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East African Communications Organisation

Communications for all in East Africa

EACO HARMONIZED SPECTRUM MANAGEMENT STRATEGY AND ROADMAP FOR FUTURE SPECTRUM RELEASE

Prepared by EACO

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Abbreviations and Acronyms

4G	-	Fourth generation mobile phone standards and technology
5G	-	Fifth generation mobile phone standards and technology (not yet fully developed)
AIP	-	Administered Incentive Pricing
ARPU	-	Average Revenue per User
Award Process	-	The procedures set out in the Regulations for the award and issue of the Licences
BS	-	Base Station
CEPT	-	European Conference of Postal and Telecommunications Administrations
dB / dBm	-	Decibel.
DTT	-	Digital Terrestrial Television
EIRP	-	Equivalent Isotropically Radiated Power.
EMC	-	Electromagnetic compatibility
ERP	-	Effective radiated power
ETSI	-	European Telecommunications Standards Institute
HVEC	-	High Efficiency Video Coding
IMT	-	International mobile telecommunications
ITU	-	International Telecommunications Union
ISP	-	Internet Service Provider
LSA	-	Licence shared access of radio spectrum
LTE	-	Long Term Evolution.
MCA	-	Maritime and Coastguard Agency MHz Megahertz. A unit of frequency equal to 1,000,000 cycles per second
MFCN	-	Mobile/Fixed Communications Networks
PMSE	-	Programme-making and special events.
RF	-	Radio Frequency
WRC	-	World Radio communication Conference
EACO	-	East Africa Communication Organisation
EAC	-	East Africa Community
DTT	-	Digital Terrestrial Television

DTH	-	Direct to Home
IoT	-	Internet of Things
M2M	-	Machine to Machine
NBP	-	National Broadband Plan
ASA	-	Authorized Shared Access
MOCN	-	Mobile Operator Core Network

Executive Summary

The radio frequency spectrum is part of electromagnetic waves propagated in space and used as a communication medium for all wireless systems. The radio frequency spectrum is universally acknowledged to be a valuable, scarce public resource and thus subject to transparent, predictable and coherent governing policies, legislations and regulations. The National Regulatory Authorities' (NRAs) mandates among others, is to manage the country's radio frequency spectrum resource. Management of this scarce resource entails spectrum planning and allocations, spectrum licensing and assignments and spectrum monitoring and enforcement of various wireless communications services and users.

The Spectrum Management Strategy stipulates the spectrum management strategic priorities for the next ten years as follows:

a. Providing timely information to the public on all radio frequency spectrum available for use, and spectrum assigned to licensed operators.
b. Develop Broadband Plans with spectrum plans that support the roll-out of mobile broadband.
c. Develop and publish Spectrum Roadmap with an emphasis on articulating a plan to make spectrum available in view of new technologies and existing/future demand for mobile broadband services.
d. Support technology neutrality approach to spectrum licensing to ensure future re-farming of spectrum; and flexible enough to accommodate new and emerging technologies within existing licensing frameworks.
e. Participating in ITU study groups and World Radiocommunication Conferences (WRCs) to make an informed decision of the spectrum allocation for new services and additional spectrum for existing services.

The Spectrum Management Strategy identifies the issues in spectrum use and in downstream markets that may necessitate changes in spectrum management policies and, where possible, suggests the actions that National Communication Regulatory Authorities may need to take to address these issues. The key areas in spectrum management that we consider are:

a) Approach to licensing conditions;
b) Spectrum Licensing Recommended Best Practice

c) Approach to assignment of new spectrum;
d) Approach to pricing for new spectrum;
e) Spectrum licence renewal and pricing for existing spectrum;
f) Network sharing and spectrum pooling; and
g) Spectrum trading.

The objective of this Spectrum Management Strategy and Roadmap is to highlight the fundamental issues that affect spectrum requirements and management to address and provide guidance for effective and efficient use of spectrum over the coming years.

1.0 Section 1: Introduction

1.1 Background and Purpose

1.1.1 The East African Communication Organization (EACO) recognizes the importance of harmonization of the communications sector policy and regulatory frameworks as the key determinant of legislation and regulation amongst its member states. Harmonization and common approach to management and allocation of radio frequency spectrum allows for efficient and effective use of radio frequency spectrum as well as assurance of interoperability of equipment and communication services. It also supports the wireless service provision in the region.

1.1.2 EAC strategic objectives on communication sector include harmonisation of ICT policies, laws and regulations among the EAC Partner States, promote the establishment of communications infrastructure and services and standardisation of technologies and services. This strategy will facilitate and coordinate management of radio frequency resource in EACO region.

1.1.3 Radio Frequency Spectrum is a medium by which information may be transmitted wirelessly over distances ranging from a few meters to thousands of kilometers. It is a valuable national resource underpinning important economic, social and communications activities. These include widely used services, such as mobile/fixed wireless communications and broadband, radio and TV broadcasting, and the safe operation of air and maritime transport.

