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Factors That Impede Transmission and Reception of Mobile Cellular and Global Positioning System (GPS) Signals in Adamawa State

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Abstract: *This project was designed to assess the extent to which some factors affect transmission and reception of mobile cellular telephone signals in Adamawa State. To carry out the study, four research questions and one hypothesis were formulated, all derived from the literature review. The research question ascertain to what extent does mode of propagation, weather, topography, cellular site obstruct transmission and reception of mobile cellular telephone and Global Positioning System (GP S)Signals in Adamawa State. Questionnaire was used to collect relevant data from a total population of 40 Engineers/Technicians of Globacom, MTN and Vmobile who were operating in Adamawa State. Mean and standard deviation were used to analyse data collected, while analysis of variance was employed to test the hypothesis at the 0.01 level of significance. The study among other things revealed that there are factors that obstruct transmission and reception of signals to a very great extent are mountain, lack of enough number of relay stations antenna not sitting each other and to a great extent are capacity of transmitter forest. It was recommended that enough number of relay stations should be installed and antenna should be installed high enough to avoid obstruction by mountains.*

Keyword:*Transmission, GPS, Signals, Propagation, Weather, Topography, Mobile Cellular Telephone*

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I. Background of The Study

It is important to note that communication and electric energy systems have clearly marked different sets of factors that influence their transmission and reception. The waves form is usually known and the main concern in designing a system is to design a system with minimum energy loss. Noise limits the ability to communicate. Each GPS Satellite continuous transmits signals which contain a wealth of information, depending on the types and accuracy of positioning being carried out, a user may only be interested in a portion of the information included in the GPS signal. Similarly, a giving GPS receive may only enable use of a portion of the available information (GPS Positioning Guide, Third printing July, 1995). It is therefore important for users to understand the content and use of GPS signal, however, the signals include the carrier frequencies, Coarse Acquisition (C/A) and precise (P) codes and the satellite message.If there were no noise, message can be communicated electronically using an infinitely small amount of power. The general trend of the development of modern mobile communication is toward error-free both in design, transmission and reception of information. The development or evolution of an integrated circuit technology has led to miniaturization of radio equipment and its operation.

According to Dunlop and Smith (1998), the essential features of all cellular networks are that the final link between subscribers and fixed network is by radio. This has a number of consequences: Radio spectrum is a finite sources and the amount of spectrum available for a mobile communication is strictly limited, The radio equipment is subject to multipart propagation, fading and interference and is not therefore an ideal transmission Medium and The subscriber is able to move and this movement must not be accommodated by the communication system.The mobile is assigned a double channel and communicate with an assigned base station, and the base station communicate with all mobile handsets within their area of coverage (cell), which are connected to the mobile switching centers. The switching centers control a number of mobiles within the area, arranges base station and channels. And it also handles connections with fixed public switched telephone network. Each base station has different carrier frequencies with a usable bandwidth in association within the area.

According to Fink (1986), a call is routed via landline trunk to a cell site in the vicinity of the mobile unit; low power radio frequency (rf) transmission is used for the last few miles only. System logic must locate an active user within the grid so as to hand off control of the cell to the proper cell site as the signal strength of the active user changes. Dunlop (1998) supported the operation system of a cellular site. Thus, whenever the mobile is operating on a voice channel, the base station monitors the received signal level. However, the fixed number of carrier frequencies would improve the capacity of the system by increasing re-use of the carrier frequencies. This has two basic effects: Increase the likelihood of interference among users of same frequency in a cell. If a mobile is moving it will cross cell boundaries more frequent when cells are small. And whenever a mobile crosses a cell boundary it must change from a carrier of cell it is entering. As the changing of the carrier frequency cannot be done at the same time there will be a loss of communication, while the handover is being processed therefore the smaller the size of the cell the more rapid rate of handover. A number of radio channels on demand are shared, whereby a particular channel would be assigned to a specific individual user only when a call is in progress. In mobile radio system, high power transmitters are used so that each radio channel covers a whole city or country.

A channel being used by any one in that area will not be used by others. Each user communicates through a radio channels from a cellular telephone set to the cell-site base station. The base station is connected via telephone lines to the mobile telephone switching office (MTSO).It is this office that connects the user to the call party. If the called party is land based, the connection is made through the central office (CO) to the terrestrial telephone network. If the called party is mobile, the connection is made to the cell-site that covers the area in which the called party is located, using an available radio channel in the cell associated with the called party. The number of any mobile user is accommodated for a given sets of radio channel. As the user move from one cell to another, the mobile telephone switching office automatically switches the user to an available channel in the new cell and the telephone conversion continues uninterrupted. The cellular concept has the following advantages, as spelt out by Leon (1997): Large subscribe capacity, Efficient use of radio spectrum, Nationwide compatibility, Service to hand held portable as well as vehicle, High quality telephone and data service to the mobile user at relatively low cost.

The Navstar Global Positioning System (GPS) currently broadcasts on three frequencies: namely L1 with a centre frequency of 1575.42 MHz, L2 centred at 1227.60 MHz, and L5 at 1176.45 MHz. Only the GPS L1 Coarse Acquisition (C/A) signal was used for the results presented in this dissertation. As such, the Navstar L2 and L5 signals, along with other GNSS signals such as those transmitted by GLONASS, Galileo, and Compass will not be discussed herein.

The GPS is a satellite-based positioning system capable of providing a user position anywhere in the world. This system was developed by the Department of Defense (DoD) GPS can be used for civilian applications even though it was developed for military applications [Spilker and Parkinson, 1996].The system currently consists of 27 (nominally 24) satellites which provide continuous information for the user to compute position, velocity and time (PVT). The satellites orbit about 28,000 km above the Earth's surface and have an orbital period of 11 hr 58 m

[ICD, 2003].to support the military forces of the United States of America by providing world-wide, real-time positions [Parkinson et al., 1995]

The total number of the carrier cycles from the GPS satellites to the user are measured and converted into a range measurement using the carrier wavelength [Kaplan, 1996]. The receiver cannot determine the number of integer cycles before the signal is acquired. This is referred to as the integer cycle ambiguity. This ambiguity mube resolved before the carrier phase measurement can be used for position computation. It can be represented by Equation below [Wells et al., 1986].

