



PUBLIC CONSULTATION ON THE ROADMAP AND STRATEGY FOR 5TH GENERATION MOBILE COMMUNICATIONS IN KENYA

Deadline for Submission of Comments: 2nd November 2021

Part I - Instructions for Responses

Introduction

The Communication Authority of Kenya (CA) is the regulatory authority for the ICT industry in Kenya with responsibilities in telecommunications, e-commerce, broadcasting, postal/courier services and cyber security. CA is also responsible for managing the country's numbering and frequency spectrum resources as well as safeguarding interests of consumers of ICT services.

In furtherance of its responsibility of managing the frequency spectrum resources, the Authority has developed a 5th Generation (5G) Roadmap that outlines strategies to facilitate the deployment of the technology, enabling the country to derive maximum benefits from this new frontier.

Objective of the Public Consultation

The objective of this consultation is to give stakeholders or any interested parties an opportunity to comment on the proposed 5G roadmap and strategy for Kenya to support, boost and facilitate deployment of 5th generation telecommunications networks and support development of 5G applications at an early stage.

This roadmap is meant to position Kenya as a regional leader in 5G mobile technologies by harnessing the associated opportunities for socio-economic development.

The consultation document is available on the Authority's website at: <https://ca.go.ke/consumers/public-consultations/>

Stakeholders, including licensed operators, equipment vendors, members of the public, consumer organizations, various government agencies and interested organizations are invited to review and submit their written inputs and views indicating their specific proposals to the address indicated below or via email address spectrum@ca.go.ke on or before the close of day on **2nd November 2021**.

EZRA CHILOBA
DIRECTOR GENERAL

Consultation Procedure

All concerned and interested parties are invited to provide their views and comments on the contents in this consultation document. General views and comments on the overall consultation document are welcome. The Authority requests stakeholders that submissions should be supported by relevant evidence. Responses should include comments with regards to any proposed approach outlined in the consultation document.

Responses to this consultation should be made in writing and provided electronically in MS Word and Adobe PDF format, on or before the response date indicated. Responses must be accompanied by full contacts details (contact name, e-mail address and phone numbers) of the respondent to: spectrum@ca.go.ke

Part 2 – 5G Roadmap and Strategy

Acronyms and Abbreviations

1	AR	Augmented Reality
2	CA	Communications Authority of Kenya
3	eMBB	enhanced Mobile Broadband
4	EMF	Electromagnetic field
5	FWA	Fixed Wireless Access
6	ICNIRP	International Commission on Non-Ionizing Radiation Protection (ICNIRP)
7	ICT	Information Communication Technology
8	IETF	Internet Engineering Task Force
9	IMT	International Mobile Telecommunications – a generic term used by the ITU community to designate broadband mobile systems.
10	IMT-2020	Standard and set of specifications for 5G networks established by ITU
11	IoT	Internet of Things
12	ITU	International Telecommunication Union
13	LTE	Long-Term Evolution- also known as 4G LTE. It is a standard for wireless broadband communication for mobile systems
14	L-band	Designation of operating frequency range of 1–2 GHz in the radio spectrum
15	mmWave	Millimeter Wave - frequencies between approximately 30 GHz and 300 GHz
16	MNO	Mobile Network Operator
17	Re-farming	Process of repurposing of spectrum for new technology use
18	RITs	Radio Interface Technologies
19	RF	Radio Frequency
20	SDL	Supplementary Down Link
21	TDD	Time Division Duplex
22	ULF	Unified Licensing Framework
23	VR	Virtual Reality
24	WiGig	Wireless Gigabit - IEEE 802.11ad standard in 60 GHz band
25	WRC-23	World Radiocommunication Conference 2023
26	3GPP	3 rd Generation Partnership Project is a standards organisation that develops protocols for mobile telecommunications
27	4G	4 th Generation of Mobile Communication
28	5G	5 th Generation of Mobile Communication

Preamble

Fifth Generation (5G) technology is going to be a disruptive one. The disruption is not only in the high mmWave frequency in terms of its technical properties but also in the way it is going to transform the vertical industries and establish new business models.

The 5G technology will provide higher bandwidth and lower latency connectivity than current-generation 4G technology to enable bandwidth in excess of 100s of Megabits per second (Mb/s) with latency of less than 1 millisecond (ms), as well as provide connectivity to billions of devices. Most importantly, these technologies are expected to enable fundamentally new applications that will transform the way humanity lives, works, and engages with its environment.

The Communications Authority of Kenya (CA) is prepared to handle this disruptive technology through appropriate policies, rules and regulations to facilitate the sector to achieve the ambitious 5G rollout plans.

The Authority is committed to support the communication sector achieve its full potential through availing the requisite spectrum resources to enable implementation of 5G.

This roadmap outlines strategies that will support implementation of 5G mobile technology for the benefit of the citizens, the economy and industry at large.

