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Gigabit Fidelity (Gi-Fi) As Future Wireless Technology in Nigeria

B.I.Bakare[1] and T. J. Alalibo[2]
[1,2](Department of Electrical Engineering, Rivers State University, Port Harcourt, Nigeria.)
Corresponding Author; B.I.Bakare

Abstract: *Cellular networks are the most common means of internet connectivity among Nigerians sinceGlobal System for Mobile Communication (GSM) was introduced in 2001. Internet penetration in the country is quite low. Telecoms companiesoffer 4G connection through Long Term Evolution (LTE) technology to boost connectivity. Efforts are also being made to create Wireless Fidelity (Wi-Fi) hotspots to increase internet access. But the wide gap in digital trends and internet connectivity between the rural and urban areas is still a growing concern; thus there is need to consider other network connection. Gigabit Fidelity (Gi-Fi) technology is a recent wireless communication technology that provides faster connectivity and high data speed. Gi-Fi is the first transceiver on a chip with antenna operating at 60 GHz offering data rate up to of 5Gbps within a 10m range. Gi-Fi is a promising technology that can bring about high penetration of internet connectivity in Nigeria. This paper reviews the trend of internet connectivity in Nigeria, Gi-Fi technology and its challenges.*

Keywords -*Antenna,Gi-Fi, LTE, Wi-Fi, Wireless broadband*

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I. INTRODUCTION

The importance of communication cannot be underestimated as it is a key part of human endeavours for exchange of information among parties or entities at location within same proximity or physically apart. In term of wireless communication, cellular networks are the most widely used.Smart phones, tablet, other internet-enabled devices as well as the increasing numbers of accessible applications on those devices have greatly accelerated the growth of internet consumption. A report by [2] in July 2018 on global mobile data traffic presented an estimate of 4.1 billion active internet user, from which 3.7 billion are mobile device users, and it was projected that between 2016 and 2022 the estimated numbers would increase more than seven times [2][3]. According to a survey by ITU (International Telecommunication Union**)**, More than 80% of the world's population have access to mobile networks and to the internet, with almost half the population in low-income countries [4]. Nigerians has the desire to always stay connected and access to internet keep growing at the rate of approximately 2.8% per month since 2012 [1].Cellular network is the most popular means of wireless connectivity and plays a major role in satisfying the 'always online' need among Nigerians.

This paper reviews the Gi-Fi technology as a future alternative to LTE technology in Nigeria. The growth of telecommunication technologies in Nigeria has seen positive growth [5]. Bluetooth, WiFi, 3G networks are popular wireless communication networks use in Nigeria. The high penetration of smart phones into the country has also increase the use of these networks. Recently 4G Long Term Evolution (LTE) is offered to users by Telecom companies to boost communication and high data rate. Though the coverage of the 4G network in Nigeria is limited to few cities, the acceptance of the network is quite high as many people move from 3G phones and SIM card to 4G ones. Despite the advantages of available technologies for wireless communication, there is an increasing demand for high speed connections and transfer, which led to the introduction of modified standards for data exchange rate, that is, Gi-Fi.

Gi -Fi or Gigabyte Wireless is the first transceiver in the world that is integrated on a chip using Complementary Metal oxide Semiconductor (CMOS) process. It satisfies the standards of IEEE 802.15.3C. The chip is about 5mm square having a 1 mm wide antenna operating at 60Hz. Gi-Fi offers up to 5gigabyte per second transfer rates for audio and video data within a range of 10 meters and utilized less than 2watts of power to transmit data over short distance, similar to Bluetooth. As an integrated transceiver chip, it is very small and can be embedded in devices, enabling networking of office and homes devices. This breakthrough in technology provides a low cost, low power and high broadband chip to is a vital element for future digital economy.

1.1 Network Evolution

Fig 1 shows the different wireless technologies available. Wireless connection techniques have made possible services such as far distance communications which is impractical or impossible with utilization of wires. Over the years, mobile technologies have advance from the early phase of telephony systems to modern

communication systems that support heterogeneous applications. Bluetooth, Wi-Fi, WiMAX (Worldwide interoperability for microwave access) and other wireless communication technologies have become indispensible in the communication world and have contributed advancements in technologies and ground-breaking solutions to internet connection and in transfer of information such as data, audio, videos and so on, at different data on rates. Gi-Fi is an appropriate technology for short distance data transmission however Wi-Fi still gain from being able to provide wireless coverage over a greater distance.

