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Technical Evaluation of the Internet Signal Strength of a State University in North Central Nigeria based on Select Users' Perception and a Qualitative Study

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ABSTRACT

When computers are connected to a network in an educational institution, each computer can make its resources available to other computers in the institution by sharing them over the network. A first step to building a (wireless) network is choosing the correct antenna for one's application. This research work evaluates the general performance of the internet network of Kogi State University, Nigeria, from the perspective of the installed antennas. This is a public tertiary institution located in North Central Nigeria. Two basic approaches were used in evaluating the network, namely, the use of questionnaires (and interview), and via observation/qualitative study. A focussed total of 200 copies of the questionnaire were randomly distributed to staff (academic and non-academic) and students across seven faculties of the institution such that all the copies were returned. This translates to an average of about 25 questionnaires per faculty. The results of the study show that the university network is performing below expectation of majority of the users. Among others, it is recommended that the antennas be installed at a fairly substantial height.

Keywords: *Users' Perception, Qualitative Study, Questionnaire, Internet Signal Strength, Antenna, University*

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1. INTRODUCTION

When computers are connected to a network in an educational institution, each computer can make its resources available to other computers in the office or school by sharing them over the network. Instead of working in isolation as normally done on a single computer not linked to a network, one can work collectively within a system that shares resources among a group of computer users. Each computer connected to the network can share folders, entire disk drives, or a CD-

ROM drive. In addition, other computers on the network can access documents and other files stored in the folders and on the drives. Instead of copying a document to a diskette or flash drive and giving it to another person to view, anyone can open and view the document using the network. A computer network, often simply referred to as a network, is a collection of computers and devices interconnected by communication channels which facilitate communications and allows sharing of resources and information (Tanenbaum, 1989).

Many studies have been conducted on the networks of Nigerian universities. For instance, Abduldayan et. al. (2013) presented a report on a comparative evaluation of the networks of three federal universities, namely Federal University of Technology, Minna, Niger State; University of Jos, Plateau State; and University of Lagos, Lagos State. While the first two universities are located in North Central Nigeria, the third is located in South Western Nigeria. Using a combination of questionnaire, interview and direct observation, users' perception of the performance of wired and wireless services in the universities was collated vis-à-vis such criteria as network media, bandwidth and latency. Among others, the authors argued for an improvement of the services of these networks via upgrading and expansion towards serving effectively the increasing population of the university communities.

In the present paper, the authors focused on North Central Nigeria, and concentrated on a state university in the region, namely, Kogi State University (KSU), now known as Prince Abubakar Audu University (PAAU). The university came into being on 18th November, 1999 when the legislative bill establishing it was signed into law by the then Executive Governor of Kogi State, Prince Abubakar A. Audu. The institution's foundation stone was laid on 30th November, 1999 by the then Civilian President and Commander-in-Chief of the Nigerian Armed Forces, Chief Olusegun Obasanjo (www.ksu.edu.ng).

The specific objectives of the paper include:

(i) To find out the extent to which the wireless network of Kogi State University is available and efficient with respect to staff and students, as at the 15th year of the university's existence;
(ii) To know the perception of users on the university network signal strength;
(iii) To provide suggestions for improving the institution's network.

2. LITERATURE REVIEW

In an earlier paper (Oluwade et. al., 2011), the authors discussed some important technical and sociological factors necessary in providing reliable university-wide internet service. By using the internet service provision in a private university located in North Central Nigeria as a case study, the following factors, among others, were highlighted/identified: bandwidth, routing policy, path length, available budget and general topology of the university. Oluwade (2007) used mathematical modeling via the qualitative theory of ordinary differential equation to construct point-to-point primitive network topologies. And in Oluwade (2008), the author presented a qualitative survey of global standards relating to networking, security, mobile phone radiation and health informatics. These included IEEE 802.11b standard for wireless networking and IEEE P1902 standard for long wavelength wireless network protocol.

In their work, Khalajmehrabadi et. al. (2017) presented an overview of challenges facing wireless local area networks (WLAN) and possible modern day solution. Some fundamentals of Wi-Fi are discussed in Ferro and Rink, euro.ecom.cmu.edu; Martindale, 2020; Fleishman, 2009; Flores, et. al., 2013 and Villegas et. al., 2007.

