RESEARCH ARTICLE OPEN ACCESS

Empirical Determination of Locations of Unstable and Blank Gsm Signal Network Receptions in a Cell Site

Alor M.O*, Abonyi D. O**, Okafor P. U***
Department of Electrical/Electronic Engineering, Enugu State University of Science And Technology

ABSTRACT
In a GSM network coverage area there exist locations where network signal reception is always either unsteady or blank. These problems are the cause of intermittent call receptions or no network reception at some locations in cell sites. This paper discusses a practical work carried out in a cell site located in a remote area in Eastern Nigeria to determine such locations. To do that, received signal field strength measurements were initially conducted at 3m interval starting from 100m away from the base Station to determine the suspected locations of unsteady and blank network receptions in the field. Further extensive measurements were then taken at each of the suspect locations. Analyses of the data obtained shows that a lot of such phenomenon may exist in cell sites.
KEYWORDS: cell site, blank network reception, fading, unsteady network reception

I. INTRODUCTION

Mobile Communication has made voice and data Communication accessible to millions of people irrespective of their location and time [1]. The concept of mobile communication is the use of low power transmitters to cover a small geographical area called cells in a communication network [2]. Ideally, each cell site has a transmitter from where communication signals are transmitted in space and received by mobile units within the cell site that the transmitter is covering. Hence the transmitter in the cell site acts as a link between the mobile units within the site [3][4]. Between the transmitter and the receiver are structures that do scatter, deflect, reflect, etc. the transmitted signal such that it arrives at its destination in multiples. One of such problems is multipath reception. Multipath reception is the arrival of a transmitted signal in several versions of the original transmitted form. The result of the multipath reception is signal fading which; is the rapid change in level of the received signal.

Because of fading there exist some spots within the cell site where the signal transmitted by the transmitter are received intermittently, at some other location the level of the received signal may not be strong enough to support voice and data communications. The effect is that any mobile receiver who finds itself in a location of unsteady network reception spot will experience intermittent or interruptions of an ongoing calls which may sometime result in call drops. For data the effect is continuous signal failures. On the other hand any mobile receiver who finds itself in a location of blank network reception will not be able to receive or transmit voice or data messages.

Network planners and installers always look out for such locations in the cell sites to enable them proffer proper solution since such phenomenon are capable of reducing the network capacity [5]. This paper therefore gives field practical method of identifying locations of unstable and blank network signal reception in any cellular cell site.

Free Space Propagation

In free space, a radio wave transmitted from a point in any given direction will propagate outwards from that point at the speed of light. The wave will travel in a straight line, as there is nothing under that situation to prevent it from doing so. Therefore in theory, a radio wave when launched carries on in a straight line forever traveling at the speed of light and without any loss. But in real life situations there is what is called free space loss. Free space loss is not really a loss at all. It relates to the intensity of the wave at a distance from the source measured by some standard collector, like an antenna or a telescope. As the wave spreads out, the intensity becomes lower [6].

Radio Communication

The space between a transmitter and a receiver in real sense is not free as there exist numerous obstacles between them. These obstacles can reflect, obstruct, refract and also deflect the propagated radio waves as it travels through them causing variations on the strength of the signal as a result of the encounter with the obstacles. The resultant variations in the strength of the signal are called signal fading. Two major factors that cause signal fading are Path loss and Multipath receptions. Multipath reception is a phenomenon that results in radio signals reaching the receiving antenna by two or more paths. Factors that affect Multipath Reception include: reflection, diffraction obstruction and scattering of the

propagated signal as result of such phenomenon like buildings, trees and other obstacles on the path of the propagated signal [7]. There are other weather factors like rainfall and wind.

Path Loss

Known widely in radio communications as large scale fading is a factor of distance between the transmitter and the receiver in any radio communication. Propagated signal strength (Pt) reduces inversely with the square of the distance as the signal moves away from the transmitter [8]. In an isotropic antenna the received signal R(t) at any point around the antenna is given by

$R(t)=P(t)/4\pi d^2$ (1)

Apart from the distance of the receiving unit from the transmitter, the received power also depends on how much power is captured by the receiving antenna which is defined by the antenna area involved in capturing the signal called capture Area Ar. Hence received power at any point Pr is

$Pr = RtAr$ (2)

For a hypothetical isotropic antenna

$Ar = \lambda^2/4\pi$

So that from equation 1 & 2 above Pr is now

$Pr= Pt(1/4\pi d)^2$

But Path loss (Lp) is given as the ratio of the transmitted power to the received power, and $\lambda = c/f$ therefore

$Lp = (4\pi/c) fd^2$

c = speed of light

f = transmitting frequency

Since the signal power level is always measured in dB and substituting for $c = 3 \times 10^8$, the standard path loss equation can be given as

$Lp = 32.4 + 20\log f + 20\log d$ dB

Therefore if a transmitted power Pt goes through free space the possible power that can reach a receiving unit is given by

$Pr = Pt – Lp + Gt + Gr – Lct – Lcr$

Pr = Received power (mw or dBm)

Pt = Transmitter power (w or dB)

Lp = Path loss (dB)

Gt = Transmit antenna gain (dB)

Gr = Receiving antenna gain (dB)

Lct = Cable loss between the transmitter output and the transmit antenna

Lcr = Cable loss between the receiving antenna and the receiver input

II. DESIGN

Two types of field measurements were taken at the study field:

(A). Preliminary measurements for the initial identification of location of unsteady and blank network receptions in the study field.

(B). Further measurements at those initial identified locations to classify which of them receives good, intermittent or unsteady signal.

Then MAT LAB plots were used to analyze the data obtained from the field experiments.

3.1: EXPERIMENT REQUIREMENTS

Reference pegs

Three sets of reference pegs were prepared for the experiments. The first set about 301 pieces without paints will be used to mark out test locations of 3 meter distances starting from 100meters away from the base transceiver up to 1Km for the initial experiments. The second set about 10 pieces painted red will be used to indicate identified locations of unstable network receptions. And the last set of another 10 pieces painted black will also used to indicate locations of total blank network signal receptions.

Field Signal Strength Measurement Meter

Two types of signal field strength measurement meters were used:

(i) Mongoose signal field strength meter (MSFSM) and

(ii) Base station analyzer (BSA).

The Mongoose field strength meter because of its very handy size was used to carry out the preliminary measurements. The more sophisticated Base station analyzer was then used to confirm the signal level at the identified locations and the distance of the location from the base transceiver.

