A Comprehensive Review of Wireless Fidelity (Wi-Fi) Technology In Nigeria

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Abstract: *Wireless Fidelity (Wi-Fi) broadband network technology has made tremendous impact in the growth of broadband wireless networks. Wireless broadband networks are expected to grow in terms of broadband speed and coverage. There has been growing interest in how to provide universal Wi- Fi access in developing countries. . The trend in digital divide between the rural and urban areas for developing countries like Nigeria reveals a wide gap. Efforts are being made by developed nations to close the gap; hence, there is the need for reversal of this trend by developing nations in their pursuit of sustainable technological development. This paper centers on the trend of Wi-Fi hotspot technology in Nigeria, the effects so far (advantages and disadvantages) and areas of future reconsiderations as compared to the developed Nations*
Keywords: *Broadband, Hotspot, OFDM, Router, Wi-Fi,.*

I. Introduction

Wireless connectivity, often known as Wi-Fi, is the technology that allows a PC, laptop, mobile phone, or tablet device to connect at high speed to the internet without the need for a physical wired connection. The technology uses radio signals to transmit information between your Wi-Fi enabled devices and the internet, allowing the device to receive information from the web in the same way that a radio or mobile phone receives sound. Wi-Fi would certainly not be in existent without a resolution made in 1985 by the Federal Communications Commission (FCC), America'. Its telecoms regulator, to open several bands of wireless spectrum, allowing them to be used without the need for a government licenses. This was an unheard-of move at the time; other than the ham-radio channels, there was very little unlicensed spectrum. But the FCC, prompted by a visionary engineer on its staff, Michael Marcus, took three chunks of spectrum from the industrial, scientific and medical bands and opened them up to communications entrepreneurs. [1]

This paper seek to examine the trend of Wi-Fi technology in Nigeria, its effects so far (advantages and disadvantages) and areas of future reconsiderations. Wi-Fi stands for "Wireless Fidelity" and was used to describe Wireless LAN (WLAN) products that are based on the IEEE 802.11 standards. Wi-Fi uses both single carrier direct-sequence spread spectrum radio technology and multi-carrier OFDM (Orthogonal Frequency Division Multiplexing) radio technology. Wi-Fi is owned by the Wi-Fi Alliance which is a consortium of separate and independent companies agreeing to a set common interoperable products based on the family of IEEE 802.11 standards [1]. Wi-Fi certifies products via a set of established test procedures to establish interoperability. Those manufacturers that are members of Wi-Fi Alliance whose products pass these interoperability tests can mark their products with the Wi-Fi logo [1]. The 21st Century has accomplished incredible growth of electronic resources (e-resources) which have massively change the information seeking attitude of students and researchers globally. In recent times, electronic resources have been recognized as the major sources for information broadcasting in the universities, particularly for researchers, Wi-Fi playing key roles.

Wi-Fi technologies have gone through several generations since their inception in 1997. Wi-Fi is supported to different ranges under Microsoft Windows, Apple Macintosh and open source UNIX and Linux operating systems. Wireless LAN technology has speedily become very prevalent all over the world. The wireless local area network (WLAN) protocol, IEEE 802.11, and related technologies facilitate protected access to a network infrastructure. Until the development of WLAN, the network client needed to be physically linked to the network by using some kind of wiring. Wireless technology was confirmed to be very practical (not only) for home users. Such a convenient option to be comfortably linked to internet on a mobile device without the need of wires is still gaining in attractiveness. This led to an attempt to make a configuration of WLAN easier for regular user without any awareness about computer science. The result of this was standard known as Wi-Fi Protected Setup (WPS). WPS, as a standardized technology, is implemented on wide diversity of currently manufactured wireless access points.[2]

II. Wi-Fi Deployment

When planning to deploy a wireless network, you must first determine the number of clients you expect to serve, the type of traffic you expect on the network, the amount of throughput you want the network to provide, and the number of access points you need and where to mount them for optimal coverage as shown in figure 1 below. The most important step in a Wi-Fi deployment is the site survey. There are three types of surveys: Passive, Active, and Predictive.

