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5G TECHNOLOGY: OPPORTUNITIES AND CHALLENGES

FATIMA MAIKUDI ABUBAKAR; AND SHITU ABDULLAHI LAME

Computer Science Department, Sch. Of Communication and Information Sciences, AD Rufai College of Education, Legal and General studies Misau, Bauchi State.

ABSTRACT

5G technology is the fifth generation mobile cellular network, 5G mobile networks are expected to be the next big leap in mobile broadband that will provide greater download speeds as high as 20gbps, 5G will support the massive numbers of devices that will simultaneously access the network, which will be far more than 4G LTE can handle. This paper highlights

INTRODUCTION

5G is the 5th generation mobile network. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices (Qualcomm 2020). 5G technology is the fifth generation cellular network, it is currently the fastest wireless network giving most highest internet and download speed. 5G technology is delivering life-changing technologies through next-generation networks. The increased speed promised by 5G is achieved partly by using additional higher-frequency radio waves in addition to the low and medium band frequencies used in previous cellular networks.

Fifth-generation (5G) mobile networks are expected to be the next big leap in mobile broadband. With expected peak download speeds as high as 20 gigabits-per-second, 5G users will be able to download a full-length movie in seconds and enable specialized tasks and functions,

the opportunities that 5G technology presents to mobile cellular networks, IoT applications such as health care, education, energy, also challenges and evolution of different generations of mobile wireless technology.

Keywords: 5G, Technology, Broadband, Gbps, Cellular, networks, evolution, wireless

including remote precision medicine, connected cars, virtual and augmented reality experiences, as well as the internet of things (IoT) (Brookings.edu 2019).

Earlier generations of cellular networks such as 4G focused on ensuring connectivity, the 5G technology introduced connectivity to the advanced level by delivering connected experiences from the cloud to clients.

5G technology will introduce advances throughout network architecture. 5G New Radio, the global standard for a more capable 5G wireless air interface, will cover spectrums not used in 4G. New antennas will incorporate technology known as massive MIMO (multiple input, multiple output), which enables multiple transmitters and receivers to transfer more data at the same time. 5G technology is also designed to support a converged, heterogeneous network combining licensed and unlicensed wireless technologies. This will add bandwidth available for users.

5G devices connect to the network through the highest speed antenna within range at their location, Low-band 5G uses a similar frequency range to 4G cellphones, 600–850 MHz, giving download speeds a little higher than 4G, 30–250 megabits per second (Mbit/s).

Low-band cell towers have a range and coverage area similar to 4G towers. Mid-band 5G uses microwaves of 2.5–3.7 GHz, allowing speeds of 100–900 Mbit/s, with each cell tower providing service up to several

kilometers in radius. This level of service is the most widely deployed, and was deployed in many metropolitan areas in 2020.

The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds, eventually up to 10 gigabits per second (Gbit/s), Due to the increased bandwidth, it is expected the networks will increasingly be used as general internet service providers for laptops and desktop computers, competing with existing ISPs such as cable internet, and also will make possible new applications in internet of things (IoT) and machine to machine areas.

5G technology should improve connectivity in underserved rural areas and in cities where demand can outstrip today's capacity with 4G technology. New 5G networks will also have a dense, distributed-access architecture and move data processing closer to the edge and the users to enable faster data processing (Cisco 2019).

The 5G network will also simplify mobility, with seamless open roaming capabilities between cellular and Wi-Fi access (Cisco 2019). Mobile users can stay connected as they move between outdoor wireless connections and wireless networks inside buildings without user intervention or the need for users to re-authenticate.

5G architectures will be software-defined platforms, in which networking functionality is managed through software rather than hardware. Advancements in virtualization, cloud-based technologies, and IT and business process automation enable 5G architecture to be agile and flexible and to provide anytime, anywhere user access. 5G networks can create software-defined sub network constructs known as network slices. These slices enable network administrators to dictate network functionality based on users and devices.

5G also enhances digital experiences through machine-learning (ML)-enabled automation. Demand for response times within fractions of a second (such as those for self-driving cars) require 5G networks to enlist automation with ML and, eventually, deep learning and artificial

intelligence (AI). Automated provisioning and proactive management of traffic and services will reduce infrastructure cost and enhance the connected experience.

5G networks are predicted to have more than 1.7 billion subscribers worldwide by 2025 (Global newswire, 2020). Like its predecessors, 5G networks are cellular networks, in which the service area is divided into small geographical areas called cells. All 5G wireless devices in a cell are connected to the Internet and telephone network by radio waves through a local antenna in the cell.

