Licensing and Shared Spectrum Framework

for

Community Networks

May 2021

ACKNOWLEDGEMENT

The Communications Authority of Kenya acknowledges exceptional support from the following organisations in developing this framework in response to the COVID-19 pandemic.

The Association for Progressive Communications (APC) is an international network of civil society organisations dedicated to empowering & supporting people through the strategic use of ICTs. The APC has been supporting local community networks since its inception in 1990 and since 2017, APC has been running a program supporting grassroots groups in the Global South to use technology to develop communication infrastructure in their communities.

The Kenya ICT Action Network (KICTAnet) is a multi-stakeholder Think-Tank for people and institutions interested and involved in ICT policy and regulation. KICTANet is a catalyst for reform in the ICT sector, that provides a platform for continuing cooperation and collaboration with industry, technical community, academia, media, development partners & Government agencies. It is involved in policy advocacy, capacity building, research & stakeholder engagement.

The UK Prosperity Fund Digital Access Programme is a Foreign & Commonwealth Development Office initiative that aims to catalyse more inclusive, affordable and secure digital access for excluded and underserved communities in Kenya, Nigeria, South Africa, Brazil and Indonesia. Increased digital inclusion in the programme countries will form the basis for more thriving digital ecosystems that generate high-skilled jobs, opportunities for local digital entrepreneurship focused on development challenges, as well as potential partnerships with international and UK business aimed at mutual prosperity.

The University of Strathclyde is a leading technological university in Glasgow, Scotland, UK whose Software-Defined Radio Lab is researching and trialling agile radio network solutions featuring 4G/5G, Xilinx RFSoC, OpenRAN, Neutral Hosting, Shared Spectrum, Dynamic Spectrum Access and MultiUser MIMO technologies. It is leading an Engineering & Physical Sciences Research Council project on 'Enabling affordable Internet access with dynamic spectrum management & software-defined radio'. Under the project, researchers from Malawi, Kenya, Zambia & Ghana are guiding the adoption of dynamic spectrum management and supporting the development of appropriate regulatory policies in their respective countries.

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1 EXECUTIVE SUMMARY

The Communications Authority of Kenya (CA) is the regulatory authority for the ICT sector in Kenya with responsibilities in telecommunications, e-commerce, broadcasting, postal/courier services and cybersecurity. The Authority is responsible for managing the numbering and frequency spectrum resources for the country as well as safeguarding consumers of ICT services.

The Authority is committed to discharging its mandate to ensure that the ICT sector contributes to the socio-economic growth of Kenya, in line with its vision of '*a digitally transformed nation'*. In order to address rapidly rising demand, the Authority is considering methods beyond the traditional model of commercial operator licensing and exclusive spectrum assignments. Effective implementation of a spectrum sharing framework will enable efficient utilisation of the spectrum while protecting existing primary users from harmful interference. Spectrum sharing has the ability to increase spectrum efficiency as it makes fallow spectrum available without displacing incumbent users. The Authority envisions that this will be an important way to unlock maximum value from radiocommunication services and serve as a flexible way to reduce artificial spectrum scarcity.

By developing this framework, the Authority demonstrates its commitment to addressing barriers facing communities in underserved areas and radiofrequency spectrum efficiency challenges through innovation and provision of an enabling regulatory environment, which allows optimal use of spectrum for universal access to ICT services.

Local ownership and management of small-scale community-based network services which leverage new low-cost electronic networking equipment is an approach that is increasingly attracting attention globally. This has resulted in the emergence of growing numbers of community-based public networks around the world, primarily offering Wi-Fi service, while others provide mobile services. These local initiatives are typically called "community networks" and are now operating in many developing and developed countries. Their numbers are still relatively small due to limited awareness of the new opportunities to self-provide communications infrastructure, and also because of the regulatory barriers and human capacity constraints that are present, particularly in rural areas.

While Kenya is among East African countries that have already seen the emergence of some community networks, the number of these networks and their scalability could be significantly increased by enhancing the current regulatory environment to lower the barriers to small-scale and social purpose or not-for-profit community network operators.

In reaching the unconnected segments of the population, mainly in remote, or sparsely populated, low-income areas, there is recognition by the Authority that a variety of complementary strategies are needed to meet needs for affordable communications infrastructure. The COVID-19 pandemic has reinforced the need for additional means to help broaden connectivity in the country.

The Authority has reviewed the identified priority areas where small changes to the current frameworks for operator licensing and spectrum access could unlock the potential for communities across Kenya to enhance their capacity and build their own communications infrastructure. This work is based on input from project partners along with case studies of emerging community networks in Kenya and around the world, complemented by interviews with local stakeholders and key experts.

The key regulatory development needs identified culminated in the development of a framework that is responsive to the needs of community networks. The key regulatory actions that planned to actualise the framework are summarized below.

Licensing	**Plan of Action**
Near Term	● To integrate a new license category for community networks[1] within the Unified Licensing Framework review process currently underway. ● To ensure that the financial and administrative requirements for community networks are commensurate with their scope and scale.

Spectrum	**Plan of Action**
License-exempt (Near Term)	● To review the Guidelines on the use of Radiofrequency Spectrum by Short Range Devices to amend EIRP limits for 2.4 & 5 GHz Wi-Fi for Point-to-Point and Point-to-Multipoint use. ● To review options for lowering the barrier to use of other license-exempt bands for PtP and PtMP use, including 24 GHz and 60 GHz.

[1] See Section 5.2 for a definition of a community and a community network

	● To expand the range of frequencies available for license-exempt use, especially in the 5-6 GHz bands.
License-exempt (Medium Term)	● To strengthen collaborations with service providers to foster standards and regulatory inclusion.
TV White Spaces (Near Term)	● To expedite the commercial availability of geolocation database service and implement required mechanisms to make the TVWS spectrum available immediately to operators. ● To establish an incubatory period for TVWS technologies. ● To evaluate with regional regulators the feasibility of a common approach implementation of geolocation databases.
IMT Spectrum (Medium Term)	● To develop a shared spectrum framework for underutilised IMT spectrum bands.
Spectrum Fees (Medium Term)	● To review the spectrum fee framework, recognizing the need for significantly reduced fees for underserved areas.

Other	**Plan of Action**
Access to backhaul networks (Medium term)	● To require fibre-optic network operators to publish a standard Reference Access Offer (RAO) in order to ensure access, transparency and non-discrimination in wholesale backhaul markets.

2 INTRODUCTION

The Communications Authority of Kenya (CA) is the regulatory authority for the communications sector in Kenya, responsible for facilitating the development of the information and communications sector including; broadcasting, cybersecurity, multimedia, telecommunications, electronic commerce, postal and courier services. Under the 2018-2023 strategic plan, the Authority is taking deliberate actions to further enable access to communications services in underserved areas, such as by promoting the use of shared spectrum strategies. Under this particular initiative, CA is developing a licensing and shared spectrum framework for community networks. CA envisions that community networks will enable enhanced internet access in Kenya, especially in its rural areas.

Declining rates of growth in connectivity indicate that new approaches are needed to provide affordable access in unserved and underserved areas. This calls for use of alternative and complementary models for communications service providers to enable affordable and sustainable ways of minimising the digital divide.

To this end, the Authority has collaborated with the Association for Progressive Communications (APC), the Kenya ICT Action Network (KICTAnet) and the University of Strathclyde, to engage key stakeholders in this process of developing an inclusive framework for community networks. This project has been conducted with support from the United Kingdom's Foreign, Commonwealth & Development Office (FCDO) Digital Access Programme. The collaborative study has involved a variety of experts, researchers and stakeholders to participate in shaping the strategy for community networks in Kenya. The proposed framework is informed by a survey of self-identified community networks in Kenya, extensive stakeholder consultation, and a review of CA practices as well as international good practices.

The purpose of this project was to review prevailing factors affecting operator and spectrum licensing for community networks and prepare a framework to establish a more enabling environment for their implementation. This work builds on the efforts by the Communications Authority of Kenya (CA) to develop a dynamic spectrum access framework under its Strategic Plan[2]. The framework has been developed through regular consultations of key stakeholders in the ICT sector.

[2] https://ca.go.ke/wp-content/uploads/2020/02/4th-CA-Strategic-Plan-2018-2023-min.pdf

It is generally accepted that an accessible, open and affordable Internet plays a fundamental role in allowing individuals, businesses and governments to benefit from the information society. While the value of being connected to a communication network is steadily rising, half of the world's population remains unconnected to the Internet. In the last decade, Kenya has experienced growth in the ICT sector with the government investing in critical infrastructure such as fibre optic cables which connect Kenya to international fibre networks. Also, the government of Kenya connected each County to the national fibre optic backbone.[3] However, even with the progress, 48% of Kenyans, especially those living in rural areas, remain unconnected to mobile networks[4] and fixed networks are beyond the reach of most Kenyans.

Traditional solutions are showing signs of having reached their limits. Attempts to address this problem, whether through universal service strategies/funds, private sector initiatives or philanthropy, have met with limited success. This presents a conundrum for policy-makers and regulators where value continues to accrue to those with affordable access to communication infrastructure while the unconnected fall further and further behind by simply staying in the same place. Community Networks (CNs) are built, used, and managed by local stakeholders in a bottom-up manner. In Africa, community networks are more than telecommunications infrastructure. They exist in support of existing economic and social activities. Beyond access, they create a platform that promotes building local capacities, creation, and distribution of locally relevant content.[5] The holistic approach to digital inclusion adopted by community networks enables meaningful connectivity that is contextualised within local realities. Kenya's national broadband strategy, adopted in 2018, advocated for investment in bottom-up citizen models as one of the broadband investment models.[6]

In Kenya, there exist four community networks pilot projects, namely TunapandaNET in Kibera, Nairobi; Lanet Umoja in Nakuru; Dunia Moja in Kilifi; and lastly, Aheri in Nyanza. These networks, which are championed by not-for-profit organizations, exist in rural Kenya, except TunapandaNET, and were started to address existing access challenges such as affordability, limited digital literacy skills, lack of locally relevant content and platforms.

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[3] http://icta.go.ke/national-ict-masterplan/

[4] https://www.gsma.com/newsroom/press-release/reform-policy-to-boost-kenyas-mobile-connectivity-says-gsma/

[5] https://www.internetsociety.org/wp-content/uploads/2017/08/CommunityNetworkingAfrica_report_May2017_1.pdf

[6] https://www.ict.go.ke/wp-content/uploads/2019/05/National-Broadband-Strategy-2023-FINAL.pdf

Differing local contexts have led to various service provision models, however, connecting educational institutions has been identified as a common need and priority area for communities. It is not a surprise therefore that all the mentioned community networks connect schools and vocational training centres. Although the community network movement has been growing in Kenya in the last two years, entry-level barriers such as the high cost of bandwidth, access to spectrum and high licensing costs remain a big challenge. For example, these four networks mostly utilize Wi-Fi technologies both for backhaul and hotspots using license-exempt spectrum due to lower equipment costs and availability. However, challenges with congestion and signal interference affect the quality of connectivity services. Licensed spectrum can overcome these challenges because it's protected from interference. However, high spectrum fees make it inaccessible for community networks due to limited funding.

While there are success stories of community networks around the world, they are yet to enter the mainstream of policy and regulatory discourse. Community networks face several challenges that require consideration by policymakers and regulators so that they can thrive and grow. For instance, CNs are often unable to navigate the complex legal requirements for registration, licensing, and permitting and/or are unable to cover their associated costs. Other common challenges faced by CNs are related to the technical, economic, and human capacity aspects, particularly towards ensuring the sustainability of community networks. Several community networks are launched with grant funding but struggle to transition to a revenue-based model to sustain the network when grant funding lapses.

3 GLOBAL CONTEXT

It has been close to three decades since Internet and mobile network technologies became widely available, yet almost half the world remains unconnected[7]. The International Telecommunications Union (ITU's) latest statistics show that growth in uptake of internet services from mobile networks continued to decrease in 2019. This is particularly noticeable for developing countries, where for the last three years, the percentage of the population with mobile broadband subscriptions have remained in the low 60s, while the least developed and landlocked countries languish below 40%[8].

The essential role that Internet access plays in coping with the COVID-19 pandemic, and indeed in modern life in general, has become abundantly clear to all. Recent actions by regulators around the world to address the additional strain on networks have brought some relief, particularly in increasing capacity for existing networks. However, rural areas with sparse populations and often lower income levels have yet to see any significant change in access. Aside from the need to address remote and under-served areas with new infrastructure, efforts are also necessary for the billions of existing subscribers who are 'barely connected' due to the high cost of metered mobile broadband use.

Coverage and affordability challenges are also compounded by demand-side barriers, such as the gender gap[9], lack of relevant available content, limited literacy (both basic and digital) and low ownership rates of Internet-capable devices[10]. The sum of these barriers is more acute in rural areas. In 2018, measures of the "rural mobile Internet gap" in Low and Middle-Income countries revealed that those living in rural areas were 40% less likely to use the mobile internet than those in urban areas. In Sub-Saharan Africa, the rural mobile Internet gap is estimated to be 58%[11].

There is a wide range of actions that governments and regulators can take to address these issues.[12] Key among these actions is the recognition that coverage provided by commercial national network operators can be complemented by a diversity of social-purpose networks operated by local authorities, small businesses, NGOs and voluntary associations of users. These local operators serve much smaller and more distinct markets; they have a deeper knowledge of their users and can provide more

[7] The latest ITU estimate is that 51% of people in the world were online in 2019
[8] Measuring digital development: Facts and figures 2020 https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx
[9] Structural, social and economic barriers hinder the ability of women and people with non-binary gender identities to access the internet. ITU suggests that there are about 250 million fewer women online than men, and that the problem is more pronounced in developing countries https://www.itu.int/en/action/gender-equality/Documents/EQUALS%20Research%20Report%202019.pdf
[10] Connecting the Unconnected: Working together to achieve Connect 2020 Agenda Targets
[11] GSMA: The State of Mobile Internet Connectivity 2019
[12] Expanding the telecommunications operators ecosystem: Policy and regulatory guidelines to enable local operators

affordable connectivity when it comes to serving a local market if the regulatory conditions are supportive. Key changes to the telecoms sector that are enabling these new models include:

- *Disaggregation of the value chain in the telecoms industry.*

  As telecommunications networks become less vertically integrated, opportunities for new market entrants are increasing. Previously, to enter a market, an operator needed to invest in international, national, middle mile, and last-mile infrastructure. Today many countries encourage competition in each of these segments.
- *The spread of fibre optic backbone infrastructure.*

  This is now changing access markets in many areas in developing countries, opening up possibilities for new players who can deliver targeted, localised, more affordable solutions to unserved populations.
- *Commodity last-mile and middle-mile technologies.*
  - Innovations in low-cost electronic networking technologies have created new possibilities for affordable access. Riding on increasingly pervasive terrestrial fibre infrastructure, low-cost Wi-Fi is now provided by a wide variety of different types of providers. By 2022 about 550 million Wi-Fi hotspots worldwide are expected[13] because many have realized that wherever there are high-speed backhaul networks, the marginal cost to add Wi-Fi access points is minimal.
  - Also, mobile network base stations using software-defined radios can now be deployed for a fraction of the cost of traditional mobile networks based on technology from a variety of startups. The result is that it is now possible to put up a mobile network serving hundreds of users for less than ten thousand dollars.
  - A new generation of devices from new microwave companies, as well as companies historically focused on license-exempt bands makes possible fibre-like wireless connections over many kilometres.
  - Dynamic spectrum access technology is also gaining interest, benefitting from the opportunistic use of spectrum frequencies on a secondary basis where the unused frequency in question may be already assigned on a primary basis to another operator.