1.1.4 Radio spectrum is also fundamental in the day-to-day operation of the emergency services and defence forces and is a vital input to many other services including important scientific applications, such as weather forecasting and monitoring the Earth's environment. However, it is a finite natural resource with competing uses and users and so it must be managed effectively and efficiently used.

1.1.5 Everyone within EAC region: people, businesses and public organisations uses

or relies on a range of wireless services and technologies on a daily basis. Some of the most prevalent consumer uses of spectrum include:

a) Browsing the internet at home or on the go using a **mobile** network and/or a **Wi-Fi** connection.
b) Making a mobile phone call or sending a text message using a **mobile** network.
c) Watching **television** or listening to the **radio**, via an aerial or satellite dish.
d) Using a **Bluetooth** connection to connect a wide range of personal and home devices.
e) Accessing navigation services on a smartphone or in-car SatNav using a **GPS** signal provided by satellite.
f) **Satellite & Wireless broadband** for homes that are no connected to a reliable fixed network, for example those in remote areas.

1.1.6 This Spectrum Management Strategy and Roadmap document sets out how the National Communication Regulatory Authorities intends to ensure the effective and efficient management of this important natural resource in the years ahead for the benefit of EAC member states.

1.1.7 The National Regulatory Authorities manages their national radio spectrum within a complex and rapidly changing economic and technological environment. The increasing sophistication of wireless technologies, and the rapidly growing and competing demand for spectrum from different users and services, means that spectrum management is becoming increasingly challenging. The challenges are further compounded by the, often conflicting, nature of stakeholder's demands on the use and management of radio spectrum therefore the National Regulatory Authorities must find the appropriate balance across a wide range of policy objectives.

1.2 General Terms/Definitions

Radio: A general term applied to the use of *radio waves*.

***Radio waves or hertzian waves*:** Electromagnetic waves of frequencies arbitrarily lower than 3 000 GHz, propagated in space without artificial guide. Radiocommunication: Telecommunication by means of radio waves

Assignment (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.

Radiocommunication service: A service as defined in this Section involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes.

Spectrum Trading: is a transfer of the rights to use a specified set of frequencies from one person to another. It can either be the transfer of all the frequencies associated with a license or it can be a partial transfer in terms of frequency, geography and even by time.

Licenced Shared Access (LSA): Is a technological solution, which allows sharing agreements by time, frequency or geography. Technologies has been developed which allow several users to share a frequency band without causing interference.

Spectrum pooling: is defined as an approach where licensees who hold exclusive spectrum licenses make an agreement to jointly use their spectrum.

1.3 Legal context on spectrum management strategy

The National Regulatory Authorities within EAC member states have been established by their respective Acts that grants them the powers to assign, modify, renew and cancel radio frequency licenses and sets out details of how these powers can be used.

1.4 Spectrum Management Strategic priorities

a. Provide timely information to the public on all radio frequency spectrum

available for use, and spectrum assigned to licensed operators.

b. Develop spectrum plans that support the roll-out of mobile and/fixed broadband.
c. Develop and publish spectrum roadmaps with an emphasis on articulating a plan to make spectrum available in view of new technologies and existing/future demand for mobile and/fixed broadband services.
d. Support technology neutrality approach to spectrum licensing to ensure future re-farming of spectrum; and flexible enough to accommodate new and emerging technologies within existing licensing frameworks.
e. Participate in ITU study groups and World Radiocommunication Conferences (WRCs) to make an informed decision of the spectrum allocation for new services and additional spectrum for existing services.
f. Expand opportunities for innovative spectrum access models.
g. Incorporate flexible approaches to Spectrum Regulation to facilitate efficient use of spectrum by:
    i. Developing a spectrum sharing framework for mobile and/fixed broadband
    ii. Developing modalities for Spectrum Trading
    iii. Allowing National Roaming to encourage network deployments, particularly in rural, unserved and underserved areas
    iv. Introducing/imposing 'Use it or lose it' [or 'Use it or Share it'] obligations on spectrum licenses by setting specific time to operators to use the assigned spectrum to guard against unhealthy competition practices
    v. Incorporate principles associated with staggered/instalment payments for settling spectrum fees.

1.5 The Objective of the Spectrum Management Strategy and Roadmap

a. To ensure that assigned frequencies are valued, used appropriately and brought into use in a timely manner

b. To develop a harmonized approach on spectrum management to promote Regional Integration;
c. To optimise spectrum, use by allowing spectrum refarming to accommodate emerging technologies.
d. To monitor, investigate and enforce adherence to the regulatory framework and licensing conditions pertaining to spectrum management as set out by the NRAs
e. To continue using a converged/unified licensing framework that supports technology and service neutrality
f. To guide the National Regulatory Authorities within EAC in the efficient management of the radio frequency spectrum to enable deployment of wireless networks.
g. To ensure that adequate spectrum is available to meet the increasing demand for wireless services. The increasing evolution of wireless technology and the reduced time for new technology requires a proper planning framework.
h. To ensure timely allocation of spectrum for new technologies to provide licensees adequate time for planning and deployment of wireless networks.