LITERATURE REVIEW

The changes required by future emerging technologies will determine whether 5G is merely an evolution of the existing network or revolution (Al-Falaly et al 2017). Massive multiple-input, multiple-output (M-MIMO), beamforming, device-to device (D2D) communications, small cell deployment, and other technologies have already been adopted in recent 4G releases and need only be modified for 5G adoption. Thus, to support these technologies, the network could merely evolve from 4G, and all current mobile devices would be supported. However, the millimeter wave band will necessitate many revolutionary technologies due to its different propagation characteristics and hardware constraints. A significant change will be required on the network node and architecture levels, and this change will extend to mobile devices; current devices will need to be modified or upgraded to support this 5G revolution because the millimeter wave signal is incompatible with these devices' frequency.

The evolution of cellular networks (1g, 2g, 3g, 4g) are as follows;

1G: 1G was launched by Nippon Telegraph and Telephone in 1979, 1G was first introduced to the citizens of Tokyo. By 1984, the first generational network covered all of Japan, making it the first country to have 1G service nationwide (CENG 2020). It was the first technology that enables

a caller to dial a number and the calls get connected without human switchboard operator to connect the call.

By 1984, the first generational network covered all of Japan, making it the first country to have 1G service nationwide. March 1983 the Ameritech introduced 1G to the United States.

Motorola introduced the first commercially available cellphone to the public in 1983 -the Dyna TAC. The Motorola DynaTAC provided 30 minutes of talk time and took roughly 10 hours to charge.

1G suffered a lot of challenges such as low sound quality while making calls, background noise and low coverage, download speed was very slow (2.4kbps), No roaming support was provided either. Security didn't exist over a 1G channel because there was no encryption, meaning anybody with a radio scanner could drop in on a call.

According to Wikipedia, Russia has the only 1G cellular network still in operation.

2G: In 1991, 22 years after the NTT technology spread across most of the world, Finland launched a mobile network that established the 2nd generation of mobile networks (Premium Times 2020).

2G provided significant improvement in mobile calls introducing encrypted calls (nobody could break in your call) unlike the 1G network where an intruder could drop in on a call, it also made improvements as regards to background noises while on call, also improved sound quality, download speeds were also faster, averagely 0.2 Mbps.

2G introduced digital signaling within the radio network. It came with circuit-switched mobile data services like text messaging, and packet delivery at 9.6Kbits/sec.

With this network, it will take you about 14 hours to send a 1Mb picture to a friend in the same city assuming it was just the two of you on the network.

2G's introduced another means of communicating through text messages (SMS) and multimedia messages (MMS). Using the same

control channels as talk, SMS and MMS, messages are sent in packets of data from your cell phone to a tower then to your friend's phone.

2G brought the "Candy bar phones" with Nokia in the lead producing popular cellphones such as the Nokia 3210

3G: Following rhe succes of 2G, the demand for mobile internet service came about which brought about the 3G technology. 3G was deployed for the public in Japan by NTT DoCoMo in 2001, 3G focused on standardizing vendors' network protocol. In turn, users could access data from anywhere, which allowed international roaming services to begin.

Compared to 2G, 3G had 4 times the data transferring capabilities reaching up to 2 Mbps on average and later 6Mbps. It was because of this increase that video streaming, video conferences, and live video chat were possible.

This new technology allowed users to listen to music, call, text, and search through the internet on their mobile devices. There were 2 major smartphone competitors – Blackberry and Apple.

4G: Like 3G, 4G is a set of requirements, specifically, IMT-advanced, published by the ITU in 2008 after network operators and vendors agreed to retire 3GPP2 and converge around LTE as the common standard for all future networks.

4G was introduced for commercial use in Norway last quarter of 2009, Starting at a minimum of 12.5 Mbps, it provided high-quality video streaming/chat more than that of 3G, fast mobile web access, HD videos, and online gaming. Unlike 2G and 3G, 4G is more advanced cellular network that requires mobile devices to be specifically designed to support it.

The best-selling cellphones since 4G was introduced included the iPhone 6 at 22.4 million units and the Samsung Galaxy S4 at 80 million units worldwide.

The iPhone 6 was Apple's best-selling smartphone to date, but the Samsung Galaxy S4 (right) was also a trendy smartphone and the best-selling Android-powered mobile phone ever.

Since its adoption in 2009, 4G has just about reached its capacity in terms of data transferring speeds. With new technologies being introduced at a rapid pace, the world needs a faster network.

WHAT IS 5G?

According to (Madan, et al 2019), 5G is the next generation of mobile standards being defined by the ITU. IMT-2020 (5G) is a name for the systems, components, and related elements that support enhanced capabilities beyond those offered by IMT-2000 (3G) and IMT-Advanced (4G) systems.