[13] Cisco Annual Internet Report (2018–2023) White Paper

Based on these recent changes in the telecommunications industry, *local operators,* in the form of both commercial ISPs and not-for-profit community networks, have been quick to take advantage of new technologies where regulations allow for this expansion of the telecommunication operator ecosystem, demonstrating their agility and interest in providing services in areas unserved by national networks.

Due to their relatively recent emergence, there is no universally accepted definition of community networks as yet, however, it is generally understood that they are built, used, and managed by local stakeholders in a bottom-up manner. The North American Regional Internet Registry (ARIN) provides a useful working definition of a community network: "A community network is deployed, operated, and governed by its users, to provide free or low-cost connectivity to the community it services. Users of the network or other volunteers must play a primary role in the governance of the organization, whereas other functions may be handled by either paid staff or volunteers.[14]"

3.1 Case Study of Prominent Community Networks in Africa

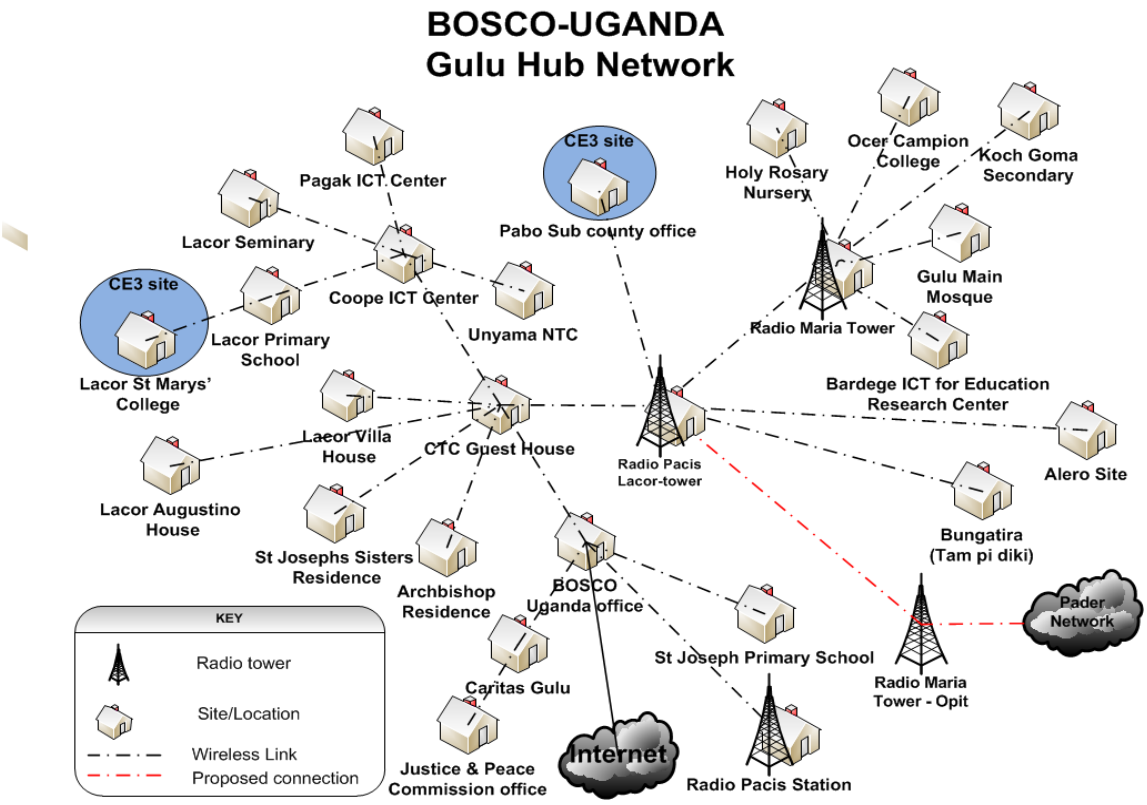
Community networks (CNs) are based on a wide range of technologies, from the mobile cellular networks of TIC AC in Mexico, and the rural fibre networks of B4RN in the UK, to the many Wi-Fi-based networks such as Bosco, Zenzeleni and PamojaNet in Africa, as described in more detail below[15]. In the COVID-19 era, community networks are playing an increasingly important role in meeting the rising demand for last/first-mile connectivity. In Africa, community networks are usually more than telecommunications infrastructure providers; they exist in support of economic and social activities, often aiming to minimise the outflow of economic value leaving the community to pay for connectivity services. Beyond access, they also create a platform that promotes building local capacities, as well as the creation and distribution of locally relevant content[16].

3.1.1 Battery Operated Systems for Community Outreach (BOSCO) - Uganda

BOSCO is a Non-Profit NGO under the umbrella of the Catholic Archdiocese of Gulu. BOSCO is registered with Uganda Communications Commission (UCC) as using the 802.11 license-exempt spectrum for its operations to reach communities. Initiated in 2006, BOSCO started operation in 6 Internally Displaced People (IDP) camps in the two districts of Gulu and Amuru, providing VOIP, Internet and intranet services for the connected camps, with the aim of ending the severe isolation experienced by displaced people.

[14] https://www.arin.net/participate/policy/nrpm/#2-11-community-network
[15] Bottom-up Connectivity Strategies: Community-led small-scale telecommunication infrastructure networks in the global South
[16] Internet Society: Understanding Community Networks in Africa

As people resettled back in their communities after the war in Northern Uganda, the network expanded to provide services to 13 districts in the Acholi, Lango and West-Nile sub-regions with about 50 community-owned ICT centres that focus on building digital literacy and entrepreneurship skills. The network, which now spans over 80 km of backhaul, is built using the license-exempt WiFi spectrum in the 2.4 GHz and 5 GHz bands. The organization owns 9 towers but also works closely with community radio stations which give them access to the FM broadcast towers. A majority of areas in Northern Uganda have not been connected to the country's electrical grid thus BOSCO relies on solar energy to power the network. Through its CE3 (Connectivity, Education Entrepreneurship and Electricity) project, the organization has helped local communities set up and manage large solar energy systems (6KW, 30KW) in secondary schools, ICT centres and local enterprises. In addition to internet and solar power, ICT content is translated to the local Acholi language and Training of Trainers (ToT) to youth and women who run ICT centres takes place.



Network Diagram of BOSCO Uganda. Used with permission from BOSCO Uganda[17]

17 https://boscouganda.com/

3.1.2 Zenzeleni Community Networks - South Africa

Zenzeleni community network is the first cooperatively owned Internet service provider in South Africa. The network started over 10 years ago in the Eastern Cape as a postgraduate doctoral research project at the University of the Western Cape (UWC), in partnership with the Mankosi community. Since then the initiative has developed into a set of independent entities utilising a two-tier operational model consisting of Zenzeleni Networks NPC, a not-for-profit umbrella organization that supports two local co-operatives (Zenzeleni Mankosi and Zenzeleni Zithulele) who in turn provide internet services to their respective communities. The network utilizes 2.4 GHz and 5 GHz license-exempt spectrum and fibre for backhaul capacity. Zenzeleni cooperatives' services include prepaid hotspot vouchers and dedicated access for anchor clients, such as a local bank branch. The network operates a total of 60 hotspots supporting 11 anchor clients and over 8,000 unique devices.

3.1.3 PamojaNET Community Network - Democratic Republic of Congo (DRC)

PamojaNET, a community network located on Idjwi Island in Lake Kivu, has been supported by La Difference, an NGO focussing on the provision of social and economic development support to the population of this remote island in the DRC. The network was initiated in 2017 following a request from the King (Mwami) of the northern region to create opportunities for the local youth. Idjwi Island has no electrical grid and has limited 2G network coverage. After setting up a 40km link across Lake Kivu to the nearest city of Bukavu, PamojaNET was able to offer solar power based Internet connectivity to the island residents and local organisations using fixed wireless connections and public Wi-Fi hotspots, along with a public access kiosk. The network is planning to use Open Cellular GSM base stations to enable the use of low-cost voice and SMS services through ordinary feature phones, as well as interactive voice response applications. To address affordability gaps, the network provides free off-peak Wi-Fi access which is subsidised by income generated from services provided to business and NGOs.

4 KENYAN CONTEXT

The communications sector has grown over the years and particularly after the introduction of the Unified Licensing Framework (ULF) which led to technology and service neutral licensing. The enactment of the Kenya Information and Communications Act (KICA), as well as the Constitution of Kenya in 2010, spurred the growth of the Sector.

The government has made major investments in critical infrastructure, including in both undersea cables and terrestrial fibre optic networks, with the result that every county is connected to the national fibre optic backbone and, by extension, the global Internet. Government investments have been complemented by the private sector, which has invested heavily in the communications sector. Operators like Safaricom, Liquid Telecom and Jamii Telecom have shown consistent growth in their subscriber numbers. The number of mid-level licensees, consisting of Tier-3 Network Facility Providers (NFP Tier-3)[18]Applications Service Providers (ASP), and Content Service Providers (CSP) have also increased in number, along with corresponding growth in subscribers. Generally, there is an increased number of license applications across all categories.

However, even with the progress described above, 48% of Kenyans, mainly those living in rural areas, remain unconnected to mobile networks, and fixed-line and wired networks are beyond reach for most Kenyans. according to the Authority's sector statistics report for the 2nd quarter 2020-21[19] the number of fixed broadband subscriptions from all Network Facilities Providers was 643,748. The Kenya Integrated Household Budget Survey, released in 2018, presents a worrying report of only 16.7% of households in rural areas being connected to the Internet.

To provide more widespread access, capacity building and promotion of innovation in ICT service across the country, the Kenya Information Communications Amendment Act (KICA) of 2009 introduced a Universal Service Fund (USF). Despite the current efforts to improve the enabling environment for telecom development, licensing obligations (which include business plan review, licensing, gazettement,

[18] Under current regulations in Kenya, all telecommunications operators must have been issued a Network Facilities Provider (NFP) license in order to build and operate telecommunications infrastructure. The Authority operates a three-tiered license structure for NFP licenses based on the geographic scale of deployment, the lowest tier of which (Tier-3) licenses operators to provide infrastructure at the county level.

[19] Second Quarter Sector Statistics Report for the Financial Year 2020/2021 (October - December 2020) https://ca.go.ke/wp-content/uploads/2021/03/Sector-Statistics-Report-Q2-2020-2021.pdf

license terms and conditions, license fee and frequency fees) remain a significant barrier to the growth of small-scale internet service providers. This is evidenced by the large number of potential NFP Tier-3, ASP and CSP licensees that currently operate outside the licensing regime. These entities (commonly known as WISPs (Wireless Internet Service Providers) and WASPs (Wireless Application Service Providers) have strong business propositions which allow them to continue to provide wireless services which attract customers in direct competition to licensed operators.

As of 2020, the Register of the Unified Licensing Framework shows 53 NFP Tier-3 licensees. Of those, the overwhelming majority (46) primarily operate in Nairobi (86 %), 1 in Mombasa, 1 in Marsabit, 1 in Eldoret, 1 in Nakuru, 1 in Kilifi and 2 in Nanyuki. Put another way, 41 of the 47 counties are not served by relatively small-scale NFP Tier-3 licensees[20]. The table below summarizes the fees such an organization would have to pay to acquire both NFP Tier-3 and ASP licenses.

Market Segment	**License period (Yrs)**	**License Application Fee**	**Initial Operating License Fee**	**Annual Operating fee**
Network Facilities Provider (Tier-3)	15 Years	KShs. 5,000	KShs. 200,000	0,4% of Annual Gross Turnover or KShs. 160.000 whichever is higher
Application Service Provider	15 Years	KShs. 5,000	KShs. 100,000	0,4% of Annual Gross Turnover or KShs. 80.000 whichever is higher

Also, both licenses require holders to produce an annual compliance report and meet several other conditions both for the application and the maintenance of the license.

For many small companies, including community networks, who may have a business proposition for unserved and unserved areas (in addition to the competitive markets) the current regulatory requirements may undermine their business proposition, resulting in lost opportunities, lack of competition and low market penetration.

This underlines the need for CA to revisit the regulatory framework to ensure that it creates a new entry point and lower thresholds for small investors, which include community networks. This would result in a more inclusive licensing framework, meaning greater numbers, greater tax revenue and more competition, driving down access pricing and providing diversity and choice to the consumers. The greater the number of licensees brought under the licensing umbrella, the greater the volume of

[20] The geographic spread of ASP licensees could not be ascertained but it is likely that they follow a similar pattern

revenue raised in the sector overall, including fees for the CA. Also, this would have positive externalities for the entire economy. Finally, it would help to more accurately quantify the small operator ecosystem.

In Kenya, the community network sector is slowly growing, especially after Kenya hosted the first and second Africa community networks summits in 2016 and 2017. Although there has been some interest from communities to start networks, barriers such as lack of financing, limited local expertise at the community level, and a lack of enabling policy and regulatory environment have contributed to the slow growth of these initiatives.

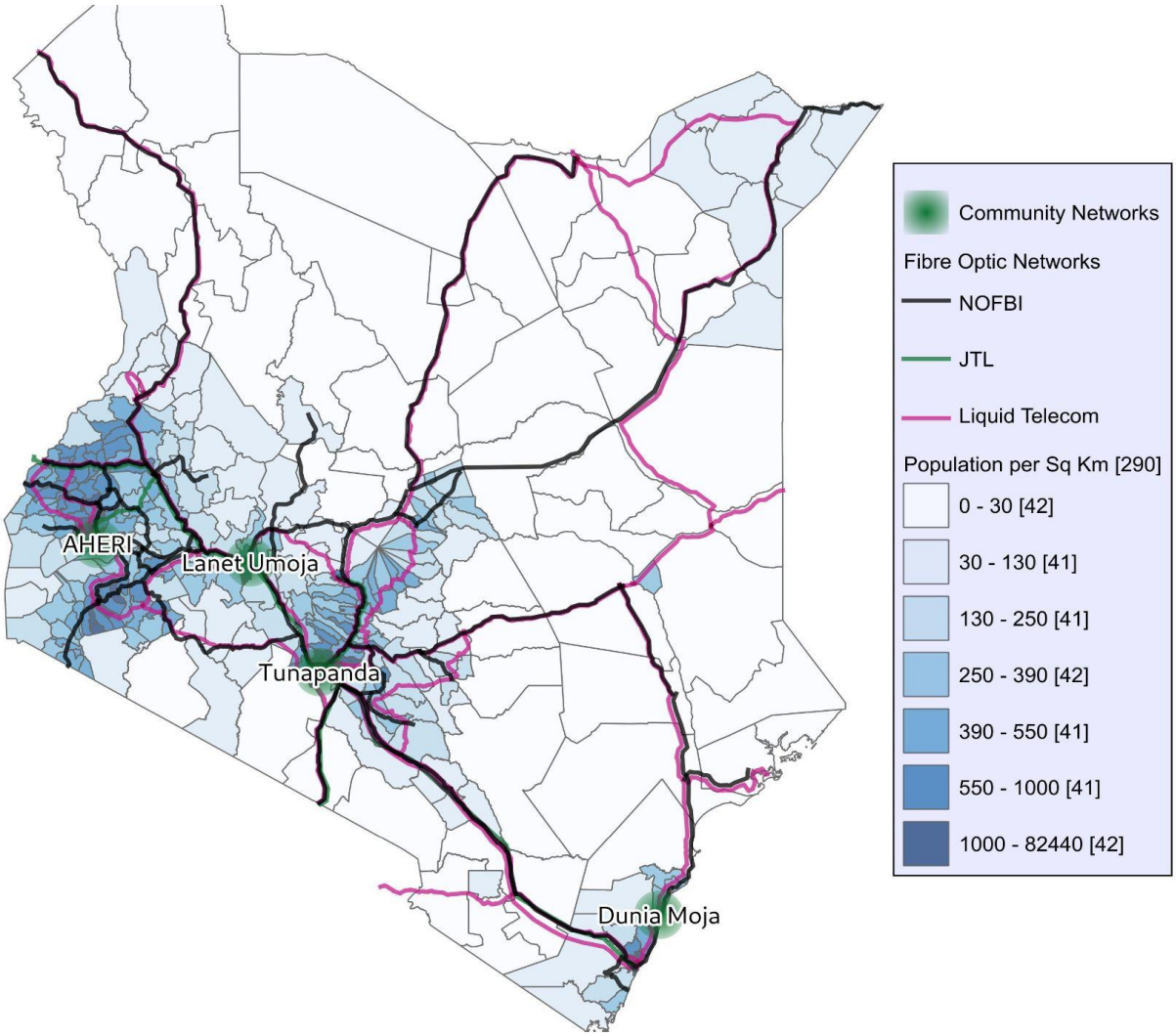
In 2020, APC[21], in partnership with Rhizomatica and supported by the UK government's Digital Access Programme (DAP), started implementing a project to support community networks in Kenya in collaboration with the Kenya ICT Network (KICTANeT) and Tunapanda Institute. The project provides technical assistance, capacity building, policy and regulatory advice and community mobilization. It focuses on building the technical, organisational and business capacity of community network actors and facilitators at different levels.