2.0 Section 2: Future Demand of Radio Frequency Spectrum

The management of radio frequency spectrum will present significant challenges in the coming years. The challenges arise from trends which are being observed across a wide range of telecommunication markets. It is important to foresee future demand of radio frequency spectrum within the EACO region and consider the following aspects: -

a) Increasing levels of smartphone adoption and an ever-growing range of services, which drive, increased data consumption leading to exponential growth in the demand for network capacity. The demand for increased capacity will increase the need for additional spectrum to be made available and increased efficiency in the use of spectrum which has already been assigned.
b) The desire to promote the availability of mobile broadband services to rural communities and the need to support additional capacity demands will

require both low, mid and high frequency spectrum to be made available.

c) A growing interest in the Internet of Things (IoT) which envisages an expanding array of smart devices connecting to telecommunications network providing machine-to-machine (M2M) and machine-to-people (M2P) applications. This will lead to growth in low power, localised devices which will also require spectrum to support their deployment; and
d) An industry which is characterized by high-levels of rapid and often dramatic technological change and so the spectrum which is made available to the industry needs to be managed carefully to ensure that it is deployed optimally The development of 5G technologies and making available suitable frequencies on a timely basis is an example of the challenges that lie ahead.

The growing demand for wireless broadband capacity could drive the most significant changes in spectrum use over the next 10 years. National Regulatory Authorities will face significant challenges in spectrum management over the next decade and exactly how these challenges will develop remains highly uncertain. Both National Regulatory Authorities and their stakeholders need to adopt a spectrum management strategy which is flexible and agile, able to respond to the changing nature of demands on radio spectrum.

2.1 Drivers of radio frequency spectrum demand

Radio Frequency Spectrum serves as a critical input to a wide range of services, each of which confers different benefits on society. The use of radio frequency spectrum to provide communication and broadcasting services represent that generate some of the greatest benefits.

- ✓ Digital Terrestrial Television (DTT) and Satellite TV (DTH) provide significant value to consumers by delivering a variety of free-to-air and pay-TV broadcasting services and sustaining choice of digital TV channels and platforms. Both DTT and DTH can also deliver important citizen benefits by delivering near-universal free-to-air (FTA) Public Service Broadcasting (PSB) and its associated social and cultural benefits. Higher definition channels require more bandwidth than standard definition services and while new codec

standards like High Efficiency Video Coding (HEVC) can help mitigate this demand, broadcasting will continue to require significant spectrum resources.

- ✓ Mobile communications services deliver significant benefits for consumers through voice and data services. Wireless broadband is the key growth area in the mobile sector and future developments in data applications will continue to drive growth and consumer benefits for many years to come especially in the fourth industrial revolution.
- ✓ Satellite Communication Services (GSO and NGSO Satellites)
- ✓ HAPS and HIBS Connectivity
- ✓ The evolution of Wi-Fi

2.2 Key forecasting assumptions

In reviewing future spectrum demands, we have identified the following assumptions that have guided the demand forecasts:

a) The highest value use of spectrum will vary between bands and geographic areas over time. As such, mobile broadband will only sometimes be the highest value use of a particular spectrum band;
b) Wireless broadband services will continue to deliver socio-economic benefits to EAC and these benefits will increase with greater use of mobile broadband services made possible through increased network capacity;
c) Demand for mobile broadband services (and therefore capacity and hence spectrum) will continue to increase for the foreseeable future, though the rate of this increase is difficult to determine;
d) The lead-times for making additional spectrum available for mobile broadband will remain long due to the timeframes for mobile broadband technology development and standardisation, international spectrum harmonisation and domestic re-farming of spectrum;
e) Spectrum will continue to be a key enabler for many other non-mobile broadband services that provide important socio-economic benefits to East Africa. The associated requirement for spectrum to enable these services will continue, however these requirements may vary over time;
f) Technology neutrality and the provision of sufficient tenure to support

reasonable levels of return on investment will remain core principles when designing spectrum channel arrangements for broadband services;

g) International spectrum harmonisation and technology standardisation will continue to play a key role in delivering equipment economies of scale for operators in East Africa due to the relative size of the East Africa market;
h) The increased interest, demand and proliferation of NGSO satellites.

3.0 Section 3: Spectrum Management Strategy

This section sets out the National Communication Regulatory Authorities' current approach to managing spectrum in key areas. It identifies the issues in spectrum use and in downstream markets that may necessitate changes in spectrum management policies and, where possible, suggests the actions that National Communication Regulatory Authorities may need to take to address these issues. The key areas in spectrum management which we consider are:

a) Approach to licensing conditions
b) Spectrum licensing recommended best practice;
c) Approach to assignment of new spectrum;
d) Approach to pricing for new spectrum;
e) Spectrum licence renewal and pricing for existing spectrum;
f) Network sharing and spectrum pooling; and
g) Spectrum trading.