Passive Survey**:** Passive surveys are surveys that are performed with a listen-only mode. The survey client never associates to the access point (AP). Such surveys can be helpful when you look for rogue devices or you want a good gauge of downlink RF coverage from the infrastructure devices.

Active Survey**:** Active surveys are performed with the survey client associated to the APs used throughout the survey. When a client is associated, it performs all the tasks a typical 802.11 client performs, which includes rate shifting data rates as the RF condition changes and performs retransmissions. Active surveys are commonly used for new WLAN deployments because they provide the most details upon which to base a design. There are two main methods used in active surveys: Basic Service Set Identifier (BSSID) Method: This method locks a client into an AP's radio MAC address and prevents the client from roaming, Service Set Identifier (SSID) Method: This is more commonly used for post-deployment scenarios and used to survey multiple APs. It enables the survey client to associate to an SSID where the client roams between multiple APs.

Predictive Surveys**:** Predictive surveys are performed with a software program. The program uses the information about the coverage area to perform AP placements based on RF algorithms. These surveys are typically void of any type of field measurements.

Figure 1. . Simple wi-fi configuration

III. The Trend Of Wi-Fi Technology In Nigeria

According to a study conducted by Ericsson Consumer Lab [3], it was reported that about 82% of people in Nigeria are currently using mobile phones to access the internet, while 95% of broadband users access mobile broadband in smart phones. Also according to an article on the estimate of Nigeria internet users, 46.1% of the total of over 186 million use the internet, which accounts for 2.5% share of world internet users.

Furthermore, the Ericsson report stated that there are more user of mobile broadband across devices than Wi-Fi, and over 50% of the population of internet users in Nigeria switch between Wi-Fi and broadband due to changing location and availability of connection.

Wi-Fi in Nigeria started from the era of smart communication devices. Several communication companies had contributed immensely to the rapid recognition of Wi-Fi Nigeria. Campus Area Network (CAN) uses Wi-Fi technology as a means of communication and collaboration in data intensive environments. These networks are found in most tertiary educational institutions today. A typical campus network interconnects

hundreds of departments across so many buildings, providing high speed access for both students and staff. Once, connected, users have access to a wide range of resources such as printers, network file servers, research materials, lecture notes, tutorials, and even lecture on demand [2]. Other services in CAN includes streaming multimedia, skyping between classes, peer to peer file sharing. Applications such as email, discussion forums, bulletin boards, class schedulers, resource booking systems and various other administrative applications are also available through the campus network. Within the CAN, the users can essentially be partitioned into three functional groups namely: students, staff and visitors. These user groups are most often granted different access rights to resources on the CAN depending on the general needs of the particular group.

MTN is one of the largest Internet Service Providers (ISP) in Africa and the largest in Nigeria. It offers an array of broadband (wireless) plans that allow access to high speed broadband Internet access through their integrated network of HSDPA-3G, EDGE and GPRS technologies. The MTN 3G compatible or Data modem automatically chooses the fastest connection available depending on the location, making the process simple and effective and leaving the customer free to search the web without needing to understand all the various technologies. MTN's 3.5G Mobile Broadband is the fastest and most reliable way to access the Internet. With 3.5G or 4G Broadband MTN customers benefit from download data speed up to 4-5 times faster than currently available. GLOBACOM (Glo mobile) had launched 4G mobile technology in Nigeria. What made this special is that some networks in some advanced countries are just deploying or are yet to deploy 4G. For example, Verizon wireless in the United States just launched its 4G network also based in December, 2010, while AT&T also in the United States launched their 4G network in the second quarter of 2011. This made Glo mobile the first network to go beyond 3.5G mobile technology in Nigeria.

Other service providers who have 3G and 4G services include Etisalat, Starcomms, and Visafone which is the largest Code Division Multiple Access (CDMA) network operator in Nigeria. Furthermore, wireless broadband services have been provided by companies like Spectranet, Smile and Oxygen.