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1. Introduction

The Communication Authority of Kenya (CA) is the regulatory agency tasked with facilitating the development of the information and communications sector in the country including, telecommunications, postal & courier services, Radio Communications, Broadcasting & multimedia, Electronic Commerce and Cyber security. This responsibility entails managing the country's numbering and frequency spectrum resources, administering the Universal Service Fund (USF) as well as safeguarding interests of consumers of ICT services.

In a bid to effectively undertake its spectrum frequency management role, the Authority has developed a 5G roadmap and strategy for Kenya whose aim is to support, boost and facilitate the deployment of 5th generation telecommunications networks (5G) and development of 5G applications. This roadmap is meant to position Kenya as a global leader in 5G mobile technology by harnessing the associated opportunities for citizens, the economy and industry. The roadmap will guide the Authority in the efficient management and availing of the requisite spectrum to the sector/industry to enable fast deployment of 5G networks.

This 5G roadmap and strategy is aligned to the Kenya Vision 2030, the Government's *Big 4 Agenda*, Kenya Digital Economy Blueprint, National Broadband Strategy 2018-2023, National ICT Policy 2020 and the Authority's Strategic Plan for the period 2018-2023

1.1. Objective of the 5G Roadmap and Strategy

The goal of this roadmap is to facilitate implementation of 5G mobile technology for the benefit of the citizens, the economy and industry at large and make Kenya a global leader in 5G mobile technology. The roadmap outlines strategies that will enable the deployment of 5G technology to facilitate emerging technologies, develop innovative new use cases, spur socio-economic growth, and job creation. The roadmap addresses 5G rollout challenges such as availability of the requisite frequencies, network security and safety, among others. Further, the successful implementation of 5G is based on a defined plan for its development in Kenya.

The following are the main pillars of Kenya's 5G roadmap and strategy:

1. Ecosystem to enhance 5G network rollout
2. Requisite frequencies to support 5G
3. Technology standards, safety and security
4. Trials/pilots deployment, innovation sandboxes and technology demonstration
5. Education and awareness promotion
6. Legal & regulatory issues
7. Collaboration between telecommunications and other user industries

2. Development of a 5G Ecosystem to Enhance Network Rollout

5G is the next generation of mobile technology, also known as IMT-2020. The 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 more than just evolution of wireless technologies, it is a new paradigm that represents convergence of wireless with computing and the cloud enabling everything to be “smart”, because everything is connected.

It is the opinion of the Authority that it is important to establish a 5G ecosystem in Kenya that will support a wide range of uses and users.

2.1. Drivers of 5G Technology

5G will provide a new platform with the scalability and adaptability to cost efficiently support the new wireless applications, services, and deployment models. The technology will harness its versatile capabilities to enable new applications and services to deliver further benefits to government, enterprises and citizens. 5G technology is thus driven by these new uses and the resulting exponential growth of mobile data traffic that is complemented by a greater number of more capable smartphones, larger file downloads and streaming driven by increasing demand for video content, an increasing number of connected devices, including those related to the Internet of Things (IoT).

In addition, 5G will be driven by heterogeneous services with vastly different requirements – from very low energy sensors, wearables, and new form factors, to new mission-critical applications with high reliability and low latency (e.g. smart city and critical infrastructure, medical and emergency response, sensing and remote control), to very high data transmissions across wide bandwidths for ultra-high capacity broadband.

The technology is essential for the new digital economy and the next wave of productivity and innovation throughout the various sectors of Kenya’s economy. It can facilitate bridging the digital divide by connecting the unconnected. Generally, deployment of 5G will further facilitate socio-economic development in the country by boosting labour productivity and job creation, as well as improving the range and quality of services available to all types of end users.

5G networks will deliver fibre-like data speeds, low latency, more consistent performance, and massive capacity. These capabilities will underpin use cases and facilitate delivery of innovative applications including mobilization of media and entertainment, rich user-generated content, improved performance in congested environments, high-speed mobility, connected cloud computing, immersive experiences (such as augmented reality and virtual reality), connected vehicles, connected drones, smart manufacturing and smart city.

2.2. 5G Contribution to socio-economic growth

Access to connectivity is a major driver of economic growth and societal development. The country will realise both economic and social benefits (productivity, efficiencies and jobs) from the continued evolution of 5G, contributing significantly to expansion of innovation, productivity, and collaboration across enterprise, research and academia.

Globally it has been proven that an increase in broadband penetration in a country contributes to socio-economic development. Although the estimation of exact contribution may vary, increase in broadband penetration contributes to several sectors of the economy, including growth of Gross Domestic Product (GDP), job creation, increased educational opportunities, better services, and rural development.