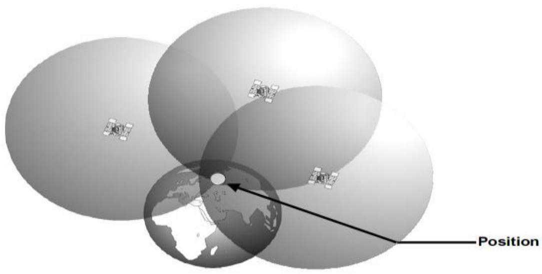
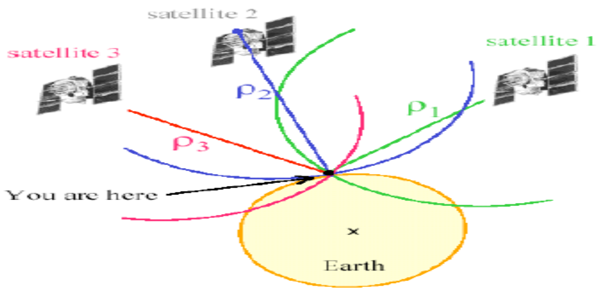


Figure 1: The position is determined at the point where all three spheres intersect
Sources: (Purdue University) Hofmann-Wellenhof et al. 2001 (Springer

$$\theta(t) = -\lambda\phi(t) = \rho(t) + dorb + c(dt(t) - dT(t)) + dtrop(t) - diono(t) + \lambda N + \varepsilon\theta$$

Where

θ(t) is the carrier phase measurement at time t (m),
ϕ(t) is the carrier phase measurement (cycles),
λis the carrier wavelength (m/cycle),
N is the integer carrier phase ambiguity (cycles), and
εθis the carrier multipath and measurement noise (m).



GPS satellites transmit on two frequencies in the L-band of the frequency spectrum calledL1 and L2 signals. The L1 signal is the primary frequency and is transmitted at
1.57542 GHz and L2 is the secondary frequency and is transmitted at 1.2276 GHz. The
GPS signal is a BPSK DS spread spectrum signal [ICD, 2003]. The GPS signal broadcast on the L1 and L2 frequencies have the signal structure given in Equations below and (2.7) [Kaplan, 1996].

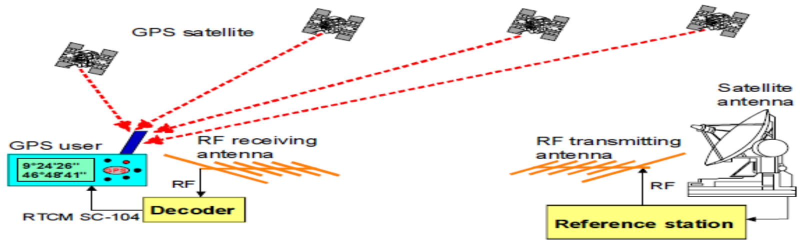


Figure 2: Correcting measured pseudo-range *Sources: (Purdue University) Hofmann-Wellenhof et al. 2001 (Springer*

L1(t) = A1P(t)N(t)cos(2πf1t) +A1C/A(t)N(t)sin(2πf1t)
L2(t) = A2P(t)N(t)cos(2πf2t) 2.7

Where
A1 is the L1 signal amplitude,
A2 is the L2 signal amplitude,
P(t) is the P-code,
C/A(t) is the C/A-code,
N(t) is the navigation data,
cos(2 π f1t),cos(2 π f2t), sin(2 π f1t) are the un-modulated L1 and L2 signals, and
L1(t) and L2(t) are the modulated L1 and L2 signals.

2 cesium and 2 rubidium clocks (10-13-10-14 day variation)

L Band Frequency: 10.23 MHz

X154 x120

2 signals: L1=1575.42 MHz, L2=1227.60 MHz

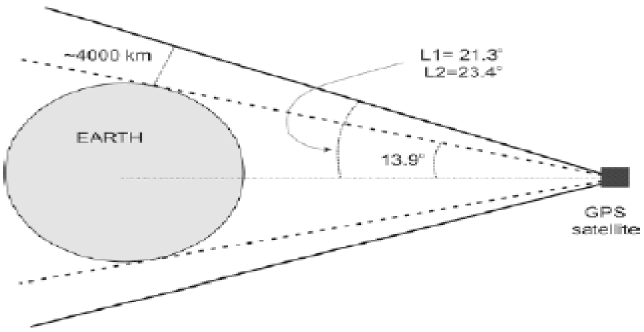


Figure 3: GPS Transmission Beams *Sources: (Purdue University) Hofmann-Wellenhof et al. 2001 (Springer)*

The navigation data bit duration puts a limit on the coherent integration period. This limit puts a constraint on the processing signal gain in the acquisition process which determines the GPS signal level that can be acquired [Ward, 1996]. To acquire weak signals the predetection integration time has to be extended beyond 20ms. A method of achieving this is to perform coherent integration for 20ms and non-coherent integration for the desired duration [Choi et al., 2002].Non-coherent integration squares and sums the signal across the coherent integration periods. This allows for a coherent integration time to be less than 20 ms and a predetection integration time beyond 20ms. Non coherent integration introduces a squaring loss which can be reduced by multiplying the adjacent coherent integration samples over the desired period [Chansarkar, 2000],RFI is a major source for degradation of the GPS accuracy and reliability. Since there are other sources of errors which further degrade GPS accuracy, this makes RFI mitigation more difficult. GPS satellites and users are mobile which make it difficult to integrate the signals over long periods of time to average out the effects of noise. Satellite and user motion introduce Doppler effects, slow power fluctuations (due to changes in the effective antenna gain and path loss) and fast power changes (due to multipath fading, blockage and shadowing) [Heppe and Ward, 2003].