Experimental Routes/Test spots:

The route for the preliminary experiments were carefully chosen and marked out along the Enugu-Oji old road on the 0° -120° sector of the study site. The route however is not in a straight line. Then 3m points were measured out starting from 100m away from the base transceiver and an unpainted reference peg was placed at each of the marked out spots.

This was done for up to 1.02Km from the base transceiver. The preliminary experiments are an organized method of identifying locations in the field where the signal reception is unstable and also the points where there are no reception at all and at all times. So whether the line of measurements is a straight line or not is immaterial for this work. What is important is being able to locate points of unsteady and blank network receptions in the study field.

III. THE PRELIMINARY EXPERIMENTS

This experiment was carried out to determine suspect locations of unstable and blank network reception points in the network coverage area. The identified suspect locations will be subjected to further measurements for confirmations and

classifications. To start the preliminary measurements**,** standing at the first marked point (about 100m away from the base transceiver) in the first sector (0° - 120°), and using the mongoose field strength measurement meter, the frequency range for the network of study was selected from the measurement meter and measurements/observations of the received signal strength at that location was taken every second for a minute**,** the average readings for the one minute noted as one cycle measurements**.** Thereafter this process was repeated in the next marked point and so on until all the 301 marked out points have been taken**.** The whole procedure was repeated for two other cycles and the average of the three cycles measurements recorded was obtained and noted accordingly as indicated on the table 1. The average of the 3 cycle measurements is shown also in table 2 to be used for the analysis.

Table 1(A, B & C): Data from the Preliminary Measurements conducted at the Study Field

Table 1A

Measurement taken every 3 meters at the study field																		
Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm			
	1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**
100	-50	-51	-53	**-51**	202	-54	-58	-56	**-56**	303	-69	-71	-72	**-71**	402	-68	-66	-69	**-68**
103	-49	-52	-50	**-50**	205	-60	-61	-62	**-61**	306	-70	-72	-69	**-70**	405	-69	-68	-73	**-70**
106	-50	-54	-53	**-52**	208	-59	-58	-60	**-59**	309	-71	-67	-68	**-69**	408	-66	-68	-72	**-69**
109	-56	-57	-60	**-58**	211	-59	-60	-59	**-59**	312	-67	-70	-68	**-68**	411	-73	-68	-69	**-70**
112	-59	-61	-62	**-61**	214	-86	-92	-90	**-89**	315	-69	-70	-73	**-71**	414	-70	-69	-72	**-70**
115	-72	-70	-73	**-72**	217	-61	-59	-62	**-61**	318	-74	-72	-71	**-72**	417	-65	-73	-69	**-69**
118	-51	-51	-56	**-53**	220	-62	-63	-61	**-62**	321	-71	-69	-67	**-69**	420	-68	-69	-72	**-70**
121	-46	-47	-50	**-48**	223	-60	-61	-60	**-60**	324	-69	-71	-68	**-69**	423	-73	-70	-75	**-73**
124	-58	-59	-61	**-59**	226	-99	-98	-100	**-99**	327	-72	-73	-69	**-71**	426	-74	-73	-75	**-74**
127	-64	-63	-67	**-65**	229	-58	-60	-60	**-59**	330	-60	-56	-69	**-58**	429	-72	-71	-73	**-72**
130	-48	-53	-65	**-55**	232	-56	-59	-60	**-58**	333	-64	-63	-62	**-63**	432	-70	-69	-71	**-70**
133	-59	-61	-61	**-60**	235	-58	-62	-61	**-60**	336	-64	-65	-61	**-63**	435	-63	-62	-60	**-62**
136	-55	-57	-58	**-57**	238	-60	-66	-63	**-63**	339	-70	-71	-67	**-69**	438	-65	-65	-64	**-65**
139	-45	-45	-48	**-46**	241	-64	-64	-66	**-65**	342	-68	-70	-7	**-68**	441	-68	-65	-67	**-67**
142	-58	-60	-58	**-59**	244	-70	-71	-73	**-71**	345	-69	-68	-70	**-69**	444	-65	-68	-67	**-67**
145	-65	-69	-70	**-68**	247	-87	-89	-95	**-90**	348	-70	-67	-71	**-69**	447	-66	-69	-68	**-68**
148	-48	-50	-46	**-48**	250	-68	-66	-69	**-68**	351	-74	-67	-69	**-68**	450	-69	-66	-68	**-68**
151	-49	-48	-50	**-49**	253	-69	-68	-71	**-69**	354	-70	-69	-72	**-70**	453	-70	-71	-69	**-70**
154	-54	-57	-58	**-56**	258	-63	-63	-59	**-62**	357	-71	-69	-71	**-70**	458	-70	-72	-69	**-70**

157	-54	-58	-58	**-57**	261	-59	-59	-58	**-59**	360	-65	-70	-67	**-69**	461	-69	-71	-68	**-69**
160	-56	-58	-59	**-58**	264	-61	-63	-60	**-61**	363	-61	-70	-66	**-67**	464	-69	-72	-70	**-70**
163	-59	-61	-62	**-61**	267	-69	-68	-67	**-68**	366	-64	-61	-59	**-60**	467	-71	-73	-72	**-72**
166	-60	-63	-64	**-62**	270	-71	-69	-72	**-71**	369	-70	-61	-60	**-62**	470	-70	-72	-71	**-71**
169	-60	-56	-59	**-58**	273	-63	-65	-68	**-65**	372	-72	-69	-66	**-68**	473	-69	-71	-70	**-70**
172	-60	-59	-58	**-59**	276	-52	-52	-54	**-53**	375	-76	-74	-69	**-72**	476	-70	-75	-73	**-73**
175	-58	-61	-63	**-61**	279	-62	-63	-62	**-62**	378	-69	-70	-78	**-75**	479	-71	-72	-70	**-71**
178	-57	-59	-60	**-59**	282	-68	-71	-72	**-70**	381	-73	-78	-74	**-74**	482	-76	-77	-80	**-78**
181	-58	-62	-63	**-61**	285	-67	-71	-70	**-69**	384	-99	-75	-71	**-73**	485	-87	-86	-96	**-90**
184	-59	-57	-59	**-58**	288	-63	-63	-64	**-63**	387	-79	-101	-103	**-101**	488	-73	-77	-86	**-79**
187	-60	-58	-61	**-60**	291	-78	-81	-85	**-81**	390	-79	-80	-76	**-78**	491	-65	-66	-63	**-65**
190	-59	-56	-59	**-58**	294	-68	-67	-69	**-68**	393	-76	-78	-74	**-76**	494	-66	-69	-68	**-68**
193	-59	-58	-56	**-58**	297	-68	-70	-71	**-70**	396	-69	-74	-78	**-74**	497	-105	-96	-95	**-99**
196	-61	-60	-62	**-61**	300	-68	-69	-74	**-70**	399	-76	-78	-70	**-75**	500	-67	-66	-64	**-66**
199	-51	-53	-59	**-54**															