3.1 Approach to licensing conditions

3.1.1 Licence obligations such as coverage obligations can be an important element in delivering policy objectives. Coverage obligations could take the form of percentage territorial coverage, population coverage, road, city and/or rural or hard-to-reach areas, and indoor coverage obligations. Such coverage obligations should drive/promote widespread coverage of communications services and universal access to ICT products, to bridge the digital divide, for socio-economic development. The regulator and licensee should agree to a minimum arranged level of QOS, timetabled for each stage.

3.1.2 The conditions imposed in licences including coverage and other quality of service obligations should always be carefully considered. It is recommended that EAC member states consult and negotiate with local MNOs to design obligations that can realistically be met. Onerous and inflexible conditions that may be impractical or impossible to meet can jeopardise investments and incentivise consumer price rises. Instead, regulators should engage in a dialogue with licence holders to arrive at more practical solutions. There are examples where coverage obligations for rural areas can be an efficient tool when used in conjunction with measures to lower the cost.

3.1.3 Coverage obligation should give freedom to the licensee to fulfill the obligation using a different spectrum band. For instance, a licence for a block in the 3400-3600 MHz could carry an obligation to provide coverage to a percentage of the population, but it should be possible for the licensee to meet the obligation with spectrum below 1 GHz. In addition, the licence terms should allow the regulators to cancel (or revoke) the licence in the case where the obligations are not met, so that the spectrum can be freed and re-issued.

3.1.4 Issue licences which shall have no more restrictions than necessary and shall, as far as possible, be technology and service neutral. The licences shall also have a long duration to ensure predictability for the licensees and an opportunity to earn a reasonable return on investment. Technical conditions will be based on the decisions of relevant international bodies such as the ITU, ATU and CEPT relating to the harmonisation of frequencies.

3.1.5 Spectrum licences have traditionally contained a range of non-price terms and conditions, which go beyond those necessary to manage interference between users. Providing for flexible spectrum use by limiting licence conditions enables spectrum be redeployed at a time of rapid technology and market changes and brings down the cost-of-service provision. The conditions imposed in licences including coverage and other quality of service obligations should always be carefully considered. Conditions that are unrelated to avoiding interference should be kept to a minimum or removed entirely. There are examples where

coverage obligations for rural areas can be an efficient tool when used in conjunction with measures to lower the cost.

3.2 Spectrum Licensing Recommended Best Practice

3.2.1 There is no single best practice to spectrum licensing. However, best practice depends on the National Regulatory Authorities policy objectives, market competitiveness, current use of spectrum, and investment over a given period of time. The following are some spectrum licensing best practices recommended for the adoption of National Regulatory Authorities (NRAs):

i. **Auctions**: Auctions are considered the best licensing methods (this needs to be qualified) that ensures spectrum is assigned to the users who are most likely to put it to use. Auctions should be designed to support efficiency in the utilization of the spectrum and to encourage competition in the market. Other spectrum licensing methods, such as Administrative Procedure which is based on first Come, first served, and Beauty Contest can also ensure spectrum is assigned to the users who are most likely to put it to use if properly designed.

ii. **Setting moderate Spectrum prices:** there should be a balance between revenue generation for the country from spectrum sales and cost of socioeconomic benefit of spectrum. NRA's should set Spectrum prices as low as possible to encourage competition and effective delivery of mobile and broadband services. It is equally important to set subsequent renewal fees for the Spectrum license to encourage technological innovations.

iii. **Sufficient License duration and renewal period:** NRA's should consider having a long license duration and renewal period for mobile/broadband system license h to give licensee regulatory certainty and encourage long term network investment. Renewal decisions should also be made in advance of the licence expiry to

facilitate ongoing network investment and ensure continuity of service delivery to end users without disruptions.

iv. **Technology and service neutrality for Spectrum licence:** This is important to ensure that spectrum is utilized efficiently and optimally in line with evolutionary trends of technologies and services.

v. Timely plan for mobile/broadband system spectrum licensing: Licensing frameworks such as National Broadband Plan (NBP), National Policy on 5G Technology can present viable information about spectrum roadmap providing a schedule for forthcoming spectrum releases to meet the government's broadband plan as well as other demands on spectrum.

vi. **Effective Licence conditions:** Conditions such as roll out obligations, coverage requirements, use-it-or-lose-it should facilitate availability, accessibility and affordability of service to end user without imposing constraints that will lead to the failure of the licensee or loosing rights to the spectrum.

vii. **Spectrum trading:** There should be framework for spectrum trading in place to promote efficient spectrum use. The framework should support efficient spectrum utilization by enabling unused or underutilized spectrum to be transferred to licensees who will make better use of it.