Two critical technical concepts in the measurement of network signal strength are path loss and line of sight (Akpaida et. al., 2018; www.L-com.com). As a signal propagates through the air, it experiences some loss, called path loss. This is as a result of the signal spreading out over a wider area, and also due to some signal being absorbed by air itself as the signal travels farther away from the source antenna. Given the transmitter gain (Db), the distance (m or km) and frequency (GHz), the path loss (Db) between two antennas can be calculated using many existing path loss calculators based on models. A typical example of these calculators is the Pasternack's Free Space Path Loss Calculator (https://www.pasternack.com/t-calculator-fspl.aspx). The line of sight, on the other hand, is the path between two antennas. There are three main categories of line of sight. Full line of sight (los) is one in which no obstacles reside between the two antennas. Near line of sight (nlos) includes partial obstruction such as tree tops or building between two antennas. Lastly, Non line of sight (Nlos) is one in which full obstruction exists between two antennas. These three categories are depicted in Figure 1, where the

Fresnel zone is the area around the visual line of sight that radio waves spread out into after they leave the antenna.

In Akpaida et. al. (2018), the authors carried out measurement of signal penetration level and path loss characteristics of certain modern residential and office apartments in Ogbomosho, South western Nigeria.

Broadly speaking, there are two types of network configuration, namely peer-to-peer networks and client/server networks (Tanenbaum, 1989**)**. These are depicted in Figure 2 and Figure 3 respectively. Peer-to-peer networks are more commonly implemented where less than ten computers are involved and where strict security is not necessary. All computers have the same status, hence the term 'peer', and they communicate with each other on an equal footing. Files, such as word processing or spreadsheet documents, can be shared across the network and all the computers on the network can share devices, such as printers or scanners, which are connected to any of the computers.

Client/Server networks are more suitable for larger networks. A central Computer, or 'server', acts as the storage location for files and applications shared on the network. Usually the server is higher in performance than average computer performance. The server also controls the network access of the other computers which are referred to as the 'client' computers. Typically, teachers and students in a university will use the client computers for their work and only the network administrator (usually a designated staff member) will have access rights to the server.

Omnidirectional antenna provides a 360 donut shaped radiation pattern to provide the widest possible signal indoor and outdoor wireless applications coverage. An analogy for the radiation pattern would be how an un-shaded incandescent light bulb illuminates a room.

Directional antennas, as the name implies, focuses the wireless signal in a specific direction resulting in a limited coverage area. An analogy for the radiation pattern would be how a vehicle head light illuminates the road.

3. **METHODOLOGY**

As at the time of this study in the second decade following the year 2000, Kogi State University used a wireless network antenna of class 108.11g, otherwise known as 802.11g Wi-Fi, transmitting at 54mbps speed (IEEE specification). This network could only support about 20 percent of the about 17,000 university population. A questionnaire, supported with interview questions, was designed to obtain the views of a focused group of 200 respondents who are members of the university community. The respondents were asked seven basic questions, as shown in the Appendix. Also, a qualitative evaluation of the network was carried out.

Essentially, the types of Wi-Fi antennas that were installed at the various faculties and buildings were observed by the authors, supplemented with available documentation and interview with selected users. It was observed that Building No. 7, otherwise known as 'Digital Centre', is the base transceiver station for the institution's network while Building No. 6 (housing the Faculty of Arts and Humanities) is the base station controller. Network signals are transferred and controlled to the various buildings and faculties by means of omnidirectional and directional antennas.

4. RESULTS AND DISCUSSION

Figure 4 is a schematic diagram of the major buildings within the main campus of Kogi State University. Table 1 shows the responses of the 200 persons whose views were sought on the state of the wireless signal strength on campus. This result has been presented graphically in Figure 5. Based on respondents' opinion as shown in the table, the vast majority of users consider internet access as not easily available and not efficient.

It is important to design and implement a network which can provide a standard networking model and best practice. This will assist in the network planning and in overcoming the problem of poor signal strength in the institution's network. In accomplishing the above, designers need to use micro oven antenna and latest wi-fi technology, as well as find the right wireless channel. In particular, micro oven antenna is an antenna that can penetrate through opaque material and can overcome the problem of nlos and Nlos.

