NATIONAL POLICY ON
FIFTH GENERATION (5G) NETWORKS
FOR NIGERIA'S DIGITAL ECONOMY

5G

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MUHAMMADU BUHARI,GCFR
PRESIDENT, COMMANDER-IN-CHIEF OF THE ARMED FORCES
OF THE FEDERAL REPUBLIC OF NIGERIA

▶ **PRESIDENT'S MANDATE**

The advantages of 5G technologies with regard to enhancing connectivity, improving healthcare, supporting education, fostering smart cities and boosting agriculture are well known. It will also support security institutions with real time communications. However, our decision to roll-out the technology was not merely premised on these benefits, rather we ensured that the technology met the minimum standards of safety and security, among others. In order to determine this, approval was given for 5G trials which commenced in November 2019. Following the trials, extensive multi-stakeholder consultations were organised to determine the suitability of the technology for the Nigerian environment.

The National Policy includes a deployment plan to ensure that major cities across the country benefit from 5G technologies. It also seeks to make 5G a major driver of our economy, a catalyst for smart cities in the country and a platform for the creation of jobs that support our digital economy. We assure investors that we will continue to provide an enabling environment for their businesses to be very successful as we roll-out this technology.

I applaud the Honourable Minister of Communications and Digital Economy, Prof. Isa Ali Ibrahim (Pantami), for the giant strides that have been made in the Digital Economy Sector. I also commend all the stakeholders who participated in the development and review of the National Policy. The Nigerian Communications Commission must ensure the implementation of the National Policy and this is to be supervised by the Minister. I urge all stakeholders to give the implementation of this National Policy top priority for the overall benefit of the sector and our country.

Muhammadu Buhari
October 2021

PROF. ISA ALI IBRAHIM (PANTAMI) FNCS, FBCS, FIIM.
MINISTER OF COMMUNICATIONS AND DIGITAL ECONOMY
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▶ **FOREWORD**

The National Policy on 5G Networks for Nigeria's Digital Economy was approved by the Federal Executive Council on the 8th of September, 2021. The approval of the Policy was a culmination of a painstaking process that included a trial phase and extensive stakeholder engagement.

The 5G-trials took place over a 3-month period, commencing from the 25th of November, 2019. The report of the 5G-trials was critically reviewed and studied by stakeholders, with a view to understanding the health and security implications of deploying 5G in Nigeria. The review showed that 5G is safe for deployment in Nigeria and would not compromise our security as a country.

Furthermore, leading international organizations like the World Health Organisation (WHO) and the International Telecommunication Union (ITU), organs of the United Nations, have so far confirmed that the deployment of 5G networks do not cause any adverse health effects and are safe.

In addition, Fifth Generation (5G) Mobile Networks are emerging technologies that have the potential to significantly enhance our experience with mobile networks and real time communications. Some of its advantages include much lower latency, higher bandwidth, greater device density, longer battery life for nodes, and greater network flexibility. The features can also enhance services in different sectors of the economy, including healthcare, education, agriculture, transportation and manufacturing, to mention but a few. A number of countries have already commenced the deployment of 5G Networks and are enjoying its benefits. These include the United States, United Kingdom, Republic of Korea, China, South Africa, Lesotho, etc.

The National Policy captures all the necessary information guiding the processes for the deployment of 5G technology in Nigeria. It also aligns with other Policies of the

Federal Government and will support in their implementation. These Policies include the National Digital Economy Policy and Strategy for a Digital Nigeria, the Nigerian National Broadband Plan and the National Policy for the Promotion of Indigenous Content in the Nigerian Telecommunications Sector.

The National Policy on 5G Networks for Nigeria's Digital Economy addresses the provision of the required spectrum and enabling environment to ensure full deployment of 5G. The implementation of the Policy will support the development of the Nigerian economy and will serve as a catalyst for the successful implementation of our National Digital   Economy Development and Strategy (NDEPS) for a Digital Nigeria.

The Policy is designed to achieve the following, amongst others:
I.   to ensure effective deployment of 5G to cover major urban areas by 2025;
ii.   to ensure security of 5G ecosystem and the protection of data;
iii.   to ensure that international best practices and globally accepted standards and specifications are entrenched in Nigeria's 5G ecosystem;   and
iv.   to ensure that the required infrastructure needed for successful deployment   of 5G networks such as data centres, power, etc, are catered for in deployment strategies of 5G networks.

His Excellency, President Muhammadu Buhari has directed me to instruct the Nigerian Communications Commission (NCC) to develop the requisite strategies, standards, guidelines and frameworks for the successful deployment of the 5G networks across the country. The NCC is also directed to collaborate with relevant institutions and stakeholders in order to achieve the aims and objectives of the National Policy.

On behalf of the Digital Economy family, I wish to extend our sincere gratitude to His Excellency, President Muhammadu Buhari, GCFR, for his tremendous support towards this and other programmes and initiatives of the sector.

Prof. Isa Ali Ibrahim (Pantami), *FNCS, FBCS, FIIM*
Minister of Communications and Digital Economy of the Federal Republic of Nigeria
Chairman, National Frequency Management Council (NFMC)
October 2021

1.   Introduction

The mobile technology space has witnessed major innovations and produced increasingly dynamic changes in communication services which have transformed human endeavors and activities globally. The transgenerational change in mobile technology is currently at the fifth Generation (5G) stage which is a quantum leap from earlier generations of mobile technology.

The Federal Ministry of Communications and Digital Economy (FMC&DE) ensures that the goals of the National Digital Economy Policy and Strategy (NDEPS) of the Federal Government are attained and one of the instruments for the realization of the NDEPS is the availability of a robust Information and Communication network in the country. Therefore, FMC&DE having identified the unique benefits and the role 5G can play in attaining the objectives of the digital economy, is setting up a policy that will facilitate the deployment of 5G Technology in Nigeria.