There is potential for 5G to bring changes across a range of sectors and industries. Depending on the focus of its implementation, the deployment of 5G networks can have both qualitative and quantitative impacts in the economy. For example, improved access to medical professionals and health data through mobile connectivity could lead to overall health improvements. Expanded availability of educational resources and job training could affect the characteristics of the labour pool. Improvements in industrial settings could increase efficiency and productivity, resulting in changes to the cost structures of underlying products used.

Furthermore, some studies and forecasts indicate that 5G use cases will be reflected across multiple sectors or verticals, demonstrating the wide range of potential impacts of 5G technology and services across various economies. For example, gaming and software industries in Kenya can take advantage of 5G and develop virtual reality (VR) applications for education or augmented reality (AR) applications for tourism for local markets that can also be exported to other markets globally.

2.3. 5G Use Cases

5G is expected to address three key usage scenarios: enhancement of the traditional mobile broadband services, ultra-reliable and low latency communications and massive machine-type communications. 5G has versatile capabilities that can facilitate innovative applications. There is a need to foster the development of innovative uses and applications with potential to impact across industries in the country. Table 1 below presents selected 5G use cases and applications.

Table 1: Selected 5G use cases and applications

Application	Use Cases	Examples
Communications	<ul style="list-style-type: none">● High-speed home and office broadband● 5G dongles/mobile routers	<ul style="list-style-type: none">● Improved broadband connectivity due to higher-speed, lower-latency connections● Expanded Internet access due to new or expanded network deployments

Agriculture & Water	<ul style="list-style-type: none"> ● E-farming ● Stationary/near-stationary monitoring networks ● Collaborative robots ● Remote smart meters 	<ul style="list-style-type: none"> ● Connected sensors for smart agriculture systems enabling better monitoring of crops, animals, and equipment. ● Animal tracking could also benefit wildlife management and protection ● Integration into agricultural processes can increase efficiencies and lower costs for labour-intensive industries ● Smart water management
Healthcare	<ul style="list-style-type: none"> ● e/m Health ● Virtual meeting ● High-speed broadband in the home ● High-speed broadband in the office ● Remote object manipulation ● Smart wearables 	<ul style="list-style-type: none"> ● Remote access to medical professionals and specialized care through enhanced videoconferencing, remote diagnosis, and remote surgery ● Collection and analysis of patient data from connected wearable sensors/monitors ● Personalized medicine leveraging data collected from wearables and improved access to providers ● Assisted living / home care automation ● Connected Ambulances
Education	<ul style="list-style-type: none"> ● High-speed home broadband ● Virtual meeting ● Virtual or augmented reality ● Remote object manipulation 	<ul style="list-style-type: none"> ● Improved and more immersive distance learning via videoconferencing and improved access to rich media resources ● Industrial/workplace education due to videoconferencing, augmented reality/virtual reality, and haptic feedback
Manufacturing, Mining, and Construction	<ul style="list-style-type: none"> ● Collaborative robots ● Remote object manipulation ● Virtual meeting ● Virtual or augmented reality ● Ultra-low-cost networks 	<ul style="list-style-type: none"> ● Smart factories, including replacement of wired connections, cell automation, machine vision, improved efficiency ● Real-time assistance via videoconferencing and augmented reality ● Remote control of industrial equipment ● Smart Grids for energy
Public Safety and Disaster Response	<ul style="list-style-type: none"> ● Broadband to special events ● Remote object manipulation 	<ul style="list-style-type: none"> ● Enhanced, secure, mission-critical communications

		<ul style="list-style-type: none"> ● Coverage extension in out-of-network areas through new device-to-device connectivity models ● Unmanned vehicles/drones for rescue and reconnaissance
Smart City & Transportation	<ul style="list-style-type: none"> ● Internet of Things (IoT) ● Big data analysis and AI 	<ul style="list-style-type: none"> ● Smart Sustainable intelligent traffic surveillance Systems ● Connected and autonomous vehicles ● Connected infrastructure equipped with sensors and cameras for traffic management and preventive maintenance ● Enhanced vehicle safety
Tourism and travel	<ul style="list-style-type: none"> ● Remote object manipulation ● Virtual reality (VR)/ augmented reality (AR) 	<ul style="list-style-type: none"> ● Robot monitoring ● Robotic customer service assistants and chatbots ● Immersive experiences for tourists through augmented, virtual and mixed reality, 3D motion tracking, and 4k 360° VR interactive content streaming ● Virtual tour guides

3. Frequencies to Support 5G

Spectrum is the lifeblood for all wireless communication networks. The Authority is adopting globally harmonized spectrum and standards that will facilitate the development and implementation of 5G and the expansion of LTE network coverage in Kenya. Further, the Authority has developed a spectrum release plan to ensure that appropriate spectrum is made available in a timely manner to enable robust 5G service.