1.2 Statement of the Problem

There have been complaints by subscribers of mobile cellular phones over the services rendered by mobile cellular operators. According to Martin, Mo and (Bostian 2005), depending on the design and application of the device, the range with which signal covers varies tremendously. While some devices (such as Rf tags) operate over a few inches, other devices (such as those used in wireless computer networking) operate over a wide range of miles. He explained further that the range depends on many factors, which include the following: the environment A highly dependent factor in the range of device. Cellular environments may cause excessive multipart, which can reduce both the range of coverage and data rate of the device, the operating frequency of the device and the output power. These might be the reasons or part of the reasons for the poor services provided by the mobile cellular telephone providers over the efficient services provided. And to some extent, busy network and lack of services from place to place and time to time. As Ndukwe (2005) pointed out in a Nigerian television network programed score card, one of the problems faced by mobile telephone providers is the telephone traffic network. Therefore, there is need to find out the reasons for lack of services always and the problem that led to busy network.

1.3 Area of the Study

The study was carried out in the three senatorial district of Adamawa State. It covers the entire State, based on the three (3) mobile telephone operators, who operate within the Zone. Adamawa State is located in north-eastern region of Nigeria which is characterized with relief features. It lies between latitude 7^0N and 11^0 N of the equator and between longitude 11^0E and 14^0 E of the Greenwich meridian. It shares boundary with Taraba state in the south and west, Gombe state in its Northwest and Borno in the North. the map of Nigeria showing the state as well as that of the study areasas presented Figures 1.2

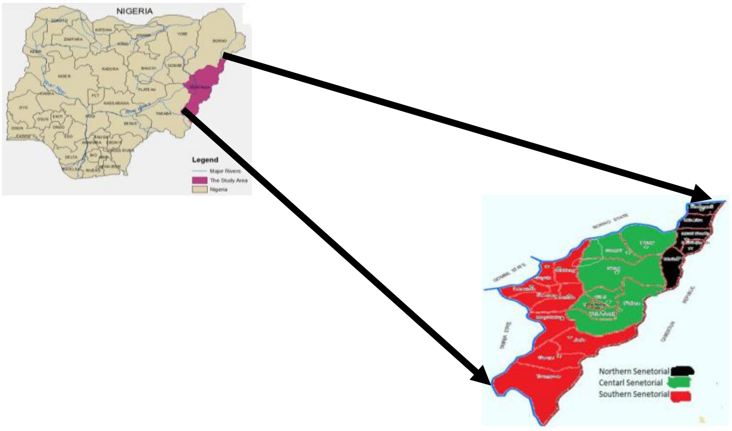


Figure 4: Map of Adamawa Showing the Study Area

1.4 Significance of the Study

The findings of this research work can be of immense benefits to mobile communication providers by enabling them to enhance their efficiency in services within Adamawa State. Since the problems clearly spelt out the subscribers of mobile cellular telephone would be aware of the reasons for poor services and under what condition the services arise. The Nigerian Communication Commission, who is the policy formulators of the communication industry, would be guided by the findings, by providing law which can guide and allow the providers to enhance better services at a cheap rate.

II. Review Of Related Literature

2.10Mode of Propagation in Wireless Communication

The type of propagation used in radio transmission depends on the frequency (speed) of the signal. Cellular phones used frequencies in the ranges of 824 – 849MHz and 869 – 894MHz, which are all within the range of ultra-high frequency (UHF). (*Anthere and Jastrown 2003*) emphasized that ultra-high frequency (UHF) 300 – 3GHz wave always uses line of sight propagation. Use includes UHF television, mobile telephone, cellular radio, paging and microwave links: (*Anock 2002*) argued that very high frequency (VHF) and UHF range of frequencies, the ionosphere is not able to refract the energy towards earth. Also ground wave losses are so high that those waves can propagate only in few hundred feet by means of surface waves. Communication at these frequencies can be carried out by means of space wave by elevation the transmitting and receiving antenna from earth. This becomes possible because of small wavelength of their frequencies. According to (*Matz 1998*) VHF and UHF propagation can be divided into two categories line of sight (LOS) propagation, including some troposcatter and mobile multipath scatter and non-line-of sight (non-los) propagation, including aural refraction, meteor trail reflection and ionosphere reflection. These two propagation categories either have fade notches that are much wider than the information band-width (LOS case) or much narrower than the information band width (Non-Los) the first treat fade as "Flat" over the channel. According to Dunlop and Smith (1998) if the height of the base station is hi and the height of the mobile antenna is h_2 and the separation between a transmitter and receiver is d, it is assumed that d is small enough to neglect the earth curvature. There will be both direct and ground reflected waves. According to *(Anthere and Jastrow 2003)* very high signals are transmitted in straight line directly from antenna to antenna. An antenna must be directional facing each other either tall enough or close enough together, not to be affected by the curvature of the earth. An argument was posed by *(Anokh 2002)* that "the wave radiated from transmitting antenna may reach a receiving antenna by travelling over several possible paths of propagation. According to *(Kiver and Kaufman 1983).* Who state, "The energy of all electromagnetic wave is divided between an electric field and magnetic field; in free space. These fields are at right angles to each other."