Focusing on densely populated areas, Oxygen Broadband is deploying several Wi-Fi hotspots spread across the Nigerian commercial capital, Lagos. The company is targeting a country wide expansion by 2017 to have a hotspot 10 to 20 meters from you, that's the Oxygen dream. "Oxygen is Nigeria's first metro Wi-Fi provider. The first hotspot was sited at the Computer Village with 35,000 devices connected. Legend, a multimedia serve brand, deployed a municipal Wi-Fi network in the Federal Capital Territory (FCT) providing access available to the public on a paid or free basis. The FCT has now joined over 100 cities across the world with the latest initiative of the outfit with a chain of hotspots connected through a type of wireless backhaul system using a cluster of Wireless Access Points (APs).

"Public services such as: CCTV security systems, access to emergency services and online city directories can ride on the back of a municipal Wi-Fi network, ensuring the security and safety of citizens. "Wi-Fi hotspots are powered by fiber-optic cable connectivity, which means that these networks possess huge bandwidths that allow for heavy usage from multiple users without any compromise in speed. Users who like to download or stream, will find these Wi-Fi networks very conducive for such activities.

IV. The Effect Of Wi-Fi Technology

The effects of Wi-Fi in Nigeria could be categories in terms of its negative impact on the society, Advantages of Wi-Fi Technology and Finally the Disadvantages of the Technology..

➢ Negative impact on the Society

Scientists engaged in the study of biological and health effects of non-ionizing electromagnetic fields (EMF) have raised fresh alarm. Based on their peer-reviewed, published research, the scientists said they have serious concerns regarding the ubiquitous and increasing exposure to EMF generated by electric and wireless devices. These include–but are not limited to–radiofrequency radiation (RFR) emitting devices, such as cellular and cordless phones and their base stations, Wi-Fi, 29 broadcast antennas, smart meters, and baby monitors as well as electric devices and infra-structures used in the delivery of electricity that generate extremely-low frequency electromagnetic field (ELF EMF).

Numerous recent scientific publications have shown that EMF affects living organisms at levels well below most international and national guidelines. Effects include increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life.

According to Joel Moskowvitz [4], these findings justify their appeal to the United Nations (UN) and, all member States in the world, to encourage the World Health Organization (WHO) to exert strong leadership in fostering the development of more protective EMF guidelines, encouraging precautionary measures, and educating the public about health risks, particularly risk to children and fetal development. They said by not taking action, the WHO is failing to fulfill its role as the preeminent international public health agency.

The scientists collectively request that: children and pregnant women be protected; guidelines and regulatory standards be strengthened; manufacturers be encouraged to develop safer technology; utilities responsible for the generation, transmission, distribution, and monitoring of electricity maintain adequate power quality and ensure proper electrical wiring to minimize harmful ground current; the public be fully informed about the potential health risks from electromagnetic energy and taught harm reduction strategies; medical professionals be educated about the biological effects of electromagnetic energy and be provided training on treatment of patients with electromagnetic sensitivity; governments fund training and research on electromagnetic fields and health that is independent of industry and mandate industry cooperation with researchers; media disclose experts' financial relationships with industry when citing their opinions regarding health and safety aspects of EMF-emitting technologies; and white-zones (radiation-free areas) be established.

Seven Ways Your Wi-Fi Could Cause Harm.

✓ Insomnia: When exposed to electromagnetic radiation, you will have more difficulty falling asleep. So when you can't sleep maybe you should just turn off your phone.

✓ Neutralizes Sperm: Wireless radiation reduces sperm movement and fragments your DNA.

✓ Affects Cell Growth: Sleeping with your phone next to your head can affect your ability to concentrate. Experiment: One set of plants was grown in a room free of wireless radiation; the other group grew next to two routers that releases the same amount of radiation as a cell phone. Result: The plants closest to the radiation didn't grow.

✓ Damage to Child Development: This radiation has the ability to alter and stunt the growth of body tissue. Young children are more likely to be affected during their developmental stages.

✓ Reduces Brain Activity in Females: Experiment: A group of 30 healthy volunteers, 15 men and 15 women, were given a simple memory test. First, the entire group was tested without any exposure to Wi-Fi radiation and the results were fine. Then, they were exposed to 2.4 GHz Wi-Fi from a wireless access point for about 45 minutes. Result: During that portion of the testing, brain activity was measured and the women had a noticeable change in brain activity and energy levels.