A variety of spectrum is necessary to support 5G networks, which will operate in a mix of spectrum bands. Low-band spectrum below 1 GHz provides wide area and deep indoor coverage and supports IoT low data rate applications. Medium-band spectrum from 1 to 6 GHz provides both good network coverage and capacity capabilities. High-band spectrum above 24 GHz (mmWave) offer very high data rates and high system capacity in dense deployments. Low- and mid-band spectrum is critical for robust LTE deployments, while spectrum in all three bands will be needed to support the full range of capabilities and requirements of various 5G applications, services, and deployment models.

5G will make the best use of a wide array of spectrum available across spectrum bands for deployment of IoT, enhanced mobile broadband, and mission-critical applications and services,

like connected autonomous vehicles, critical infrastructure management, remote medical procedures, as well as command and control communications for drones and robotics.

While previous generation networks primarily operated in licensed spectrum bands below 3 GHz, 5G will bring the next level of convergence with support for licensed, shared, and unlicensed spectrum. Private networks can operate with exclusive or shared spectrum use, the latter being particularly important given the high projected demand for spectrum in a variety of frequency ranges.

5G can be introduced in existing frequency bands previously used for other services (re-farmed) or shared with existing services or in new bands. MNOs can therefore either re-farm their existing spectrum or seek new frequency bands to deploy 5G networks.

The proposed spectrum bands are typically in internationally harmonized frequencies identified for IMT. The deployment of 5G in these harmonized bands will benefit from economies of scale, enabling global roaming, reducing equipment design complexity, preserving battery life, improving spectrum efficiency and potentially reducing cross border interference. Consequently, harmonization of spectrum for IMT leads to simplification and commonality of equipment, which is desirable for achieving economies of scale and affordability of equipment.

The successful deployment of 5G requires timely availability of sufficient spectrum, in suitable frequency bands to support targeted network coverage, capacity and speed. To that end, the Authority is proposing a spectrum release plan as indicated in the timetable in this Roadmap.

3.1. 5G Frequency Bands

The following are core bands for deployment of 5G globally/regionally to address diversified requirements from the varied 5G usage scenario.

1. Low-band (sub 1 GHz) - High priority

a) The 700 MHz band (694 - 790 MHz)

The sub 1-GHz spectrum provides deep and large coverage for eMBB, IoT and low latency applications and services and can be used in the 5G context to ensure adequate coverage.

The 700 MHz band was primarily assigned to analogue TV. As a second digital dividend, it was relinquished by broadcasting services and allocated to mobile services. Although this band offers limited bandwidth – allowing for guard bands, it provides 2 x 30 MHz in duplex, which has been split into blocks of 2 x 10 MHz.

2. Mid-band (1-6 GHz)

b) The L-band (1427 - 1518 MHz) - Medium priority

The L-band is a good complimentary band to combine with sub 1 GHz band (e.g. 700 MHz band). The band provides a good combination of capacity and coverage. The ecosystem is developed in Europe for its use by supplemental downlink (SDL), which could lead to benefits from economies of scale. A total of 90 MHz of spectrum is available on TDD basis.

c) The 2.3 GHz band (2300 - 2400 MHz) - High priority

The band provides wider bandwidths enabling enhanced mobile broadband and mission-critical communications. There is a total of 100 MHz TDD spectrum available in the band. Depending on the need to implement a guard band, the total spectrum could be less. As per current LTE standards, the blocks could be split in multiples of 20 MHz, and licensed up to 2 operators, in order to ensure a minimum amount of spectrum per operator.

d) The 2.6 GHz band (2500 - 2690 MHz) - High priority

The band has been freed up and a bandwidth of 190 MHz is available for licensing. The current LTE device ecosystem for this band includes a combination of 140 MHz in FDD and 50 MHz in TDD blocks. There is need to re-plan the band on TDD basis and avail the spectrum to licensees on a competitive basis. The spectrum could be split into two blocks of 100 MHz and 90 MHz and licensed to two operators.

e) The C-band (3300 - 3600 MHz) - High priority

The C-band is emerging as the primary frequency band for deployment of 5G with greatest potential for global harmonization allocated on TDD basis. It provides an optimal balance between coverage and capacity for cost effective network deployment. In Kenya, the band is fragmented and currently assigned to operators and needs to be re-planned to enable re-farming for 5G. Already one operator has re-farmed its spectrum holding in the 3.5GHz band and deployed a 5G trial network.

f) The 4.8 GHz band (4800 – 4990 MHz) - Low priority

The band is identified for IMT in Kenya and some countries through a footnote in ITU Radio Regulations. The conditions of use of the band for IMT will be reviewed by WRC-23. The ecosystem for the band is still under development and has not yet matured. The band could be considered to be released to the market after the decisions of WRC-23.