The intervention aims to ensure that the organisational and business models needed for sustainability are enhanced, to enable their integration into the context of public and private sectors, and to catalyse access to connectivity for excluded or underserved communities and vulnerable populations. The initial phase of the project implementation saw KICTANET conduct an introductory training on Community Networks at the Kenya School of Internet Governance (KeSIG). The 5th edition of KeSIG was convened from 26th – 28th October 2020. In 2021, TunapandaNET together with other local-level practitioners & experts will launch the first school of community networks in Kenya.

4.1 Mapping of Pilot Community Networks in Kenya

The mapping of pilot community networks in Kenya involved contacting individuals working with organizations championing these initiatives to better understand the motivations behind their establishment as well as the challenges faced by these networks. The mapping exercise engaged four community networks namely: Dunia Moja, AHERI, Lanet Umoja and TunapandaNET. The community networks profiles are shared below.

[21] "Connecting the unconnected: Supporting community networks and other community-based connectivity initiatives" https://www.apc.org/en/project/connecting-unconnected-supporting-community-networks-and-other-community-based-connectivity



Map of Community Networks in Kenya. Source: APC

4.1.1 Dunia Moja Community Network

Dunia Moja community network is championed by Lamuka Hub[22], a social enterprise based in Mtondia Village in Kilifi County. The organization's initiatives are geared towards closing the digital divide through digital literacy training for youth and teachers and connectivity. They also partner with vocational training centres to ensure the youth are exposed to the global village to make their training relevant in the 21st century. In 2020, the community network connected 3 schools in a pilot project. The network users are mostly teachers and students but they plan to extend the network to the villages around the schools soon. Currently, people access the network from the schools or the Lamuka Hub.

[22] Dunia Moja Community Network, Kilifi - https://sites.google.com/ duniamoja.network/lamuka/home

4.1.2 AHERI Community Network

Africa Higher Education Research Institute[23] (AHERI) is an initiative under the Community Initiative Support Service, an organization established over 30 years. AHERI hosts annual conferences that seek to promote the use of technology in Higher Education and engage in Research in the same area. In 2020, AHERI initiated the AHERI community network, providing connectivity to technical and vocational education and training centres and community-based organizations. The network has 4 nodes in Kisumu City (Nyalenda, Dunga Beach, Akala in Siaya County, Ngíya in Siaya County, Omuga (Kabondo) in Homabay County where CISS community partner centres are based.

4.1.3 Lanet Umoja Community Network

Lanet Umoja is a community network championed by Afchix[24] and the late Chief Kariuki with support from USAID. AfChix is a network of women in Technology who consider gender diversity in the Computer Science & ICT industry very critical for increased creativity and innovative performance of the industry. Initiated in 2018, the Lanet Umoja community network provides connectivity to public schools in Lanet and also has public Wi-Fi hotspots providing internet access to the communities near the school. Additionally, the CN has provided training to youth in the community on network management and maintenance. Community leaders were also trained on how to prepare a business and sustainability plan for the network and they are already using the business plan to source funding in other prospective organizations for purposes of expanding and scaling the community network.

4.1.4 TunapandaNET Community Network

TunapandaNET[25] is a low-cost community wireless network championed by Tunapanda Institute, whose goal is to build a digital ecosystem to address digital inequalities for the socially and economically disadvantaged living in Kibera, an informal settlement in Nairobi, Kenya. The network addresses these by focusing on the provision of access to connectivity, building digital capacities, digital platforms and the creation of locally relevant content by, with and for the community. The network started in 2015 when

[23] Aheri Community Network, Kisumu - https://aheri.org/ & https://cisskisumu.org
[24] Lanet Umoja Community Network, Nakuru - http://www.afchix.org/
[25] Tunapanda Community Network, Kibera, Nairobi - https://tunapanda.org/

Tunapanda Institute had an idea of decentralizing learning from their headquarters in Olympic Kibera, which could only accommodate 30 trainees per cohort. The organization started digitizing its 3-month curriculum and is developing an e-learning platform called Swag. At that time, little did the organization know that what was being attempted was a community network or this would grow into something larger than them. In 2016, a successful pilot was made to connect TunapandaNET to a partner centre. In 2017, TunapandaNET through the support of the Internet Society Africa Bureau and community network operators attending the Africa community network summit deployed phase 1 connecting 4 centres to Tunapanda Institute. In 2018, TunapandaNET started the second expansion phase supported by the Internet Society and now has connected a total of 24 nodes including schools, community public spaces, institutions, organizations and health centres.

4.2 Technical, Operational and Institutional Models

The common motivation for the establishment of the community networks is the provision of affordable access to the internet. Except for TunapandaNET in Kibera, where Internet service providers are already active, the other three networks exist in areas where broadband provision is only available via national commercial mobile operators offering data bundles.

The pilot community networks were initiated by individuals from the community, an example being Dunia Moja in Kilifi which is championed and led by Mr Twahir Hussein, a local expert who started by running Lamuka Hub, a digital literacy training and public Internet access centre. In other instances, the community network was initiated by external individuals or organizations who worked in close collaboration with local community members, individuals and authorities. An example is Lanet Umoja which was initiated by AfCHIX working in close collaboration with the late Chief Kariuki of Lanet Umoja Community in Nakuru North District. Popularly known as the tweeting Chief, the late chief was able to use his already existing huge social media platform as well as local connections to mobilise 400 local women groups.[26] The institutional models vary from community-based organizations to Non Governmental Organisations. At the core of these pilots, networks are aligned with the local sensitivities & needs.

[26] Afchix - Projects

All the pilot community networks use license-exempt 2.4/5 GHz Wi-Fi spectrum bands for service provision. This choice is because of the relatively low cost and availability of Wi-Fi-based equipment which brings down the start-up costs of the network. The networks are centrally managed with the core network hosted at the anchor organization locations within the community in the case of TunapandaNET, AheriNET and Duniamoja. From the core network, the community networks setup point to multipoint connections using partner organizations with the geographical advantage as relay sites. The access layer, networks have 3 main models:

- **Public community spaces:** The community network provides connectivity to community public spaces such as youth and women empowerment centres. Some of these centres have computers while other users access the internet via mobile phones. Tunapanda, AHERI and Dunia Moja are providing services to public community spaces, women and youth centres.
- **Public Wi-Fi hotspots:** The community network provides public hotspots in designated places in the community where residents can access the internet.
- **Private Wi-Fi hotspots:** The community network provides connectivity to homes, local businesses and institutions such as schools, NGOs and health centres.

All the respondents stated that they provide both indoor and outdoor wi-fi equipment to the network users which is quite costly. AHERI and TunapandaNET stated that they are in the process of exploring models where the users can pay for equipment costs in instalments.

The two main backhaul technologies utilised by the pilot community networks are Wi-Fi in the 5 GHz range and fibre. The cost of backhaul is the largest expense for the networks and accounts for about 75% of the networks operation costs. The cost of backhaul capacity varies from one network to another but it's considerably higher for the networks not just because of the geographical location but also the fact that they purchase at retail prices due to lower consumption or affordability. Individually, the community networks cannot reach the wholesale capacity threshold. TunapandaNET and Lanet Umoja backhaul capacity is provided by the Kenya Education Network. Tunapanda joined the KENET membership and received other value-added services such as technical capacity building and support.

4.2.1 Community Involvement

One of the unique attributes of community networks is community engagement in different aspects of the deployment and operations of the network. In Kibera, Lanet Umoja and Kisumu the community

members are involved in the network deployment and operational activities such as mast fabrication, infrastructure build, network support and maintenance. There are also champions within the community who are involved in awareness-raising and mobilization. In Lanet Umoja, the local government administration office acts as the liaison and community champion. In Kibera, Tunapanda collaborates with the local associations of community schools, youth and women to raise awareness about the network as well as foster local partnerships.

Across all the four Kenyan networks, the community hosts, powers and provides security for the network equipment. Because of their bottom-up approach nature, community networks understand the socio-economic demographics at the local level and with a holistic approach to closing the digital divide. This is evident in how the pilot community networks approach the limited technical expertise at the local level as they have incorporated capacity building components to ensure skills transfer to community members. In Kibera, Tunapanda started a network technician internship program that identifies and trains interested youth from the community on networking. In Lanet Umoja, AfCHIX partnered with the Internet Society and offered technical training on community networks. The pilot community networks are not only tackling the connectivity and skills gap, but they also address the gender digital divide. Lanet Umoja community network is a women-led community network with 80% decision making steered by women. The network uses a gender centred approach that engages grassroots women who use their grassroots mobilization strategies.

4.2.2 Seed Funding & Financial Sustainability

Due to several factors such as lack of awareness of the potential benefits of the internet, long term investments required and low incomes levels in these areas, the networks have had to rely on donor funding and in-kind equipment donations,receiving support from organizations such as the Internet Society[27], Association of Progressive Communications[28], USAID[29] and Basic Internet Foundation[30]. Operating expenses are majorly through support from anchor organizations, individuals pooling together finances and volunteers.

[27] The Internet Society: Community Networks
[28] Connecting the Unconnected: Supporting community networks and other community-based connectivity initiatives
[29] AFCHIX | Round 1 | WomenConnect Challenge | US Agency for International Development
[30] Basic Internet Foundation | Basic Internet Foundation

4.2.3 Challenges Experienced

Below are some challenges faced by the pilot community networks.

Legal Challenges

- Three of the pilot community networks have an interest in becoming licensed operators. However, on researching the existing licensing categories they could not find any that fitted the not for profit models. Additionally, the financial, technical, and reporting requirements strain the capabilities of these pilot CNs that have limited to no financial resources.
- High cost of equipment which is resulting from the high import duties and customs fees on telecommunications equipment and user devices.
- The community networks also expressed finding it challenging to understand the license application process and have had to seek advice from existing NFP Tier-3 and Tier-2 operators. Those living outside of Nairobi are left with no option but to travel to the Headquarters office based in the capital city or regional offices to access the regulator's office.
- There has been some interest among some to access licensed spectrum especially TVWS for rural deployment but was not successful.
- The pilot community networks expressed interest in acquiring a licensed spectrum that will enable them to cover longer distances, overcome interference and congestion challenges. However, high spectrum fees and the fees associated with acquiring and operating a licensed spectrum is quite steep.
- Lack of clarity about whether part of the USAFs could be used for these types of initiatives.

Technical Challenges

- The widespread adoption of Wi-Fi also presents an interference challenge from other transmitters, especially for backhaul links affecting the network quality. Besides, Wi-Fi does not work well in environments without a line of sight, & not all user devices are equipped with Wi-Fi.
- Limited local technical competencies in network deployment, support and maintenance.
- The cost of minimum volume purchases for wholesale fibre backbones is costly and limits the communities' ability to obtain affordable backbone capacity.

Limited Access to Financing

- The pilot community networks exist in low-income areas making it challenging to get access to financing and the human capacity required to deploy, operate, and maintain these networks.
- The locations of these networks make them an unlikely beneficiary of loans from traditional lending institutions and commercial investors.
- Lack of, or limited, open-access national fibre backbones, which would facilitate the reduced cost of backhaul.

Supporting Infrastructure

- Unreliable electricity especially in rural areas results in service disruptions forcing the community networks to invest in solar panels and batteries to power equipment.

4.3 Stakeholder Consultations

The preliminary stakeholder engagement exercise sought to understand the challenges faced by the existing telecommunication operators in Kenya with regards to licensing, fees, spectrum, and administrative costs when deploying and operating a network as well as their recommendations for change. Additionally, it sought to hear their views on community networks, their role in the provision of last-mile connectivity especially in underserved areas, and recommendations on what could be done to create a more enabling environment for their growth. The engagement process involved the following stakeholders in the telecommunications ecosystem:

- NFP Tier-1 network operators - Telkom Kenya, Safaricom PLC
- NFP Tier-2 operators - Liquid Telecom, Kenya Education Network (KENET) and Kenya Power and Lighting Company (KPLC)
- NFP Tier-3 operators Mawingu Networks, Bluestreak Horizons Networks, Poa Internet, BRCK
- Government - The Information and Communication Technology Authority
- Other interviewees were with Kenya Community Network Media, Simplifi Networks, Pyramite IT

4.3.1 Summary of Consultations per Stakeholder Group

Network Facilities Providers - Tier-1

The operators cited the high cost of the spectrum from the initial acquisition to the annual operating charges as the major barrier to delivering affordable access, especially in unserved and underserved areas. The stakeholders recommended that spectrum fees should be determined in a way that promotes efficient use of spectrum and reduces the challenges faced by operators in provisioning of services in unserved and underserved areas. Although the stakeholders had limited familiarity with community networks, they were not opposed to the establishment of these networks but emphasised the need for community ownership in ensuring viability.

Network Facilities Providers - Tier-2

Access to affordable backhaul was identified as the main challenge faced by the engaged stakeholders. Other challenges were high spectrum fees, congestion in the license-exempt 5 GHz which they used for backhaul links and stringent regulations at the national and county level. The stakeholders proposed an increment of the license-exempt spectrum as well as the creation of policies differentiating rural and urban areas. Another proposal was for NOFBI to provide backhaul at prices that are affordable for all operators. There was consensus among the stakeholders on the importance of small scale operators and local operators providing last-mile connectivity. To enable growth, it was proposed that the regulator should consider reducing the barriers to entry which may incentivise informal operators,legitimise their operations as well as encourage the emergence of new ones. On community networks, the stakeholders recommended the need for a legal framework for community networks, examples mentioned were association of cooperatives, or not-for-profit organizations. It was also recommended that the regulator can waive fees for not-for-profit community networks.

Network Facilities Providers - Tier-3

Access to affordable backhaul is a major challenge especially for operators in rural areas. All the Tier-3 operators expressed concern over the growing number of unlicensed providers operating with no repercussions, resulting in an uneven playing field. Regulatory compliance, cost of doing business, and administrative requirements might result in stifling the growth of licensed operators. This was perceived as unfair by the stakeholders as they compete in the same market with unlicensed operators. With regard to spectrum availability, the NFP Tier-3 operators recommended dynamic spectrum sharing in underserved areas, access to unutilised LTE spectrum, and an increase in license-exempt frequencies.