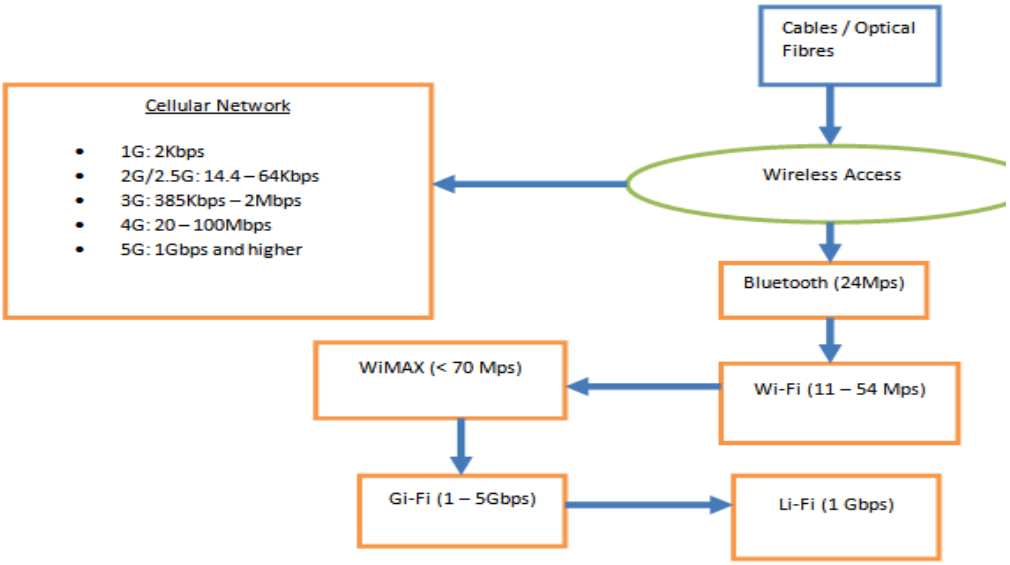

Fig 1 Wireless technologies with data rates

II. The Trend Wireless Technology In Nigeria

Nigeria has experience growth in the telecommunication industry especially after the introduction of Global System for Mobile Communication (GSM) in 2001 [5]. The mobile technology industry has provided economy benefits in the country by means of "job creation, infrastructural development and contributing over 70 billion dollars to gross domestic product (GDP)" [6].Internet penetration in Nigeria is relatively low – by 2017 only about 50.2 per cent of the population. Nigeria is making effort to increase the number of broadband connectivity from its present level of 8% to 30% by 2018, which is still below the target of ITU of 15% by 2015 [7]. Despite not meeting the target, Nigeria rank as the second highest generators of internet traffic from mobile devices, with Kenya as the highest [2]. At this rate, the demand for faster network and internet connections to facilitate business and social activities in Nigeria is weighing on the shoulders of telecommunication companies.

Fixed broadband for 24 hours internet connectivity are not common in typical Nigerian homes because there are hardly any active telephone infrastructures. In addition fixed broadband services are either unreliable or too expensive to many Nigerians such that only one-third of active internet users make use of broadband, and its usage is declining[8][9][10]. Bluetooth, Wi-Fi are very common techniques for internet connection in Nigeria. Free and secured Wi-Fi hotspots can be found in private and public areas whereby users can connect with Wi-Fi enabled devices or routers. Even smart phones can generate Wi-Fi hotspots for faster connection to other devices. There are efforts to increase the penetration of internet in the country. Such efforts include Nigeria collaboration with Google to open 200 free Wi-Fi shots by 2019 [8].