3.2.2 Policy makers need to ensure that technologies delivering innovative applications and services should have access to sufficient spectrum through appropriate regulatory regimes, licensed as well as license-exempt. Certain spectrum licensing approaches are more suited to specific spectrum licensing regimes e.g., the first come first served approach is suitable for lightly licensed general authorisations such as Amateur, Aeronautical and Maritime services where the spectrum is shared, while auctions are suitable for individual licenses where demand exceeds supply. Policymakers need to ensure that licensed,

lightly licensed and license-exempt wireless technologies have access to sufficient spectrum.

3.3 Approach to assignment of new spectrum

There are two main approaches used for assigning the rights to use a particular spectrum band:

i. **Administrative approaches,** whether via 'beauty contests' or 'direct assignments', the authority assigns the spectrum to the candidate that is considered to best meet a number of criteria such as financial resources, industry experience, technology and rollout plans and, in some cases, price offers. Administrative assignment may be suitable in cases where there is less demand, an authority wishes to consider multiple objectives, or where an authority wishes to avoid high licence costs which could impact network investment.

ii. **Auctions,** in which the licence is assigned to the highest bidder (with that bidder either paying the amount they bid or, in some cases, the amount of the second highest bid); Auctions are most suitable when there is excess demand for the spectrum and hence the benefit of auctions in awarding spectrum to the operators, which are most likely to put it to the best use, helps maximise benefits to society. Auctions can deliver strong social benefits as long as they are properly designed. Auctions are a proven means of awarding spectrum to those who are most likely to be put it to the best use. However, poor auction design can lead to spectrum being assigned inefficiently or in a way that undermines competition.

3.4 Approach to pricing of new spectrum

3.4.1 There are two types of spectrum pricing;

i. **Spectrum access fees,** which represent the price paid to gain initial access to spectrum;

ii. **Spectrum usage fees,** which are annual charges for the on-going use of spectrum.

The price paid for spectrum should reflect its economic value and seek to provide the people of East Africa with a fair return for a scarce, natural resource.

3.4.2 Spectrum Pricing: Costs associated with Licensing: in general, there are two types of such cost: the first is related to the preparation and issuing of the licence or authorisation, and the second is related to maintenance and enforcement of the license. A single fixed fee applied to the licenses can cover the first type while the second could be covered by the application of a fixed annual fee for each type of licence, and the application of a levy based on the licensee's turnover or profitability.

3.4.3 Costs associated with Spectrum Management; this include costs related to participation in international fora, e.g. the ITU, ATU, licensing of radiocommunication services, coordination of frequency assignments, both within country's territory and with neighboring countries, enforcement of licence conditions, and pricing the spectrum.

3.4.4 High spectrum prices have been linked to lower investment in networks, worse quality and coverage, and lower consumer welfare. Effective spectrum pricing policies are vital to ensure that operators have the resources to invest in the network. The value for spectrum during a period can be influenced by several factors including: geography, competition amongst potential users, advances in technology, the present value of cash flows derived from a service over time, and the general economic climate. Spectrum licence values are therefore reflective of the benefits to be gained by society from its best use of spectrum bands.

3.4.5 There are best practices that can be adopted when setting prices for spectrum and this includes the following;

i. **Administrative Pricing:** It is used in cases where there is no scarcity by applying lower charges (potentially below cost) to frequency bands and/or locations that are not congested to encourage migration from congested bands

or locations. In addition, administrative pricing should encourage users who have an alternative to migrate to other technologies or frequencies;

ii. **Auction:** This involves the awarding of licenses to those who bid the greatest amount in monetary terms. There are many varieties of auction and their design is a specialized skill. The awarding authority is usually responsible for designing the auction, setting up the procedures for running the auction, ensuring that all potential bidders have full knowledge of the rules and procedures and for running the auction to a conclusion;

- As mobile spectrum is a limited resource, it is vital that governments and regulators ensure that the spectrum is awarded to operators who will use it most efficiently to support affordable, high quality mobile services.
- Governments and regulators may also try to use auctions to meet other goals such as raising revenues for the state, or altering the structure of the mobile market by facilitating the entrant of a new operator.
- Auctions have proved effective at determining fair and efficient spectrum assignments in a timely manner when the demand for spectrum from qualified applicants exceeds the available supply.
- Provide a transparent, impartial and legally robust means of assigning spectrum to those who will use it most efficiently to support attractive, high quality mobile services.
- Auctions are suitable for expired licences if the licensee does not want to renew the spectrum or if they have breached the terms of the licence.

iii. **Hybrid approach:** A hybrid approach combines elements of both auctions and administrative pricing, for example by including a financial bid as one element of a beauty contest.

iv. **Benchmark Approach:** When evaluating benchmarks of amounts paid for spectrum licences or authorizations, it is very important to consider the local demand for spectrum and the level of competition amongst operators reflected

in the revenue and cost drivers associated with a particular market sector and with individual operators. Regulators may decide to carry out benchmarking, by drawing inferences from market prices in other jurisdictions for similar spectrum bands by considering:

- prices on a “per MHz per population” basis, adjusted for differences in GDP per capital;
- the price relationships across bands in countries where auctions in higher and lower value bands have occurred;
- differences in license durations; and
- Differences in timing of payments.