Table 1B

Measurement taken every 3 meters at the study field																			
Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm				Dist (m)	Received signal in dBm			
	1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**		1st cycle	2nd cycle	3rd cycle	**Avg**
503	-81	-78	-77	**-79**	602	-79	-77	-80	**-79**	703	-78	-72	-77	**-76**	802	-85	-78	-83	**-82**
506	-75	-76	-77	**-76**	605	-75	-78	-77	**-77**	706	-72	-74	-79	**-78**	805	-90	-82	-84	**-85**
509	-76	-81	-74	**-77**	608	-79	-75	-79	**-78**	709	-79	-73	-70	**-74**	808	-80	-90	-86	**-85**
512	-74	-76	-75	**-75**	611	-75	-78	-80	**-78**	712	-76	-78	-72	**-75**	811	-82	-80	-82	**-81**
515	-78	-74	-76	**-76**	614	-73	-76	-78	**-76**	715	-72	-72	-70	**-71**	814	-81	-78	-82	**-80**
518	-73	-75	-75	**-74**	617	-75	-74	-75	**-75**	718	-85	-82	-80	**-82**	817	-85	-84	-79	**-83**
521	-78	-72	-74	**-75**	620	-79	-75	-76	**-77**	721	-78	-82	-84	**-81**	820	-71	-76	-85	**-77**
524	-76	-75	-69	**-73**	623	-74	-77	-75	**-75**	724	-79	-76	-84	**-80**	823	-80	-76	-79	**-78**
52	-	-72	-	**-71**	626	-72	-81	-70	**-74**	727	-81	-78	-	**-79**	82	-	-85	-92	-

7	67		74										78		6	81			**86**
530	-72	-68	-71	**-70**	629	-72	-74	-72	**-73**	730	-80	-76	-79	**-78**	829	-96	-90	-87	**-91**
533	-68	-72	-73	**-71**	632	-60	-67	-68	**-65**	733	-78	-78	-76	**-77**	832	-80	-76	-77	**-78**
536	-75	-72	-70	**-72**	635	-66	-69	-70	**-68**	736	-83	-78	-77	**-79**	835	-97	-99	-103	**-100**
539	-74	-75	-73	**-74**	638	-69	-68	-73	**-70**	739	-81	-74	-79	**-78**	838	-81	-80	-76	**-79**
542	-78	-75	-71	**-75**	641	-69	-76	-74	**-73**	742	-77	-81	-78	**-79**	841	-77	-76	-80	**-78**
545	-75	-76	-77	**-76**	644	-72	-69	-74	**-71**	745	-82	-75	-76	**-78**	844	-77	-75	-82	**-78**
548	-78	-85	-89	**-84**	647	-69	-77	-74	**-73**	748	-69	-62	-70	**-67**	847	-80	-76	-76	**-77**
551	-78	-81	-82	**-80**	650	-73	-71	-73	**-72**	751	-69	-69	-67	**-68**	850	-87	-90	-97	**-91**
554	-82	-78	-87	**-79**	653	-73	-72	-74	**-72**	754	-74	-69	-68	**-70**	853	-76	-84	-87	**-82**
557	-78	-74	-73	**-75**	658	-72	-73	-75	**-73**	757	-78	-73	-72	**-74**	858	-67	-67	-71	**-68**
560	-73	-74	-78	**-75**	661	-72	-74	-75	**-74**	760	-80	-74	-73	**-76**	861	-72	-68	-67	**-69**
563	-79	-78	-75	**-77**	664	-76	-73	-78	**-76**	763	-89	-87	-87	**-88**	864	-83	-83	-93	**-86**
566	-79	-80	-75	**-78**	667	-81	-80	-79	**-78**	766	-105	-101	-99	**-102**	867	-81	-76	-80	**-79**
569	-79	-76	-80	**-78**	670	-102	-103	-104	**-103**	769	-90	-86	-87	**-88**	870	-77	-76	-84	**-79**
572	-86	-92	-88	**-89**	673	-84	-81	-86	**-84**	772	-85	-80	-78	**-81**	873	-82	-77	-81	**-80**
575	-75	-82	-79	**-79**	676	-85	-86	-81	**-84**	775	-80	-77	-76	**-78**	876	-81	-78	-77	**-79**
578	-84	-78	-76	**-79**	679	-79	-83	-81	**-83**	778	-80	-78	-78	**-79**	879	-76	-79	-80	**-78**
581	-74	-80	-75	**-76**	682	-82	-79	-81	**-81**	781	-80	-78	-78	**-79**	882	-82	-75	-77	**-78**
584	-77	-76	-73	**-75**	685	-79	-75	-74	**-76**	784	-80	-78	-75	**-78**	885	-74	-75	-80	**-76**
587	-79	-74	-73	**-75**	688	-74	-77	-75	**-75**	787	-80	-77	-76	**-78**	888	-75	-78	-84	**-79**
590	-80	-75	-73	**-76**	691	-77	-76	-79	**-76**	790	-82	-80	-83	**-82**	891	-98	-103	-105	**-102**
593	-73	-76	-80	**-76**	694	-67	-70	-71	**-69**	793	-84	-84	-81	**-83**	894	-75	-81	-82	**-79**
596	-73	-78	-82	**-78**	697	-69	-72	-68	**-70**	796	-87	-82	-83	**-84**	897	-85	-86	-96	**-89**
599	-80	-77	-75	**-77**	700	-70	-73	-72	**-78**	799	-90	-86	-86	**-87**	900	-78	-80	-88	**-82**