5G is the fifth generation of cellular networks. Up to 100 times faster than 4G, 5G is creating never-before-seen opportunities for people and businesses (Ericson 2021). It is a new global wireless standard after 1G, 2G, 3G, and 4G networks. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices. 5G is currently the fastest wireless network giving the highest internet and download speed. 5G technology is delivering life-changing technologies through next-generation networks. The increased speed promised by 5G is achieved partly by using additional higher-frequency radio waves in addition to the low and medium band frequencies used in previous cellular networks.

5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to more users. Higher performance and improved efficiency empower new user experiences and connects new industries.

The main advantage of the new networks is that they will have greater bandwidth, giving higher download speeds, eventually up to 10 gigabits

per second (Gbit/s), Due to the increased bandwidth, it is expected the networks will increasingly be used as general internet service providers for laptops and desktop computers, competing with existing ISPs such as cable internet, and also will make possible new applications in internet of things (IoT) and machine to machine areas.

5G is designed to not only deliver faster, better mobile broadband services compared to 4G LTE, but can also expand into new service areas such as mission-critical communications and connecting the massive IoT.

5G REQUIREMENTS

- 1-10Gbps connections to endpoints in the field
- 1 millisecond end-to-end round trip delay (latency)
- 1000x bandwidth per unit area
- 10-100x number of connected devices
- (Perception of) 99.999% availability
- (Perception of) 100% coverage
- 90% reduction in network energy usage
- Up to ten-year battery life for low power, machine-type devices

Source: GSMA Intelligence

TRENDS OF 5G TECHNOLOGY

March 2019, there are reportedly 52 countries and territories that were considering introducing certain spectrum bands for terrestrial 5G services, consultations were held regarding suitable spectrum allocations for 5G. Spectrums have been reserved for 5G technology.

April 3, 2019, South Korea and USA's Verizon became the first countries to adopt the 5G technology, although South Korea were the first to adopt the new technology but allegedly South Korea's 5G technology was initially launched for 6 South Korean celebrities to claim the title of first country to adopt the 5G technology. Few hows later after the South Korea's launch, Verizon then launched its 5G services in the United

States, and disputed South Korea's claim of becoming the world's first country with a 5G network. Afterwards the three giants in South Korean telecommunication industry, The SK Telecom, KT, and LG Uplus increased the number of users on 5G network by 40,000.

June 2019, the Philippines became the first country in Southeast Asia to roll out a 5G network after Globe Telecom commercially launched its 5G data plans to customers.

December 2019, AT&T introduced 5G technology changing its initial plan of launching it all over United States in early 2020.

October 13, 2020, Apple announced the iPhone 12 and the iPhone 12 Pro, the first line of Apple phones to support 5G connectivity. Apple collaborated with Verizon to enable 5G plans on iPhone 12 (Thales group 2021).

As of March 2021, 157 mobile operators have launched commercial 5G services in 62 countries, according to GSMA Intelligence. The study forecasts 551m subscriptions by the end of 2021, and 1.8 billion by the end of 2025(Thales Group 2021).

April ending 2021, 756 5G devices have been announced (from which 61.9% are already commercially available). Phones represent close to 50% of the announced 5G-compliant devices (GSA May 2021 report).

According to a November 2020 report from Ericsson, 5G will reach 3.5 billion subscriptions by 2026, making it the fastest generation ever to be rolled out on a global scale.

5G TECHNOLOGY: OPPORTUNITIES, CHALLENGES AND RISK

The fifth generation (5G) comes with vast opportunities and advantages as well as threats to the mobile technology industry and will achieve greater standards compared to the earlier mobile cellular networks (1G, 2G, 3G, 4G, 5G)

Opportunities

At the highest level, 5G is an opportunity for policy-makers to empower citizens and businesses. 5G will play a key role in supporting

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governments and policy-makers in transforming their cities into smart cities, allowing citizens and communities to realize and participate in the socioeconomic benefits delivered by an advanced, data intensive, digital economy. (Madan, et al 2019).

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Another advantage of the 5G new networks is that they will have greater bandwidth, giving higher download speeds, eventually up to 10 gigabits per second (Gbit/s), Due to the increased bandwidth, it is expected the networks will increasingly be used as general internet service providers for laptops and desktop computers, competing with existing ISPs such as cable internet, and also will make possible new applications in internet of things (IoT) and machine to machine areas. 5G technology will also improve connectivity in rural areas and in cities where the demand outrun 4G technology. New 5G networks will also have a dense, distributed-access architecture and move data processing closer to the edge and the users to enable faster data processing.

The 5G network will also simplify mobility, with seamless open roaming capabilities between cellular and Wi-Fi access. Mobile users can stay connected as they move between outdoor wireless connections and wireless networks inside buildings without user intervention or the need for users to re-authenticate.