3. High-band/mmWave (above 6 GHz)

The following are the millimeter wave bands that can be used for 5G by Mobile Network Operators (MNOs) and different industry verticals.

g) The 26 GHz band (24.25 - 27.5 GHz) - Medium priority

The 26 GHz band is one of the bands in which early mmWave 5G deployments are underway to support ultra-high capacity and delivery of extremely high data rates and low latency required by

some 5G enhanced mobile broadband (eMBB) applications. The 26 GHz band is most suitable for outdoor hotspot, in-building coverage and fixed wireless access (FWA) with outdoor customer-premises equipment (CPE). The band is important in the overall 5G ecosystem as it will address specific 5G eMBB use case requirements and demands.

There is a total bandwidth of 3.25 GHz based on TDD and split into blocks of 200 MHz. In this band, a contiguous bandwidth of approximately 800 MHz per MNO network can be allocated to support the achievement of certain 5G/IMT-2020 key performance indicators such as peak throughput and area density.

h) The 40 GHz band (37-43.5 GHz) - Low priority

The 40 GHz band is harmonized globally for deployment of IMT. It is a promising band for the early deployment of 5G millimetre wave systems. It provides extreme bandwidths for ultra-high broadband speeds. It may be used for private 5G networks by verticals though the ecosystem has not developed and matured at the moment.

4. Other mmWave frequency bands

i) The other 40/50 GHz bands - Low priority

The 40/50 GHz bands include the 47.2-48.2 GHz frequency band. The band is identified for deployment of IMT in a few countries. It provides extreme bandwidths for ultra-high broadband speeds. It may be used for private 5G networks by verticals though the ecosystem has not developed and matured at the moment.

j) The 66 - 71 GHz band - Low priority

The 66 - 71 GHz band is identified for IMT for flexible use for 5G systems enabling both IMT and non-IMT technologies and shared with WiGig systems. The band provides extreme bandwidths for ultra-high broadband speeds.

Summary of 5G Frequency bands

	Frequency band	Bandwidth	Priority
1	694 - 790 MHz	2x10 MHz	Low
2	1427 - 1518 MHz	91 MHz	Medium
3	2300 - 2400 MHz	100 MHz	High
4	2500 - 2690 MHz	190 MHz	High
5	3300 - 3600 MHz	300 MHz (re-farm)	High
6	4800 – 4990 MHz	190 MHz	Low

7	24.25 - 27.5 GHz	3.25 GHz	Medium
8	37- 43.5 GHz	6.5 GHz	Low
9	47.2 - 48.2 GHz	1 GHz	Low
10	66 - 71 GHz	5 GHz	Low

5. Unlicensed band to support 5G

Licence exempt frequency bands are those that can be used by certain applications without the need for prior authorisation or an individual right of use. This does not mean that they are not subject to regulation – use must still comply with pre-defined technical rules to minimise the risk of interference. Both licensed and license-exempt wireless technologies are required to support broadband connectivity. Most licence exempt bands are harmonized and are shared with other services such as industrial, scientific and medical (ISM) equipment or radars. Wi-Fi and Bluetooth are some of the most familiar examples of licence exempt applications.

There is currently 538.5 MHz of mid-band spectrum available for licence-exempt use in ITU Region 1, which includes Kenya. The bands used are: -

- 2400 - 2483.5 MHz
- 5150 - 5350 MHz
- 5470 - 5725 MHz

One of the technical solutions that may be considered for license-exempt broadband services is Wi-Fi. In addition, 5G NR-U has been developed by 3GPP (via Release 16) which allows for both non-standalone and standalone operation of 5G NR transmissions in the license-exempt 5 GHz and 6 GHz bands. The enhancement of the specifications is continuing.

The lower 6 GHz band (5925-6425 MHz) is being considered in all the three regions of International Telecommunication Union (ITU) for license-exempt use in order to meet rapidly increasing demand for unlicensed spectrum. Wi-Fi technology is expected to play an important role in supporting 5G networks, with ultra-dense, high-speed connections to wireless and wired networks. Wi-Fi complements 4G and 5G connectivity. Globally, Wi-Fi offload will remain important. Technologies using licence-exempt spectrum offer very low barriers to entry. Wi-Fi serves as a platform for the creation of innovative business models

The African Telecommunications Union (ATU) has adopted Recommendations to open up the lower 6 GHz band (5925-6425 MHz) for license-exempt use to support the operation of Wi-Fi in Africa.

3.2. Allocation of Spectrum for 5G services

In order to realize the full potential of 5G, it is important that adequate spectrum is made available in appropriate frequency bands. The Authority will endeavour to plan the spectrum for 5G efficiently through facilitation of adequate contiguous spectrum, while also avoiding spectrum fragmentation.

To ensure effective delivery of 5G services that meets ITU-R's IMT-2020 target values (DL 100Mbps and UL 50Mbps) in a commercial scale, contiguous spectrum of 60 – 100 MHz in bands below 6 GHz may be assigned to each MNO, subject to availability, to facilitate the delivery of affordable, high throughput 5G services. For bands above 6 GHz, contiguous spectrum bandwidth of at least 800 MHz per MNO is necessary to enable eMBB.