Table 1C

Dist (m)	Received signal in dBm			
	1st cycle	2nd cycle	3rd cycle	**Avg**
903	-79	-83	-80	**-81**
906	-80	-78	-78	**-79**
909	-81	-80	-86	**-82**
912	-106	-103	-102	**-104**
915	-84	-82	-84	**-83**
918	-87	-92	-90	**-90**
921	-86	-84	-85	**-84**
924	-80	-81	-85	**-82**
927	-81	-82	-86	**-83**
930	-84	-80	-85	**-83**
933	-82	-81	-87	**-83**
936	-86	-85	-80	**-84**
939	-81	-86	-88	**-85**
942	-96	-97	-100	**-98**
945	-87	-86	-93	**-89**
948	-106	-100	-101	**-102**
951	-80	-86	-83	**-83**
954	-80	-85	-81	**-82**
957	-81	-80	-88	**-83**
960	-78	-87	-85	**-83**
963	-82	-85	-82	**-83**
966	-87	-85	-84	**-85**
969	-83	-84	-82	**-82**
972	-100	-98	-100	**-99**
975	-84	-83	-77	**-81**
978	-80	-86	-83	**-83**
981	-86	-85	-81	**-84**
984	-80	-85	-86	**-84**
987	-81	-84	-90	**-85**
990	-99	-102	-98	**-100**
993	-81	-90	-85	**-85**
996	-87	-85	-80	**-84**
999	-82	-86	-81	**-83**
1002	-81	-84	-84	**-83**

Table 2 (A & B): Average of the 3 cycle Preliminary Measurements at the 301 locations in the study field

Table 2A

Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)
100	-51	202	-56	303	-71	402	-68	503	-79	602	-79
103	-50	205	-61	306	-70	405	-70	506	-76	605	-77
106	-52	208	-59	309	-69	408	-69	509	-77	608	-78
109	-58	211	-59	312	-68	411	-70	512	-75	611	-78
112	-61	214	-89	315	-71	414	-70	515	-76	614	-76
115	-72	217	-61	318	-72	417	-69	518	-74	617	-75
118	-53	220	-62	321	-69	420	-70	521	-75	620	-77
121	-48	223	-60	324	-69	423	-73	524	-73	623	-75
124	-59	226	-99	327	-71	426	-74	527	-71	626	-74
127	-65	229	-59	330	-58	429	-72	530	-70	629	-73

130	-55	232	-58	333	-63	432	-70	533	-71	632	-65
133	-60	235	-60	336	-63	435	-62	536	-72	635	-68
136	-57	238	-63	339	-69	438	-65	539	-74	638	-70
139	-46	241	-65	342	-68	441	-67	542	-75	641	-73
142	-59	244	-71	345	-69	444	-67	545	-76	644	-71
145	-68	247	-90	348	-69	447	-68	548	-85	647	-73
148	-48	250	-68	351	-68	450	-68	551	-80	650	-72
151	-49	253	-69	354	-70	453	-70	554	-79	653	-72
154	-56	258	-62	357	-70	458	-70	557	-75	658	-73
157	-57	261	-59	360	-69	461	-69	560	-75	661	-74
160	-58	264	-61	363	-67	464	-70	563	-77	664	-76
163	-61	267	-68	366	-60	467	-72	566	-78	667	-78
166	-62	270	-71	369	-62	470	-71	569	-78	670	-103
169	-58	273	-65	372	-68	473	-70	572	-89	673	-84
172	-59	276	-53	375	-72	476	-73	575	-79	676	-84
175	-61	279	-62	378	-75	479	-71	578	-79	679	-83
178	-59	282	-70	381	-74	482	-78	581	-76	682	-81
181	-61	285	-69	384	-73	485	-77	584	-75	685	-76
184	-58	288	-63	387	-101	488	-79	587	-75	688	-75
187	-60	291	-81	390	-78	491	-65	590	-76	691	-76
190	-58	294	-68	393	-76	494	-68	593	-76	694	-69
193	-58	297	-70	396	-74	497	-99	596	-78	697	-70
196	-61	300	-70	399	-75	500	-78	599	-77	700	-78
199	-54										

Table 2B

Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)	Dist (m)	Avg. of the rcvd signal level (dBm)
703	-76	802	-82	903	-81
706	-78	805	-85	906	-79
709	-74	808	-85	909	-82
712	-75	811	-81	912	-85
715	-71	814	-80	915	-83
718	-82	817	-83	918	-90
721	-81	820	-77	921	-84
724	-80	823	-78	924	-105
727	-79	826	-86	927	-83
730	-78	829	-88	930	-83
733	-77	832	-78	933	-83
736	-79	835	-100	936	-84
739	-78	838	-79	939	-85
742	-79	841	-78	942	-98
745	-78	844	-78	945	-89
748	-67	847	-77	948	-99
751	-68	850	-78	951	-83
754	-70	853	-93	954	-103
757	-74	858	-68	957	-83
760	-76	861	-69	960	-83
763	-88	864	-86	963	-83
766	-88	867	-79	966	-85
769	-102	870	-79	969	-82
772	-81	873	-80	972	-99
775	-78	876	-79	975	-81
778	-79	879	-78	978	-83

781	-79	882	-78	981	-84
784	-78	885	-79	984	-84
787	-78	888	-102	987	-85
790	-82	891	-88	990	-100
793	-83	894	-79	993	-85
796	-84	897	-89	996	-84
799	-87	900	-82	999	-84
				1002	-83

4.1 Analysis of the data obtained from the preliminary measurements

Fig. 2 below is the MAT LAB plot of the average of the received signal field strength measured at each of the 301 marked out spots.

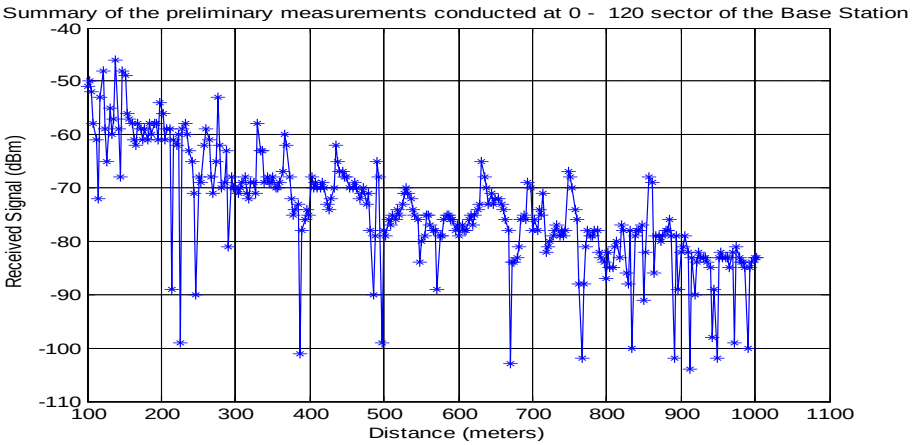

Fig. 1: Plot of received signal field strength against each of the 301 locations

From research findings received signal strength level of above -91dBm will support communication at any point in any cell coverage area. Meaning that when the signal strength goes below that level good communication cannot be guaranteed at such location [9][10][11]. Such points may likely experience unsteady or blank network reception depending on the level of signal received.