Additionally, the operators recommended that the NOFBI management should be independent of big operators as well as make it more accessible to small operators at an affordable price. Some of the stakeholders understood the community networks model while others had a vague understanding of the concept. One of the stakeholders recommended the creation of an NFP Tier-4 with simple registration and low cost to the operators to set up access.

The Information and Communication Technology Authority

The ICT Authority has expressed interest in supporting community networks to access affordable backhaul. They are planning to implement a project connecting schools to the backbone using the Kenya Power (KPLC) infrastructure to connect the schools. Since this infrastructure will go through communities, the stakeholder proposed that it can also be used to provide backhaul capacity to community networks. The networks can be charged a small percentage to support the maintenance of infrastructure.

5 LICENSING

Four self-defined community networks were identified in the context of the project. These networks currently operate informally due to the challenges of meeting the financial and regulatory requirements of the NFP Tier-3 and ASP licenses. Preliminary findings from the stakeholder's interviews suggest that this may also be true for other small commercial network operators working in areas where the population density and/or the disposable income levels are not high. It is, therefore, necessary for the Authority to implement less onerous mechanisms in order to create an enabling environment for community networks.

Reducing operator licensing fees and the administrative overhead for community networks has been identified as a key aspect of CA's licensing practices that can be implemented. Concerning this, the following can be observed:

- Some institutions are permitted by CA to install telecommunication infrastructure with a certain license-exempt spectrum (5 GHz, 24 GHz) for their **private use**, within a campus or building, without the requirement to hold an NFP license, by simply notifying CA.
- A category of license called the Public Communication Access Centre (PCAC) license was identified as part of the Register of Unified Licensing Framework Licensees 2008. This category was created for those **reselling** services and had no fee associated with it and very few compliance requirements. This category, which could be considered an ASP waiver, was removed from the Unified Licensing Framework 2015 due to the lack of requests from licensees at the time. It may be considered as a possible way of creating a unique category for CN's under ULF.
- The existence of fee reductions for some licensees has been identified, when the service is provided in a **not-for-profit** nature & restricted to a specific community, as in the case of KENET.
- The Authority is currently undertaking a review of the Unified Licensing Framework where provisions to create a new licensing category for small telecommunication service operators and other alternative providers are being considered.

5.1 International Perspective

A review of small scale operators licensing across 14 countries has been conducted in order to identify best practices from around the world. The details of this review are included in Appendix 3. A description is presented containing the categories identified that could support this process.

5.1.1 Operator's License-exempt frameworks

Reducing requirements for fees and frequent reporting for community networks, or for providers that abide by certain principles (non-for-profit, reselling, private use, limited geographic scope, service to underserved and unserved areas etc), would be very similar to the way community networks are sanctioned by the regulator in South Africa. Similar to the Kenyan scenario, in South Africa, small operators deploying infrastructure and providing telecommunication services require two licenses: an electronic communication networks services (ECNS) class license (similar to the NFP Tier-3 license), and an electronic communication services (ECS) class license (similar to the ASP license).

License-exemptions are included as part of Section 6 in the "Electronic Communications Act 2005" and operationalized in 2008: "*Regulations regarding licence-exempt electronic communications networks, electronic communications network services, and electronic communication services in terms of Section 6 of the Electronic Communications Act, 2005*", where ICASA outlined conditions by which operators could be exempted from holding ECNS and ECS licenses. Existing definitions in the regulations for "private networks" as a category to be exempted from the ECNS license, as well as for "resellers" and "not-for-profits" as a category to be exempted from ECS licenses are provided in Appendix 7.

In both cases, "*license-exempt services are not absolved from:*

- *(a) Having all the necessary radio frequency spectrum and ECNS licences, as appropriate; and*
- *(b) Ensuring that all electronic communications equipment and facilities as well as radio apparatus to be used in respect of the services provided in terms of the license-exemption is type approved.*"

The Regulations also include a similar wording to the one included in the PCAC, whereby: ***"The Authority may, in the course of carrying out its obligations [...], require a person providing ECS and/or ECNS in terms of a license-exemption to provide information to enable the Authority to:***

- *(a) monitor and enforce consumer protection, quality of service, competition and other requirements of the Act and related legislation;*
- *(b) allow for the assessment and allocation of applicable fees and related requirements;*
- *(c) facilitate the efficient use of scarce resources; and*
- *(d) collect and compile aggregate information to be used for sectoral planning and reporting.*"

To the best of our knowledge, ICASA has not requested license-exempt holders for any "*fees or related requirements*'', besides those conditions imposed to PECN holders if they start making capacity available on a commercial basis. In the South African framework, fees are articulated in the "*General License Fee Regulations 2012*", as amended, and they are only applicable to license holders. Hence, obtaining these exemptions effectively waives the holder from paying fees, contributing to the Universal Service Fund as well as from reporting requirements.

The process to apply for a license-exemption is included in the "*Licensing Processes And Procedures For Class Licences 2010*"[31], where ICASA prescribes that:

- "*A person intending to provide a license-exempt service must notify the Authority in the format as set out in Form M.*
- *A person intending to operate, construct or maintain a PECN must notify the Authority in the format as set out in Form M.*
- *The notice to exempt a PECN must be in the format as set out in Form M."*

After processing Form M[32] successful applicants receive a licensing exempt number of the form: "*PECN/XXXX/YEAR/ECSLE/XXXX/YEAR*", for an organization having deployed a private network, and either reselling or providing services on a not-for-profit basis. This license-exempt number is used, for instance, when engaging with wholesale providers who can only engage with operators sanctioned as part of the regulatory framework. Similar authorisation waivers exist in Brazil for entities deploying localised services for up to 5000 subscribers[33].

[31] https://www.icasa.org.za/legislation-and-regulations/class-licensing-and-procedures-regulations-2010
[32] license-exemption Application form for services and networks (ecns and ecs) — Independent Communications Authority of South Africa
[33] https://antigo.anatel.gov.br/setorregulado/component/content/article/2-uncategorised/528-redes-comunitarias

5.1.2 Community Networks license

In Argentina, the regulator created a special category for Community Networks within their licensing framework via Resolution 4958/2018[34] defining Community Networks. This Resolution applies to Community Networks that provide access to the Internet in rural areas, areas with scarce infrastructure, and/or to vulnerable sectors of the population. The framework defines Community Networks as telecommunications infrastructure managed by the users of the network or by not-for-profit entities they establish, in settlements smaller than 5,000 inhabitants. Applicants meeting these criteria are exempted from paying licensing fees. Holders of this license are not allowed to resell service for commercial profit, defaulting to the requirement to obtain a Value Added Service license (similar to ASP) if they do so.

5.1.3 Operator's Authorization

Another option to consider is eliminating the requirement for an operator license for small operators, including community networks. Instead, a 'declaration of activity might be used, as is the case for operators in European Union countries[35]. Other countries that do not require a license for small network operators include Canada, the United States, New Zealand, Australia and others.

5.2 Plan of Action

The Authority has developed a plan of action for various aspects that will enable sustainable development of Community networks, following preliminary stakeholder engagement and in line with regional and international best practice. In particular, the following actions shall be implemented in the Near Term:

- To integrate a new license category for community networks within the Unified Licensing Framework reform process currently underway called Community Network Service Provider (CNSP) License.
- To ensure that the financial and administrative requirements for community networks are commensurate with their scope and scale

[34] https://www.enacom.gob.ar/multimedia/normativas/2018/res4958.pdf
[35] An example here is the UK Regulator's General Conditions of Entitlement which set out the conditions that must be met by anyone operating a telecommunications service.

For the purpose of this license, the Authority will draw on the descriptions of 'community' and 'community broadcaster' in the Information and Communications Act, which defines a community as "*a geographically founded community or any group of persons or sector of the public having a specific, ascertainable common interest*" and a community broadcasting service as an entity which meets all the following requirements:

a. *is fully controlled by a non-profit entity and carried on for non-profitable purposes;*
b. *serves a particular community;*
c. *encourages members of the community served by it or persons associated with or promoting the interests of such community to participate in the selection and provision of programmes to be broadcast in the course of such broadcasting service; and*
d. *may be funded by donations, grants, sponsorships or membership fees, or by any combination of the aforementioned*

The same requirements may be applied *mutatis mutandis* to a community network service provider, such that the requirements should include:

a. is fully controlled by a non-profit entity and carried on for non-profitable purposes;
b. serves a particular community;
c. encourages members of the community served by it or persons associated with or promoting the interests of such community to **participate in the governance, design, and operationalisation of such service**; and
d. may be funded by donations, grants, sponsorships or membership fees, or by any combination of the aforementioned

Procedures, sometimes not formalized, to reduce the financial and administrative overhead for some networks have previously existed among CA practices. The creation of the CNSP license will allow for the standardization of these practices. Additionally, integrating this category within the Unified Licensing Framework will make the process for the application and granting of licenses more integrated across CA units and their recognition by other stakeholders in the industry.

The new community network service provider license category is a hybrid model with authorisation for small scale infrastructure and service provision for a particular community in a sub-county. In the case of Kenya, it was not practical to consider the restriction of communities to settlements of less than 5,000 people, as socially vulnerable unserved or underserved populations may inhabit larger settlements. This limit is already under review in Argentina. Using the geographical boundary of a "sub-county" was viable to be used instead.

In furtherance of the Authority's responsibility to facilitate access to ICT services by the underserved, entities eligible for this CNSP license include Community Based Organizations and Non-Governmental Organisations operating in a sub-county. This approach has been adapted from the existing community broadcasting license framework. The CNSPs shall be subjected to a reduced fees structure as follows.

Market Segment		License Period (Years)	License Application Fee	Initial Operating License Fee	Annual Operating Fee	Access Fee for Frequency Spectrum	Annual Spectrum Fee
7	**COMMUNITY NETWORKS**						
	Community Network Service Provider (For deployment within a sub-county boundary)	10 Years	KShs. 1,000	KShs. 5,000	KShs. 5,000	Fee waiver for non-protected access to lightly-licensed and license-exempt frequency bands by wireless access systems.	

The community network service provider license category has adapted some aspects from the community broadcasting licensing category, so that it incorporates the requirements to respect and uplift the interest of the community as well as to ensure that the composition of its management and staff reflects the racial and gender demographics of the community it serves.

5.2.1 Licensing Requirements

- In terms of ensuring that the administrative requirements for community networks are commensurate with their scope and scale it is proposed that:The Application Form for the CNSP license draws from the existing Community Broadcasting Application Form used by Authority, and includes the requirement of two letters of support from Community Leaders as part of the process to ensure community ownership.
- The Compliance Return Form for the CNSP license draws from those used by NFP and ASP licensees focusing on the infrastructure and services that will be provided by CNSP licensees and hence reducing the complexity of the reporting process.

5.2.2 Difference between proposed CNSP license and Tier-3 NFP License

The CNSP license differs from the existing Tier-3 NFP license in the following respects:

1. Exclusively for Community Based Organizations and Non-Governmental Organisations.
2. The geographical coverage of a CNSP will be a sub-county boundary rather than a County.

3. The CNSP will comprise both infrastructure and service provision license provisions resulting in a single license being required to operate.
4. The Authority may consider an exemption for applicable fees for non-protected access to lightly-licensed and license-exempt frequency bands by wireless access systems.
5. Initial and annual fees would be lower than NFP Tier-3 license fees
6. CNSPs would be exempt from USF contributions
7. The Authority shall initiate the process of negotiating discounted rates for access to backhaul capacity by CNSPs, with the ICT Authority (ICTA) or KENET (For CNSPs founded around educational institutions). Backhaul costs are the single biggest recurring cost for operators.
8. Licences are issued for ten years and can be renewed six months before the end of the ten years.

Pros:

- Offers a relatively clear distinction between CNSP license and NFP Tier-3 license. CNSP operators that grow beyond a sub-county should apply for an NFP Tier-3 and ASP license.
- Would create a mechanism to attract existing community networks that have been operating outside the regulatory tent into the overall regulatory framework
- Has sufficient provisions to protect and incentivise community networks

Cons:

- No clear upgrade path for community network operators that scale beyond a sub-county boundary.

6 SHARED SPECTRUM

Wireless technologies are fundamental to affordable access, especially in underserved areas. Affordable access to radio spectrum is therefore essential for local operators seeking to provide sustainable access solutions in underserved areas. While regulators have unlocked spectrum for national network operators, community networks and smaller commercial wireless network operators have struggled to gain affordable access to radio spectrum to offer services. This section explores changes to spectrum regulation that could unlock more potential for community networks by expanding the range of spectrum options open to them, ranging from license-exempt to licensed IMT spectrum, and an emerging range of options that are beginning to blur the boundaries between licensed and license-exempt.

While the scarcity of spectrum as a natural resource is a fundamental principle[36] of spectrum management, it is more applicable to urban areas than rural areas, where large amounts of the spectrum typically remain unused. This is not surprising because although spectrum licenses for mobile services are typically national in scope, the business models of national mobile operators are oriented towards investment in infrastructure in more densely populated urban areas where there is a sufficiently large potential customer base combined with typically higher incomes. This leaves spectrum unused in many rural areas despite being assigned to a network operator. Incentives in the form of subsidies to national network operators for rural rollout have achieved some success but are also not a priority for corporate shareholders. These rural areas are at the frontier of the digital divide where local operators who are pioneering new business models for connecting the unserved urgently need access to the wireless spectrum. This section explores potential changes in both licence-exempt and licensed spectrum frameworks to unlock more affordable access.

6.1 License-exempt

License-exempt spectrum in the form of Wi-Fi is widely used by consumers and service providers alike. The flexibility of Wi-Fi equipment, which can serve both as an access technology as well as a backhaul PtP or PtMP technology, along with its affordability, has led to its extensive use in a wide variety of scenarios, from simple hotspots for home users to microwave links of hundreds of megabits per second.

[36] FREQUENCY SPECTRUM MANAGEMENT GUIDELINES 2020 Doc. No: CA/FSM/GUIDELINES/01/2020 Principles 3.1

Current regulations in Kenya regarding power output levels and frequencies available are detailed in Appendix 2. Wi-Fi devices in 2.4 GHz and 5 GHz do not require a unique national type approval but must comply with maximum permitted output powers specified for each band, which currently aligns with the EU regulations[37].

6.1.1 International Perspective

The availability of frequencies for license-exempt use in Kenya (see Appendix 1) is similar to frequencies and associated power levels set by many other countries. Kenyan regulations regarding power levels for Wi-Fi use are compared against several countries in Appendix 2.

Community Networks and small-scale commercial wireless Internet service providers have achieved remarkable success with the use of the license-exempt spectrum framework. Wi-Fi has proven adaptable to public access points (both indoor & outdoor), to fixed wireless access services (point to multipoint), and affordable line-of-sight wireless backhaul (point to point). In the 6 months from July to December 2020, over 30,000 Wi-Fi devices were imported into Kenya[38]; a success indicator for the Wi-Fi ecosystem.

As the success of Wi-Fi as a backhaul technology has grown, some regulatory agencies have acted to increase the value of Wi-Fi frequencies by establishing higher power output regulations specifically for PtP and PtMP links as opposed to access networks. Because of the narrower potential for interference, it is possible to consider high power levels in links that are set up to connect particular devices focused on each other. Canada[39], New Zealand[40], South Africa[41], and the United States[42] are just a few of the countries that have implemented regulations enabling differentiated power output regulations for PtP/PtMP use versus access networks.