The 5G Communication Technology is the next evolution of the mobile communications technology which can create new opportunities for growth in the economy by enabling dynamic business models and opening new opportunities and markets. It also provides tremendous improvements in interpersonal communications with several innovations and services.

Furthermore, 5G will initiate several new changes in mobile connectivity with an enormous capacity to boost productivity and grow the economy. These are the key reasons behind the drive to ensure the deployment of 5G in Nigeria in line with the NDEPS for a Digital Nigeria. Mobile technology has continued to improve since the commercial implementation of the first telephone system in 1876. It is estimated that by the end of the year 2021, global mobile data traffic would reach a monthly rate of 56.8 exabytes, as compared to 3.7 exabytes in 2015. Each mobile communications technology brings with it, new capabilities that ultimately transform both work and interpersonal communications.

Furthermore, 5G represents the fifth generation in mobile communications evolution and an incremental deployment is expected over the following decade. 5G is designed to be a system of systems that will bring flexibility to mobile, fixed and broadcast networks, as well as support more extensive data requirements. The Technology will impact on the way interactions are done by enabling revolutionary business models, enhanced lifestyles, and increased productivity. Some of the technologies already being supported by 5G include automated cars and advanced manufacturing, Internet

of Things (IoT) which will enable thousands of connected devices, such as smart energy meters, work together and share information, with minimal human interface. These changes and innovations have enormous economic benefit. According to Information Handling Service (IHS) Market report, 5G will enable $12.3 trillion of global economic output in 2035; the global 5G value chain will generate $3.5 trillion in output, and support 22 million jobs in 2035; the 5G value chain will invest $200 billion annually in Research and Development (R&D) to continually expand and strengthen the 5G technology base within network and application infrastructure base.

It is important to note that South Korea, China, and the United States are the countries that lead the world in building and deploying 5G technology. However, Lesotho, through Vodacom is the first African country to test 5G in 2018 (although only for two enterprise clients), while South Africa (through the MNO Rain) was the first to commercially launch 5G services in late 2019. Vodacom launched commercial 5G services on the 5th of May 2020 in 3 South African cities.

Accordingly, to successfully roll out 5G, stakeholder engagements have been identified as a key strategy. Stakeholders have been engaged over five different times. The Nigeria Communications Commission (NCC) has also been tasked with the responsibility to create awareness on 5G and also provide several platforms for the Stakeholder engagements. It is essential to note that, a Proof of Concept (PoC) non-commercial technology trial was instituted with key industry stakeholders to undertake a PoC for the 5G Technology in Nigeria. Six locations across the nation were selected during phase 1 of the trial test. The NCC temporarily assigned two candidate frequencies for these trials with MTN Nigeria Communications PLC (MTN) serving as the Operator. Nigeria launched its 5G trials on the 25th of November, 2019.

The locations selected were:
(i)   Abuja (Federal Capital Territory)
(ii)   Calabar
(iii)   Lagos
(iv)   Kano
(v)   Abeokuta
(vi)   Ibadan

The selected frequencies for the trials were the 3.5GHz and the 26GHz frequency bands. Key network characteristics observed during the trials include the following:
i.   throughput, latency and jitter measurements;
ii.   co-channel interference impact on qos;
iii.   handover performance between access points (as applicable);

iv.   type/models of 5G terminals used for the test;
v.   types of services (voice, data, video, etc.); and
vi.   health and safety (emf radiation level).

1.1   Stakeholder Engagement

The Policy formulation process involved the engagement of all relevant stakeholders in the public and private sectors. The engagements were in multiple phases. As part of the process, a draft Policy was shared with stakeholders, who reviewed and provided invaluable comments and contributions. Some of the phases and institutions included in the stakeholder engagement are listed below:

(i)   public hearing at the National Assembly;
(ii)   directive of Minister to NCC for further engagement in which over fifty (50) Institutions were invited;
(iii)   advice of the Office of the National Security Adviser (ONSA) on study group as part of the stakeholder engagement;
(iv)   National Frequency Management Council (NFMC) directive to NCC to involve security agencies;
(v)   trials from the 25th of November, 2019,along with stakeholders; and
(vi)   report of the trials and recommendations.

1.2   Authority

This Policy has been developed under the authority of the Honourable Minister of Communications and Digital Economy in line with the following sections of the Nigerian Communications Act 2003 (NCA 2003):

i.   Subsection 23 (a): The Minister shall have the following responsibilities and functions pursuant to this Act— the formulation, determination and monitoring, of the general policy for the communications sector in Nigeria with a view to ensuring, amongst others, the utilisation of the sector as a platform for the economic and social development of Nigeria; and

ii.   Subsection 25 (1): The Minister shall, in writing, from time to time notify the Commission or and express his views on the general policy direction of the Federal Government in respect of the communications sector.

This Policy can be cited as "National Policy on Fifth Generation (5G) Networks for Nigeria's Digital Economy." and shall come into effect on the date of the signature.

1.3 Vision and Mission

Vision
"To accelerate the deployment of 5G networks for the citizens to benefit from digital services and applications that require instantaneous response and huge bandwidth."

Mission
"We facilitate 5G deployment that will ensure a nationwide upscaling of communication networks to ensure the full utilization of emerging technologies."

2. Direction of the Policy

The Policy targets the deployment of 5G Networks to harness the economic benefit of its deployment nationwide. It is expected that this National policy will ensure collaboration with stakeholders to stimulate the adoption of its objectives nationwide by ensuring the required spectrum and enabling environment are provided for its deployment.