2.20Obstruction of Weather on Transmission/Reception

The medium of transmission of information in mobile cellular telephone is the atmosphere. Any signal transmitted and received over a wide area of coverage faces a lot of disturbances, either as a result of topography or elements of weather. These may cause the like mode of signal along the medium to change or attenuated completely. According to Brierley (1986) weather is an attenuation factor in scattering of radio waves by small objects on its path or to the absorption of energy from the medium through which the wave passes. He explained further that, objects commonly causing scattering of signal are raindrops and ice particles. In temperate climates attenuation due to scattering is rarely significant at frequencies below 10GHz, but may be considerable at frequencies above 10GHz when there is heavy rain... Stremler (1977) viewed that effect of weather as some refraction on bonding of path does not occur for low evasion angles and communication beyond the line-of-sight is still possible at high frequencies multipath propagation and fading may vary as a function of meteorological conditions in this propagation. According to Timothy (1986), at sufficiently high frequencies, electromagnetic waves interact with molecules of atmospheric gases, to cause attenuation. Fink (1986) looked at rain as an element of weather, which causes attenuation of signal. Thus "rain is an important effect and causes a noticeable attention of frequencies as low as 3GHz and interruption of line-of-sight links at frequencies as low as 6GHz. Rain restricts the reliable use of frequencies much above 30GHz. To terrestrial links near the Zenith Michael (2002) viewed transmitted signals as theories are often degenerated by weather or other factors. For example, temperature layers cause some of the signal to be refracted from the earth surface and also affect the transmitted signal.

2.30The Obstruction of Topography on Transmission/Reception

This is another factor that prevents transmission and reception of signals, in which radio wave propagation is used. According to Devoured, Haccvat, Natafish and RYO (2002), radio broadcasting is based on electromagnetism which is reshaped, controlled, transmitted and received. At the most basic level radio broadcast system consists of a transmitter and receiver. Content is encoded into a sine wave and transmitted over with a radio wave via an antenna. Receivers with the range of a transmitted signal picks the radio signal through its antenna, decode the content from the sine wave and "plays" the content through the speaker. But according to Brierley (1986), the electromagnetism would be faced with attenuation due to absorption which occurs when radio waves passes through walls and vegetation. This idea was supported by Green (1985), that the distance between transmitting and receiving stations is usually the range of 300 to 500km and nearly always caver geographically hostile terrain, such as mountains, jungle or ocean. He further explained that, the direct wave must be well clear of any obstacles such as trees, buildings which might block the path, and this factor will determine the necessary aerial height. According to George and Morgan (2002), mountainous terrain creates coverage holes and shadow areas; because they create barriers to frequencies sent from cells.... Buildings are barriers to transmission and reception of frequencies. According to Parson and Gardiner (1989) radio waves are transmitted cross barriers/obstacles due to the nature of transmission. Thus, electromagnetic energy is the form of radio wave that propagates onward from a transmitting antenna. And there are three main ways in which these waves, travel, much depend on the frequency of transmission. The ground is that portion of the radiation directly affected by the surface of the earth. Fink (1986) argued that not only the population distribution of power of the transmitter determines the area of coverage but also the topography of the area under consideration. And according to Fink (1986) point-to-point microwave link frequencies above 1 GHz are designed to achieve essentially free space attenuation. He explained that this is done by the use of narrow bean antennas and path profile chart to engineer the line-of-sight path so that it will have adequate clearance from terrain and surrounding obstacles. Assertion had been made by Brierley (1986) that the strength of the received radio signal may be influenced by obstacles which do not actually obstruct the line-of-sight between the transmitter and receiver....Stremler (1977) stated that the direction of the skywave above frequency of about 30GHz is not altered enough to return to earth and propagation above this frequency is predominantly straight line from a transmitter to receiver.

2.4 Influence of Cellular Site on Transmission/Reception

Cellular site otherwise, known as a cell site (short form), is a location unit through radio links are established between wireless system and a wireless unit. It consists of a transmitter/receiver, antenna tower, transmission radios and controllers. The directivity of the cell and its capacity has adverse effects on the transmission of radio waves. According Dunlop and Smith (1998) system capacity is defined as the number of available channels or alternatively in terms of number of subscribers, that the system will support interconnectivity takes place from the caller to cell station and the receivers or mobile switching center to the receiver. This indicated that when there is failure on one thing, there is going to be failure in services. According to Dunlop and Smith (1998) system capacity depends on: The number of radio channels; The size of the cell; The frequency re-use (or frequency re-used distance). He explained that the total number of voice channels that can be made available to any system depends on the radio spectrum allocated and the bandwidth of each channel. Once this number is defined a frequency reuse pattern must be developed which will allow optimum use of this channel. This in turn, is closely linked with cell-size. The minimum distance which allows same frequency to be re-used will depend on many factors, for example: the number of co-channel cells in the vicinity of center cell; the geography of the terrain; the antenna height; transmitted power within each cell. According George and Morgan (2003) a wireless network requires the presence of three things. Mobile units: - These are the portable cellular phone people use; Cellular transmission/reception site: - Consists of at least one transmitter and receiver antennae. Each antenna provides cellular coverage for a given geographical area. The site requires an electrical input to power the equipment; Mobile telephone switching office: - all calls are transmitted and received by a receptor site and sent to the switching office where they then sent to appropriate location called by the cellular customers. Parson and Gardiner (1986) explained the base station coverage and capacity as the traditional problem faced by mobile radio system designers is how to balance the apparent conflicting requirements of area of coverage and user capacity. According to George and Morgan (2003), geographical terrain provide a good site for cellular reception/transmission towers because they are high evaluations; water is also good for carrying signals over long distances. And buildings too, are good sites for mountain cells. According Stremler (1977), the distance of communication is governed predominantly by the height of the transmitting and receiving antennas. Tanba and Schilling (1971) observed that for two particular antennas to minimize interferences and spurious signals it is advantageous that both antennas be directed to each other so that there is maximum interception of the signal. Conner (1979) supported this idea that a receiving antenna is rotated to obtain the direction of high field strength. According to Shay (1998), in cellular telephone network, the geographical area is divided into multiple regions or cell, each of which has a reception and transmission station. For a considerable distance of more than 40km (Green (1985) there must be need for a number of relay stations. This means that for a distance more than 40km from a base station, there should be another relay station for onward transmission and reception of signals. Low frequency transmission in ground wave propagation leads to lack of signal in an area. Similarly, Anoch (2002) explained that in ground wave propagation losses are so high that such waves can propagate only a few hundred feet. This means that a signal transmitted through ground wave propagation would follow the curvature of the earth. This implies that the signals take the shape of any obstacle it had come across. So, very high frequencies are required for transmission and reception of signals in Adamawa State, due to mountainous area. Microwave slight distortion obstruct transmitted signal from reaching the next antenna. According to Fink (1986) a point-to-point microwave links frequencies to achieve free space attenuation. This is being achieved through the from terrain and surrounding obstacles. Antenna offset feet parabola deviate from direction of satellite obstruct transmitted signal to a great extent. This is because to the satellite, if they are not in line-of-sight. A slight deviation of the antenna due wind or any external force will create signal distortion. This is in line with the earlier report by Anthere and Jastrow (2003) that very high signals are transmitted in straight line from antenna to antenna.