Latency (time delay required to transmit data from the source to the destination) of less than one millisecond, whereas the standard for 4G technology is 50 milliseconds and a much higher connection density, from a standard of 2,000 devices per km2 to one million devices per km2. 5G is going to help further IoT because of the latency and bandwidth improvements it can offer. The IoT opportunities that will especially

benefit from mobile and cellular connectivity include transportation, manufacturing, farming, and smart cities use cases. And 5G could even make new and emerging use cases and applications a true reality for the first time, such as connected cars, which require lightning-fast, low-latency technologies (Crm.com 2021).

Aside from the cutting-edge use cases, many industries right now need highly reliable low-latency wireless links that can power applications as quickly as possible for their existing IoT use cases

5G technology will allow networks to be sliced, meaning that the same physical infrastructure can host several logical networks. As a result, an Internet service provider could provide various services with different performance characteristics (e. g., download speed, latency or download usage limits) on the same physical network to meet a particular need. However, network slicing may not be fully compatible with the current principle of net neutrality, and the federal government may need to determine whether this is consistent with the relevant legislation.

5G technology presents a significant economic benefits, For example, according to an analysis by Accenture, by 2026 5G technology could contribute, to the creation of 250,000 permanent jobs and an annual increase in Canada's gross domestic product of nearly $40 billion.

Huawei's latest Global Industry Vision (GIV) report projects a per-person average possession of five smart devices by 2025. Apart from eight billion smartphones, there will be more than 20 billion PCs, tablets, VR headsets, smart watches, and smart screens among other smart devices. (Huawei 2020). 5G's high bandwidth makes it possible to seamlessly switch video calls, video entertainment, and personal data across these devices. In addition, over 20 billion real-time online smart home devices, such as sound boxes, projectors, printers, and blood pressure meters will be operated and managed with 5G connections to enrich personal and home services.

As a result of 5G connections, these physical devices for homes or offices can be systematically integrated with the digital world to build new smart infrastructure platforms for consumption, education, travel, and work. This, in turn, will create new types of smart services.

5G eliminates data upload limitations, meaning that a massive amount of data can be transferred from hundreds of millions of devices to cloud servers to provide AI operations with tremendous data, which will greatly reduce the training period (Huawei 2020). 5G enables devices to make the best of the powerful computing in the cloud to relax requirements on local computing, reducing device costs. Furthermore, 5G enables the transfer of AI operation results to devices to greatly expand the availability of AI-based functionality (Huawei 2020).

Challenges

Regulation of wireless infrastructure

In 2018, there were approximately 13,000 wireless antenna locations in Canada. This number is expected to increase as the IoT evolves dramatically with the introduction of 5G technology. It is estimated that the number of connected objects could jump by several billion in the next decade, resulting in a significant increase in connectivity needs. Small cell antennas (the size of a shoebox) will be used to expand the network and meet increased connectivity needs. They could be installed on various kinds of infrastructure, such as street lights, bus shelters and public buildings.

Health risks

5G technology possesses certain health risks, the negative effects of radiofrequency (RF) radiations is the issue of concern with resulted in studies with several opinions. However, there is little data on the impact of 5G technology in the specific case of individuals who may be exposed

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to a higher concentration of Radio frequency (RF) radiations due to the greater number of antennas that will be used.

Security

Huawei has been the focus of security concerns over its deployment of this technology. According to various sources, several security breaches have been identified in the software and firmware used in Huawei's devices. Additionally, a report from the United Kingdom's Huawei Cyber Security Evaluation Centre (HCSEC) Oversight Board concludes that the Board is not confident that Huawei's plan to address these concerns is sufficient (Huawei 2020)

CONCLUSION

5G is a new technology that presents outstanding benefits to mobile cellular networks, telecommunication industry and I.T world in general. 5G giving higher internet and download speed will enable networks to be used as standard and reliable internet service providers hence providing alternatives to the cable internet, also A.I tasks and other specialized tasks such as vision, Speech recognition, Natural Language understanding, smart cars, Robot control as well as the internet of things (IoT) will be made easy.

Despite the promising opportunities presented by 5G technology, there are certain challenges of health and security risks that the new technological break though possesses, the negative effects of radiofrequency radiations has continued to raise a lot of controversies. Also there have been concerns of security breach due to 5G, However, despite the few challenges the deployment of 5G would provide significant benefits to the telecommunications, cellular networks and all internet services economically and technologically.

RECOMMENDATION

5G will promote internet services and create new opportunities for economic growth by enabling new and dynamic business models and

opening up new opportunities, 5G Technology will initiate several new changes in mobile connectivity, the challenges and risks should be limited and minimized so that 5G will achieve its designed goal of boost connectivity, productivity and technological economic growth.

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