2.1 Policy Implementation

The Nigerian Communications Commission (NCC) under the supervision of the Federal Ministry of Communications and Digital Economy is charged with the responsibility of the implementation of this Policy, through the development of strategies, standards, guidelines and frameworks aimed at accelerating the deployment of 5G Networks nationwide.

To guarantee a coordinated effort in implementing the 5G Plan, the NCC has been directed to collaborate with relevant agencies under the Ministry of Communications and Digital Economy, and all other stakeholders to achieve the aims and objectives of this National Policy. With the approval of this National Policy, the implementation is to commence immediately to cover major cities across the different geopolitical zones of the country e.g Abuja, Lagos, Rivers, Kaduna, Gombe, Anambra, and other States where the deployment is required and subsequently to other urban cities by 2025. This National Policy shall be reviewed as the need arises.

2.2 Policy Objectives

Some of the Policy Objectives are as follows:
(i)   to ensure efficient assignment of spectrum for deployment of 5G technology;
(ii)   to create an enabling environment for investment in the Telecom Sector;

(iii)   to collaborate with relevant stakeholders to ensure availability of fibre and other backhaul infrastructure where required;

(iv)   to ensure effective deployment of 5G to cover major urban areas by 2025;

(v)   to ensure the security of the 5G ecosystem and the protection of data;

(vi)   to ensure that international best practices and globally accepted standards and specifications are entrenched in Nigeria's 5G ecosystem;

(vii)   to create an enabling environment for innovation, digital entrepreneurship, and the proliferation of impactful 5G use cases; and

(viii)   to ensure the required infrastructure needed for successful deployment of 5G Networks such as data centres, power etc. are catered for in deployment strategies of the 5G networks.

2.3   Expected Outcomes of the Policy

The outcome of this National Policy is to ensure the successful deployment of 5G Networks in Nigeria with a good spread that promotes access to emerging technologies and other services that require high bandwidth and instantaneous response. Furthermore, it is expected with the deployment of 5G services and applications that were before difficult to be deployed in Nigeria will become readily available for the citizens especially in Agriculture, Tourism, Medicine, Emerging Technologies, Manufacturing among others and also support virtual and connected devices.

Accordingly, it is expected that this National Policy will foster collaboration among all relevant stakeholders, and ensure Nigeria exploits the economic benefit of the implementation of this National Policy, improve Quality of Service (QoS) & efficiency of Mobile Networks, and Security benefits among others in line with global best practices, and in alignment with NDEPS 2020-2030.

3. Focus Areas

To successfully accelerate the deployment of 5G Networks in Nigeria with a national coverage especially in urban areas and other places, there is need to focus on key technical areas where the development of such capacity will have the greatest level of impact, and significantly reduce any challenge that may arise.

The following have been identified as such Technical Areas:

(i)   deployment plan;

(ii)   legal and regulatory framework;

(iii)   network roll-out;

(iv)   security;

(v)   coverage and capacity;

(vi)   spectrum allocation and spectrum assignment;
(vii)   5G technology standards;
(viii)   use cases and emerging technology trends;
(ix)   digital economy; and
(x)   health, safety, and environment (HSE).

3.1   National Deployment Plan

One of the goals is to make Nigeria one of the leading nations in the deployment and utilization of 5G, in a manner that is beneficial to all the stakeholders and contributes maximally to the building of Nigeria's digital economy. To achieve this, Nigeria actively participated in the International Telecommunication Union Radiocommunication Sector (ITU-R) study cycle under the Task Group 5/1 that culminated in the identification of the 5G spectrum in the mmWave band. Sequel to that, the NCC suspended an impending licensing of allocated spectrum in the 38GHz and 42GHz bands as well as further licensing of the 26GHz band, due to the identification of some parts of these bands for 5G deployment.

In addition, Nigeria also participated in the evaluation of submitted/proposed Radio Interface Technologies (RITs) through the creation of Nigerian Evaluation Group under the auspices of the registered Independent Africa Evaluation Group within the ITU-R process. The 5G evaluation process was concluded in February, 2020.

The Federal Government of Nigeria approved the 5G trial in selected locations within the country in collaboration with mobile operators. The NCC has also been directed to engage with the academia, while at the same time funding 5G related research projects. This is aimed at providing quality research findings to drive the implementation and deployment of 5G technology in Nigeria. These engagements are also targeted at enabling the development of robust National policies which will contribute maximally to the digital economy drive of the Nation.

The specific targets of these engagements include the development of policies which have the potential of:
a.   accelerating the deployment of 5G networks in Nigeria;
b.   maximizing the productivity, efficiency, and benefits of 5G to the nation;
c.   creating new opportunities for Nigerian businesses at home and abroad and encouraging investment in the country; and
d.   ensuring the operations of 5G networks are in conformity with international standards.

3.1.1 The Need for a 5G Deployment Plan

In line with the objectives of NDEPS to accelerate a digital economy in Nigeria, and the positioning of Nigeria as an early adopter of digital technology and a major participant in the growing global digital economy, the successful and timely deployment of 5G is crucial. It is expected to facilitate several emerging technologies, generate innovative new use cases, spur significant socio-economic growth, and create jobs.

However, the plan for 5G is hampered by a myriad of policy and regulatory challenges that need to be addressed before the rollout of 5G services. These include spectrum allocation, spectrum assignment, infrastructure challenges, Right-of- Way issues, network security, data privacy, health, safety, and so on.

In March 2020, the Nigerian National Broadband Plan (NNBP) 2020 – 2025 was unveiled and launched by President Muhammadu Buhari, GCFR. The new NNBP unveiled a detailed strategy for rapid rollout of broadband services across the nation and sets goals for effective coverage, data pricing and minimum data download speeds in both urban and rural areas.