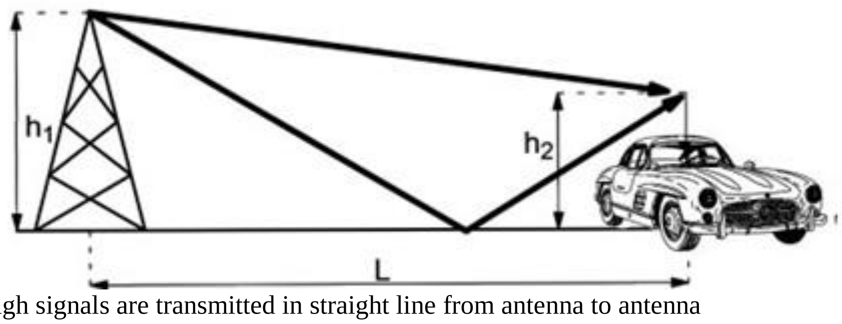


Figure 4: very high signals are transmitted in straight line from antenna to antenna
Sources; GSM Switching, service and protocol: Second edition, 2001

2.31 Elements of weather: Cellular telephone signals are transmitted through the atmosphere.

The signals encounter a lot of obstructions by the elements of weather. This is in line with what Brierley (1986) had stated; that objects commonly causing scattering of signals are raindrops and ice particles. In the findings raindrops prevent transmission and reception of signals to a great extent. It is plot possible, therefore, to receive or transmit any message because of the scattering of signals by heavy rainfall. Presence of high temperature had been pointed out by respondents to obstruct signals to great extent. This is in accordance with the earlier findings by Michael (2002) that temperature layers cause some of the signals to be refracted. Some portions of the transmitted signals are reflected from the earth surface which affects the transmitted signals. This leads to the multi-path fading. Low temperature is favorable in transmission and reception of mobile cellular telephone signals in Adamawa State. Presence of thunder prevents transmission and reception of cellular telephone signals to a great extent in Adamawa State. This is because due to the coming together of positive and negative ions which creates spikes, thereby distorting the nature of signals transmitted presence of high humidity obstructs transmission of signals to a moderate extent. Low humidity favours transmission and reception of signals. Likewise wind, cloud and harmattan have been identified by respondents as obstructing signal to a moderate or even poor extent. This means that they do not obstruct signals.

2.32Topography: another factor that obstructs transmission and reception of mobile cellular telephone Signals to a very great extent. It could be due to high hill, mountains, tall buildings and very thick forest. Respondents have identified mountain as the most effective means of obstruction of signals among all other factors. This is in line with George and Morgan (2002) that mountain creates coverage holes and shadow area to the other side of the mountain. The earlier report of Brierley (1986) attributed that attenuation due to absorption occur as a result of walls and vegetation's. This has been identified by respondents that presence of thick forest obstructs mobile cellular signals to a great extent. The presence of a river neat a cellular site enhances transmission of signals. Respondents had identified the presence of a river obstructs signals to a poor extent. This means that river (water) do not obstruct signal but rather transmit signals by itself. This is the same thing with what George and Morgan (2002) have reported that water is good for carrying signals over a long distance.

2.33Cellular site: This is a location unit through which radio links are established between two wireless units. In the cell-site capacity of a transmitter very greatly prevents transmission and reception of mobile telephone signals. According to earlier report of Dunlop and Smith (1998), the total number of voice channel that can be made available to any system depends on radio spectrum allocated and the bandwidth of each channel. This means that if the total number of chancels in a cell site is in operation, another signal coming must wait to a dropped channel, for connectivity to be achieved. Height of an antenna prevents transmission and reception of signals to a very greatly if the antenna is not high enough because of the mountainous terrain. The height of the antenna should be such that there is no obstruction between two antennas. This had been supported by the earlier findings by Dunlop and Smith (1998) and Stremler (1977), that distance communication is governed by the height of a transmitting and receiving antennas. This means that two antennas must be high to avoid obstruction of signals by tall buildings; mountains, hills and trees. Ranges of coverage of cell-site also prevent transmission and reception of signal to a great extent. This means that the distance, which a cell-site would cover, is a problem, as explained by Parson and Gardiner (1989), that the base station coverage and capacity is a traditional problems faced by mobile radio system designers on how to balance requirements of area coverage and user capacity. Power capacity and air-conditioner prevent signal transmission to a great extent. But the problem of power failure has been taken care of by providing automatic stand-by generators, as had been mentioned by one of the respondent.

III. Method Of Data Collection

The questionnaires were administered to the respondents personally by the researcher. The respondents made up of the Engineers/Technicians of Globacom, GPS, MTN and Vmobile.