From the plot above thirteen locations were identified as having its measured signal reception below -91dBm as given in table 3 below. From the preliminary experiments those locations are called suspect locations of unsteady and blank network reception points. The locations are to be subjected to further measurements to confirm and classify whether they are spots of good signal reception points, unsteady signal reception points or blank signal reception points. Suspected locations of unstable and blank network reception from figures 1

Table 3: Suspect points of unsteady and blank network receptions

Suspected locations	Distance from base station in meters
1	226
2	387
3	497
4	670
5	769
6	835
7	853
8	888
9	924
10	948
11	954
12	972
13	990

4.2: CLASSIFICATION OF THE SUSPECT LOCATIONS AS UNSTEADY AND BLANK OR GOOD NETWORK RECEPTION POINTS.

Further measurements was carried out at each of the identified suspect locations above to establish which of them is for unstable, blank or even a good network reception points. Several measurements were conducted during the three major seasons in Nigeria: Rainy, Hama tan and Dry seasons to ensure that the identified points were not influenced by weather changes. In addition the measurements were also conducted at different times of the day to also ensure that readings obtained were not influenced by call traffic.

For each of the suspect locations the following experiments were conducted

(a) Dry season measurements (November):

Using the Mongoose field strength measurement meter, received signal field strength readings were taken for 3 minutes between 0600 – 0630hrs (for low call traffic period), 1100 – 1115 hrs (for High traffic period) and 1500 1515hrs (for mild traffic period), three times a week for one month. The average of the readings obtained was noted.

(b) Ham tan season measurements (December):

The procedure used during the dry season measurements was repeated and the readings obtained noted also

(c) Rainy season measurements (July)

The procedure used during the dry season measurements was repeated and the readings obtained noted

Table 4A: (Dry Season 'DS' measurements)

Suspect location	Received signal in dBm														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
1	-58	-59	-58	-59	-60	-61	-89	-90	-60	-62	-58	-59	-61	-86	-82
2	-52	-88	-87	-90	-62	-99	-89	-61	-62	-70	-85	-88	-87	-89	-70
3	-60	-61	-63	-68	-100	-98	-84	-84	-85	-58	-59	-87	-88	-70	-71
4	-92	-98	-99	-99	-98	-100	-101	-102	-82	-99	-103	-105	-103	-100	-98
5	-61	-82	-85	-87	-90	-92	-95	-99	-78	-74	-75	-75	-87	-100	-100
6	-100	-102	-110	-99	-99	-98	-100	-101	-100	-98	-99	-99	-98	-98	-99
7	-62	-63	-70	-86	-65	-72	-71	-75	-86	-86	-98	-97	-99	-86	-85
8	-85	-87	-90	-70	-72	-73	-72	-71	-71	-78	-68	-69	-76	-75	-75
9	-69	-69	-70	-73	-74	-75	-76	-77	-78	-78	-85	-90	-95	-75	-74
10	-78	-92	-94	-96	-98	-85	-79	-80	-81	-85	-90	-91	-95	-84	-83
11	-80	-82	-81	-80	-79	-80	-81	-79	-78	-78	-88	-90	-95	-86	-85
12	-83	-84	-84	-90	-98	-86	-85	-84	-84	-83	-84	-83	-83	-82	-82
13	-90	-92	-95	-99	-99	-98	-86	-85	-84	-89	-88	-90	-79	-80	-89

Table 4B: (Hama tan Season 'HS' measurements)

Suspect location	Received signal in dBm														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
1	-70	-67	-64	-65	-90	-69	-70	-71	-71	-100	-75	-76	-78	-76	-75
2	-78	-76	-92	-93	-95	-99	-99	-80	-81	-82	-75	-99	-98	-99	-78
3	-72	-71	-100	-75	-76	-77	-76	-80	-78	-78	-77	-76	-78	-77	-75
4	-99	-99	-102	-103	-107	-99	-65	-89	-66	-86	-92	-98	-99	-99	-99
5	-72	-73	-95	-98	-99	-100	-101	-100	-99	-98	-84	-85	-78	-79	-100

6	-100	-103	-105	-105	-100	-98	-98	-74	-85	-86	-94	-96	-98	-99	-99
7	-78	-99	-98	-100	-102	-101	-99	-95	-72	-75	-76	-100	-106	-86	-87
8	-80	-76	-77	-79	-89	-90	-78	-77	-76	-78	-79	-78	-78	-79	-79
9	-82	-79	-81	-79	-79	-81	-80	-85	-86	-85	-89	-86	-85	-83	-83
10	-99	-98	-100	-98	-85	-84	-86	-102	-104	-101	-99	-85	-84	-89	-90
11	-80	-80	-81	-82	-81	-98	-100	-80	-81	-82	-85	-83	-82	-80	-80
12	-85	-83	-82	-79	-85	-100	-98	-84	-83	-85	-86	-63	-82	-82	-83
13	-89	-90	-86	-86	-83	-82	-79	-86	-89	-90	-98	-99	-102	-104	-102

Table 4C: Rainy Season 'RS' measurements

Suspect location	Received signal in dBm														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
1	-76	-74	-75	-73	-70	-99	-98	-84	-72	-99	-72	-71	-72	-74	-72
2	-85	-80	-88	-89	-90	-91	-96	-100	-103	-100	-85	-79	-100	-90	-87
3	-80	-81	-82	-84	-90	-96	-83	-88	-86	-82	-79	-78	-78	-79	-80
4	-101	-99	-98	-102	-83	-67	-98	-100	-100	-102	-110	-106	-107	-99	-101
5	-100	-102	-101	-100	-100	101	-97	-78	-97	-100	99	-101	-100	-69	-59
6	-99	-99	-98	-100	-81	-82	-102	-101	-98	-100	-110	-103	-90	-100	-102
7	-78	-99	-101	-99	-83	-78	-99	-98	-90	-78	-100	-101	-98	-92	-100
8	-70	-68	-69	-73	-78	79	-78	-74	-76	90	-95	-86	-88	-85	-82
9	-85	-80	-82	-81	-75	-72	-70	-95	97	-86	-84	-85	-84	-75	-78
10	-90	-88	-85	-82	-99	-101	-99	-100	-82	-76	-78	-89	-92	-99	-83
11	-79	-78	-90	-89	-91	-85	-83	-83	-79	-78	-75	-78	-76	-77	-76
12	-79	-80	-81	-83	-83	-84	-85	-85	-86	-84	-83	-82	-81	-81	-80
13	-100	-102	-101	-100	-100	-101	-97	-78	-97	-100	99	-101	-100	-81	-80