Table 2 presents an assessment of the network signal strength of Kogi State University buildings. The best signal strength is recorded in Building 7 which is the location of the base station transceiver antenna. Very weak signals (or no signals at all) are noticed in Building numbers 4, 10, 13 and 16.

In the case of the university's neighbours, their routers interfere with and cause the university's signal to degrade. Wireless routers can operate on a number of different

channels, and it is desirable that the routers operate on a channel with as little interference as possible. A tool like Wi-Fi Stumbler or Wi-Fi Analyzer may be used to find the perfect channel in the various faculties/buildings (Villegas et. al., 2007).

In solving the perennial problem of power failure, solar electronic systems/machines may be used as an alternative to conventional electricity. Solar power is the conversion of sunlight into electricity, either directly using photovoltaics or indirectly using concentrated solar power. An advantage of these systems is that, other things being equal, they will perform their function as long as there is sunlight.

In general, it is important to install the antenna at an appropriate height. If it is installed sufficiently high, most of the signal will meet the requirement of the receivers or clients. If the antenna is installed at a height that is too low, then nearby obstacles will reduce and reflect too much of the signal thereby creating large shadow area where the coverage is weak. Planning the wireless coverage is much like planning sprinkler coverage for watering a lawn. Omnidirectional antennas should be used to cover large circular areas, whereas directional and sector antennas ought to be used to cover conical or triangular areas. The floor plan and intended areas to be covered by each access point and antenna need to be drawn. Antennas and access points need to be added to areas of weak coverage until the desired level of service is achieved.

In addition, whenever the wireless signals are transferred they are blocked by certain obstacles such as walls, trees, gates and human beings. The university wireless facility does not work whenever there is power failure; it is also quite slow and covers limited area within the university premises.

5. CONCLUSION

This paper has presented a report on the perception by select users, as well as the authors' qualitative evaluation of the network signal strength of Kogi State University, Nigeria, as at the 15th year of the university's establishment. This is a public university located in the North Central region of Nigeria. The results of the study show that the university network is performing below expectation of majority of the users. The focus of the paper is on general users of the network and does not distinguish between category of staff on one hand (i.e. whether academic or non-academic) or the category of users on the other hand (i.e. whether staff or students). Further work may be done to focus on the state of the university network currently or by, say, the 25th year of the university's existence. In addition, similar studies may be carried out on the network of other higher institutions, especially those located in Kogi State and North Central Nigeria.

POSTSCRIPT

This paper is a re-presentation of the research work carried out by the first author under the supervision of the second author (Yakpe, 2014).

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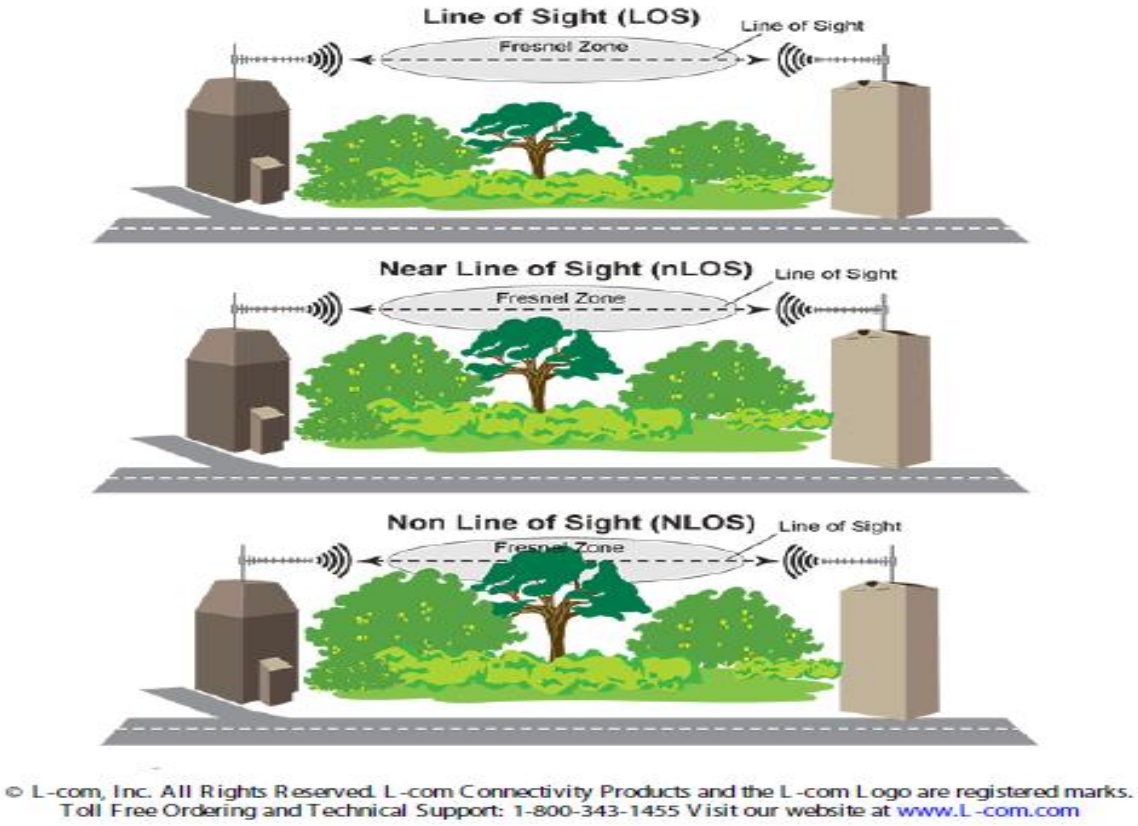