✓ Effects on Fertility: Results of experiments on animals show that some specific wireless frequencies can prevent egg implantation. According to the Global Healing Center, during the study, mice exposed 2 hours a day for 45 days had significantly increased oxidative stress levels.

✓ Cardiac Stress: Your heart reacts when surrounded by wireless networks including 3G and LTE phones. Your heart rate increases as if you are under stress. You may have not noticed this because you weren't aware of the dangers.

All this seems scary but the use of your wireless networks can be regulated. Every time you're not using your wireless device you can put it away. You don't necessarily have to turn it off, but ensure you switch off your mobile data and any wireless routers in the house. It is more important to do so before you sleep and avoid sleeping with your phone under your pillow.

➢ Advantages of Wi-Fi Technology

i. Wi-Fi allows LANS to be deployed without cabling for client's devices, typically reducing the costs of network deployment and expansion. Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANS.

ii. Wi-Fi is widely available in more than 250,000 public hotspots and tens of millions of homes, corporate and university campuses worldwide. Wi-Fi Protected Access (WPA and WPA2) is not easily cracked if strong passwords are used and WPA2 encryption has no known weakness. New protocols for Quality of Service make Wi-Fi more suitable for latency sensitive applications.

iii. As wireless network adapters are built into most modern laptops, the prices of chipsets for Wi-Fi continues to drop, making it an economical networking option included in ever more devices. Wi-Fi has become widespread in corporate infrastructures, which also helps with the deployment of Real Time Location Systems (RFID) technology that can ride on Wi-Fi.

iv. Different competitive brands of access points and client network interfaces are Inter-operable at a basic level of service. Products designated as 'Wi-Fi Certified' are backwards interoperable. Wi-Fi is a global set of standards. Unlike mobile telephones, any standard Wi-Fi device will work anywhere in the world.

➢ Disadvantages of Wi-Fi Technology

i Wi-Fi networks have limited range. A typical Wi-Fi home router using 802.11b or 802.11g with a stock antenna might have a range of 32m (120ft) indoors. Range also varies with frequency band. Wi-Fi in the 2.4 GHz frequency block has slightly better range than Wi-Fi in the 5 GHz frequency block. Outdoor range with improved (directional) antennas can be several meters or more with line-of sight.

ii Wi-Fi performance also decreases exponentially as the range increases. Wi-Fi is also less reliable and fast as Ethernet or other cable systems. 802.11g networks have a maximum of 54 Mbit/s while cables can reach speeds of 1000 Mbit/s or more. Wi-Fi is not suitable for servers or users who need fast LAN access. In practice, measured rates across the Wi-Fi network will be much less than the headline rate, so 5 Mbit/s is typical as a real,

measured transfer rate. 802.11n improves this, but again does not achieve the headline rate for real use. For Internet access, those with faster broadband rates- such as 20 Mbit/s will notice an increase in performance using a wired connection rather than Wi-Fi. This is because of protocol overheads.

iii Wi-Fi pollution, or an excessive number of access points in the area, especially on the same or neighboring channel can prevent access and interfere with the use of other access points by others, caused by overlapping channels in the 802.11g/b spectrum, as well as with decreased signal-to-noise ratio (SNR) between access points. This can be a problem in high-density areas, such as large apartment complexes or office buildings with many Wi-Fi access points. Additionally, other devices use the 2.4 GHz band; microwave ovens, security cameras, Bluetooth devices, Amateur radio, video senders, and cordless phones, can cause significant additional interference. General guidance to those who suffer these forms of interference or network crowding is to migrate to a Wi-Fi 5GHz product, (802.11a or the newer 802.11n) as the 5 GHz band is relatively unused and there are many more channels available. This also requires users to set up the 5 GHz band to be the preferred network in the client to configure each network band to different name.

iv Each node on the network is typically able to see all the communication between other nodes and the access point, allowing network traffic to be easily captured with a packet snuffers. Hence, when a Wi-Fi network is not encrypted, as most public hotspots are, the network is vulnerable to side jack attacks.

v It is also an issue when municipalities, or other large entities such as universities, seek to provide large area coverage. Everyone is considered equal for the base standard without 802.11e/WMM when they use the band. This openness is important to the success and widespread use of 2.4 GHz Wi-Fi, but makes it unsuitable for most public service functions or where reliability is required.

