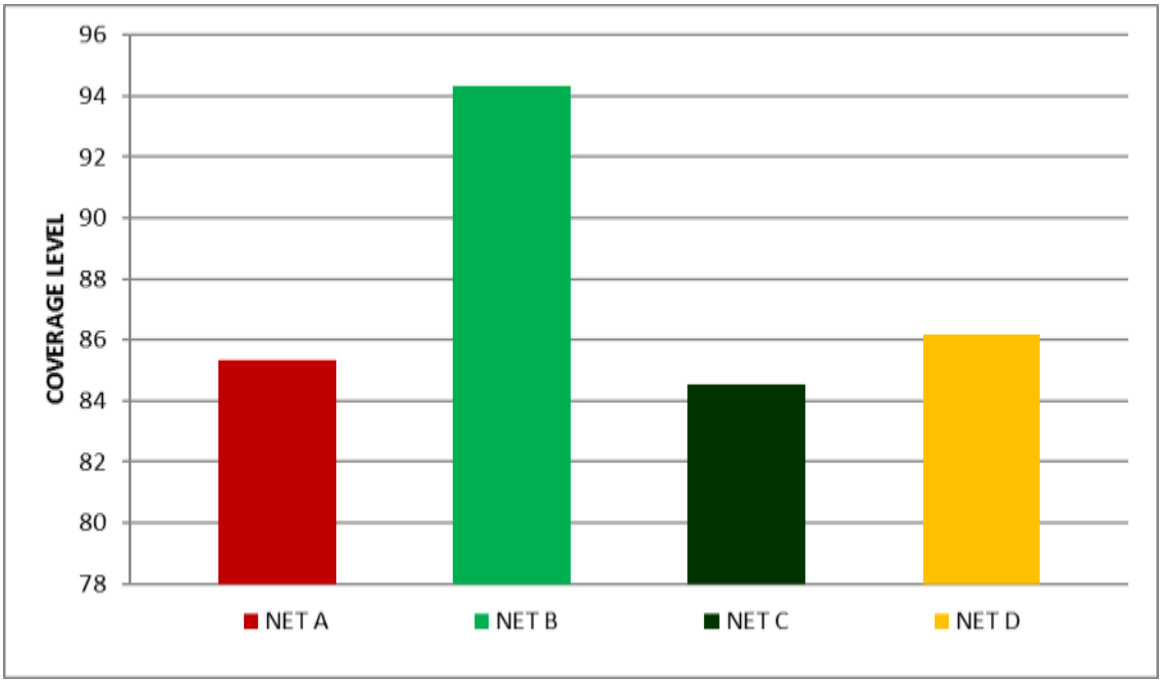

Fig. 5 Analysis of the Average Coverage Level from May 2014 to April 2015.

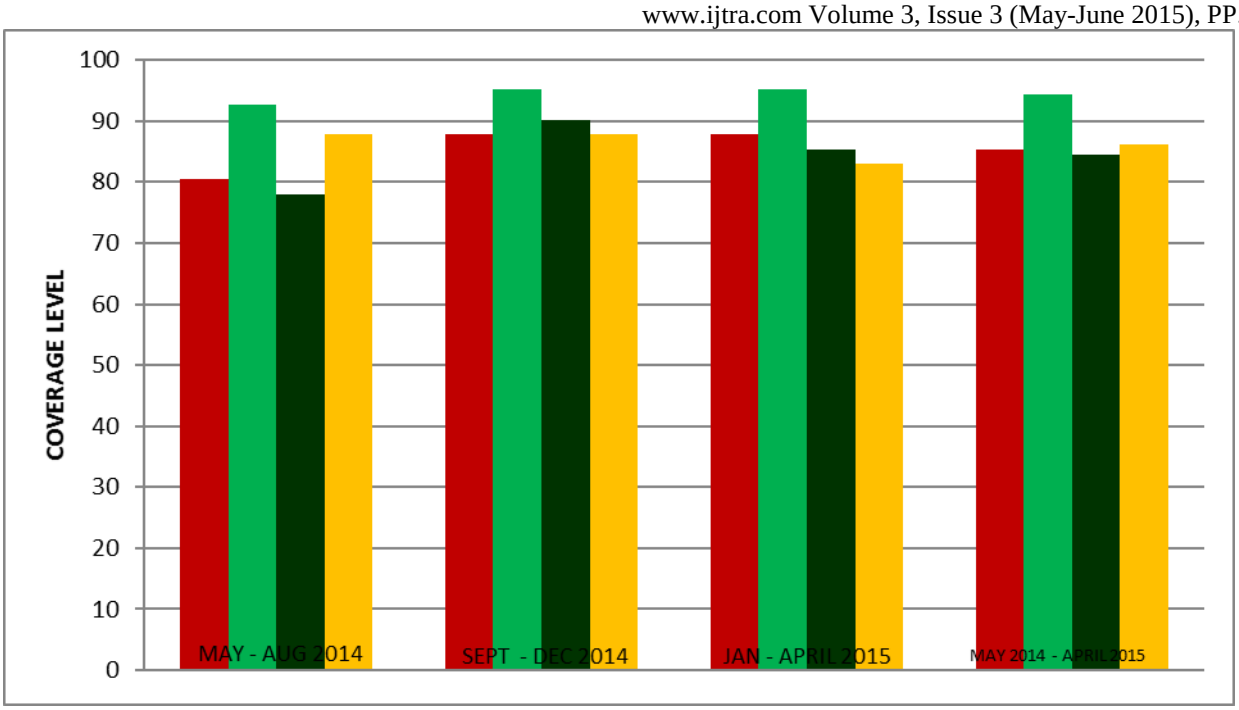

Fig. 6 Combine Coverage Level Plot for Operators from May 2014 to April 2015 and the mean coverage level for the operators

IV. CONCLUSION

The result of this investigation shows that no single network provider gave an excellent coverage for the period of the investigation. However, Net B offered a very good level of coverage and quality of service compared with Net A, Net C and Net D during the period of the investigation. The quality of services provided by the network provider generally needs improvement. It was also observed that Net A, Net C and Net D experience more periods of no – signal (no – network) and fluctuations of signals within the period of the investigation. In order to ensure a better coverage and a better quality of service, Net A, Net C and Net D need to increase the number of their Base Stations to ensure a satisfactory service to its subscriber.

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