Figure 1: Three Main Categories of Line of Sight
(Source: itm-components.co.uk)

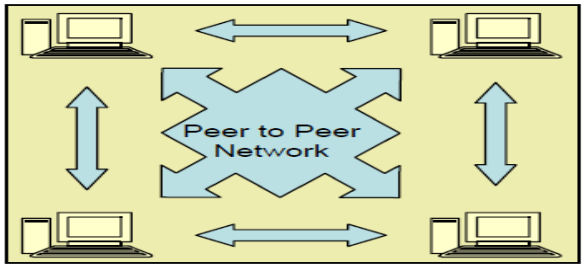

Figure 1: Peer to Peer Networking
(Source: bditbiz.wordpress.com)

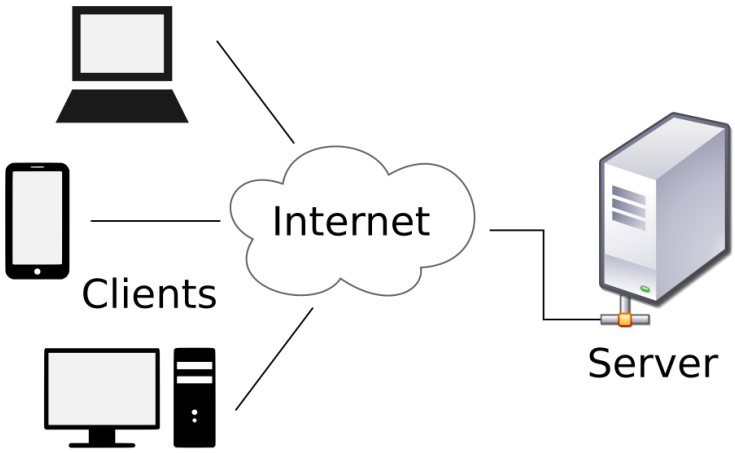

Figure 3: Client-Server Networking

(Source: https://en.wikipedia.org/wiki/Client-server_model)