3.3. 5G Spectrum Sharing

The demand for 5G spectrum is expected to rise exponentially in the near future. IMT spectrum is often assigned through individual licensing, the Authority is considering making certain 5G spectrum available through spectrum sharing.

Spectrum sharing mechanisms allow a limited number of licensed users to access the spectrum, under certain conditions. It is often used when spectrum cannot be released everywhere or within a certain timeframe, or if spectrum use must be coordinated to mitigate interference.

Further, shared licenses will be issued to support verticals such as local/private 5G networks, managing interference through geographic separation or other mitigation techniques. The limited coverage needed for private networks makes it well-suited for a shared-use format in mmWave bands, for instance, where interference can largely be managed through geographic separation. Private networks can provide benefits for small geographic areas that require high bandwidth such as industrial facilities, universities, and ports. Because the spectrum is used over smaller geographic areas than a traditional wide-area mobile network, the same spectrum can be used by multiple users, provided sufficient geographic separation exists to avoid interference.

3.4. 5G Spectrum Pricing

The cost of deployment of 5G networks are expected to be high due to network densification. In this regard, there is a need to determine appropriate spectrum acquisition and usage fees. Reasonable frequency fees for 5G spectrum will promote infrastructure investment and encourage the swift deployment of 5G networks, allowing operators to focus available capital on network investment.

Currently, licensees with at least 51% ownership by Kenyans are allowed to pay initial spectrum license fees in equal instalments for 10 years for initial frequency fees of above Kshs. 1B. Locally owned operators who wish to deploy 5G can take advantage of this provision.

3.5. Licensing

The Authority issues technology and service neutral licenses based on a unified licensing framework (ULF) which enables licensees to deploy any technology and provide any services in the bands identified and assigned for IMT (mobile) services. Technology-neutral licenses allow operators to upgrade networks and deploy the latest technologies under existing licenses, which increases spectral efficiency while enabling licensees to pursue the technologies that best fit their business models.

Technology-neutral licensing allows operators to leverage existing mobile spectrum resources and augment them with additional bands, such as the 26 GHz band.

Licensees who wish to re-farm their existing spectrum resources to deploy 5G are required to seek Authorisation without any additional fees to enable the Authority carry out compatibility analysis to determine impact of introducing 5G within and in adjacent bands to avoid interference.

4. 5G Technology, Standards, Safety and Security

The 5G standards are being developed by multiple standards bodies including the 3GPP, IETF, and ITU. Kenya continues to participate in international forums to contribute to the development of 5G technology and standards.

Kenya actively participated in various forums that dealt with the studies for the successful identification of the 5G spectrum in the mmWave band. Arising from the study, the Authority suspended licensing of the 26 GHz band due to the foreseen potential identification of portions of the band for 5G services.

4.1. 5G Technology and Standards

The standards for 5G will be a major step forward in enabling global interoperability for 5G deployment to deliver quality, efficient, cost effective and innovative services to end customers in the country and the world at large.

It is anticipated that the Authority will facilitate availability of affordable standardised 5G equipment on the market to support a broad range of technical features that can meet the wide-ranging requirements of 5G use cases, through adoption of globally harmonised standards.

4.2. Safety and Security of 5G

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) issued the latest RF EMF Guidelines in March 2020. The ICNIRP Guidelines on Limiting Exposure to Electromagnetic Fields are for the protection of humans exposed to radiofrequency electromagnetic fields (RF) in the range 100 kHz to 300 GHz. The guidelines cover many applications such as 5G technologies, Wi-Fi, Bluetooth, mobile phones, and base stations.

Further, strict exposure limits for electromagnetic fields have been applied for 2G, 3G and 4G LTE in line with international standards. The consensus of experts is that compliance with the international limits provides protection against all established health hazards. Therefore, 5G exposure will not cause any harm provided that networks adhere to the ICNIRP (2020) guidelines. The Authority will ensure that all networks deployed in Kenya do so in line with ICNIRP guidelines in order to ensure safety.

Another important aspect of 5G is to ensure security of 5G network architecture. The evolving nature of connected services and the expected significant increase in the number and types of devices connected increase the importance of cyber security, including the ability to detect threats, authenticate users, and practice good operation. 5G provides better security by design with more enhanced security requirements on the basis of network evolution and adapting learning from earlier technologies.

The Authority adopts approved international standards developed by ITU and 3GPP to ensure interoperability and security of mobile systems. Authority plans to leverage the expertise of various stakeholders and international best practices in cyber security to develop technical codes and standardized minimum security assessment checklist to ensure that 5G networks meet the up-to-date technical standards and are in line with global norms in relation to 5G security.