3.4.6 Maximizing revenues from spectrum should not be a measure of success as it can have negative socioeconomic costs. Competition in communications markets can be undermined and there is a risk of higher retail prices and lower network investment. Recent studies demonstrated higher spectrum prices played a significant role in slowing the rollout of next-generation mobile networks, had a significant effect in reducing the network quality experienced by consumer, and are associated with higher consumer prices in developing countries.

3.4.7 The primary objective should therefore be to assign spectrum to those users that will be able to extract most value from this scarce and finite resource for the benefit of society as a whole. Licensing authorities should set reserve prices conservatively to allow the market to determine a fair price and to reduce the risk of leaving spectrum unassigned. Where spectrum is auctioned, ongoing charges should be limited to recovering the cost of spectrum management. Any subsequent fees associated with licence renewal should not prevent reasonable returns being earned on risky investments as this discourages technological innovation.

3.5 Approach to spectrum licence renewal and pricing for existing spectrum

3.5.1 Uncertainty over future rights to use the spectrum may lead to operators ceasing investment in the development of their networks and competing less strongly to grow their customer base until the uncertainty is resolved. A failure to renew an operator's existing rights to use spectrum also may harm service continuity or quality of service to customers.

3.5.2 A presumption of renewal helps avoid investment being delayed because of uncertainty over future rights. A decision not to automatically renew a licence should only be made where there is a reasonable prospect that the benefits from reassigning spectrum would exceed the costs. Given the large number of licences approaching the end of their current term, timely renewal decisions (ideally 3-5 years in advance of licence expiry) can facilitate ongoing network investment and enable planning so as to provide for service continuity to end-users.

3.5.3 Predictability can be supported when governments publish (a) national broadband plans setting out how targets for widespread broadband will be achieved and (b) a spectrum roadmap providing a schedule for forthcoming spectrum releases to meet the government's broadband plan as well as other demands on spectrum. In particular, A spectrum roadmap is an important means of ensuring sufficient spectrum will be available to meet the requirements driven by changing technology and demand. Information on future spectrum release is critical in order for businesses to prepare investment plans, secure financing and develop arrangements for deploying particular technologies. A sound spectrum roadmap should cover:

i. an audit setting out current use of spectrum and identifying any spectrum that could be re-allocated to higher value use;
ii. the schedule for future spectrum releases;
iii. how spectrum will be assigned including a framework for determining spectrum prices and other terms and conditions;
iv. the timing and process for spectrum renewal decisions;
v. a plan for the introduction of technology neutral licensing and trading if not already in place.

3.6 Approach to shared access to spectrum and spectrum pooling

a) Licenced Shared Access (LSA)

Is a technological solution, which allows sharing agreements by time, frequency or geography. Technologies has been developed which allow several users to share a frequency band without causing interference. LSA was developed to guarantee LSA licensees a predictable quality of service and exclusive access to shared spectrum resources. LSA is “licensed” access which means licensees have the same right of use, as defined in the LSA rules, as is the case with spectrum licenses which are not shared. From a spectrum policy perspective, LSA is a complementary method of guaranteeing access to spectrum - in addition to exclusive spectrum licenses and license-exempt spectrum - which enables the sharing of spectrum between a limited number of licensed users. LSA can help to accommodate increasing demand for radio spectrum, notably for mobile broadband. Spectrum policy should, therefore, aim to provide economic incentives and legal certainty for users to develop and deploy spectrum-sharing technologies, for example based on sharing contracts.

b) Spectrum Pooling

Spectrum pooling is defined as an approach where licensees who hold exclusive spectrum licenses make an agreement to jointly use their spectrum. This concept is mainly applicable to mobile networks. Technology Multi-Operator Core Network (MOCN) is available that allows a network operator to provide access to a single radio access network by other operators. Each operator operates its own core network, including one or more independent nodes.

Spectrum pooling in mobile networks can lead to more efficient use of spectrum because it increases the total bandwidth available to users in a cell and therefore improves the probability of a higher throughput being available to users.

Given its role in improving efficiency in spectrum use, spectrum pooling in

the form of MOCN or some other technical solution should be encouraged where it can help in achieving national policy objectives. However, spectrum pooling agreements should not be prohibited or hindered by administrative or financial disincentives and should be subject to competition law and ex-ante competition assessment.

c) Sub-Ordinated Spectrum Licenses

Often spectrum licenses cover an entire country, but the licensee may not have a need for the licensed spectrum in all locations. This presents an opportunity for a licensee to sub- ordinate spectrum to a local operator or other user, who would make use of the spectrum in that area thereby ensuring that spectrum that would otherwise be unused is put to use and will generate local socio-economic benefits.