Table 5 (A, B & C): Average result of the 3 Season Measurements conducted at each of the Suspect Locations

Table 5A

No. Of Tests	Suspect location 1				Suspect location 2				Suspect location 3				Suspect location 4			
	Received signal (dBm)				Received signal (dBm)				Received signal (dBm)				Received signal (dBm)			
	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**
1	-76	-70	-58	**-68**	-85	-78	-52	**-72**	-80	-72	-60	**-71**	-101	-99	-92	**-97**
2	-74	-67	-59	**-67**	-80	-76	-88	**-81**	-81	-71	-61	**-71**	-99	-99	-98	**-99**
3	-75	-64	-58	**-66**	-88	-92	-87	**-89**	-82	-100	-63	**-82**	-98	-102	-99	**-100**

4	-73	-65	-59	**-66**	-89	-93	-90	**-91**	-84	-75	-68	**-76**	-102	-103	-99	**-101**
5	-70	-90	-60	**-73**	-90	-95	-62	**-82**	-90	-76	-100	**-89**	-83	-107	-98	**-96**
6	-99	-69	-61	**-76**	-91	-99	-99	**-96**	-96	-77	-98	**-90**	-67	-99	-100	**-89**
7	-98	-70	-89	**-86**	-96	-99	-89	**-95**	-83	-76	-84	**-81**	-98	-65	-101	**-88**
8	-84	-71	-90	**-82**	-100	-80	-61	**-80**	-88	-80	-84	**-84**	-100	-89	-102	**-97**
9	-72	-71	-60	**-68**	-103	-81	-62	**-82**	-86	-78	-85	**-83**	-100	-66	-82	**-83**
10	-99	-100	-62	**-87**	-100	-82	-70	**-84**	-82	-78	-58	**-73**	-102	-86	-99	**-96**
11	-72	-75	-58	**-68**	-85	-75	-85	**-82**	-79	-77	-59	**-72**	-110	-92	-103	**-102**
12	-71	-76	-59	**-69**	-79	-99	-88	**-89**	-78	-76	-87	**-80**	-106	-98	-105	**-103**
13	-72	-78	-61	**-70**	-100	-98	-87	**-95**	-78	-78	-88	**-81**	-107	-99	-103	**-103**
14	-74	-76	-86	**-79**	-90	-99	-89	**-93**	-79	-77	-70	**-75**	-99	-99	-100	**-99**
15	-72	-75	-82	**-76**	-87	-78	-70	**-78**	-80	-75	-71	**-75**	-101	-99	-98	**-99**

Table 5B

	Suspect Point 5				Suspect Point 6				Suspect Point 7				Suspect Point 8			
No. Of Tests	Received signal (dBm)				Received signal (dBm)				Received signal (dBm)				Received signal (dBm)			
	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**
1	-100	-72	-61	**-78**	-99	-100	-100	**-100**	-78	-78	-62	**-73**	-70	-80	-85	**-78**
2	-102	-73	-82	**-86**	-99	-103	-102	**-101**	-99	-99	-63	**-87**	-8	-76	-87	**-57**
3	-101	-95	-85	**-94**	-98	-105	-110	**-104**	-101	-98	-70	**-90**	-69	-77	-90	**-79**
4	-100	-98	-87	**-95**	-100	-105	-99	**-101**	-99	-100	-86	**-95**	-73	-79	-70	**-74**
5	-100	-99	-90	**-96**	-81	-100	-99	**-93**	-83	-102	-65	**-83**	-78	-89	-72	**-80**
6	-101	-100	-92	**-98**	-82	-98	-98	**-93**	-78	-101	-72	**-84**	-79	-90	-73	**-81**
7	-97	-101	-95	**-98**	-102	-98	-100	**-100**	-99	-99	-71	**-90**	-78	-78	-72	**-76**
8	-78	-100	-99	**-92**	-101	-74	-101	**-92**	-98	-95	-75	**-89**	-74	-77	-71	**-74**
9	-97	-99	-78	**-91**	-98	-85	-100	**-94**	-90	-72	-86	**-83**	-76	-76	-71	**-74**

10	-100	-98	-74	**-91**	-100	-86	-98	**-95**	-78	-75	-86	**-80**	-90	-78	-78	**-82**
11	-99	-84	-75	**-86**	-110	-94	-99	**-101**	-100	-76	-98	**-91**	-95	-79	-68	**-81**
12	-101	-85	-75	**-87**	-103	-96	-99	**-99**	-101	-100	-97	**-99**	-86	-78	-69	**-78**
13	-100	-78	-87	**-88**	-90	-98	-98	**-95**	-98	-106	-99	**-101**	-88	-78	-76	**-81**
14	-69	-79	-100	**-83**	-100	-99	-98	**-99**	-92	-86	-86	**-88**	-85	-79	-75	**-80**
15	-59	-100	-100	**-86**	-102	-99	-99	**-100**	-100	-87	-85	**-91**	-82	-79	-75	**-79**