Another area of Wi-Fi regulation under review by some regulatory bodies is the requirement for Dynamic Frequency Selection (DFS). DFS requires a Wi-Fi router to scan for radars and to switch channels if transmissions are detected. As a result, DFS can cause connection delays for Wi-Fi users and constraints on equipment use as not all Wi-Fi equipment manufacturers support DFS. Some countries

[37] Kenya – Type Approval No Longer Required for SRD
[38] Based on data supplied by CA on type approved imports for the period July-December 2020.
[39] 5 GHz Regulations in Canada (2018 Update)
[40] Wireless Basics | Support
[41] license-exempt bands in South Africa which may be used for outdoor wireless access systems Last updated May 2013 The table below
[42] FCC Rules and Regulations

including Canada[43] and the United Kingdom[44] have reviewed DFS requirements in 5 GHz frequencies intending to increase the potential use and impact of those frequencies, while still offering protection from interference to radar users.

The success of Wi-Fi coupled with the demand for devices that support faster download speeds and more users has led regulators in some countries to consider the extension of Wi-Fi into other frequencies. The United States has been a pioneer in this regard, extending license-exempt use of 5 GHz into 5.9 GHz as part of its COVID-19 response[45] and, even more significantly, unlocking 1200 MHz of spectrum in the 6 GHz range for license-exempt use[46]. Many other countries around the world are considering 6 GHz for license-exempt operation, although some are only currently considering the lower 6 GHz (5925-6425 MHz).

In many countries, the success of Wi-Fi as an enabler of small to medium scale Internet Service Providers has catalysed the formation of industry associations to represent the interests of smaller operators with the regulator but also to share knowledge and resolve issues among operators. Successful wireless ISP associations play an important role in:

- Representing the voice of smaller operators with regulator and communication ministries;
- Establishing and upholding standards for quality in WiFi equipment deployments;
- Technical training and capacity-building for operators; and,
- Dispute resolution in cases of interference.

Countries that have robust and active Wireless ISP associations include Canada[47], New Zealand[48], South Africa[49], the United Kingdom[50], the United States[51] among many others.

6.1.2 Plan of Action

Around the world, the success of Wi-Fi has prompted regulators to expand access and reduce barriers to license-exempt spectrum to capitalise on its success. CA can leverage the success of Wi-Fi as an enabler of commercial wireless ISPs and community networks by implementing the following changes.

[43] Decision on the Technical and Policy Framework for Radio Local Area Network Devices Operating in the 5150-5250 MHz Frequency Band - Spectrum management and telecommunications
[44] Consultation: Improving spectrum access for Wi-Fi – spectrum use in the 5 and 6 GHz bands
[45] October 28, 2020 FACT SHEET* Modernizing the 5.9 GHz Band First Report and Order, Further Notice of Proposed Rulemaking, and Or
[46] Federal Communications Commission FCC 20-51 Before the Federal Communications Commission Washington, DC 20554 In the Matter of
[47] CanWISP - Canada
[48] Wispa NZ - New Zealand
[49] Wireless Access Providers Association - South Africa
[50] UKWISPA: Wireless internet service providers - United Kingdom
[51] Wireless Internet Service Providers Association - United States

Plan of Action	Rationale	Action
Review SRD guidelines[52] to increase EIRP limits for or PtP/PtMP use in 2.4 and 5 GHz WiFi.	Adjustment to PtP and PtMP EIRP levels could increase the potential of Wi-Fi equipment in 2.4 GHz and 5 GHz to deliver access in rural areas.	Near term
Expand the range of frequencies available for license-exempt use, especially in the 5-6 GHz range.	The success of the Wi-Fi ecosystem can be leveraged by extending the range of frequencies available for license-exempt use. This would have the impact of reducing congestion in backhaul connections by increasing the range of license-exempt frequencies;	Near term
Review options for lowering the barrier to use of other license-exempt bands for PtP and PtMP use including 24 GHz and 60 GHz.	While the requirements by network operators may be limited at the moment, evidence from equipment sales in markets with thriving ISP sectors, suggests a natural evolution from 5 GHz to high frequency license-exempt bands as demand for capacity increases.	Near term
Strengthen collaboration with service providers to foster standards and regulatory inclusion in Kenya.	Improved industry collaboration can act to socialise good practice among operators, encourage conformance with regulatory requirements, and build the technical and business capacity of small operators	Medium term

6.2 Television White Spaces (TVWS)

Advocacy for secondary access to licensed spectrum in the television frequencies began in the United States in the early 2000s culminating in regulation for TV White Space (TVWS) technology being enacted in 2011. Kenya and South Africa were the first African countries to pilot the use of TVWS technology in 2013. While the technology trials proved successful, enabling regulation took time to follow due to the novelty of the regulatory framework and the need to provide guarantees of non-interference to the primary spectrum holders. The Dynamic Spectrum Alliance[53], a global, cross-industry, not-for-profit organization is advocating for regulations and economic best practices that will lead to more efficient utilization of spectrum and foster innovation and affordable connectivity for all.

[52] Guidelines on Short Range Devices 8th July 2016 (1).docx

[53] http://dynamicspectrumalliance.org/about-us/

In Kenya public consultations on the use of TVWS technology began in March of 2020[54]; a process that has culminated in the development of a framework for 'Authorisation of the Use of TV White Spaces'. Under the framework, geolocation database service providers will need to be qualified by the Authority to provide the necessary service to authenticate the use of TVWS devices on a dynamic, ongoing basis. Administrative and regulatory requirements will also need to be established.

Access to TVWS technology[55] will allow community networks and small network operators greater flexibility in the establishment of broadband backhaul links to connect networks. TVWS is particularly useful for complex terrains that might require multiple towers to build similar infrastructure with WiFi technology. The framework enabling and governing the use of TVWS technologies in Kenya was formally approved by the Communication Authority in April 2021.

6.2.1 International Perspective

Adoption of TVWS regulation in Sub-Saharan Africa has been slower than might be expected, given that successful trials were carried out in 2013. While trials and pilots have been implemented in more than a dozen countries in the region, only South Africa and Mozambique currently have fully regulated networks in active operation. There are signs that this is about to change. In addition to Kenya, Nigeria, Uganda, and Ghana have concluded public consultations with the intent of implementing TVWS regulations. The increasing normalisation of TVWS regulation should send positive signals to manufacturers resulting in lower prices and a more diverse ecosystem of devices.

One of the aspects that have proven most challenging with the implementation of TVWS regulation has been the establishment of the geolocation database service[56] that authenticates frequency-use for each TVWS device. Because automated geolocation authentication databases are a relatively new approach to spectrum regulation, it has not always been obvious who should operate the database, who should pay for it, and how it should be overseen.

While the geolocation database mechanism of TVWS regulation has proven a successful mechanism for the control of access to TVWS frequencies in the United States and the United Kingdom, it has not always been as clear cut in Sub-Saharan African countries.

[54] Draft Dynamic Spectrum Access Framework for Authorisation of the Use of TV White Spaces. https://ca.go.ke/public-consultation-on-the-draft-dynamic-spectrum-access-framework-for-authorisation-of-the-use-of-tv-white-spaces/
[55] http://dynamicspectrumalliance.org/wp-content/uploads/2019/10/Enhancing-Connectivity-Through-Spectrum-Sharing.pdf
[56] http://dynamicspectrumalliance.org/wp-content/uploads/2020/03/DSA_infographic-TVWS_English.pdf

In the two countries with existing TVWS regulation, Mozambique, after experimenting with a commercial geolocation database, chose a more basic approach to the assignment of TVWS frequencies electing to assign frequencies manually on demand. South Africa's regulation[57] calls for a commercial geolocation database service provider as well as a reference service database, developed and provided by their state-owned research agency, the Council for Scientific and Industrial Research (CSIR). To date, no commercial service provider has emerged. As a result of the pandemic, the South African regulator has requested that the CSIR make the geolocation database available to operators that were granted permission to operate TVWS services as part of the regulator's COVID-19 response. Currently, the database is being made available for free to small operators[58]. If TVWS is to approach the ease-of-use and utility of Wi-Fi, then seamless, free or very low-cost access to a geolocation database will be essential. A comparison of TVWS regulations around the world is available in Appendix 3.

It is worth noting that TVWS may be the tip of the iceberg in terms of the implementation of dynamic spectrum regulation. In the United States, a similar spectrum access framework to TVWS has been implemented in the 3.5 GHz bands. Citizens Broadband Radio System (CBRS), as it is known, protects the incumbents' holders of spectrum in the frequency but also allows access to the band on a regional license and/or license-exempt basis.

[57] Regulations on the use of Television White Spaces 2018 — Independent Communications Authority of South Africa
[58] Television White Spaces network operators can now use CSIR's geolocation spectrum database

6.2.2 Plan of Action

Plan of Action	Rationale	Action
• To expedite the commercial availability of geolocation database service and implement required mechanisms to make the TVWS spectrum available immediately to operators.	• The qualification of geolocation databases, in accordance with the stipulated procedures, will allow for commercial adoption of TVWS technology. Alternatively, the issuance of interim authorisations to database service providers is a suitable short-term regulatory action during this pandemic period.	Near term
• To establish an incubatory period for TVWS technologies.	• To encourage the rollout of infrastructure in rural areas and support the development of innovative services, it will be important to lower the bar as much as possible for TVWS technology use. This incubatory period will help a market for TVWS technologies take root, making it an accessible technology for CNs.	Near term
• To evaluate whether a regional approach to the implementation of geolocation databases is feasible and practical.	• Given that other countries in the region will face the same challenge with geolocation databases as they implement TVWS regulation. This might also address any cross border interference issues with TVWS.	Near term

6.3 International Mobile Telephony (IMT) Spectrum

International Mobile Telephony (IMT) spectrum refers to the range of frequencies allocated for mobile network operators. This includes the range for 2G and 3G (UMTS) networks, as well as a host of new frequencies for 4G (LTE) and 5G use.Kenya has three major mobile network operators: Safaricom, Airtel, and Telkom Kenya, with approximately 64%, 27%, and 6% respectively[59] of the mobile market. These operators have the lion share of all IMT spectrum assignments, with Safaricom dominating the other two. Full details of IMT spectrum assignments can be found in Appendix 3.

While the early assignments of IMT spectrum to national network operators had comparatively modest up-front regulator fees associated with them, mobile network operators can now expect to pay a

[59] Second Quarter Sector Statistics Report for the Financial Year 2020/2021 (October - December 2020) https://ca.go.ke/wp-content/uploads/2021/03/Sector-Statistics-Report-Q2-2020-2021.pdf

significant premium for access to IMT spectrum. This has also been true of the Digital Dividend[60] bands liberated by the migration from analogue to digital TV broadcasting. The 800 MHz band (DD1) has been divided equally among the three incumbent operators holding existing IMT licenses, for a fee of $25M for each 2x10 MHz tranche of the spectrum. Similarly, in the 700 MHz band (DD2), Jamii Telecommunications Limited (JTL) has acquired a license for 2x10 MHz of spectrum for $25 M[61]. Other consortia have applied for 700 MHz spectrum but Jamii remains the only assignment to date. Kenya is one of only a handful of countries in Sub-Saharan Africa that have successfully assigned spectrum in both the Digital Dividend bands.

Kenya was one of the first countries in the region to successfully assign the digital dividend spectrum and was able to negotiate this process without the implementation of a spectrum auction.

While the 2300 MHz, 2600 MHz, and 2500 MHz bands have been assigned to operators in some other countries in the region, in Kenya, these bands have been in use by government agencies. CA has initiated the migration of government users of these bands to alternative frequency bands, and the bands could be re-farmed for IMT network deployment. In 2019, CA permitted frequency trials for 5G in 2600 MHz.

For Fixed Wireless Access, CA has assigned spectrum in 1700 MHz, 3300 MHz and 3500 MHz to provide last-mile connectivity. According to CA's most recent annual report[62], there has been a decline in the use of these licensed frequencies for fixed wireless access in favour of license-exempt 5 GHz equipment. This may be a reflection both of the improvement in cost, range and performance of 5 GHz wireless equipment as well as the cost savings of using equipment that doesn't attract a spectrum fee.

6.3.1 International Perspective

A typical IMT spectrum license spans 10-15 years, offering exclusive access to spectrum across an entire country. This approach to assigning spectrum which guarantees access to spectrum without interference for long periods is appreciated by large investors who value the predictability and exclusivity that it provides. For the regulator, the high prices paid for the spectrum create an incentive for the operator to build out a network to recoup their investment. Given the value now placed on the IMT spectrum, the process of spectrum assignment for national, exclusive spectrum licenses is necessarily a decision of national strategic importance.

[60] The Digital Dividend: a revolution in technology
[61] This license differs slightly from 800 MHz in that the licensee has been permitted to pay the fee over the 10 year period of the license.
[62] Annual Report for Financial Year 2018-2019 - Communications Authority of Kenya

However, high spectrum prices have also had the unfortunate side-effect of creating an insurmountable barrier for small to medium size networks wishing to compete in the mobile ecosystem. Until recently there was no resolution to this impasse, but changes in the telecommunications ecosystem are unlocking new possibilities, as highlighted earlier. With access to fibre backbones and low-cost IMT base station equipment, it is now conceivable for small network operators and community networks to finance and operate local mobile broadband infrastructure.

Reflecting the growing interest in these innovations, new regulatory frameworks are beginning to emerge around the world that specifically address the challenge of unlocking access to the IMT spectrum for smaller operators, opening up opportunities for community networks and NFP-T2 & T3 operators.

6.3.1.1 Spectrum Set-Aside for Underserved Regions

One of the simplest ways to unlock IMT spectrum for affordable access in rural areas would be to set aside a portion of a frequency band specifically to serve the least connected regions of the country. In Mexico, the regulator has done this by granting a concession for the use of 2x5 MHz of spectrum in the GSM 850 MHz band[63] for social purposes. Because this spectrum intends to address affordable access in those rural localities without connectivity services, the concession was restricted in such a way that the deployment of mobile networks with this spectrum must only be in regions without connectivity and that meet at least one of the following criteria:

- Rural areas with less than 2500 inhabitants;
- Rural areas identified as priorities by the regulators; or,
- Areas designated for the development of indigenous peoples.

The size of spectrum assignment is small enough to not threaten availability for incumbent operators.

6.3.1.2 Use-it or share-it spectrum mechanisms

There is a growing body of research[64] that suggests that regulators would be better served by IMT spectrum licenses that guarantee incumbents protection from interference, as opposed to the exclusivity of spectrum use. This “use it or share it” approach to licensing has begun to make its way from theory into practice. For example, in the UK the award of the 800 MHz band in 2012 came with the following clause in the licenses:

[63] a Region 2 allocation for GSM mobile that is the equivalent of 900 MHz in Region 1
[64] Calabrese, Michael. Use it or Share It: A New Default Policy for Spectrum Management by Michael Calabrese :: SSRN

"*For the avoidance of doubt, the Licences will not guarantee exclusive use of the spectrum awarded. In the future, we may grant additional authorisations to allow the use of all, or part, of the spectrum, including the spectrum that is the subject of this Award Process. We would develop and consult on the conditions of use under any such additional authorisations to manage the risk of harmful interference*[65]*"*

Similarly, the Mexican regulator introduced the following clause into the renewal of the PCS license:

"8.6. Services for secondary use. The Institute reserves the right to grant other authorizations for the use, development and exploitation of the frequency bands covered by this Radio Spectrum concession, or portions thereof, for secondary use. In such case, the use of the bands subject of this Radio Spectrum concession shall have protection against harmful Interference.[66]*"*

The introduction of *use-it or share-it* provisions in spectrum licenses opens the door to innovation for regulators to unlock access to unused spectrum, especially in rural areas. For example, in the UK, the regulator OFCOM has introduced a Local Access License[67] which allows access to IMT frequencies in regions where existing operators are not using their assigned spectrum and have no near-term plans to occupy it. This arrangement is brokered by the regulator for a modest spectrum fee (80 GBP) for the first three years. After that, the user is at liberty to re-apply for an additional 3 year period or to negotiate an arrangement directly with the incumbent spectrum holder.