3.1 Method of Data Analysis

The data was collected through the use of questionnaires, which was analyzed using mean, standard deviation and analysis of variance (ANOVA). In descriptive analysis mean and standard deviation was used to answer the research questions. While ANOVA was used to test the hypothesis, The formulae used for the mean and standard deviation are: -

$$Mean(\bar{x}) = \frac{\sum x}{n}, and Standard Deviation(SD) = \frac{\sum(\bar{x} - x)^2}{n-1}$$

Mean was calculated to find out the degree of obstruction of signal by the factors that prevent transmission/reception.

3.2 Validation of the Instrument

After drafting the questionnaire, it has undergone a careful assessment. This is to enable the researcher to find out the weakness, and strengths of the instrument. This had been done by passing the questionnaire to three lecturers of Technology Education Department who are experts in electrical/electronics. The questionnaire was also validated by three transmission experts in the field of communication.

3.3 Reliability of the Instrument

The type of reliability that was established for the study is the test-retest reliability. This was done to determine the consistency of the instrument over time. The instrument was administered to thirteen (13) respondents who did not participate in the main study. Data collected from the respondents were used to compute the reliability of the instrument using Pearson product moment correlation coefficient formula. The reliability of the instrument was found to be 0.78. The table for the data and formula used in calculating the correlation coefficient can be found in Appendix.

IV. Result And Discussion

The results are presented according to the research questions and hypotheses which were developed in chapter one. To ascertain the degree of obstruction which the various factors identified, in table 2 have on mobile telephone signals, the respondents rated each of the factors based on Likert's scale (To a very great extent (point 1) and to a very poor extent (point 5). The table revealed that low frequency transmission in ground wave propagation had the lowest mean rating of 1.6. This means that it obstruct transmission, and reception of signal to a very great extent. Antennas not sitting each other, lack of relay stations also obstruct transmission and reception of signal to a very great extent while parabolic antenna deviate from direction of satellite micro-wave distortion space wave propagation with a low power gain have a mean rating of 2.0, 2.0, 2.3 respectively obstruct signal to a great extent. The variability in the degree of obstruction according to the standard deviation was observed on item 5 – space wave propagation with low power gain having a deviation of 0.03 and low frequency transmission in ground wave propagation having the highest deviation of 0.4. Therefore, from the mean score the factors that obstruct signal to a very great extent are as follows: Low frequency transmission in ground wave propagation; Antenna not sighting each other; lack of relay station.

Table 1: The survey of the response

Cellular Operator	Number of Administered questionnaire	% of Total Respondents	Number of questionnaires returned	% returned
Globacom	8	16.67	8	17.78
GPS	5	10.42	5	11.11
MTN	17	35.42	17	37.78
Vmobile	18	37.5	15	33.33
Total	48	100	45	105

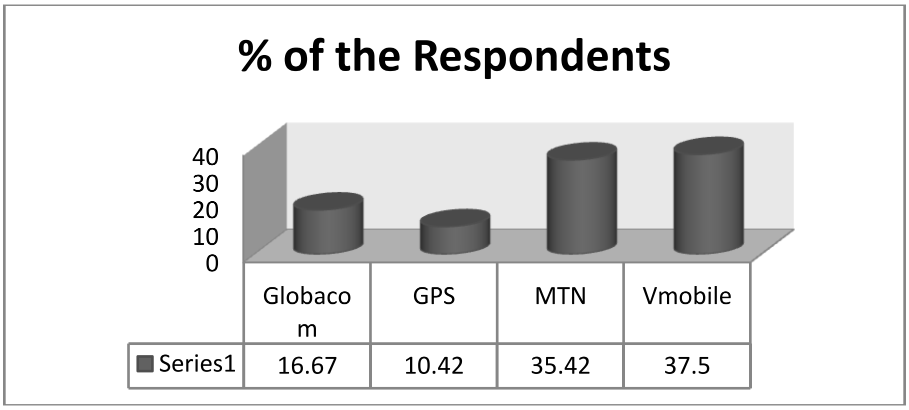


Figure 4: Survey of the Response

From the table above, it can be seen that forty three questionnaires were administered and four questionnaires were returned by the various engineers/technicians of the cellular operators. The percentage of the returned questionnaires is 93% while those that are not returned are 7% which is three (3) questionnaires.

S/No	Factor	Mean	SD	Remark
1.	Antennas not sighting each other	1.7	0.17	Very great extent
2.	Lack of relay station	1.7	0.17	Very great extent
3.	Microwave slight distortion	2.0	0.10	Great extent

4.	Low frequency in ground wave	1.6	0.4	Very great extent
5.	Space wave with low power gain	2.3	0.03	Great extent
6.	Antenna offset feed parabola deviate from direction of satellite	2.0	0.12	Great extent