Table 5C

	Suspect Point 9				Suspect Point 10				Suspect Point 11				Suspect Point 12			
No. Of Tests	Received signal (dBm)				Received signal (dBm)				Received signal (dBm)				Received signal (dBm)			
	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**	RS	HS	DS	**Avg**
1	-85	-82	-69	**-79**	-90	-99	-78	**-89**	-79	-80	-80	**-80**	-79	-85	-83	**-82**
2	-80	-79	-69	**-76**	-88	-98	-92	**-93**	-78	-80	-82	**-80**	-80	-83	-84	**-82**
3	-82	-81	-70	**-78**	-85	-100	-94	**-93**	-90	-81	-81	**-84**	-81	-82	-84	**-82**
4	-81	-79	-73	**-78**	-82	-98	-96	**-92**	-89	-82	-80	**-84**	-83	-79	-90	**-84**
5	-75	-79	-74	**-76**	-99	-85	-98	**-94**	-91	-81	-79	**-84**	-83	-85	-98	**-89**
6	-72	-81	-75	**-76**	-101	-84	-85	**-90**	-85	-98	-80	**-88**	-84	-100	-86	**-90**
7	-70	-80	-76	**-75**	-99	-86	-79	**-88**	-83	-100	-81	**-88**	-85	-98	-85	**-89**
8	-95	-85	-77	**-86**	-100	-102	-80	**-94**	-83	-80	-79	**-81**	-85	-84	-84	**-84**
9	-97	-86	-78	**-87**	-82	-104	-81	**-89**	-79	-81	-78	**-79**	-86	-83	-84	**-84**
10	-86	-85	-78	**-83**	-76	-101	-85	**-87**	-78	-82	-78	**-79**	-84	-85	-83	**-84**
11	-84	-89	-85	**-86**	-78	-99	-90	**-89**	-75	-85	-88	**-83**	-83	-86	-84	**-84**
12	-85	-86	-90	**-87**	-89	-85	-91	**-88**	-78	-83	-90	**-84**	-82	-63	-83	**-76**
13	-84	-85	-95	**-88**	-92	-84	-95	**-90**	-76	-82	-95	**-84**	-81	-82	-83	**-82**
14	-75	-83	-75	**-78**	-99	-89	-84	**-91**	-77	-80	-86	**-81**	-81	-82	-82	**-82**
15	-78	-83	-74	**-78**	-83	-90	-83	**-85**	-76	-80	-85	**-80**	-80	-83	-82	**-82**

IV. PROCEDURE FOR CLASSIFICATION OF THE SUSPECT LOCATIONS

For the classification of the suspect points the following assumption were made Any suspect point where the average of the received signal for the three seasons is less than -91dBm

(a) For 3 tests but not more than 6 trials will be classified as an unstable location.
(b) For 7 tests but not more than 9 trials will be classified as an unstable location.
(c) For 10 tests but not more than 12 tests the measurement process will be repeated for that point every hour for 12 hours in a day for one week. If the condition persists that point will be declared an unstable point.
(d) Above 12 tests the location is a blank network point

(e) Otherwise the location is a good network reception point.

Base Station Analyzer will then be used to further confirm the received signal strength and the distance of the location from the Base Transceiver [12].

5.1 ANALYSIS AT THE SUSPECT LOCATIONS

For this paper analysis of the data obtained at 6 suspect locations only will be presented as the analysis of the rest of the locations followed the same pattern.

Suspect Location One

MAT LAB plot of data from tables 5A, for suspect location 1 is shown fig 2 below

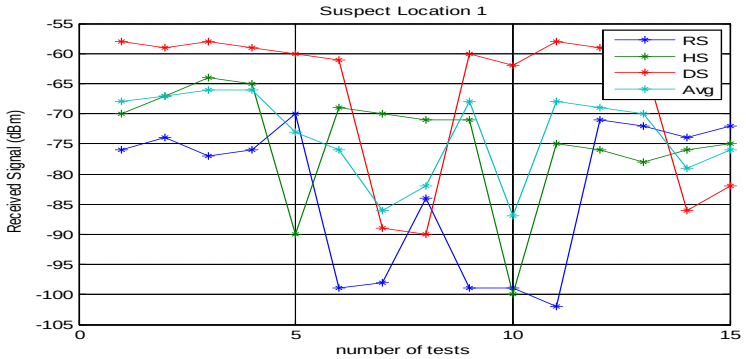

Fig.2: Plot of Signal behavior at suspect location 1

From the plot, none of the average of the 3 seasons measurements went below the threshold (-91dBm) indicating that the location receives good network signal, even though on the rainy season and ham tan season's experiments, there were occasions when the signal level went below the threshold which may be why it was picked as a suspect point. But those incidents were not enough to classify the location as unsteady or blank network receptions. The conclusion is that suspect location 1 is a point of good network reception. Any mobile phone user with that network will experience full network reception if found at that point.

Suspect Location 2

The plot of data obtained from further measurements conducted at suspect location 2 (table 5A) to classify whether the point receives stable, unstable or blank network signal is shown in fig 3below.

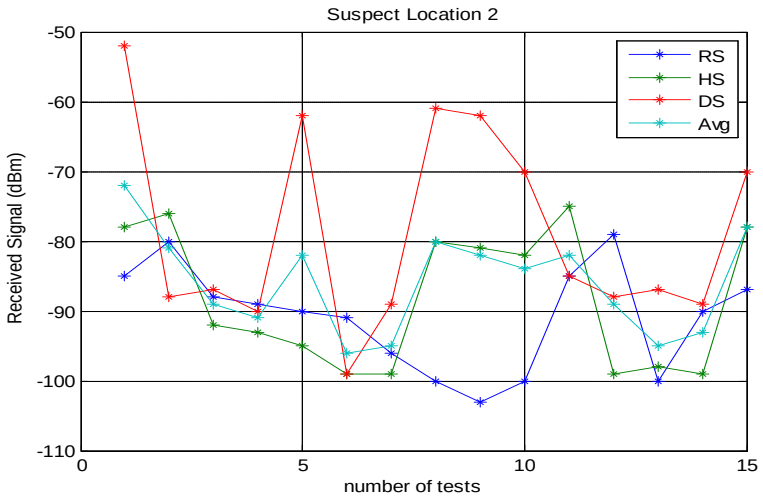

Fig. 3: Signal behavior at suspect point 2

From the average of the measurements in the plot, it's very clear the received signal levels fell below the threshold for at least 3 times. The conclusion therefore is that suspect location 2 is a point of unstable network reception. Any mobile user of that network who finds his or herself at that point will experience unsteady network receptions.

Suspect Location 3

Figure 4 below is the plot of data (table 5A) obtained from experiments conducted at suspect point 3 to observe the signal behavior at the point.

Fig 4: Signal Behavior at Suspect location 3

Although from the plot there were moments when the received signal level fell below the threshold, but the average level of the three season's measurements did not show any point when the received signal level fell below the threshold, therefore suspect point 3 is a point of good signal reception. Network users at that location will be receiving full network signal.

Suspect Location 4

Figure 5 below is the plot of data (table 5A) obtained from the experimental work at suspect location 4 to observe the behavior of received signal at that location.