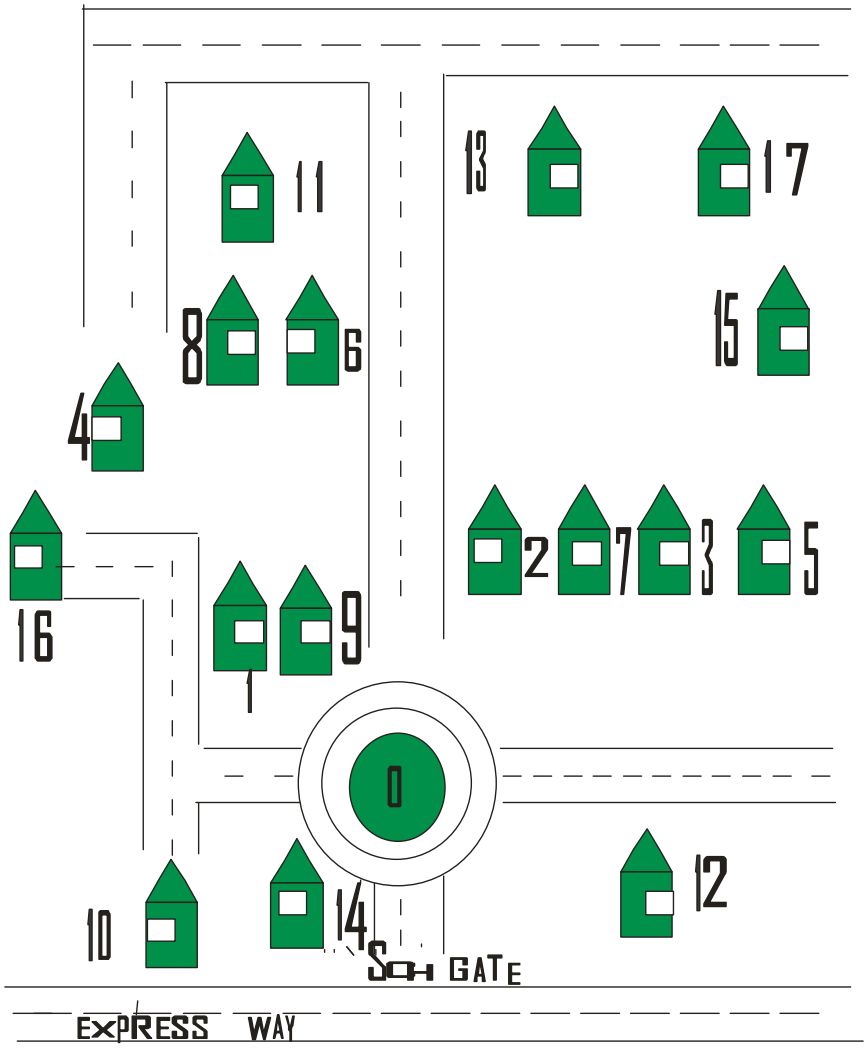

Figure 4: Schematic Diagram of the Major Buildings/Structures Within the Network of Kogi State University, as at the University's 15th Year of Existence (where 0, 1, 2,…, 17 represent the building/structure number)

Table 1: Summary of Perception of the 200 Respondents on the General Network Signal Strength

	Not Available & Not Efficient [VERY POOR]	Not Easily Available & Not Efficient [WEAK]	Quite Available & Efficient [FAIR]	Available & Very Efficient [GOOD]	Total
Number of Respondents	50	100	30	20	200

Table 2: Summary of the Qualitative Assessment of the Network Signal Strength of Kogi State University Buildings

Building Number	Description of Building	Assessment of Network Signal Strength	Has Installed Antenna?	Other Characteristics
1	Postgraduate	Weak	No	The antenna is about 80m from the base transceiver station
2	Social Science	Average	Yes (Omnidirectional)	The antenna cut across all the building lecture rooms
3	Natural Sciences	Average	Yes (Directional)	The antenna is about 50/70m from the base transceiver station
4	Agricultural Science	No signal (very weak)	Yes (One directional)	Network signals are gotten from the base controller station
5	Management Science	Weak	No	Network signals are gotten mainly from Building No. 3 which is 80m apart
6	Arts and Humanities	Average		This is the site/location of the installed base station controller antenna
7	Digital Centre	Strong		This is the site/location of the installed base station transceiver antenna
8	Law	Weak	No	Network signals are gotten from the base station controller as a result of its 360 radiation pattern
9	University Library	Average	Yes (directional)	Network signals are gotten from base station controller which is about 200 meters apart
10	Professorial Quarters	No signal (very weak)	No	
11	Female Hostel	Weak	No	It's about 430 meters apart from the digital Centre
12	Senate Building	Average	Yes (directional)	Network signals are gotten from the base transceiver station which is about 450/500 meters apart.