The success of 5G deployment and commercial operation in Nigeria will be highly dependent on the implementation of the Plan, and so the priority is to create appropriate measures that ensure the advancement of 5G, while also addressing the challenges and issues that are specific to 5G deployment.

3.1.2 Background on 5G Technology

5G technology is the current generation of mobile communications technology, and it is designed to outpace the preceding 4G networks with new capabilities and specifications that will enable new and innovative solutions and products.

Furthermore, the most common 5G deployments around the globe have been in the 3.3GHz -3.8GHz bands in the sub 6GHz range, which is used by other communications technologies. Furthermore, other bands studied at the ITU-R and proposed for 5G deployment include spectrum above 6GHz ranging from 24GHz to 86GHz. These new frequency bands will in addition to enhancing service delivery, create additional revenue to government through spectrum licensing. 5G will leverage the existing infrastructure when deployed in a Non-Standalone (NSA) architecture and subsequently progress to the Standalone (SA) architecture.

One of the most significant advantage of 5G is the higher bandwidths in some of the frequency bands identified for the technology. These high bandwidths will translate to its ability to transfer large volumes of data at extremely high speed and very low latency. These speeds are expected to reach 10Gbps which is ten times faster than the highest rates offered by the fibre to the premises networks. The most significant advantages of 5G are the huge amount of data it can transfer and the extremely fast response.

A unique feature of the 5G which is low latency that will enable the utilization of 5G in mission critical control and remote health applications which are challenging with the 3G and 4G networks. The response time for 3G is usually rated at 100 milliseconds while that of the 4G is rated at 30 milliseconds.

Comparing this with the 5G response time, which is rated as low as 1 millisecond, provides an enormous opportunity for the development of real-time control applications. This rapid response time is made possible by the higher available bandwidth and spectrum efficiency of 5G, as applications can complete their data transfer and allow other applications to access the bandwidth. Critical applications that will benefit from these advantages include automation, particularly in the healthcare and mining sectors, massive Machine Type Communications, and the remote control of industrial processes such as oil and gas, farming, and manufacturing.

Furthermore, a vital drawback of the high frequency bands is their susceptibility to atmospheric attenuation; thus, the cells must be very small micro or femtocells. While these cell sizes are small, the form factors of the base stations are even much smaller resulting in microcell Base Transceiver Station (BTS) as small as tiny boxes on street light installations which can be powered by solar panels and batteries.

3.1.3 Standalone and Non-Standalone 5G Network Infrastructure

There are two network deployment options for a 5G network, Non-Standalone (NSA) and Stand-Alone (SA). An NSA option relies partly on existing 4G LTE infrastructure and brings some new technology like 5G New Radio (NR). According to the 3GPP Release 15 from October 2019, NSA has the 5G RAN and the 5G NR interface working together with existing LTE infrastructure and core network. This means that while only LTE services are supported, the network has the capabilities offered by 5G NR, like enhanced mobile broadband.

SA refers to a 5G network that does not rely on LTE networks and has its own core cloud-native network that connects to the NR. It is expected that network operators will implement SA after moving through an NSA. Using an NSA approach allows Operators to offer 5G-like experiences while they build out the needed physical infrastructure of a 5G network.

According to the 3GPP Release 15, the standalone deployment option is composed of user equipment, the RAN — which includes the NR — and the 5G core network. The 5G core network relies on a service-based architecture framework with virtualized network functions.

3.1.4 Justification for the 5G Deployment Plan

While the contributions and achievements of the 3G and 4G technologies have been remarkable, the current and continuous increase in development of new technologies and devices with the accompanying new service requirements creates a need for the development of technologies that can meet these requirements.

These requirements include faster connectivity, enhanced mobile broadband, higher data capacity, reduced latency and the infrastructure required to realize revolutionary innovations such as driverless cars, remote classrooms, cutting edge surgical processes etc.

The global mobile data traffic generally and in Nigeria particularly is on an upward trajectory, increasing exponentially year on year. Thus, there is need for an effective and cost-efficient network expansion to ensure optimal support for this traffic growth. It is estimated that by the end of the year 2021, global mobile data traffic would reach a monthly rate of 56.8 exabytes, as compared to 3.7 exabytes in 2015.

This assertion is based on the higher flowrate of data, the advent of new systems and technologies such as the IoT and smart cities. A recent World Economic Forum (WEF) Report concluded that 5G networks would make an estimated contribution of USD13.2 trillion in economic value globally and generate 22.3 million jobs from direct network investments and residual services.

Accenture in a 2017 study concluded that 5G could create USD500 billion in additional GDP and an estimated 3million jobs in the US through a USD275 billion investment by telecom operators. A similar study by the European Commission estimated that the benefit of 5G in Europe would reach EUR 113 billion per annum in

four key sectors, namely, automotive, healthcare, transport, and energy, while creating approximately 2.3 million jobs.

In addition, a global study commissioned by Qualcomm also concluded that 5G would enable USD12.3 trillion of economic output by 2035 with the 5G value chain supporting approximately 22 million jobs.