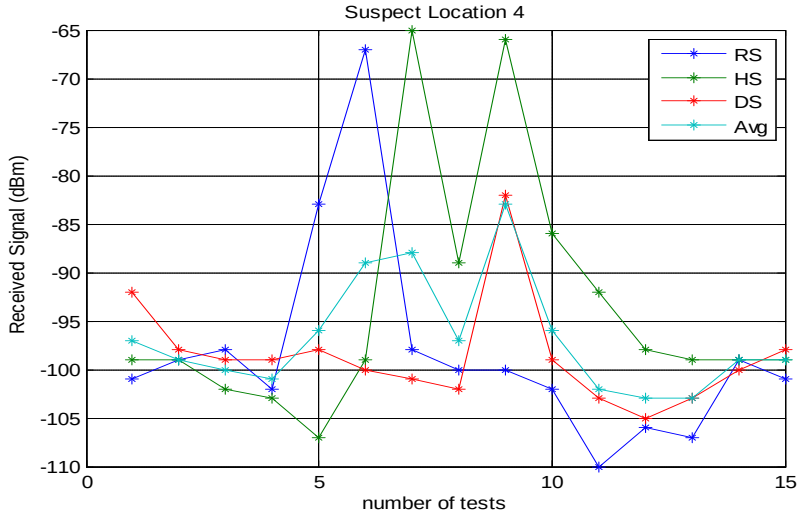

Fig 5: Signal behavior at suspect location 4

The plot above shows clearly that from the experiments conducted, the average of the three season's received signal level fell below threshold (-94dBm) for at least 12 times. Therefore the conclusion of the further investigation at suspect location 4 is that it is a location of blank network reception. Any mobile user of that network who finds his or her self at that location will definitely experience blank network reception, meaning that the person will not be able to receive or make calls at that location, though there may be occasions when there will be flashes of good network reception, but such reception will not be able to sustain calls.

Suspect Location 6

Figure 6 below is the plot of data (table 5B) obtained from measurements conducted at suspect point 6 to find out whether the point receives good, unstable or blank network signal.

Fig 6: Signal Behavior at Suspect Location 6

From the plot, the average of the measurements shows that the received signal level fell below the threshold for more than 12 times, meaning that the location is a point of blank network reception. Any mobile user who finds his or her self at that point will experience blank network reception.

Suspect Location 7

Below shows the plot of the behavior of received signal at suspect point 7 obtained from the measurements conducted at the suspect point, to classify whether the point receive good, blank network signal (table 5B)

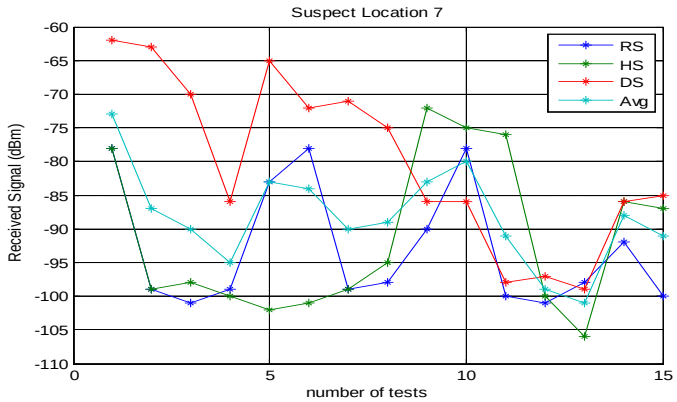

Fig 8: Signal Behavior at Suspect Location 7

The average of the three season's received signal of the experimental works conducted as shown in the plot above indicates that the received signal level fell below threshold up to 5 times but not more than 10 times, meaning that following the established procedure for the classification of the suspect points, the location is a point of unsteady signal reception. Any mobile phone user of that network will experience unsteady network reception at that location.

V. CONCLUSION

From the series of measurements taken in the study field and subsequent MAT LAB plots made with the data obtained, it was found that there are locations in the network of study where the received signal level is very much unsteady and that any Phone user with that network SIM who happens to be in such locations will surely experience unsteady network receptions which may cause call interruptions and may at some instance lead to call drops. There are also locations in the network of study where the received signal level is so low that it cannot support the making or reception of calls (blank locations) and any cellular phone user with that network SIM will experience no network coverage in such locations. Effectively, strong wind, heavy foliage, heavy rainfall, moving obstacles and network congestion among other things reduces signal reception in cellular networks.

REFERENCES

[1] A. Gbenga (2006), *Telecommunication in Nigeria Concept*

[2] M. Mailer (2013), *Wireless Networking*, Pearson Que Publishing, North America

[3] T. David and P. Viswanath (2005), *Fundamentals of Wireless Communication*, Cambridge University Press.

[4] A, Haeberlen, F. Flannery, A. M. Ladd, A. Rudys, D.S. Wallech and L.E. Kavraki. '*Practical Robust Localization over Larg – Scale* 802.11 wireless networks' Proceedings of the 10th annual international

Conference on Mobile Computing and network Mobicom'04, September 26 – October 01, 2004, Philadelphia, P.A, USA.

[5] R.M. Kanagalu (1999), *Coverage Estimation for Mobile Cellular Networks from Signal Strength Measurements*, a Ph.D thesis presented to department of Electrical Engineering, University of Texas, Dallas USA.

[6] G.N. Onoh (2005), *Communication Systems*, De – Adroit Innovation.

[7] C.C. Lee and R. Steele (2003), *Signal to Interference Calculations for Modern TDMA Cellular Communication Systems.* Proc.Inst. Elect. Eng. Comm. Vol. 142, pp. 21-30.

[8] S. Sharma (2010); *Signals and systems*, 7th Revised and Enlarged Editon. Sk Kataria & sons Publishers of Engineering & computer Books.

[9] MTN Nigeria (2009) *hand book on base station analysis*.

[10] B.G. Najashi et al (2013), *An insight into Spectrum Occupancy in Nigeria*, IJCSI Internatioanl Journal of Computer Science issues, Vol. 10,issue 1, No.1, ISSN (Print): 1694-0784 ISSN (Online),1694-0814, www.IJCSI.org, pp. 394 - 399.

[11] M. Bezler et al (2003), *GSM base station system***,** Electrical Communication, 2nd Quarter 2003, pp.134 - 139.

[12] K. Purnima, Sharma and R. K. Singh (2012) , *Cell Coverage Area and Link Budget Calculations in GSM* ,International Journal of Modem Engineering Research.