The most common internet connection is via mobile networks in Nigeria. Currently, 3G networks are facing the tremendous challenge to manage smartphones data requirements, thus many countries have migrated to 4G networks and plans are underway to roll out 5G networks. Nigeria's telecommunication companies have started offering 4 G connections as improvement over 3G connections. Glo, MTN, Airtel, and 9Mobile are the major mobile network providers in Nigeria and they have been providing 4G LTE internet services to subscribers in major cities such as Abuja, Benin, Jos, Kaduna, Lagos, Jos, Port Harcourt and others. Internet service providers such as Spectranet, Smile, ipNX, Ntel also rolled out 4G LTE services but it is used for data connectivity rather than voice services. In the light of the recent migration to 4G, the NCC (Nigerian Communications Commission) refarm/utilize the existing frequency bands originally meant for GSM data transmission instead auctioning new frequency licences. This refarming process allows 3G, LTE to utilize GSM frequencies, and it is cheaper and helps maximize the use of existing frequency spectrum. Also there are plans to utilize TV frequency for mobile network when migration from analogue TV to digital TV is complete [6][7]

LTE (Long Term Evolution)is a radio access technology created to enhance data rate and cater for the growing demand of internet connection. LTE technology provides the 4G standard developed by 3rd generation partnership project (3GPP) in 2003, which is why it is sometimes called 4G LTEas opposed to simply 4G. LTE is has a pure packet-switched design which means that only IP packet-switched traffics are supported on the network. Both data applications and real-time applications are controlled and executed by the Internet Protocol (IP), such that voice, data, and other traffics will pass through packet-connection – eliminating the analog circuit switch domain [11] [12]. LTE delivers data rate up to 100 Mbps with flexible bandwidth carriers ranging from 1.4 MHz to 20 MHz, which is ten times faster than the 3G mobile data technology. the key technologies that help LTE to support high speed and data transfer are MIMO (Multiple-Input Multiple-Output) antenna technique and OFDM (Orthogonal Frequency Division Multiplexing) technique for access. LTE is backward-compactable with 3GPP access (2G, 3G) and it supports interoperability with Non-3GPP access *i.e.* networks not developed by 3GPP (WiMAX, WLAN etc.) and fixed access (e.g. Ethernet, DSL etc.). Network operators can provide connectivity and services across the different types of access technologies [12]. Table 1 compares the generations of mobile technology.

The availability of LTE technology varies in different countries. According to 2018 report by [13], South Korea and Japan are ahead of other countries in having consistent accessibility to LTE network – about 97.49% and 94.7% respectively, while Singapore and Netherlands experience the fastest download speed with 4G LTE [13]. Since 2010, developing countries are also making major improvements to increase their 4G availability. According to our estimates, the total number of 4G LTE subscribers in Africa in April 2017 has reached around 15 million (out of 1.2 billion inhabitants), a penetration rate of above 1% of global 4G base [14]. Of the 88 countries surveyed worldwide in the February 2018 report, countries such as Egypt, El Salvador and Algeria ranked the lowest, with LTE availability being below 45 per cent [13].

In 2015, major telecommunication companies in Nigeria rolled out 4G connections for faster connection. LTE and WiMAX are the competitors for 4G connections however LTE is more popular. The acceptance of the 4G connection is fairly high as many Nigerians 'swap' their 3G SIM card for 4G SIM card. Even with its popularity, the 4G LTE, network is yet to even cover 20% of Nigerian cities which indicate slow deployment of this technology into the country [7][15]. The level of penetration and coverage of 4G LTE network in Nigeria is limited to few cities in Nigeria due to challenges such as insufficient IT infrastructures, limited spectrum, complexity of mobile devices, unpredictable usage pattern of subscribers, complexity of LTE network and others [7]. Also low-income base of users and their inability to acquire 4G mobile devices, insufficient number of base stations and issues with integrating 4G equipment with existing legacy networks, have contributed to the difficulty of consistency accessibility to the 4G LTE network in Nigeria.

4G technology is a prelude to 5G which will usher in the world of Internet of Things (IoT) technology, which have already been implemented in some countries. Nigeria is lagging behind in advent of new technologies. To ensure that the country take leverage on the new wireless technology for current revolution in the mobility, there is need for more investments by the Government on the Federal and State levels to improve and create opportunities in wireless communication technology. Then, the coverage of 4G LTE network will increase paving way for 5G network. For now, the accessibility of LTE network is not guaranteed in many locations in Nigeria, the features of Gi-Fi will be reviewed to determine if it can be utilized for in the future.