This outlook of 5G technology has led to different governments, operators, vendors, and other players in the value chain racing to reap the benefits by being the first to deploy and commercialize the technology. Key application areas that will be driven by 5G are shown in figure 1.
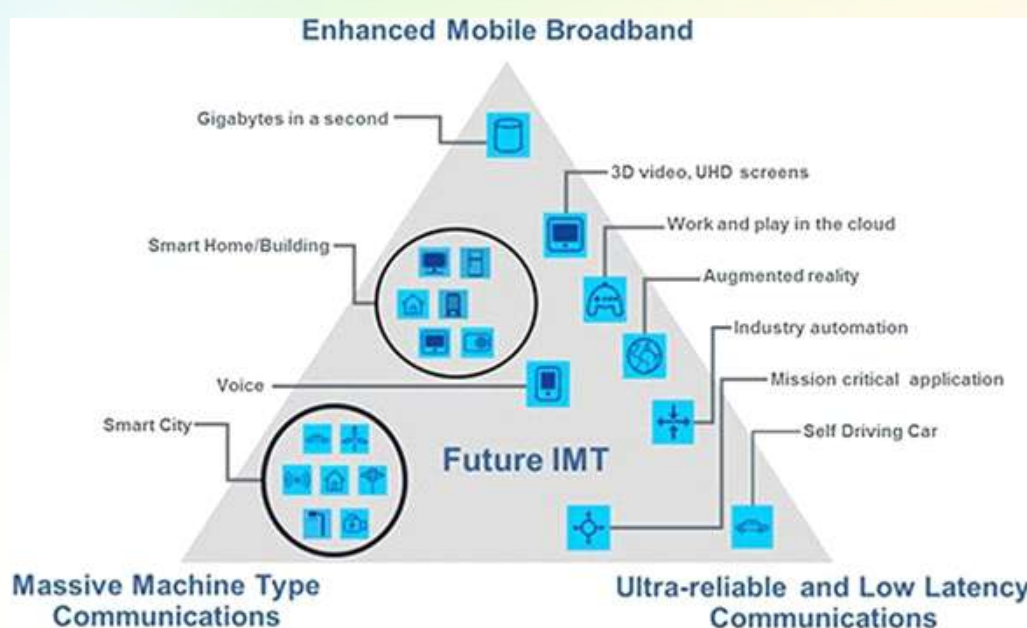

Figure 1.   5G Usage Scenarios. Source ITU

3.2   Legal and Regulatory Framework

The unique and game-changing capability of 5G creates a need for a regulatory framework that will encourage operators to rollout services in compliance with the law and subsidiary legislations issued by the Nigeria Communications Commission (NCC). This Plan will support both the deployment of 5G network and take- up of 5G services. Key features of this Plan will include the availability, allocation, and timely assignment of frequency spectrum.

To ensure an efficient regulatory framework for deployment of 5G, the Plan will:
a.   ensure the continuous development of a fit for purpose and flexible regulatory framework that keeps pace with the rapid changes and developments in

the 5G communications technology space;

b.   strengthen existing regulatory framework to address unique challenges of 5G infrastructure deployment such as investment barriers, lowering the cost of infrastructure deployment, encouraging long term capital investment in digital infrastructure, cybersecurity issues and supporting coverage enhancements in collaboration with the relevant agencies of government.

c.   encourage further investment in 5G Testbeds to improve the understanding of 5G applications and services.

3.3   Network Rollout

The current race to deploy 5G networks is targeted at providing citizens with the benefits of the technology. The proposed 5G deployment timeline is shown in Figure 2.
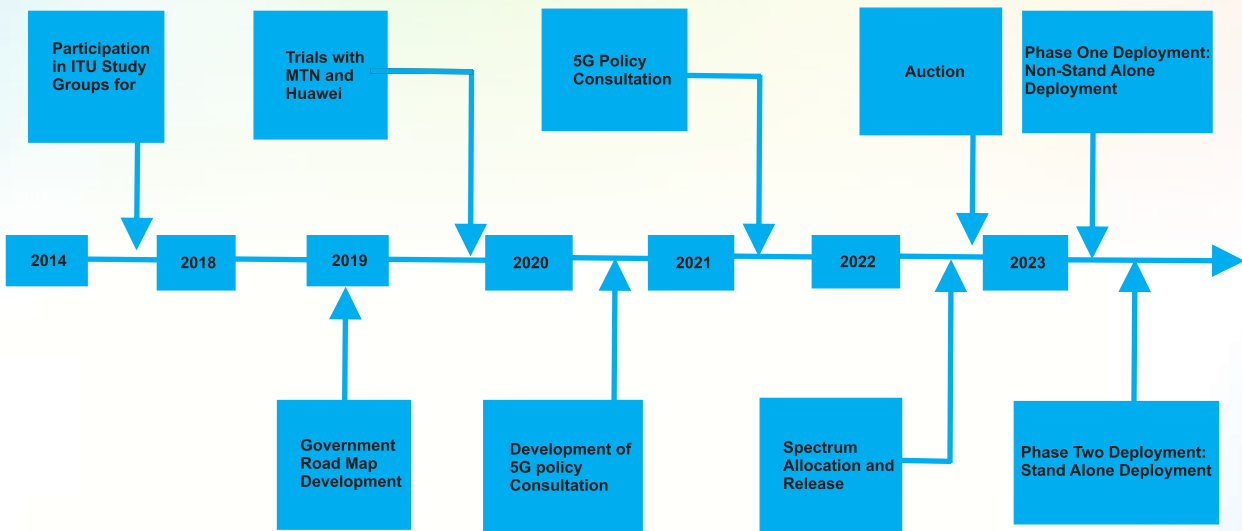

Figure 2. 5G Deployment Rollout Timeline

The activities towards facilitating roll-out of 5G services shall be based on the following:

1.   creating an enabling environment for deployment of 5G technology: The NCC is to facilitate a private sector led deployment and roll-out of 5G services. This will be implemented using appropriate strategies
including but not limited to the following:

a.   ensuring spectrum availability for 5G technology deployment at reasonable prices;

b.   developing a roadmap that will enable the NCC to initiate a collaborative process with relevant bodies;

c.   encouraging the streamlining of government processes for deployment of

communications infrastructure;

d.   advocating for legislation that designates communications infrastructure as Critical National Infrastructure (CNI);

e.   encouraging the use of fibre amongst other technologies for 5G backhaul;

f.   developing standards for small cell size roll out; and

g.   encouraging lower taxes and tax reliefs to stimulate 5G investments.