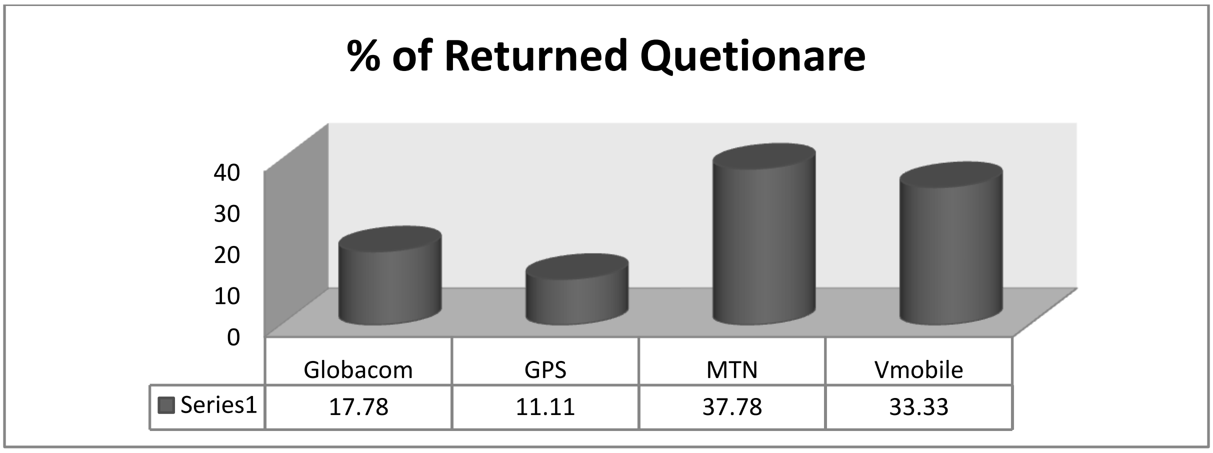


Figure 5: Questionnaires returned

S/No	Factor	Mean	SD	Remark
1.	Presence of Raindrop	2.5	0.09	Great extent
2.	Presence of high temperature	2.6	0.03	Great extent
3.	Presence of low temperature	3.8	0.27	Poor extent
4.	Direction of wind	3.1	0.13	Moderate
5.	Presence of high humidity	2.7	0.06	Great extent
6.	Presence of low humidity	3.8	0.26	Poor extent
7.	Presence of cloud	3.7	0.23	Poor extent
8.	Presence of thunder	2.0	0.10	Great extent
9.	Presence of harmattan	3.7	0.23	Poor extent

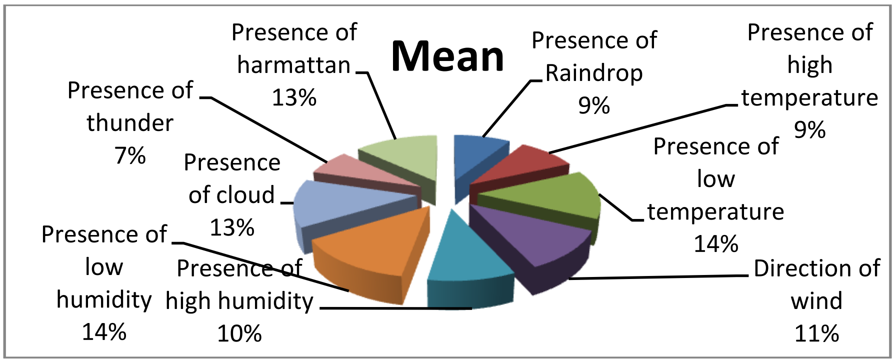


Table 4 Mean and Standard Deviation of responses on the effect of topography on transmission/reception of mobile cellular telephone signals in Adamawa State.

S/No	Factor	Mean	SD	Remark
1.	Presence of mountain barrier	1.1	0.27	Very great extent
2.	Presence of thick forest	2.2	0.04	Great extent
3.	Presence of river	3.9	0.30	Poor extent

Table 4 shows factors on topography with means rating on the extent to which they obstruct transmission and reception of mobile cellular telephone signals in Adamawa State. The table displayed the presence of mountain with a mean rating of 1.1 which obstructs transmission/reception of signals to a very great extent. While the presence if thick forest across the transmission medium obstruct transmission and reception of cellular telephone signals in Adamawa State., to a great extent, with a mean rating of 2.2. But the presence of river had a mean rating as high as 3.9 which is to an approximate do not obstruct transmission of signal because its effect is to poor extent.

S/No	Factor	Mean	SD	Remark
1.	Capacity of transmitter	1.8	0.15	Great extent
2.	Height of antenna	1.9	0.13	Great extent
3.	Position and directivity of antenna	2.3	0.1	Great extent
4.	Range of coverage of cell site	2.1	0.08	Great extent
5.	Failure of air conditioner	2.6	0.06	Great extent
6.	Power failure in cell site	2.1	0.09	Great extent
7.	Components used in handset	3.0	0.05	Moderate extent

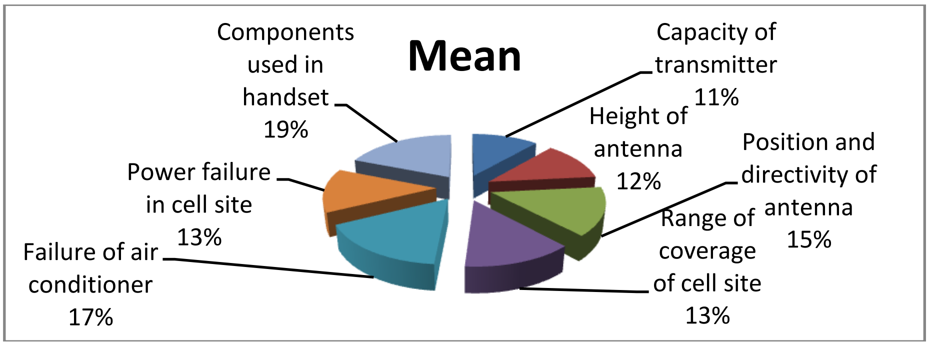


Figure 5:

To find the extent to which various factors on cell site obstruct transmission/reception of mobile cellular telephone signals in Adamawa State, table 5 have identified them. The table shows that capacity of a transmitter and high of an antenna had the lowest mean rating of 1.8 and 1.9, respectively. The two affect transmission and reception of signal to a very great extent. While, range of coverage of a cell-site, power failure in cell site, position and directivity of an antenna; and failure of air-conditioner obstruct transmission and reception of signal to a great extent, with mean rating of 2.1, 2.1, 2.3 and 2.6, respectively. But components used in handset prevent transmission and reception of signals to a moderate extent with the highest mean rating of 3.0. The deviation in the degree of obstruction ranges from the lowest deviation of 0.05 for components used in the handset and highest deviation of 0.15 for the capacity of transmitter.

4.1 Hypothesis

Ho: There is no significant difference in the opinion of engineers/technicians of Glo, GPS, MTN and Vmobile service providers concerning the factors that obstruct mobile telephone communication in Adamawa State.

Table 6: Data for three groups for calculating analysis of variance (ANOVA).