3.7 Approach to spectrum trading

A spectrum trade is a transfer of the rights to use a specified set of frequencies from one person to another. It can either be the transfer of all the frequencies associated with a license or it can be a partial transfer in terms of frequency, geography and even by time.

National Regulatory Authorities should explore other means to meet the policy objectives of encouraging efficient spectrum usage and improving coverage, for instance, by permitting trading in, and leasing of, spectrum licenses for specific underserved areas.

Allowing spectrum trading and leasing is an important way to ensure that spectrum continues to be used efficiently over time. In particular, trading in and leasing of spectrum would encourage efficiency by allowing spectrum rights to be leased or transferred to those who may make better or more efficient use of them.

A regulatory framework that supports voluntary spectrum trading offers the potential for substantial benefits to society by ensuring the continued efficient use of spectrum. Leasing of and trading in spectrum may also invite the deployment of a variety of

applications powered by mobile services – from remote diagnostics and surgery and automated cars to applications that address emerging Industry 4.0 needs.

4.0 Section 4

4.1 Roadmap for Future Spectrum Release

4.1.1 This section covers how National Regulatory Authorities will plan on the strategies to release spectrum under the following broad areas;

i. Network evolution and coverage
ii. Accelerating innovation and sharing with spectrum sandboxes
iii. Better data for better spectrum management

4.1.2 The most common usage of spectrum by consumers is through;

i. Browsing the internet at home or using the mobile network and/or Wi-Fi connection.
ii. Making mobile phone calls or sending text messages using a mobile network
iii. Watching television or listening to radio
iv. Using Bluetooth connection to connect to a wide range of personal and home devices
v. Accessing navigation services on a smartphone or in-vehicle using GPS signal provided by satellite.

4.1.3 This spectrum roadmap will be essential to ensure that there is enough spectrum to meet surging demand for mobile services through;

i. Increasing pace of mobile technology evolution and the decreasing cycle time for new technology demand requires increased agility in spectrum management and planning.
ii. Balance the time need for incumbents to relocate against the costs of delaying the introduction of new technologies – trade offs
iii. Allocate spectrum for new users in advance of the technology becoming available so that operators have time for planning, capital expenditure and implementation.

4.1.4 The advantages of spectrum roadmap include the following;

i. Helps the government to forecast future trends and manage its work and risks
ii. Help the industry with increased certainty about the government's future allocation plans and management of radio spectrum.

4.1.5 This roadmap for spectrum release defines specific actions to support the implementation of current and future wireless technologies and the development of the industry for the benefit of the EAC citizens.

4.2 Emerging challenges and opportunities to spectrum management

Key Challenges

i. **Spectrum availability** – NRAs need to determine what spectrum will be available and when the spectrum will be available to plan what spectrum the operators need to invest in over the near-to-long term to meet the rapidly growing data demand.
ii. **Regulatory certainty** – NRAs need to determine the spectrum allocation methodologies, spectrum renewal procedures and roadmaps
iii. **Licensing regime** – NRAs need to determine the (refarming, spectrum pricing, spectrum sharing)
iv. **Harmonised future spectrum** – with harmonized EAC framework, it leads to reduced equipment costs, limits interference and enable roaming.

4.3 Future technological trends and drivers

The demand for access to many segments of the spectrum is increasing as new technologies allow a variety of applications to make use of a broader range of frequency bands. While the most common frequency bands for mobile networks to date have been focused on low and mid-band spectrums, there has been interest in the use of high-bands for 5G such as millimetre wave (mmWave) between 24GHz and 86Ghz. This increased demand makes efficient spectrum use even more important. In addition, applications such as High-Altitude Platforms (HAPS) and Non-

geosynchronous satellite orbital (NGSO) satellites have also increased the pressure to access spectrum in different bands. At the same time, interconnected devices operating through applications like Bluetooth and Wi-Fi have proliferated further increasing the competition for valuable and finite spectrum.

- **5G spectrum needs**

  5G mobile networks offer significant potential to increase data transfer capacity as well as spectrum efficiency. The implementation of 5G networks will create additional demand for frequency bands below 6Ghz, which was already assigned to incumbent operators. The sub 6GHz bands have relatively better propagation properties while offering a wider coverage area than mmWave, but their heavy incumbent use limits large contiguous spectrum blocks.

  The mmWave bands offer more spectrum due to less incumbent use, allowing for wider bandwidths, and supporting higher throughputs. Its use is however limited by lower propagation characteristics making them more suitable for coverage of relatively small areas, usually in dense environment.

- **Advancing the use of IoT**

  The global number of IoT devices in use has been increasing greatly in the past few years. The increased connectivity and capacity introduced by technologies using licensed and unlicensed spectrum are fostering more connected devices as part of the IoT ecosystem.