Table 1 Generations of mobile technology

Technology	**1G**	**2G/2.5G**	**3G**	**4G**	**5G**
Start/Introduced in year	1970/1984	1980/1993	1990/2001	2000/2009	2010/2015+
Technology	Analog cellular technology	Digital cellular technology	Broad bandwidth CDMA, IP technology	Unified IP and seamless combination of broadband LAN/WLAN/PAN/WAN	Unified IP and seamless combination of broadband
Standards	AMPS (Advances Mobile Phone Systems)	2G: GSM, 2.5G:EDGE, GPRS, 1xRTT	WCDMA, CDMA-2000	Single unified standard LTE, WIMAX, WI-FI	Single unified standard (coming soon)
Data bandwidth (or speed)	2 – 14.4 Kbps	14.4 – 64 Kbps	2 Mbps	100 Mbps to 1 Gbps for low mobility	1 Gbps and higher
Service	Mobile telephony (Voice only)	Digital voice, SMS, Higher capacity packetized data	Integrated higher quality audio, video and data (multimedia, video call)	Dynamic information access, wearable devices, real time streaming	Dynamic information access, wearable with AI capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Special characteristics	First wireless communication	Digital version of 1G technology	Digital broadband, speed increment	Very high speed, All IP	Higher speed, All IP
Switching	Circuit	Circuit, Packet	Packet (except for air interface)	All Packet	All packet
Core Network	PSTN	PSTN	Packet network	Internet	Internet

III. Gi-Fi Technology

Gi-Fi (Gigabits Fidelity or Gigabit Wireless) is similar to Wi-Fi but it has data rate ten times higher than the present highest wireless transmission rate and at a very low cost (i.e. one-tenth of the cost) and it satisfies the standards of IEEE 802.15.3C [16]. Gi-Fi was developed by researchers in Melbourne University, Australia, as the first transceiver fabricated on a chip with the help of the CMOS (complementary metal oxide semiconductor) process. The single chip measures about $5mm^2$ chip with 1mm antenna operating at a frequency of 60 GHz that consumes power of about 2milliwatt or less during its operation (see Fig 2). The Gi-Fi wireless technology is known have data rate of more than one Terabits (i.e. one billion bits) per seconds. NICTA (National ICT Australia Limited) research team choose 57-64GHz unlicensed frequency band for this technology therefore the speed of Gi-Fi can be up to 5 Gbps for transfer of large videos and other information wirelessly within fractions of seconds within indoor environment – usually within a 10 meter [16] [17]. Gi-Fi can be used as mobile data backhaul through which 3G and 4G networks providers can offload some of the data, especially in major cities where mobile network heavy traffic experience heavy congestion [17]. The comparison of Gi-Fi with other wireless technologies is shown in Table 2

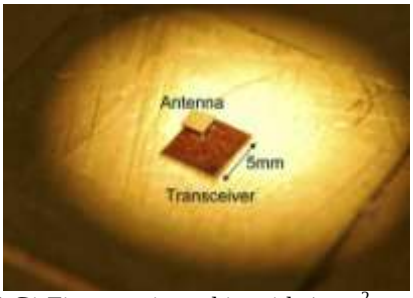

Fig 2 Gi-Fi transceiver chip with $1mm^2$ antenna

Table 2 Comparison between Gi-Fi and other existing wireless technology

Characters	**Bluetooth**	**Wi-Fi**	**WiMax**	**Gi-Fi**
Start date	1998	1990		2004
Transfer rate of data	800Kbps	11Mbps	1Gbps	5Gbps
Operating Frequency	2.4GHz	2.4GHz	2.3-3.5GHz	57-64GHz
Range	10m	100m	50km	10m
IEEE standard	IEEE 802.15	IEEE 802.11	IEEE 802.16	IEEE 802.15.3C
Power consumption	5mW	10mW	~5mW	<2mW
Authorize	Bluetooth SIG	IEEE WECA	WiMax	NICTA
Primary device	Industrial automation devices, PDAs, mobile phones,	Desktop, computers, notebook	Home devices, mobile phones, Electronic offices	Home devices, mobile phones, Electronic offices in industrial automation devices

Application of Gi-Fi Technology includesHomes and offices appliances, Wireless pan network, inter-vehicle communication system, AD hoc information distribution, media access control (MAC), imaging, video information transfer, & other applications

Advantages

- ✓ Low cost and portable
- ✓ Faster data transmission
- ✓ Low power consumption
- ✓ Internet infrastructure is not a necessity for data transfer.