6.3.1.3 Localised spectrum licenses

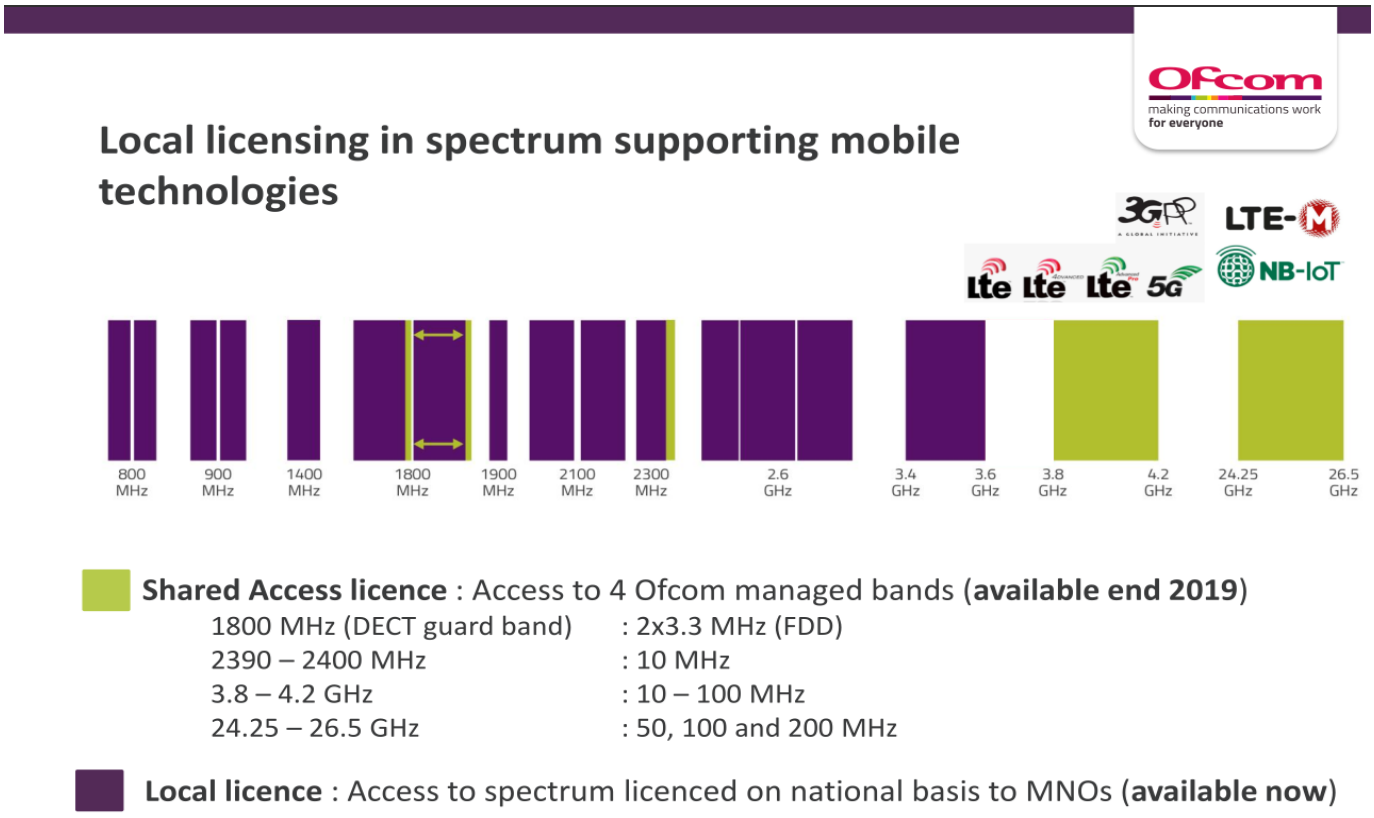
Another approach to enabling access to spectrum for local operators is to identify specific frequencies for which spectrum licenses may be granted on a highly localised basis. As the manufacturing base for low-cost LTE network equipment has grown, demand for localised access to spectrum to support private LTE networks, as well as wireless ISPs wishing to offer more comprehensive access service, has also risen. In this respect, regulators are exploring mechanisms to enable more granular access to LTE bands.

For example, in New Zealand, the regulator has established a Managed Spectrum Park[68] which set aside 40 MHz of spectrum from 2575-2620 MHz for use by local or regional operators. Originally established in 2009, the popularity of this license only began to grow in 2016 with the availability of low-cost LTE equipment from Telrad and Baicells[69]. As of 2021, there are hundreds of active licensees in the Managed

[65] Section 4.2 - page 43 The award of 800 MHz and 2.6 GHz spectrum
[66] Translated from https://rpc.ift.org.mx/vrpc//pdfs/68531_190715125729_364.pdf
[67] OFCOM Local Access Licence
[68] New Zealand - Managed spectrum park licences
[69] Conversation with New Zealand authorised spectrum engineer, Jonathan Brewer. See Appendix 5 for a table describing the current ecosystem of low-cost LTE manufacturers.

Spectrum Park. Each license has an annual fee of NZ$150 or approximately KShs. 11,000, plus an annual spectrum usage fee.

In the United Kingdom, the regulator has introduced a Shared Access License[70] which gives access to four spectrum bands that support mobile technology. This license is specific to the UK ecosystem, taking advantage of frequencies not currently assigned to mobile network operators. Power output levels are adjusted to the frequency and range of deployment with low power and medium power options. OFCOM have identified the potential for the use of geolocation databases to dynamically assign frequencies in the future but have opted for a manual system for the present. License fees vary according to the size of the spectrum channel but begin at 80 GBP for up to 10 MHz. As long as annual fees are paid and the licensee conforms with the terms of the license, the license term is indefinite.



Range of frequencies accessible under OFCOM Shared Access and Local Access license framework. Source: OFCOM

[70] United Kingdom Shared Access Licence: Guidance document

6.3.1.4 Dynamic assignment of IMT spectrum

Dynamic assignment of spectrum via a geolocation database was pioneered in the establishment of regulation for TV White Space spectrum in 2010 in the United States. Since then the US regulator has gone on to apply the same mechanism to the 3.5 GHz band, known as Citizens Broadband Radio Service or CBRS[71]. CBRS comprises a three-tier framework for spectrum access, including:

- Tier-1 – Incumbent Access, which guarantees protection from harmful interference..
- Tier-2 – Priority Access, which offers 10-year renewable licenses consisting of a 10 MHz channel. The geographic range of each license is limited to counties as defined by the US Census.
- Tier-3 – General Authorized Access, which offers rule-based access to spectrum with no guarantee of protection from interference, similar to license-exempt WiFi operation.

The implementation of CBRS, is unique to the spectrum ecosystem in the United States but the principles of dynamic tiered spectrum sharing model[72], are currently under consideration by the Authority.

The University of Strathclyde, Glasgow, UK, led a 5G RuralFirst initiative[73] to create a complete end-to-end rural 5G testbed system for trials of new wireless and networking technologies, spectrum sharing, and new applications and services. The project focused on testing innovative approaches and stimulating new business models, with a view to ensuring connectivity is accessible and affordable in hard-to-reach rural areas. The project integrated spectrum sharing strategies, bringing connectivity to rural communities. It explored smart farming, innovative methods of delivering broadcast radio and delivery of connectivity for IoT in utility and other industries in rural areas.

The successful trials demonstrated the value of connectivity to rural areas and to explore new emerging business models, across a number of broad themes[74]:

- Community & Infrastructure – testing a range of use cases and demonstrating the benefits to local residents in remote rural environments.
- Dynamic Spectrum Access – testing the feasibility of dynamic and shared spectrum for 5G to demonstrate the benefits and operability in rural areas.

[71] United States 3.5 GHz Band Overview
[72] http://dynamicspectrumalliance.org/wp-content/uploads/2019/10/Enhancing-Connectivity-Through-Spectrum-Sharing.pdf
[73] https://www.gov.uk/government/case-studies/5g-ruralfirst-rural-coverage-and-dynamic-spectrum-access-testbed-and-trial
[74] https://www.5gruralfirst.org/wp-content/uploads/2019/10/5G-RuralFirst-New-Thinking-Applied-to-Rural-Connectivity-1.pdf

- Neutral Host – providing feedback to regulators and incumbent spectrum licence holders to progress spectrum sharing and allocation policies and enable independent 'neutral host' (RAN sharing) operators to deliver connectivity in rural areas.
- Broadcast – Demonstrated the feasibility of 5G standards to provide a more efficient distribution mechanism for broadcast – both narrowcast, and wider national broadcast.
- Agri-tech – Demonstrated the potential of 5G technologies to improve agriculture.
- Industrial IoT – Demonstrated applications for renewable energy, power generation and industrial equipment.
- 5G Core Network and Radio Access Technology at pioneer band frequencies (700 MHz, 3.5 GHz & 26 GHz) and integration of other spectrum bands available for sharing.

6.3.2 Plan of Action

Consideration is being given to the establishment of an ecosystem for localised LTE network operators. These community networks and commercial NFP-T2 and NFP-T3 operators, would interconnect with other operators in the same fashion as other wireless ISPs by connecting their backhaul to an operator offering them transit or by connecting directly into an Internet Exchange Point (IXP) for peering and transit. These small network operators would necessarily provide SIM cards to their constituency. They would be subject to the same Know Your Customer (KYC) obligations as other ISPs. They would effectively be private LTE networks without any form of roaming or voice interconnection with other mobile networks. While these local operators would be using IMT spectrum, it is likely more practical to think of them operationally as ISPs.

The ecosystem for private LTE networks is becoming more and more popular around the world. The Global Mobile Suppliers Association estimates that private LTE networks have been deployed as of 2021 in 37 countries[75]. There is an opportunity to adapt this model to the provision of affordable access in underserved areas. In parallel with the availability of spectrum for small LTE operators, a large ecosystem of manufacturers has grown with dozens of low-cost LTE base stations and associated equipment available for as little as $3000. Appendix 5 lists a range of low-cost LTE manufacturers and the smallest spectrum block these eNodeB devices can operate with is 2x5 MHz of spectrum[76].

[75] Private5G Members - January 2021 - Global Update - GSA

[76] There are exceptions such as this equipment from Motorola LXN 7900 Fixed LTE 900 MHz Infrastructure but anything below 2x5MHz is better suited to IoT than broadband.

Plan of Action	Rationale	Action
● Establish a regulatory sandbox for localised spectrum access for small operators in unassigned LTE bands.	● Preliminary stakeholder interviews confirmed significant pent up demand for spectrum by community networks and commercial NFP-T2 and NFP-T3 operators. A regulatory sandbox would allow access to LTE spectrum for operators with low risk to CA.	Medium term
● To develop a dynamic spectrum access framework for underutilised IMT spectrum bands.	● Observation of local spectrum access mechanisms in other countries suggests that dynamic spectrum access mechanisms need to be well-tuned to the national ecosystem of spectrum as well as the needs of operators.	Medium Term

6.4 Spectrum Fees

The challenge of developing spectrum fee structures that are appropriate to all regions and operators is a complex task that has led to a variety of approaches across countries. It is increasingly evident that what works for a large operator may be an insurmountable barrier to fledgeling small operators. A national mobile network operator may commit $25M to a national spectrum license on the confident expectation of returns based on a well-established business model. Small operators launching services in rural and underserved regions cannot claim the same level of confidence or risk, as they innovate new business models and services. Small network operators, whether not-for-profit community networks or commercial network operators, require nurturing in the same way that new saplings in a forest need protection until their roots are more established.

As stated earlier, disaggregation of telecommunications infrastructure has opened up new opportunities for local operators but fees levied on them should be as nominal as possible, to lower the barrier to the growth of new service providers, especially in underserved regions.

Stakeholders have indicated that spectrum fees for licensed microwave links are a significant barrier. Additionally, users of 5 GHz Wi-Fi for PtP or PtMP links that cross property boundaries are obliged to seek prior approval from the CA for the installation and use of individual transmitter stations and are required to pay an annual frequency fee of KShs. 10,000 per year for each terminal/sector. This fee

structure becomes increasingly challenging for community networks as they struggle to keep costs down even while expanding the number of PtP and PtMP links in their network.

In Kenya, the annual frequency fees for fixed links are charged per transmitter in each location as per the formula below that uses a unit fee and takes into account the RF bandwidth, band and zone factors.

The fee per transmitter = RFBW 8.5KHz *K1*Unit Fee*FZ where

Unit fee = 574.10, as KShs. 574.10 is the unit spectrum fee for an 8.5 kHz band.

K1 is the band factor,

= 0.9 for frequency band ≤ 1GHz

= 0.3 for frequency band > 1 GHz and ≤ 10 GHz

= 0.21 for frequency band > 10 GHz and ≤ 20 GHz

= 0.15 for frequency band > 20 GHz and ≤ 30 GHz

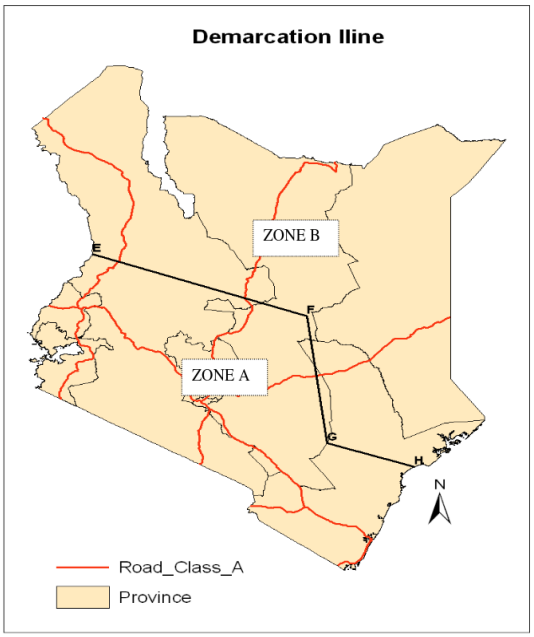
= 0.1 for frequency band > 30 GHz

RFBW is RF bandwidth in kHz subject to a minimum of 500KHz

FZ Frequency Zone Factor

= 1 for Zone A

= 0.5 for Zone B



6.4.1 International Perspective

The rapidly evolving landscape of wireless manufacturing is bringing increasingly powerful yet increasingly affordable wireless equipment across the range of wireless spectrum frequencies. Many regulators are finding that spectrum fee schemes that were designed in the pre-broadband era are not fit-for-purpose for sustainable broadband service provision. For example, Canada began a review of spectrum fees for PtP microwave links in 2019[77]. In New Zealand, the regulator has adopted a highly simplified fee structure for fixed PtP and PtMP links. All fixed links regardless of frequency, ranging from VHF to EHF, attract a single fixed annual fee of $150 NZD (~$105) per year. Additionally, In all the countries listed with active industry associations, no fee is charged for the use of Wi-Fi equipment whether for access networks or Point-to-Point or Point-to-Multipoint links.