- **The evolution of Wi-Fi**

  The evolution of Wi-Fi, over the past 24 years, IEEE 802.11, commonly referred to as Wi-Fi, has evolved from 2 Mbps to multi-gigabit speeds, a 1,000-fold increase in throughput. The standard has continuously advanced itself by introducing new protocols such as 802.11n, 802.11ac, and 802.11ax (Wi-Fi 6).

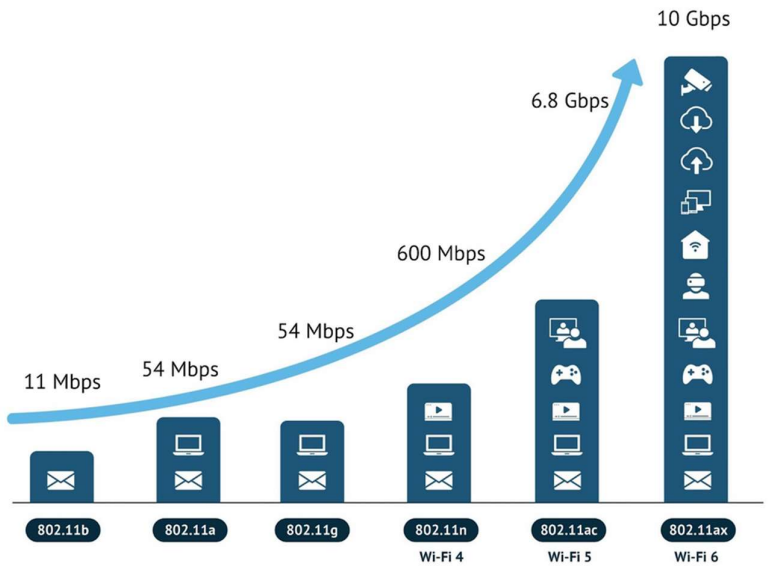

Figure 1: The growth of Wi-Fi raw data transfer rates

- **HAPS connectivity**

  High-Altitude Platform Stations (HAPS) are easily deployable stations operating in the stratosphere that can provide a variety of connectivity services to end users on the ground. HAPS are high enough to provide services to a large area or to augment the capacity of other broadband service providers. With the advantage of height, one HAPS can transmit service over an area 20-30 times greater than a traditional ground-based mobile system and at higher throughput and lower latency than satellites. Development of HAPS is expected to pave the way to connect more of the world's people to the benefits of today's digital economy, particularly in underserved communities and in rural and remote areas.

4.4 Spectrum management work projects planned to address the identified challenges and opportunities

Continued improvement in the wireless communications used by everyone by looking on the following: -

a. **Mobile spectrum demand**-The demand for mobile spectrum should be aligned with the future work of the mobile market with an insight on how

the mobile market may evolve in the future. This sets out the initial thinking on how the mobile networks could meet the future demand taking into account the spectrum, technology developments and the potential deployment strategies. This will encourage long-term thinking about spectrum for mobile networks within the context of increasing demand for spectrum from other users.

b. **Opening access to mmwave for mobile-** The WRC-19 identified several mmwave bands for 5G. The 26GHz 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 40GHz band is a promising band for early deployment of 5G mmwave systems. It provides extreme bandwidths for ultra-high broadband speeds. It may also be used for private 5G networks by verticals though the ecosystem has not developed and matured at the moment.The 66-71 GHz band is identified for flexible use for 5G systems enabling both IMT and non-IMT technologies and shared with WiGig systems. This band provides extreme bandwidths for ultra-high broadband speeds.

4.5 Harmonised Spectrum for 5G

The table below shows the harmonized spectrum for 5G

No.	Band	Bandwidth	Technology
1	450 - 470 MHz	20	4G Rural
2	694 - 790 MHz	2x30 MHz	4G
3	790 - 960 MHz	2x30 MHz	2G/4G
4	1 427 - 1518 MHz	90 MHz	5G
7	1 710 - 1 885 MHz	175 MHz	2G/4G
8	1 885 - 2 025 MHz	140 MHz	3G/4G
9	2 010 - 2 025 MHz	15 MHz	3G/4G
10	2 110 - 2 200 MHz	90 MHz	3G/4G

11	2 300 - 2 400 MHz	100 MHz	4G/5G
12	2 500 - 2 690 MHz	190 MHz	4G/5G
13	3 300 - 3 400 MHz	100 MHz	5G
14	3 400 - 3 600 MHz	200 MHz	5G
15	4 800 - 4 990 MHz	190 MHz	5G
16	24.25 - 27.5 GHz	3.25 GHz	5G
17	37 - 43.5 GHz	6.5 GHz	5G
19	47.2 - 48.2 GHz	1 GHz	5G
20	66 - 71 GHz	5 GHz	5G/WiGig

4.6 Proposed spectrum release plan

S/n	Spectrum	Timeline
1.	mmWave frequencies for 5G	2024
2.	DAB radio	2024
3.	IoT applications	2024