2. Enabling the utilization of 5G deployments as part of the nation's broadband penetration plan.

3.Promoting strategic collaborations among relevant stakeholders for the setting up of testbeds and research hubs for 5G innovation, thereby contributing to the development of global standards.

4. Ensuring optimal utilization of the cell sites by encouraging infrastructure sharing.

5. Collaborating with the industry and academia to support and promote research in the development, testing and evaluation of new technologies and innovations.

3.4   Security

5G networks constitute a significant upgrade on existing technologies and provide enhanced, more beneficial use cases for society. It will support higher capacity connections for consumers and different industries. The new and enhanced services provided by 5G networks require high technology requirements for the different aspects of the ecosystem.

5G networks facilitate a transition away from centralized, hardware-centric switching to one that is distributed and utilises software-defined digital routing. As such, more attention is to given to the design, deployment, configuration, and maintenance of 5G networks to ensure true end-to-end cybersecurity.

In line with this, the NCC is to ensure that 5G network deployment in Nigeria aligns with global best practice in the area of international security. Deployment should also comply with relevant standards like the Network Equipment Security Assurance Scheme (NESAS). The Scheme was jointly defined by the 3rd Generation Partnership Project (3GPP) and the Global System for Mobile Communications Association (GSMA).

As noted earlier, 5G relies on software and cloud infrastructure to "virtualize" network functions. Cloud services will play very critical roles in 5G, and both the

'cloudification' and virtualization of network functions will unlock a myriad of new possibilities for managing and securing networks. A Software-Defined Network is an example of the technologies that can facilitate the creation of tailored virtual environments, which enable the application of security controls customized to the data and devices used within that context. In addition to complying with relevant security standards, the NCC must also ensure compliance with the Nigeria Cloud Computing Policy.

The plan for managing the security risks associated with 5G will include but not limited to the following roles to be carried out by the NCC under the supervision of the Federal Ministry of Communications and Digital Economy (FMC&DE):

1. To collaborate with relevant agencies to:
a.   assess risks and identify the core security
b.   promote secure and reliable 5G infrastructure by regularly assessing the economic, national security and other risks to this infrastructure, including defining and maintaining the relevant core security principles for this infrastructure;
c.   monitor the economic, national security, and core security principles which includes the best practices in cybersecurity, supply chain ecosystem management, and public safety for the nation's 5G infrastructure and other risks posed by the vulnerabilities and cyber threats to the 5G infrastructure for proactive action;
d.   leverage relevant security reports to address potential and operational risks that may emanate from different aspects of the end-to-end 5G network and services;
e.   utilise NCC's Computer Security Incidence Response Team (CSIRT) to provide a response mechanism and ensure security of the cyber space and the Computer Emergency Response Team (CERT) to liaise with other CERTs in Office of the National Security Adviser (ONSA), National Information Technology Development Agency (NITDA) and Central Bank of Nigeria (CBN).
2. To participate actively in the development and implementation of international 5G security principles through bilateral and multilateral collaborations with relevant partners.
3. To encourage 5G vendor diversity to minimize risk exposure.
4. To ensure that the 5G networks are deployed with a fit for purpose security architecture to ensure data protection and privacy.
5. To strengthen domestic policies and actions that will promote local content within the industry.

3.5   Coverage and Capacity

5G network has the potential of facilitating the attainment of the goals of the Nigerian National Broadband Plan (NNBP) 2020-2025 and the objectives of the National Digital Economy Policy and Strategy (NDEPS) of the Federal Government. This capacity can only be achieved by ensuring that more locations in the country are provided with network coverage.

As of December 2019, coverage data shows that most rural areas only have access to 89.8% 2G networks coverage, while 3G has a coverage of over 74%. The data-centric 4G had only about 37% of the population covered at the same time, with less than 10% connections leading to mobile internet penetration of about 32%. However, broadband penetration for the country as of November was 47% approximately. 5G can in- crease broadband penetration while lowering the price of data due to the large bandwidths available to the standard.
NCC should adopt the following policy thrust in ensuring 5G coverage to the nation:
i.   integrate 5G networks in the attainment of the National Broadband Plan;
ii.   ensure that 5G networks are deployed to provide the recommended levels of connectivity and coverage and meet the approved quality of service metrics; and
iii   Encourage demand-driven deployment by ensuring that high consumption areas for data such as Educational, Health and industrial- institutions are prioritized in the network roll-out and coverage plan for the 5G deployment.

3.6   Spectrum and Spectrum Assignment

5G Network deployment will rely on the availability of sufficient frequency spectrum at the low, medium, and high- frequency bands to provide for the different use cases and applications. While some of these frequencies will be newly allocated and/or assigned for 5G network deployment, others will have to be re-farmed/re-planned from existing communications services.
For the purposes of spectrum allocation of 5G, the NFMC should drive the process to ensure that the required spectrum for 5G standard is made available in the most appropriate and timely manner to enable investments, innovation, andcompetition in the deployment of 5G services for the benefit of consumers and businesses. Accordingly, the NCC under the supervision of the Ministry of Communications and Digital Economy is directed to:
(I)   develop measures that support the increased flexibility in the use of spectrum, within the spectrum regulatory regime;
(ii)   ensure the maximum utilization of these spectra by providing timelines for its deployment while enforcing the "Use it or Lose it policy"; and
(iii)   encourage the full implementation of the Spectrum Trading Guidelines.

3.7   5G Technology Standards

The global collaborations supporting the development of 5G standards will be driven by market needs and be developed by the standards bodies using the bottom-up approach. Governments will be able to contribute to these developments by collaborating with the relevant players in the private sector.