[77] Canada: Decision on the Licence Fee Framework for Fixed Point-to-Point Systems

6.4.2 Plan of Action

Plan of Action	Rationale	Action
● To consider a spectrum fee reduction scheme for non-profit community networks	● To give local operators time to build their networks and revenue stream, a reduction in fees for a fixed period could lower the barrier to the growth of these networks.	Near term
● To review spectrum fee framework recognising the need for significantly reduced fees for underserved/rural areas.	● While the current spectrum fee regime does have a geographic component, a revised mechanism that acknowledges low-income and unserved regions would help to promote network development where it is needed.	Medium term

7 ESSENTIAL COMPLEMENTARY PLAN OF ACTION

While the primary focus of this framework is to address licensing and access to spectrum for community networks, their viability is dependent on other factors. This section addresses complementary issues that were raised during preliminary stakeholder interviews and which shall be taken into account in building an enabling environment for community networks.

7.1 Cost of Access to Optical Fibre Backhaul Networks

As demand for broadband increases, the availability and cost of backhaul internet capacity steadily increase in importance as a determinant of sustainability. National network operators can afford to build their fibre networks and/or negotiate competitive pricing by virtue of the capacity they require. Small network operators are often denied access to primary backbone networks because of the limited capacity they require, obliging them to purchase capacity from resellers at comparatively high prices. This presents a significant challenge to the sustainability of community networks offering access in underserved areas.

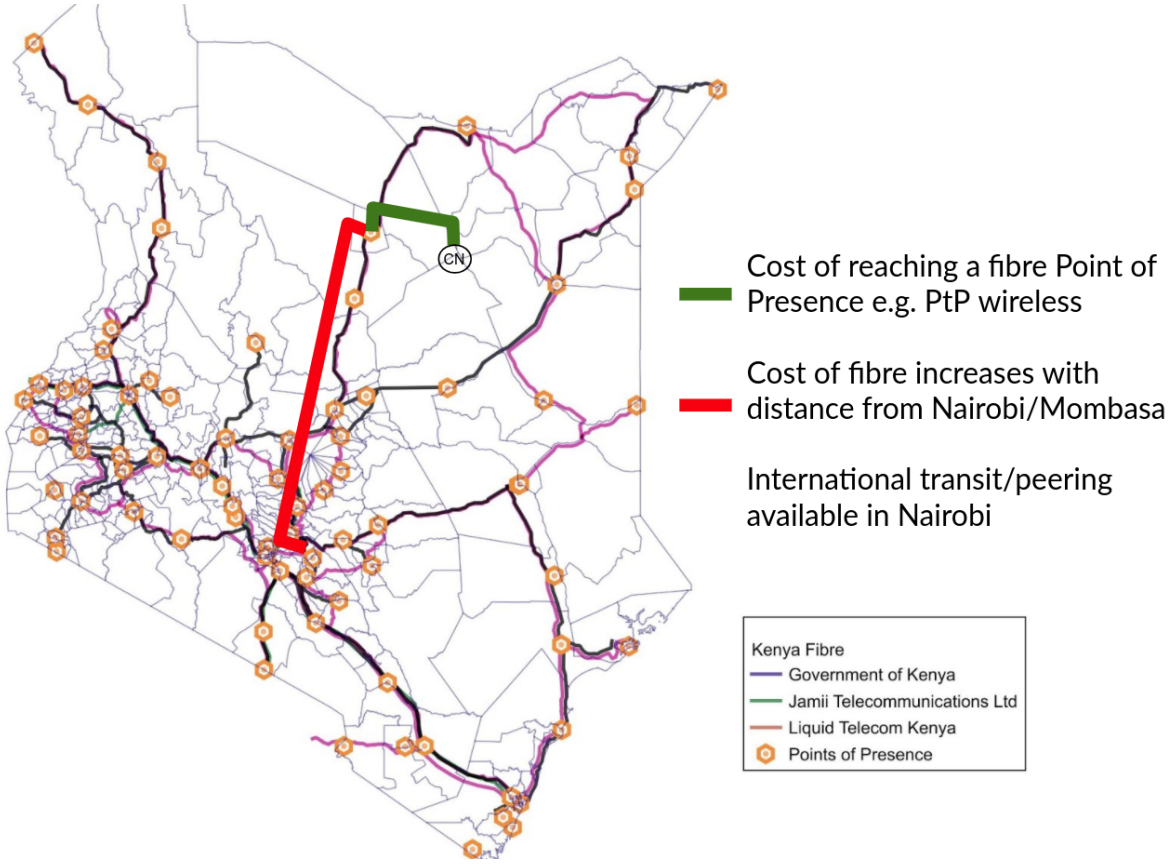


Illustration of backhaul cost. Source: APC.

Thanks to the availability of low-cost microwave backhaul technologies (represented in green in the figure above) in both license-exempt and licensed frequencies, the cost of reaching a fibre optic point-of-presence is within the financial reach of small network operators and community networks. Microwave technologies can span anywhere from a few hundred metres to more than a hundred kilometres (with repeaters). Having reached a fibre optic point of presence, community networks then theoretically have access to vast capacity connecting them at near light speed to the rest of the internet. However, the cost of access to fibre optic networks is a sticking point. Interviews with operators suggest that there is significant variance in the cost of access to fibre (represented in red above) and that the cost of fibre increases with the distance from major peering points in Nairobi or Mombasa. This puts small network operators wishing to offer services in rural areas at a significant disadvantage. An important first step in addressing the affordability of wholesale backhaul services is to reduce market information asymmetries that may exist, especially for small operators. This can be achieved by requesting NFP licensees to publish a reference pricing for their wholesale services.

The telecommunication competition study of the Kenyan market[78] carried out in 2018 by Analysys Mason, recommended that all NFP licensees be required to publish a reference access offer. This is consistent with a directive[79] published in 2006 by the Economic Community of West African States urging that technical and tariff offers for interconnection be published by public telecommunication network operators. It is also consistent with a determination in 2016 by CA on a Terrestrial Broadcast Signal Distribution Pricing And Access Framework[80].

Plan of Action	Rationale	Action
• To require fibre-optic network operators to publish a standard Reference Access Offer (RAO) in order to ensure access, transparency and non-discrimination in wholesale backhaul markets.	• Consultations with stakeholders as part of the project research revealed perceived asymmetries in backhaul pricing. Given the increasing importance of backbone infrastructure to the sustainability of small network operators and community networks, basic tariff transparency is necessary to ensure a level playing field.	Medium Term

[78] Telecommunication competition market study in Kenya
[79] Directive N° 03/2006/CM/UEMOA/CM/UEMOA Relative À L'interconnexion Des Réseaux Et Services De Télécommunications
[80] Determination No.2 of 2016 on Terrestrial Broadcast Signal Distribution (BSD) Pricing and Access Framework

7.2 Support from Universal Service Fund

A Universal Service Fund was established by the Kenya Information Communications Amendment Act, 2009[81] to complement private sector initiatives towards meeting universal access objectives. Around the similar funds are considering alternative approaches to connecting communities in underserved areas[82] in the use of funds to extend access into unserved areas.

To achieve a universal USF Broadband strategy, the Authority may consider USF projects that contain a demand stimulation and specialised capacity building element. The Authority intends to build partnerships with organisations (e.g., education institutions, civil society agencies, community network alliances) committed to training, community ICT development and community networking. The actual partnership on a county-by-county or even local level will vary, but the USF implementation framework may include a community ICT development and/or capacity building component

The community network establishment and capacity building component may be offered as separate contract components but proposals may be included in prime licensee bids, or received as separate grant application offers from licensed community network service providers entities.

Community networks require comparatively modest sums of money to get started and a small grants program initiated by the USF could kickstart new community networks. The authority will explore establishing a subsidy for start-up funds for community networks, under special projects, to help catalyse initiative from communities to develop locally-owned connectivity solutions.

In future, the authority will examine ways of supporting bottom-up digital skills capacity building initiatives by groups and organisations working within communities, who are in a strategic position to design, roll out and implement programs that are context-appropriate. This approach also has the added benefit of encouraging communities to not only consume but create for the digital ecosystem, for instance, in addressing the gap in relevant content and local languages, as well as federating research and data collection on impacts of ICTs in communities.

Not-for-profit organisations reaching out into underserved areas, often with lower associated income levels, may require additional support in order to firmly root themselves in the communities they serve.

[81] UNIVERSAL SERVICE FUND (USF) FRAMEWORK
[82] Opportunities and Challenges of using Universal Service Fund

The authority shall further examine ways to ensure that community networks receive consideration under the future framework for the Universal Service Fund.

APPENDIX 1 - Detailed Stakeholder Consultations

Network Facilities Providers: Tier-1

Existing Operator Challenges

The main challenge experienced with regard to the delivery of affordable access is the high cost of spectrum from the annual operating charges to initial acquisition costs. Other challenges included lack or limited supporting infrastructure such as roads, electricity in rural and remote areas.

Recommendations for Change

The stakeholders proposed reducing the cost of spectrum which included the initial acquisition cost and the annual spectrum fees and administrative fees. The other proposal was rethinking the taxation framework in a manner that promotes affordable access. On dynamic spectrum sharing, the stakeholders stated that there is potential for sharing especially if incentives such as relief in fees can be put in place. A partnership model could be explored as the responsibility remains with the spectrum assignee.

Views on Community Networks

While the stakeholders had limited familiarity with community networks, they were not opposed to their establishment but emphasised the need for viability through community ownership..

Network Facilities Providers: Tier-2

Existing Operator Challenges

Access to affordable backhaul is one of the main challenges that stakeholders in this category experience. One of the stakeholder's views was that backhaul is optimized for big players and sustainability is impossible as long as the regulator is not monitoring leased line prices. All the stakeholders used both licensed and unlicensed spectrum and shared that acquisition of the frequencies is a big challenge especially for higher frequencies. The stakeholders mentioned that valuable spectrum was being held back and not made available to all operators.

The issue of congestion of the license-exempt 5 GHz was also brought up with the operators experiencing interference, especially in urban areas. One of the stakeholders also expressed the challenge experienced with using 5 GHz for backhaul links across lakes resulting in investment in radios with higher specifications or licensed bands. Other challenges included high taxes and stringent regulations at the national and county level.

On small operators, the stakeholders observed that the Tier-3 license requirements were a big barrier. This resulted in the growing number of unlicensed Tier-3 operators who not only contributed to signal interference but also created an uneven competition landscape.

Recommendations for Change

The first proposal was for the regulator to provide access to more license-exempt frequencies in both urban and rural areas, especially for long distances. The fee and registration for 5 GHz should also be removed. There is a need to revise existing policies differentiating rural and urban policies. Additionally, all frequencies should be opened up in rural areas. Secondly, NOFBI should provide backhaul at prices that are affordable for all operators.

There was consensus among the Tier-2 stakeholders on the importance of small operators, both commercial and not for profit, in providing last-mile connectivity. They proposed that the regulator should reduce the barriers to entry, addressing issues such as license pricing, business requirements, and overall administration and compliance in order to increase the incentives for informal operators to acquire a license.

The regulator can also facilitate the creation of an industry association especially for Wireless ISPs modelled along the Wireless Access Providers' Association (WAPA) in South Africa. This industry association will help promote best practices among members and facilitate training. Other recommendations were the reduction or removal of the multiple taxations and the regulator finding ways to ensure the USF funds were sufficient to cover marginalised areas or compel telcos to provide services in those areas.

Views on Community Networks

The stakeholders recommended the need for a legal framework for community networks, examples mentioned were association of cooperatives, or not-for-profit organizations. ISPs both community networks and small operators, are an emerging area globally. They recommended that the regulator considers removing barriers to entry, allowing the growth to happen, then consolidate and regulate. Additionally, enable partnerships by allowing bigger companies to franchise smaller networks thus utilising unused spectrum.

It was also proposed that the regulator can waive fees for not-for-profit community networks. Additionally, one of the stakeholders stated that the regulator can use community networks as vehicles for delivering its universal service funds strategies.

On spectrum sharing, one of the stakeholders proposed that small operators and community networks could approach ISPs on spectrum sharing This would be a regulatory dispensation rather than what the operators would agree with- special treatment of some bands. For example, unused 3.5 GHz could be utilised by communities that want to build a base station in rural areas.

Network Facilities Providers: Tier-3

During the COVID-19 pandemic, digital connectivity became a lifeline. The social distancing and lockdown measures created a spike in demand, especially at the last mile. This section sought to understand the impact of COVID 19 on the NFP 3 operators offering last-mile connectivity.

For the majority of the engaged stakeholders, the pandemic resulted in huge demand for Internet connectivity and awareness thus creating demand for operators. One of the stakeholders stated that they had experienced a 70% increase in demand since March 2020. They also experienced an increase in fixed Wi-Fi connections compared to hotspots. The increased demand led to congestion in some parts of the operators' networks requiring that they invest in upgrades and also required capital expenditure for new equipment and bandwidth. Only one had their business disrupted due to the pandemic as their services were dependent on the transport industry.

Existing Operator Challenges

Access to affordable backhaul is a major challenge especially for operators in rural areas. In most cases, the infrastructure does not exist and there is no commercial incentive to connect small operators. This presents a challenge for the operators to scale resulting in them building their infrastructure over time. Capacity is also a challenge as often the backhaul is only suitable for 2G/3G connections in remote areas.

All the Tier-3 operators expressed concern over the growing number of unlicensed providers operating with no repercussions creating an uneven playing field. All operators stated experiencing interference from unlicensed providers. Burdensome compliance, cost of doing business and administrative requirements might result in stifling the growth of licensed operators and was also perceived unfair by the stakeholders as they operated on the same spectrum with unlicensed operators. The application and submission process of compliance reports involves significant overhead, the reports which are in pdf format take a long time to submit. Additionally, some of the quarterly reporting requirements are outdated, in some instances, or inapplicable in context.

Other challenges brought up were the high cost of acquiring spectrum for small operators and unstable power connections that require investing in smart energy solutions as a backup.

Recommendations for Change

On spectrum the stakeholders' views were:

- Make provisions for a regulatory sandbox about spectrum e.g. the 2.5 GHz for small operators to carry out tests at no cost.
- Introduce dynamic spectrum and geographical spectrum to underserved areas for free or low-cost access.
- Enable access to Low-frequency LTE spectrum e.g. 700 MHz, 450 MHz and TVWS especially for small operators in rural areas.

- CA should consider licensing more spectrum which can be effective in geographical locations that are unfavourable for Wi-Fi
- Increase license-exempt frequencies such as 60 GHz and TVWS
- Review and revise spectrum fees

Other recommendations included:

- The NOFBI management should be independent of big operators as well as make it more accessible to small operators at an affordable price
- Creation of a consortium of small operators to take advantage of the available/unused spectrum
- Modernize administrative processes and compliance requirements
- Review of taxation by the Ministry of ICT on excise tax and VAT for internet access

Views on Community Networks

Some of the stakeholders understood the community networks model while others had a vague understanding of the concept. The stakeholders had the following recommendations on creating an enabling environment for community networks

- The regulator needs to create a favourable environment for ISPs to spiral in growth which will benefit community networks.
- A reduction of barriers of entry for informal operators to become formal, therein these operators will work with local communities and help come up with a business model for both upstream and downstream.
- To reach the underserved communities who are pockets of the population, the creation of an NFP Tier-4 with simple registration and low cost to the operators to set up access

One of the stakeholders emphasised the need for commitment and passion by the community's members as a driver to sustainability.

Recommendations for Change

On spectrum the stakeholders' views were:

- Make provisions for a regulatory sandbox about spectrum e.g. the 2.5 GHz for small operators to carry out tests at no cost.
- Introduce dynamic spectrum and geographical spectrum to underserved areas for free or low-cost access.
- Enable access to Low-frequency LTE spectrum e.g. 700 MHz, 450 MHz and TVWS especially for small operators in rural areas.
- CA should consider licensing more spectrum which can be effective in geographical locations that are unfavourable for Wi-Fi.
- Increase license-exempt frequencies such as 60 GHz and TVWS.
- Review and revise spectrum fees.