5. 5G Innovation Sandboxes, Pilots, and Technology Demonstrations

Kenya is a technology leader in the region and seeks to maintain that leadership through creation of innovation incubators to develop 5G innovation sandboxes as well as enabling pilot programs and technology tests. An innovation sandbox will help shape regulations and tackle the challenges faced by operators. It will enable government entities, ICT companies, start-ups, investors and the network operators to work together and strengthen the leadership in the 5G technology. Many other countries have set-up innovation funds. South Korea is an interesting example, redirecting existing funds towards encouraging 5G innovation, e.g. in establishing smart factories.

The Authority will establish partnerships with various stakeholders to create innovation incubators to develop 5G innovation sandboxes as well as enabling pilot programs and technology tests.

This can be particularly focused on smart manufacturing and smart agriculture as well as smart health, as three (3) of the focus areas of the *Big 4 Agenda* with a lot of 5G use cases. Collaborative initiatives such as that under the UK Digital Access Program with UK-Kenya Tech Hub can be one opportunity for this initiative, but other countries, like Switzerland, Norway, South Korea would also likely be willing to collaborate.

In addition, with the significant expansion of wireless network capabilities enabled by 5G, as well as the planned use of spectrum bands not previously used for broadband connectivity, licensees

and potential licensees would benefit from technology demonstration to accelerate the deployment and adoption of 5G technology, including in areas with low population density.

Potential licensees can ensure that their proposed network or service is feasible while fine-tuning the network to ensure that it performs optimally. In addition, such technology demonstrations encourage innovation and experimentation, which is critical to powering advances in 5G use cases. The Authority may avail 5G trial licenses for testing purposes by interested vertical industry licensees considering availability of spectrum. The Authority will initially focus efforts on a limited number of promising pilot areas and use cases.

The Authority will establish partnership and encourage equipment vendors and MNOs to establish 5G test beds, application & use case labs and provide access to the industry and enterprises to work on Kenya specific usage scenarios and applications. The demonstrations should have cross-industry participants and funding to enable coordination and sharing of results.

6. Legal & Regulatory Issues

The following regulatory frameworks may be required to support deployment of 5G technology among others: -

6.1. Infrastructure Support

The Authority will develop appropriate framework to support the deployment of infrastructure that will facilitate 5G such as easy access to fibre optic infrastructure and passive infrastructure such as masts, data centres and edge computing. This can be accomplished through enhancement of existing framework for infrastructure sharing.

The wide available bandwidths and high throughputs that come with the millimeter wave frequencies rely on small cells and require high-speed fibre connections for backhaul. This necessitates easier approvals for optical fibre connections, stronger enforcement/punitive measures for those who engage on fibre cuts which is a critical infrastructure for the digital economy.

6.2. Development of 5G Sites

Development of framework for site acquisition especially in urban areas to install small cells in high-use locations for example on street lamp poles. This is important especially for smart poles that are erected alongside main roads, which could also have CCTV cameras. The price of these smart poles will reduce and become affordable as standards are developed and large scale deployments take place. Other interested stakeholders like the Kenya Power, the Kenya Urban Roads Authority (KURA), the Kenya National Highways Authority (KENHA) and network operators should explore opportunities for collaborations on such initiatives.

The framework should include a simplified process of infrastructure acquisition for network densification, facilitating rights of way, road permits, building permits IoT device deployment and limitation of electromagnetic fields.

Further, the regulatory framework will include easier access to government buildings to deploy 5G sites (operators can pay rent to government, but it should be easy to get permission to use government buildings); as well as using land from government agencies for example KURA for land along road reserve, and the Kenya Ports Authority (KPA) for Lamu or Mombasa ports.

6.3. Industry Verticals

The Authority will facilitate development of a flexible and adaptable regulatory framework for 5G use case requirements from industry verticals including licensing and how companies in industry verticals will work with MNOs for private 5G networks for industries, ports, farms, factories, etc.

6.4. Regional Coordination and Harmonization of 5G

The Authority participates in various regional and global forums to coordinate and harmonise technology standards. By continuing these activities in the context of 5G, the Authority will seek opportunities for Kenya to work with its neighbours to create a common enabling environment and leverage regional use cases and applications to further drive 5G adoption and development.

7. Education and Awareness Promotion

There is a need to sensitize and equip Kenyan citizens with skills to take advantage of benefits of 5G technologies and solutions and its application in the digital economy. This includes preparing citizens for the digital jobs of the future, in particular the younger generation. This would enable them to be active and successful participants in the digital society and raise awareness of risks in terms of digital rights and subsequent responsibilities, online safety and security.

Consumer education related to the different 5G bands that devices work on and whether they will work in Kenya, especially in the first year or two when the low-cost devices may not support all bands, especially the mmWave band. The Authority will partner with various stakeholders to deliver sensitization and awareness programmes.

The Authority will also support the dissemination of consumer education materials to reinforce the safety of 5G and other mobile technologies.