13	University Clinic	No signal (very weak)	No	Network signals are gotten from the base transceiver station which is about 750 meters apart
14	Security Post	Weak	No	Network signals are gotten from the Senate building which is about 150 meters apart
15	Male Hostel	Weak	No	Network signals are gotten from the base transceiver station which is about 650 meters apart
16	School of Medicine	No signal (very weak)	No	Network signals are gotten from base station controller
17	Staff Quarters	Weak	No	It is about 800 meters apart, from base transceiver station
0	University Roundabout	Weak	No	Network signal is mainly gotten from the Senate building which is about 130 meters apart

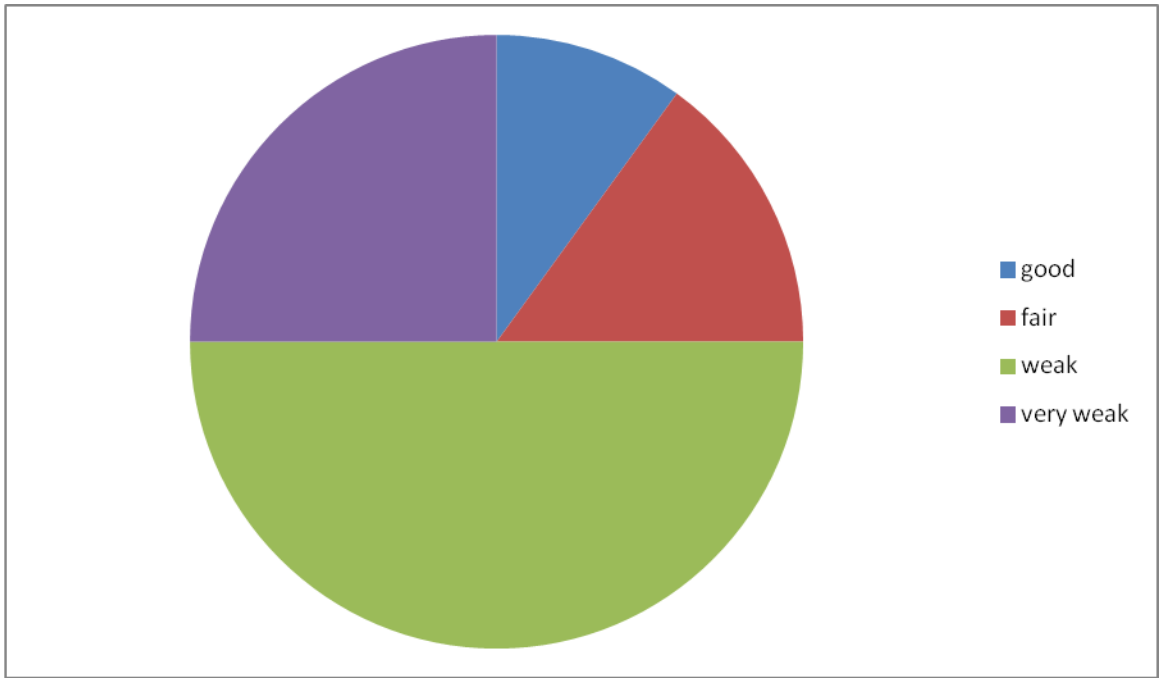

Figure 5: Pie Chart Representation of the Perception of Respondents on the University Network Signal Strength

APPENDIX

QUESTIONNAIRE

Please check all that apply, by using the key below

Good	5
Fair	4
Weak	3
Very poor	2

1) How efficient is the current Kogi State University wireless network?

a) 5
b) 4
c) 3
d) 2

2) How will you rate the availability of the network, to the staff and students of the university?
   a) 5
   b) 4
   c) 3
   d) 2

3) How will you rate the network signal or signal strength at your faculty/building?
   a) 5
   b) 4
   c) 3
   d) 2

4) How available is the electricity supply to the university?
   a) 5
   b) 4
   c) 3
   d) 2

5) How fast is the network at your faculty?
   a) 5
   b) 4
   c) 3
   d) 2

6) How visible is the installed antenna from your faculty?
    a) 5
    b) 4
    c) 3
    d) 2

7) How will you rate the uploading and downloading capacity of the network?
    a) 5
    b) 4
    c) 3
    d) 2