V. The Areas Of Future Reconsideration

Light Fidelity, popularly called Li-Fi, is a Visible Light Communication "technology that delivers a high speed, bidirectional, networked and mobile wireless communications" [5]. Light Fidelity utilizes LED light bulbs to transmit data at very high speeds. The discovery of this technology is credited to Professor Harald Haas of the University of Edinburgh. During his presentation at TED (Technology, Entertainment and Design) conference in 2011, he demonstrated how LED light bulbs can be used to both provide illumination and transmit data at speeds 10,000 times faster than Wi-Fi [6]. He further explained that digital communication can be achieved through the switching ON and OFF of the LED light bulbs. This process is self-controlled and is so fast that it is invisible to the ordinary eye. A few years ago, Cisco forecasted [7][8] that for 2011-2016 the dependence on the Internet would quadruple, with the number of internet users hitting 3.4 billion and annual global traffic rising to 1.3 zettabytes –about 1 trillion Gigabytes. The overwhelming dependence on wireless technology to cater for this ever increasing statistics has led to a shortage of the radio frequency spectrum [9].

Worldwide Interoperability for Microwave Access (WiMAX) is a fixed broadband wireless technology that is gaining acceptance and delivers large kilometer broadband connectivity in a larger geographic area than Wi-Fi. It provides canopies of signals anywhere from one to ten kilometers wide. Such WiMAX coverage range provides fixed and nomadic wireless broadband connectivity without necessarily having a line-of-sight (LOS) with a base station [2]. WiMAX will also enable greater mobility, higher speed data applications, range and throughput. WiMAX uses the IEEE 802.16 standards specifications (802.16d and g). The IEEE 802.16d specification is primarily tailored to wireless wide area networks (WWANs). The IEEE 802.16e specification on the other hand is primarily used for mobile wireless metropolitan networks (WMANs). These two specifications render WiMAX architecturally ideal for the last kilometer, the backhaul, Internet Service Providers, cellular base stations that bypass PSTN's, hotspots, and enterprise networks [4]. Abilities such as high bandwidth frequencies between 2GHz and 11GHz, makes WiMAX ideal for data transport. WiMAX has a total range of up to 50 km [1]. This ability is enhanced by WiMAX's cell radius of 5 -10 km.

The Wi-Fi CERTIFIED 802.11ac can deliver data rate which is more than double of a 802.11n network. It supports only the 5GHz frequency, means signal has less range. It supports multiple antennas that is MIMO(multiple input multiple output).The important feature 802.11ac is beam forming that gets around the general 5GHz range problem. It States with 802.11ac, the signal is propagate for broadcast directly from the access point(AP) to a certain device and back towards the AP.

To achieve today's spectrum demand different wireless access methods are utilized. Now-a-days Wi-Fi has very much congestion and also provided the consumer a economical path to the network. To achieve the goal of affordable access to all consumers super Wi-Fi is used. Super Wi-Fi will be provided over radio spectrum to share among different user and internet service providers

VI. Conclusion

This paper has discussed the current trend and future research directions that could lead to fundamental changes in wireless access solution, that is, areas of future reconsiderations includes: Li-Fi, WiMAX, Super Wi-Fi, Wi-Fi certified etc. These reconsiderations will form the basis of future Wi-Fi that will enable Nigeria as a

country cope with the present Challenges of recently developed applications and services.These applications place demands on available technology and spectrum in terms of both the capacity available and the speed that can be supported for multiple simultaneous users/uses. Higher speed and higher capacity Wi-Fi supported by additional spectrum will facilitate the continued development of wireless connected computing supporting high end-to-end connectivity speeds, improved quality of service in contested environments, higher mobile traffic offload and support the development of cloud computing applications.

This paper also examined the trend of Wi-Fi technology in Nigeria and its effects so far (advantages and disadvantages)

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