To drive the NCC's contribution to the technology and standards growth of 5G in Nigeria, the NCC with the permission of the Supervising Ministry should:

1.   Continue to engage the relevant stakeholders in the private sector and the academia to contribute to the standards and ensure that Nigeria's requirements are captured in these standards whenever the opportunity is presented.

2.   Support Micro, Small and Medium- Sized Enterprises (MSMEs) and the academia in generating innovative technologies and applications and promote the take-up and commercialization of their ideas.

3.   Partner with relevant agencies such as Tertiary Education Trust Fund (TETFUND), the Digital Bridge Institute (DBI) and the academia for the setting up of 5G testbeds to facilitate research in 5G and contribute to the advancement of the standards.

4.   Promote the involvement of MSMEs in 5G standards development.

5.   Enable and encourage the participation of relevant stakeholders at International Telecommunication Union (ITU) events and harness the contributions from these stakeholders in putting together the position of the country at these meetings.
6.   Support the development of intellectual property in the 5G communications technology space by funding research and technology trials with the academia and MSMEs.

3.8   Role of Satellite in the 5G Ecosystem

Current publications and research have shown that Communication Satellite has a great role to play in 5G deployment, and this can be realized through leveraging the advantage of the Satellite Infrastructure by mobile and fiber operators to expand their coverage areas and offload their networks through important functionalities like multicasting, backhauling, and mobility access where satellite is a better access technology.
According to the ITU Satellite Communications Symposium in 2019, the following aspects leverage the advantages of satellite's high bandwidth, and ubiquitous

coverage to enable and extend terrestrial 5G networks:
(i)   trunking and head-end feed;
(ii)   backhauling and tower feed;
(iii)   communications on the move; and
(iv)   hybrid multiplay.

Accordingly, the NCC is expected to ensure that relevant stakeholders collaborate with Nigerian Communications Satellite Limited (NIGCOMSAT) and other Satellite Service Provision Companies to leverage the existing and future Communications Satellite Infrastructure in the deployment plan of 5G in the following but not limited areas:
(i)   coverage and integration;
(ii)   resilience and over slip;
(iii)   IoT over the Satellite networks;
(iv)   content multicast and cashing;
(v)   backhauling;
(vi)   spectrum sharing; and
(vii)   any other role that the communications satellites infrastructure can play in the 5G-Ecosystem.

3.9   Use Cases and Emerging Communication Trends

A vital advantage of 5G is the number of use cases it will enable and the emerging technologies it will facilitate. This rides on its ability to provide wireless broadband services at Gigabit speeds and data connections well above 10 Gigabits per second, latency below five milliseconds and the capability to exploit any available wireless resource, from Wi-Fi to 4G and to handle millions of connected devices simultaneously.

5G technology will support the development of new applications which will connect devices and allow innovative applications and business models due to its software virtualization abilities. Examples of new technology areas to be facilitated by 5G include enhancements in application areas such as Internet of Things (IoT), Artificial Intelligence (AI), Robotics, Drones, Advanced Communication Systems, Cloud, 3D Printing, Mixed Reality, Simulation/Imaging and Gamification. These application areas will impact and create new improvements in areas such as Manufacturing, Transportation, Public Services, Health and Social Works, Agriculture, Energy, Logistics, Media and Entertainment, Mining and Quarrying, Machinery and Equipment, Automotive, Education, Information and Communication, Urban Infrastructure, Consumer experience, Sports, Semiconductor Technologies etc.

The Nigerian Communications Commission (NCC) is mandated to:

1)   encourage stakeholders to provide innovative solutions and partner with NITDA and other relevant agencies to facilitate the adoption of these technologies.

2)   support the development of indigenous innovative solutions based on the use cases of the 5G technology by funding hackathons, research fairs and startup hubs, as in the National Policy for the Promotion of Indigenous Content in the Telecommunication Sector.

3)   collaborate with relevant agencies of government to support MSMEs and provide suitable enabling environments that foster innovation and creativity.

4)   continue to collaborate with the academia and research institutions to fund research proposals that encourage the development of innovative solutions.

5)   liaise with relevant government agencies to drive the utilization and commercialization of locally developed innovative solutions riding on the 5G technology through applicable legislations and policies.

6)   undertake studies and develop regulations that en- sure that the emerging technologies are not utilized to create applications that can put the network and consumer data at risk.

7)   continue to work with relevant agencies to ensure that all devices connected to the networks are configured with the required security protocols.

8)   explore synergies between digital communications, energy, and other strategic infrastructure. This is to align regulations in telecoms and other utilities, particularly in power, to facilitate synergic investments between these types of infrastructure and industries.

3.10   Digital Economy

The huge population of Nigeria has been driving activity in the digital economy and further enhanced by a population distribution of 70% below the age of 30years old. This presents an opportunity which if properly managed, can result in substantial economic benefits and deepening of the digital economy. The best approach at maximizing this population distribution is by equipping the youth with the right digital skills to help them become job creators and not job seekers.

The Nigerian Communications Commission through the supervising Ministry is mandated to:

1) Collaborate with relevant agencies and the startup ecosystem to facilitate the advancement of digital literacy among the youth. This will be done by encouraging the set-up of startup hubs, promoting training programs and funding innovative solutions within the Nigerian Tech space.

2)   Drive the NNBP by working with relevant agencies to ensure that broadband is deployed to crucial demand drivers such as tech hubs and research institutions.

3) Invest in programmes that support digital literacy training and skills acquisition for the youths in the country.

4) Collaborate with Operators, the National University Commission (NUC), the National Board for Technical Education (NBTE) and other relevant higher edu cation regulatory bodies to help facilitate broadband penetration in the campuses of the tertiary institutions in Nigeria.

5) Develop and support an Idea-to-market innovation programmes where startups are mentored until their ideas and innovation are commercialized.