8. Promotion of Cooperation between Telecommunications and User Industries

The Authority will establish a National 5G forum with working groups in various thematic areas, which is aimed at addressing a number of aspects of 5G, such as spectrum to enable the uptake of 5G systems, policy and regulation, standards, research and development, as well as use cases.

The forum will bring together Government institutions, industry and academia to continue and expand dialogue with stakeholders on 5G. It will also include potential vertical industries or use cases.

9. 5G Rollout Timeline

The overarching goal of 5G is to enable affordable, accessible, ubiquitous and reliable networks targeted at providing Kenyan citizens with the benefits of the technology to achieve an inclusive digital economy. The goal initially focuses on providing 5G coverage in all urban areas, manufacturing areas, and transports hubs such as ports, airports, railway stations, bus stops, and key roads.

The roadmap presents the following proposed timeline for 5G rollout:

No	Measures	Output	Timeline
1	Development of 5G roadmap	5G Roadmap	September 2021
2	Public consultation on 5G roadmap	Stakeholder consultation	October 2021
3	Authorise spectrum re-farming to deploy 5G trial networks in 3.5 GHz band	Authorisation and implementation of 5G trial networks in 3.5 GHz band	November 2021
4	Establish national 5G forum	Organise 5G summit	January 2022
5	Public education and awareness	Organise public education forums with stakeholders	Continuous
6	Setting up of 5G innovation test beds, laboratories & sandboxes	Create partnership with stakeholders to facilitate implementation of 5G innovation hubs, test beds & sandboxes with	March 2022
7	Allocation of pilot frequencies in mmWave (26 GHz band)	Authorise 5G frequencies in 26 GHz band for vertical industries	April 2022
8	Authorise first 5G pilot projects in 26 GHz band	MNOs Implementation of 5G pilot projects	May 2022
9	Release of 700 MHz, 2.3 GHz, 2.6 GHz and 1.5 GHz	Spectrum auction/beauty contest	August 2022
10	Issue 5G commercial licenses in 700 MHz, 2.3 GHz, 2.6 GHz, 1.5 GHz and C bands	MNOs Implement commercial 5G networks	November 2022
11	Authorise commercial 5G in 26 GHz band	MNOs Implement 5G in 26 GHz band	December 2022

Annex 1: Questions/Areas of Engagement with stakeholders

1. What strategies do you recommend for development of a 5G ecosystem to enhance network rollout in Kenya?
2. What standard/s should Kenya adopt for 5G deployment and why?
3. Do you agree or disagree that implementation of 5G will contribute to socio economic growth of the country?
4. Which 5G use cases and applications have potential to have great impact across various industries in Kenya?
5. Do you agree or disagree that the proposed frequency bands will address 5G deployment requirements from the varied 5G usage scenarios?
6. Do you agree or disagree that opening up the lower 6 GHz band (5925-6425 MHz) for license-exempt use will support the enhanced operation of Wi-Fi and 5G NR-U?
7. Which licensing method do you propose for 5G Spectrum?
8. What is the minimum amount of spectrum that can be assigned to each MNO to ensure effective delivery of 5G services that meets ITU-R's IMT-2020 target values in the low, mid and high frequency bands?
9. Do you support the Authority's plan to avail some frequency bands in mmWave through spectrum sharing mechanism for industry verticals to establish local/private 5G networks?
10. Technology-neutral licensing – Do you support CA's plan to allow licensees who wish to re-farm their existing spectrum resources to deploy 5G to seek Authorisation without any additional fees to leverage on existing mobile spectrum resources?
11. Frequency re-farming - what approach should be taken to re-farm existing frequencies and also reclaim unused frequencies from operators?
12. What strategies do you recommend to ensure availability, interoperability and affordability of standardised 5G equipment and devices in the market?
13. Do you agree or disagree that 5G base stations require high-speed fibre connectivity for backhaul?
14. What additional security measures (if any) in addition to the measures built into existing 5G standards do you consider is required to further strengthen security of 5G networks
15. What measures should to be put in place to ensure safety of 5G networks and devices?
16. Is the proposal for Kenya to adopt latest ICNIRP 2020 Guidelines for 5G deployment appropriate?

17. Do you support CA's proposal to partner with stakeholders to create innovation incubators to develop 5G innovation sandboxes as well as enabling pilot programs and technology tests?
18. What support do vendors and MNOs require from CA to establish 5G test beds, application & use case labs and provide access to the industry and enterprises to work on Kenya specific usage scenarios and applications.
19. What strategies do you recommend to ensure compatibility of deployments across various mobile technologies such as 2G, 3G, 4G and 5G and between different operators?
20. Do you agree with the proposed legal and regulatory frameworks required to support deployment of 5G technology or what additional regulatory frameworks do you propose to support 5G?
21. Education and awareness promotion and development of in-country talent
22. Do you agree or disagree with the proposed timeline for 5G rollout and what rollout strategy would you recommend?