	Group 1		Group 2		Group 3	
S/No.	X_1	X_1^2	X_2	X_2	X_3	X_3
1.	1.6	2.56	1.9	3.61	1.5	2.25
2.	1.9	3.61	1.0	1.0	2.1	4.41
3.	2.0	4.0	2.00	4.0	2.1	4.41
4.	2.5	6.25	2.4	5.76	2.8	7.48
5.	2.3	5.29	1.6	2.56	2.4	5.76
6.	2.0	4.0	2.4	5.76	2.3	5.29
7.	2.3	5.29	2.0	4.0	3.2	10.24
8.	2.4	5.76	2.7	7.29	2.6	6.76
9.	3.8	14.44	4.0	16.0	3.7	13.69
10.	3.8	14.44	2.9	8.41	2.7	7.29
11.	2.4	5.76	2.9	8.41	2.9	8.41
12.	3.8	14.44	3.9	15.21	3.6	12.96
13.	3.3	10.89	4.1	16.81	3.7	13.69
14.	1.8	3.24	2.0	4.0	2.1	4.41
15.	3.6	12.96	4.2	17.64	3.4	11.56

16.	1.3	1.69	1.0	1.0	1.1	1.21
17.	2.3	5.29	2.0	4.0	2.2	4.84
18.	3.9	15.21	4.1	16.81	3.6	12.96
19.	1.9	3.61	1.5	2.85	1.9	3.61
20.	1.9	3.61	2.0	4.0	1.7	2.89
21.	2.3	5.29	2.0	4.0	1.7	2.89
22.	2.4	5.76	2.2	4.84	1.7	2.89
23.	2.1	4.41	2.0	4.0	2.1	4.41
24.	2.6	6.76	2.2	4.81	3.0	9.0
25.	3.1	9.61	3.0	9.0	3.8	7.84
	174.17	1642.47	175.2	1891.12	171.51	1529.74

$$\bar{x}_1 = 6.92, \quad \bar{x}_2 = 7.002, \quad \bar{x}_1 = 6.86,$$

In analysis of variance, sum of squares between the group (SS_b) and sum of squares with (SS_w)the group variance will be calculated as:

$$SS_b = \frac{(\sum x_2)^2}{n_1} + \frac{(\sum x_2)^2}{n_1} + \frac{(\sum x_3)^2}{n_1} - \frac{(\sum X)^2}{N}$$

Where n = number of subjects in a group

N = number of subject for all the group

$$SS_W = \sum X_1^2 - (\sum X_1)^2 + (\sum X_2)^2 - \left(\sum X_2\right)^2 + \left(\sum X_3\right)^2 - (\sum X_3)^2$$

(**Source:** Dr. Ezugu's Note)

$$SS_b = \frac{(174.2)^2}{25} + \frac{(175.2)^2}{25} + \frac{(171.5)^2}{25} - \frac{(520.9)^2}{75} = 0.29$$

$$SS_W = 1642.47 - 1213.82 + 1819.12 - 1227.80 + 1529.74 - 1176.49 = 1445.22$$

$$Fe = \frac{SSB/degreeoffreedombetween}{SSw/degreeoffreedomwithin}$$

$$Fe = \frac{\frac{0.29}{3-1}}{\frac{1445.22}{75-3}} = 0{,}007$$

Table 7: Summary of three groups of Analysis of variance

Source of Variation	SS	df	MS	F_e	F_t
Between group	0.29	2	0.15	0.007	5.53
Within the group	1445.22	72	20.07		
Total	1446.51				

$$MS = MeanSquare$$
$$Ft = F_{tabulated}$$

$$Taking\ 1\%\ levelofsignificance$$
$$Ft(27 - 1.3 - 1)0.01$$
$$Ft(26.2)0.01$$
$$FromF - distributiontable$$

$$Ft = 5.53$$
$$H_0 : F_e < F_t$$

Since F_e is less than F_t, therefore, we accept that there is no significant difference in the opinions of the engineers/technicians of Glo, GPS, MTN and Vmobile concerning the factors that obstruct mobile communication in Adamawa State.

V. Findings

Based on the data analysed in tables 2, 3, 4, 5 and 6, the researcher had found out that the following factors impede transmission and reception of cellular telephone signals in Adamawa State to a very great and great extent. They are:, Mountain;Antenna not sighting each other in line-of-sight propagation;Low frequency transmission in ground wave propagation;Lack of enough number of relay stations;Height of an antenna;Range of coverage of cell-site;Presence of thunder and raindrop.The factors have been outline according to the degree of obstruction based on the mean rating ranging from the lowest 1.1 for mountain to the highest mean rating of 2.1 for range of coverage of cell-site.

VI. Conclusion

The purpose of the study is to ascertain the extent to which mode of propagation; weather, topography, and cell-site obstruct transmission and reception of mobile telephone signals in Adamawa State. Based on the results of this research work, it can be concluded that factors that obstruct transmission and reception of mobile cellular telephone signals in Adamawa State are as follows: Mountain, lack of enough number of repeater stations, lack of directivity of an antenna, height of an antenna and capacity of a transmitter. These are said to prevent signals transmission and reception completely.Based on the findings of the study, if the number of relay stations were increased, signals will not continue to be lacking in other areas in Adamawa State. And with regards to the obstruction caused by mountains if very high antennas were not provided, signals will be attenuated, and subscribers will continue to complain of lack of signal in such areas. Use of low system capacity will increase the problem of network traffic as the number of subscribers is continuously increasing.

VII. Recommendations

Based on the findings of this study, the researcher wishes to recommend to the mobile cellular operators in Adamawa State: Enough number of relay stations should be installed so as to enable the signals cover the entire State;High capacity transmitter which can cover a large number of channels should be used;Antennas should be tightened to avoid deviation from line-of-sight;Very high frequencies should be transmitted at all times;Antennas should be installed high enough to locate site of antenna on a high elevation to avoid topographical obstruction in-between antennas.

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