Disadvantages

- ➢ Gi-Fi is restricted to shorter distance when compare to Wi-Fi technology and since it is a new technology, there is lack of skilled people who can deploy the technology

IV. Future Of Gi-Fi Technology In Nigeria

Within few years, Gi-Fi is expected to be the leading technology for wireless networking. It will be able to provide services with the low-cost, high broadband access, and with very high speed data rates transferred within a seconds. If the success of Wi-Fi and the imminent wide usage of WiMAX is any indication, Gi-Fi potentially can bring wireless broadband to the enterprise in an entirely new way.

Gigabit Societies are sprouting out at a different level and a different pace in different countries. Australia is the pioneer in development of GI-FI technology to provide a higher speed than Wi-Fi technology. Gi-Fi technology is implemented in some university campuses in UK in some areas. Asia and US, there are

gigabit districts where the gigabit broadband is offered. In Seoul in South Korea, large telecommunication providers offer a widespread gigabit service for the city. America had quickly adopted this technology in order to bring about development in the state. Other countries are putting efforts to lay out facilities for incorporation of Gi-Fi into their society [18]**.** In Nigeria, there is still a growing market for Wi-Fi technology as mobile network providers are struggling to keep up with demand of subscribers. Due to a limited hotspot footprint in country, network operators will need to build their own Wi-Fi networks or partner with established Wi-Fi providers. Because it is a new technology, information about Gi-Fi deployment and growth is limited.

Mobile technology is one of the most important causes of change in Nigeria. The personal and business lifestyles of Nigerians have changed in a progressive way since the introduction of GSM into the country. For years, Nigeria has been dependent on foreign countries for technological and industrial activities, which is due to challenges affecting the telecommunication sector [19]. Even though the low financial status of majority of people in the country is a challenge, subscribers are willing to pay more for reliability, efficiency and faster data speed. According to [10] and [20], broadband networks in Nigeria still need lot of improvements. The 8% of subscribers presently on the broadband services in Nigeria are facing poor network services, and increasing number of mobile users coupled with limited spectrum worsen the situation [7]. In addition, Wi-Fi is not available in most in Nigerian homes unlike countries such as UK where residents have access to Wi-Fi connections all year round. It is difficult to achieve 24/7 Wi-Fi connectivity and it is expensive.

Gi-Fi technology is yet to be implemented in Nigeria. The features of Gi-Fi technology show a promising future for faster data rates. It has low power consumption which will save cost in energy. Gi-Fi technology is similar to Wi-Fi technology, but has a higher data rate and shorter distance coverage as in Bluetooth. Despite the many advantages, Gi-Fi may experience the same challenges experienced in deploying Wi-Fi in the country. Power shortage, cost, service delivery and lack of efficient ICT infrastructures, poor income, low investment, lack of awareness are some of the challenges. Also, penetration of new technologies into the Nigeria tends to be very slow. For instance, LTE 4G was released in 2001 but it is in 2015 that Nigeria's telecommunication companies started offering 4G services. In addition, there is a lack of skilled Gi-Fi professionals since it is a new technology. Therefore the deployment of Gi-Fi technology in Nigeria will take some time

V. Conclusion

The rolling out of LTE 4G connections has help manage the increasing rate of data consumption and it has been fully implemented in many countries. Telecommunication companies in Nigeria have also join the world to implement 4G connection for their subscribers. Recently the Gigabit Fidelity (Gi-Fi) technology has been introduced in many Countries. Gi-Fi is a transceiver on a chip capable of transferring up to 5Gbps of data within a few seconds in indoor environment. This technology is said to be the future of wireless networks, in competition 5G network has faster and better internet connectivity. In Nigeria, it is possible for Gi-Fi is to be an alternative to LTE 4G networks, however most Nigerians always want to be online so the 10m range and line-of-sight operations of Gi-Fi would be a problem. Even the consistent availability of the LTE 4G network has only penetrated few cities in the country because Nigeria's ability to catch up with new technologies is quite slow.

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