6)   Aid the acceleration of economic growth, support short-term investment into the digitalization of public services to encourage private investment that will drive the economic growth.

3.11   Health, Safety and Environment (HSE)

Health and public safety are very critical concerns associated with the deployment of frequency-based technologies. The World Health Organization (WHO) and other relevant international agencies focused on public health and safety have developed and published guidelines for the safe deployment and operation of these technologies. There is a need for continuous awareness and enlightenment to assure the public of the safety of the technologies being deployed for communication services. According to WHO, to date, and after much research performed, no adverse health effect has been causally linked with exposure to wireless technologies.

The Nigerian Communications Commission (NCC) is mandated to:
(i) ensure that all equipment to be installed for the deployment of 5G in Nigeria undergoes the scrutiny of its Type Approval Process;

(ii) undertake regular public awareness campaignsto keep the public up to date with health and safety related information on the 5G technology;
(iii) ensure that deployment and installation of 5G equipment conforms with

international best practices ensuring public safety is given the highest priority; and (iv)   ensure the utilization of infrastructure sharing to optimize the use of cell site locations and minimize duplication of infrastructure

4.   Conclusion

Different countries have taken different approaches to deploying 5G. While some have focused on the development of 5G infrastructure, others have focused on the development of associated applications/technologies and   services which either enhance the 5G experience or advance the 5G capabilities. While the Federal Ministry of Communications and Digital Economy is desirous of encouraging the deployment of 5G, there is need to focus on the key strengths available in the country.

The National Digital Economy Policy and Strategy (NDEPS) provides the framework for enablement of new technologies to thrive in Nigeria. The youth population also presents an opportunity for Nigeria to focus on the development of innovative products and services which will be significantly enhanced by the deployment of 5G in Nigeria. Some of such approaches include setting up of innovation and technology hubs, sponsorship of startup events and research projects for SMEs and academia to stimulate innovation among the youth and the research community in the country. This document defines the implementation plan for the deployment of 5G technology (5G) in Nigeria. It provides a background into the benefits of 5G and outlines the Policy Thrusts, Focus Areas, Plans and Strategies for a successful implementation of 5G in Nigeria. It takes into consideration the inputs and expectations provided by stakeholders in the Communication's industry.

The document further defines an Effective Governance model for 5G deployment to provide firm security control and robust technical support for its implementation as well as the need for cooperation between nations and between different government agencies. It further proposes the use of open standards with built-in security that will ensure flexibility and coordination across the different stakeholders.

Furthermore, the document highlighted the critical roles 5G will play in several sectors cutting across numerous industries such as communications sector, the transportation sector (where 5G will enable broader adoption of autonomous vehicles and support cutting edge fleet management), the health care sector (where 5G will support life-critical medical devices), the financial sector (where 5G will underpin online financial transactions) amongst other new and upcoming use cases.

Thereupon, an effective mechanism for enforcing a unified approach to service delivery is proposed to ensure synergy amongst relevant regulatory agencies.

Finally, the Policy document outlines strategies that will be adopted to facilitate the deployment of 5G Technology. It also outlines plans which will be employed to enable the nation to derive maximum benefits from the technology, while promoting public-private participation. The NCC is assigned as the recognized Government Agency responsible for the implementation of the Policy and directed to continue to engage with all relevant stakeholders in the country and maintain active participation at the different global fora to ensure that the benefits of the technology are maximized.

Acronyms

5G	Fifth Generation
AI	Artificial Intelligence
CBN	Central Bank of Nigeria
CERT	Computer Emergency Response Team
CNI	Critical National Infrastructure
CSIRT	Computer Security Incidence Response Team
FMCDE	Federal Ministry of Communications and Digital Economy
IHS	Information Handling Service
HSE	Health, Safety and Environment
IoT	Internet of Things
ITU	International Telecommunications Union
ITU-R	International Telecommunications Union Radiocommunication Sector
MSMEs	Micro, Small and Medium-Size Enterprises
NBTE	National Board for Tertiary Education
NCC	Nigeria Communications Commission
NDEPS	National Digital Economy Policy and Strategy
NFMC	National Frequency Management Council
NITDA	National Information Technology Development Agency
NNBP	Nigeria National Broadband Plan
NSA	Non-Standalone Architecture
NUC	National Universities Commission
ONSA	Office of the National Security Adviser
PoC	Proof of Concept
QoS	Quality of Service
R&D	Research and Development
RIT	Radio Interface Technologies
SA	Standalone Architecture
TETFUND	Tertiary Education Fund
WEF	World Economic Forum

Key Stakeholders

1. Federal Ministry of Communications and Digital Economy
2. Nigerian Communications Commission (NCC)
3. National Information Technology Development Agency (NITDA)
4. Galaxy Backbone Plc (GBB)
5. Nigerian Communications Satellite Ltd
6. Universal Service Provision Fund (USPF)
7. Federal Ministry of Power
8. Federal Ministry of Health
9. Federal Ministry of Environment
10. Federal Ministry of Science, Technology and Innovation
11. Federal Ministry of Works and Housing

12. Federal Ministry of Finance, Budget, and Planning
13. Central Bank of Nigeria (CBN)
14. National Identity Management Commission (NIMC)
15. Rural Electrification Agency
16. Nigerian Internet Exchange Point
17. Office of National Security adviser
18. Nigerian National Petroleum Corporation (NNPC)
19. Federal Ministry of Water Resources
20. The National Assembly (Leadership and Applicable Committees)
21. National Office for Technology Acquisition and Promotion
22. Bureau for Public Procurement (BPP)
23. Association of Telecommunications Companies of Nigeria (ATCON)
24. Association of Licensed Telecom Operators of Nigeria (ALTON)
25. National Office for Technology Acquisition and Promotion (NOTAP)