- **The Information and Communication Technology Authority**

The ICT Authority expressed interest in supporting community networks to access affordable backhaul. They are planning to implement a project connecting schools to the backbone using the Kenya Power (KPLC) infrastructure to get to the schools. Since this infrastructure will go through communities, the stakeholder proposed that it can also be used to provide backhaul capacity to community networks. The networks can be charged a small percentage to support the maintenance of infrastructure.

Other Stakeholders

This stakeholder category included equipment vendors, an association of community radios and value-added service providers.

Challenges with the Existing Licensing and Regulatory Frameworks

The stakeholders identified the following challenges:

- Certain aspects of the process of licensing are very technical and pose a challenge to community members while applying for the license.
- High cost of licensing and spectrum access
- High import taxes and duties on equipment, the paper-based application process for equipment approval and long-time response from the regulator
- Access to LTE spectrum is out of the range of small operators.
- The most accessible spectrum is 5 GHz but is very congested impacting the quality of service

Recommendations

- The Authority should simplify the technical terms for application.
- Due diligence around real community groups and not individuals to ensure that CRs have community ownership.
- Review and reduce the equipment requiring Type approvals should be subject to the company that approves them. If a type approval has been granted for a product range, updated equipment should be covered. The application process needs to be digitized.
- Build a light license framework for fixed wireless access.
- Allocating 60-80 MHz to a head ISP that becomes the meta license holder that then makes the spectrum available to ISPs in regions.
- Licenses should be regionalised. Assigning a head organisation that hosts these licenses and manages their attribution to ISPs.

APPENDIX 2 – Plan of Action for License-exempt Spectrum Regulation

The use of the Wireless Access Systems (WAS) systems has an annual frequency fee of KShs. 10,000 per terminal. This, however, does not apply to a WAS system, with coverage and/or range that is restricted within a building and/or campus. Specific modifications are indicated below in bold.

Frequency Band (MHz)	Type of Device	Maximum Radiated Power or Field Strength Limits & Channel Spacing	Relevant Standards	Additional Requirements	Kenya TOFA Remarks
2400–2483.5	Wideband Wireless Systems. WAS/RLANs	100mW EIRP No duty cycle No channel spacing **Allow 4W for PtMP links and no limit in gain for PtP**	EEN 300 328 EN 301 489-1,17 EN 60950	CEPT/ERC/ REC 70-03	Adequate spectrum sharing mechanism (e.g. Listen-before- Talk, Detect-And-Avoid) shall be implemented by the equipment
5150-5350	Wireless Access Systems/Radio Local Access Network (WAS & RLAN) indoor use only.	200mW EIRP Dynamic Frequency Selection(DFS) & Transmitter Power control(TPC) Modulation schemes obligatory	EN 300 836-1 EN 301 893 EN 301 489-1,17 EN 60950	ITU-R M.1625 Rec. ITU-R M.1450-4, Resolution 229 (Rev.WRC- 12)	WAS- indoor use 200mW max EIRP density of 10mW/MHz in any 1 MHz (=0.25mW/25 kHz in any 25 kHz band), must employ TPC at least 3dB and DFS.
5470-5725	Wireless Access Systems / Radio Local Access Network indoor and outdoor use	1W EIRP Dynamic Frequency Selection (DFS) & Transmitter Power Control (TPC) Modulation schemes obligatory **Increase maximum EIRP to 4W**	EN 300 836-1 EN 301 489-1, 17 EN 301 893 EN 301 489-1,17 EN 60950	ITU-R M.1625 Rec. ITU-R M.1450-4, Resolution 229 (Rev.WRC- 12)	Max transmitter power of 250mW[3] with Max mean EIRP of 1W and a Max mean EIRP density of 50mW/MHz in any 1MHz band
5725-5875	Non-specific SRD	1W EIRP Dynamic Frequency Selection (DFS) & Transmitter Power Control (TPC) Modulation schemes obligatory **Allow 4W for PtMP and no limit in gain for PtP links**	EN 300 836-1 EN 301 489-1, 17 EN 301 893 EN 301 489-1,17 EN 60950	CEPT/ERC/ REC 70-03	
24.00-24.25	Non-specific SRD	100mW EIRP No duty cycle restriction No channel spacing	EN 300 440 EN 301 489-1,3 EN 60950	CEPT/ERC/ REC 70-03	Amateur User licence required Radiolocation ISM

APPENDIX 3 – Small Scale Operator License - Country Comparison

Small Scale Operators	Kenya	Mexico	South Africa	Brazil	Argentina	United Kingdom	United States	New Zealand	Canada	Uganda	Nigeria	Ghana	Tanzania	India
Operator Licensing (Minimum requirements)														
Infrastructure License	Tier-3 NFP license 0.4% or US$1500	Reseller license (no annual fee)	Class ECNS license US$875	Multimedia Licence	Community Network license	Not required (Free)	Not required (Free)	Not required (Free)	Not required (Free)	Public Infrastructure Provider Licence US$10,000	Internet Services License US$1,300	Internet Service Provider US$1337	Network Facilities (District) License US$3450	Internet Service (Category C) Secondary Service Area 8% of AGR
Service License	ASP license 0.4% or US$740		Class ECS License US$875							Public Service Provider Licence (Capacity Resale) US$3,000			Network Services (District) US$5750	
Other License											Private Network Links			
Exemptions		Exemption for social purpose		license - exemption for operators with < 5000 subscribers	towns < 5000 inhabitants					Communal Access Provider License US$3,000				

APPENDIX 4 – Small Scale Operator Access to Spectrum - Country Comparison

Small Scale Operators		Kenya	Mexico	South Africa	Brazil	Argentina	United Kingdom	United States	New Zealand	Canada	Uganda	Nigeria	Ghana	Tanzania	India
license-exempt Spectrum (MHz)															
2400 – 2483.5	**EIRP**	100mW	2W in PtP 1W in PtMP	100mW	4W	4W		4W in PtMP. PtP of 1 dBm less in TxPower per 3 dBi increase in antenna gain above 6 dBm	100mW	4W in PtMP and no limit in the Gain in PtP	100mW	1W	100mW	200mW	100mW
	Tx Power		500mW in PtP 250mW in PtMP		1W	1W		1W		1W					
Registration required?		No	No	No	No	No	No	No	No	No	No	No	No	No	No
5150 – 5250	**EIRP**	200mW	200mW	200mW	200mW	200mW	200mW	4W in PtP 53 in PtMP	1W	200mW indoor only	200mW	200mW	200mW	200mW	1W
	Tx Power		50mW			50mW		1W							
5250 – 5350	**EIRP**	200mW	1W	100mW	200mW	4W	200mW	1W	1W	1W	200mW		200mW	200mW	200mW
	Tx Power		250mW			1W		250mW		250mW					
5470 – 5650	**EIRP**	1W	1W	1W	1W	4W	1W	1W	1W	1W	1W	4W (Licensed)	1W	1W	200mW
	Tx Power	250mW	250mW		250mW	1W		250mW		250mW					
5650 – 5725	**EIRP**	1W	1W	1W	1W	4W	1W	1W	1W	1W	1W	4W (Licensed)	1W	1W	200mW
	Tx Power	250mW	250mW		250mW	1W		250mW		250mW					
5725 – 5850	**EIRP**	1W	4W	4W (PtP 200W)	4W	4W (200W for PtP links up to 5.825 GHz)	4W light license (fee and registration)	4W in PtMP and no limit in the Antenna Gain in PtP	200W for PtP	4W in PtMP and no limit in the Gain in PtP	4W in PtMP PtP of 1 dB less in TxPower per 3 dB increase in ant. gain above 6 dBi	4W (no limit in gain for PtP)	4W	1W	1W
	Tx Power		1W	1W	1W	1W		1W		1W		1W			

Registration required?		Yes	No	No		No	No except 5725-5850	No	No	No		No	No		
Small Scale Operators		**Kenya**	**Mexico**	**South Africa**	**Brazil**	**Argentina**	**United Kingdom**	**United States**	**New Zealand**	**Canada**	**Uganda**	**Nigeria**	**Ghana**	**Tanzania**	**India**
17GHz				100mW											
24.15 – 24.25 GHz	**EIRP**			100mW			100mW		1W						
V-Band (60GHz)				55dBm			85dBm (light licensed)	82dBm						10W	
E-Band (70/80 GHz)							85dBm (light licensed)		Licensed						
Dynamic Spectrum (TVWS or other)															
Regulatory Status (2021)		nearly complete		operational	consultation underway	none	operational	operational	operational	awaiting database provider	consultation underway	nearly complete	consultation started, possibly stalled?	none	none
International Mobile Telephony (IMT) Spectrum															
Alternative access to IMT spectrum			set-aside of GSM spectrum for CNs	None	None	None	Local Access and Shared Access License	CBRS	Managed Spectrum Park	none	USF project	none	none	rural spectrum license	none
Use it or Share It license provisions			**Yes**	No	No	No	**Yes**	**Yes**	No	No	No	No	No	No	No

APPENDIX 5 – Low-Cost LTE Equipment Vendors and Products

Make	Model	Power	Band Support																						Price
			1	2	3	4	5	7	8	12	13	14	17	20	26	28	38	39	40	41	42	43	46	48	68	
Acceleran	L1000				1			1				1				1	1		1	1	1	1		1	1	
Airspan	AirHarmony 1000	2x5w														1			1	1	1					
Baicells	Nova 233	1w	1		1		1	1			1			1		1										$3600
Baicells	Nova 246	20W	1		1			1			1					1										$7000
Blinq	FW-300i	10W																			1	1		1		$7000
Blinq	FW-600																			1	1	1		1		
Cambium	cnRanger Sierra 800	8TX/8RX															1		1	1	1	1		1		
Cambium	cnRanger Palisade	4W combined															1		1	1						
CellXica	MuLTEfleX																									
CIG	Picocell Model SC-200																				1	1				
Eion wireless	?																				1	1	1	1		
Ericsson	Micro 6502																									
Fairwaves	UmSITE-3G4G-TM2 SDR	2x2w & 2x5W	1		1		1	1	1							1	1									
General Dynamics	Fortress(RN2404)	4W																								
Huawei	AtomCell																									
IP.access	R60	2 x 5W	1	1	1	1	1	1	1	1	1	1	1	1		1										
Klas Telecom	VoyagerCell 4GAPx LTE	1w;2w;5w mimo																								
Limemicro systems	Crowd Cell																									
Mavenir	Remote Radio Head	4T4R 4X40W			1																					
Mikrotik	Intercell 10	2*(2*10W)															1	1								~$3000
Motorola	LXN 7900 Fixed LTE 900	up to 80W / port							1																	
Nokia	flexizone micro,mini-macro	5w – 20w			1			1	1						1	1		1								~$8-12K
Octasic	OCTBTS 8500	4W	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Make	Model	Power	Band Support																						Price

			1	2	3	4	5	7	8	12	13	14	17	20	26	28	38	39	40	41	42	43	46	48	68	
Parallel Wireless	CAP2-01	1w							1							1										
Redline	RDL-6000 L1 Ellipse 4G	+25dBm					1		1	1	1	1	1	1		1				1	1	1			1	
Star Solutions	iCell Compac LTE Macro	2x20w					1					1		1		1										$11-14K
Tecore	CoreCell-E or M	1w;10w;20w																								$10-15K
Telrad	BreezeCOMPACT1000	1W/port,4Tx4 Rx																			1	1		1		
Vanu	Anywave	5w		1	1				1																	
VNL	VBS-W2 or W10	1Wx2; 5Wx2														1										$6-7K
Band Support Totals																										
			5	3	9	2	6	7	8	3	5	5	3	5	2	12	6	3	5	7	10	9	2	7	3	

Most popular bands:	
Band 28 (700 MHz) FDD	12
Band 42 (2500 MHz) TDD	10
Band 43 (3700 MHz) TDD	9
Band 3 (1800 MHz) FDD	9
Band 8 (900 MHz) FDD	8
Band 7 (2600 MHz) FDD	7
Band 48 (3500 MHz) TDD	7
Band 5 (850 MHz) FDD	5
Band 1 (2100 MHz) FDD	5

APPENDIX 6 – TVWS Regulations Around the World

Country	Regulation status	Channel Size (MHz)	Freq Start (MHz)	Freq End (MHz)	WSDB Update Freq (hrs)	EIRP Rural (dBm)	EIRP Urban (dBm)	EIRP Nomadic (dBm)	Adjacent Channel Leakage Ratio (ACLR)	Max Antenna Height (m)
Colombia	Published	6	470	698	24	46,15	46,15	Fixed only		50
Ghana	Draft	8	470	694	24	40	36	20	ETSI	30
Kenya	Draft	8	470	694	24	40	?	?	ETSI	?
Mozambique	Draft	8	470	694	48/24	41.2	36		ETSI	40
New Zealand	Published	8	510	686	N/A	40			ETSI	
Nigeria	Draft	8	470	694	24	40	36			60
Singapore	Active	8	470	806	6	36	20	20		30
South Africa	Published	8	470	694	12	41.2	30	20	ETSI	30
South Korea	Published		470	698						
Trinidad & Tobago	Published	6	470	698	24	36		Fixed only	See regulation	
Uganda	Published	8	470	694	?	36	36	20	ETSI	50
United Kingdom	Active	8	470	790	0.25	36				30
United States	Active	6	470	694	0.3	36				

APPENDIX 7 - License-Exemption Definitions in South Africa

License-exemptions are included as part of the Section 6 in the "Electronic Communications Act 2005" and operationalized in the 2008: "*Regulations regarding license-exempt electronic communications networks, electronic communications network services, and electronic communication services in terms of Section 6 of the Electronic Communications Act, 2005*", where ICASA outlined conditions by which operators could be exempted from holding ECNS and ECS licenses. Definitions include the following:

- Deploying telecommunications infrastructure for a "*private network*" (PECN) appears as a category for the exemption from holding an ECNS. A private networks is defined as:
    - "*an electronic communications network used primarily for providing electronic communications for the owner's own use*;"
- Providing telecommunication services by:
    - reselling "*ECS duly obtained from a licensee*". In ECA 2005 "*''**reseller**'' means a person who*
        - *(a) acquires, through lease or other commercial arrangement, by any electronic communications network service or electronic communications service; and*
        - *(b) makes such electronic communications network service or electronic communications service available to subscribers for a fee, whether or not such electronic communications network services or electronic communications services made available by the reseller*
            - *(i) are identical to the electronic communications network service or electronic communications service acquired;*
            - *(ii) are packaged, bundled or otherwise re-grouped to form new or varied service offerings;*
            - *(iii) are combined, linked or used in connection with electronic communications networks or electronic communications facilities owned by the reseller; or (iv) add value to such electronic communications network services or electronic communications services, and ''resale'' is construed accordingly;*"
    - by doing it on a "***non-for-profit basis"*** appear as categories for the exemption from holding an ECS). As per the regulations "*A person who provides ECS on a not-for-profit basis is license-exempt and may include, but not limited to:*
        - *(a) a non profit organization registered in terms of the Non-Profit Organizations Act, 1997 (Act No.71 of 1997);*
        - *(b) a company registered in terms of section 21 of the Companies Act, 1973 (Act No.61 of 1 973);*
        - *(c) a not-for-profit organization established in terms of any other Act of Parliament; or*
        - *(d) an entity that provides ECS to the public for free."*