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SPECTRUM MANAGEMENT AND REGULATION IN KENYA

ENGENDERING INCLUSIVE ACCESS TO TECHNOLOGY AND INFORMATION

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Table of Contents

I. Introduction

Computers and other information communications technology (ICT) gadgets have become part of the households today and are no longer perceived as luxuries.1 In general, household ownership of personal computers and mobile phones and internet access are closely linked and dependent on household incomes2. Convergence3 of technologies in the ICT sector has also made it easier to access services like the internet. This changing technological landscape has brought about new opportunities however it also raises challenges on the spectrum management framework. This paper discusses the issues of spectrum focusing inequitable access, benefit to the public and overall national development. It expands the discourse from the typical narrative of the economic benefits to the market players to include the policy considerations of spectrum as a commons and the need for its equitable distribution. This is particularly pertinent as technological innovations have also changed the landscape and increased demand for spectrum by different users. This is also critical due to the fact that spectrum is a finite resource and the regulatory framework for its optimal use and sharing are rapidly developing. Convergence of certain sectors have also changed the market landscape and spurring debates on net neutrality4 to enhance competition in the offering of Internet related services.5Policy makers and regulators must therefore craft pro-active policy and regulatory solutions to enhance access to internet and other media for the public and inclusivity in the digital world.6Indeed the benefits of the digital economy can only be enjoyed with the when the policy makers and regulators take equality of access to spectrum into consideration. With such equitable access, service providers will be encouraged to keep up with dynamic innovation and growth of the information and technology sector. This is why this report focuses on the need to engender inclusive access to technology and information for all.

We argue that spectrum is a finite public resource which must be managed for the benefit of all and used in a way that leads to enhanced access to information and technology for all citizens. The report is divided into six parts. Part I is the introduction while Part II provides the background to spectrum management. Part III discusses spectrum management and regulation in Kenya. Part IV deals with Spectrum, Access to Technology and Access to Information while Part V deals with International Perspectives on Spectrum. Part VI comprises conclusions and recommendations.

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1 CCK, Analysis of ICT (2010) www.researchictafrica.net/countries/.../Report_of_the_National_ICT_Survey_2010.pdf. accessed 10 June 2016

2 ibid

3 Convergence as used in this paper means the erosion of the traditional boundaries between previously separate ICT services, networks, and business practices due to dynamic markets and technological developments.Consequently, arising from convergence in the ICT sector industries are adapting and new industries are emerging to deliver enriched user experiences for consumers, enterprises, and the private sector.

4 Net neutrality refers to the principle that Internet service providers should enable access to all content and applications regardless of the source, and without favoring or blocking particular products or Available at www.elibrary.worldbank.org/doi/abs/10.1596/978-0-8213-8169-4 accessed 1th September 2016

5 International Telecommunication Union, *Trends in Telecommunications Reforms 2015: Getting Ready for the Digital Economy* (ITU 2015) ISBN 978-92-6115521-6.

6 Ibid

II. Background on Spectrum Management

A. History

In 1887 a radio transmitter began working briefly - the first and at that time the only one in the world. It was located in the research laboratory of a young German physicist, Heinrich Hertz[7], and its transmissions could be received over a range of just a few metres.[8]Ten years later (1897), just barely over a century ago, Guglielmo Marconi[9] first transmitted a wireless signal. It took another ten years (1907) for Lee de Forest[10] to develop a workable amplifier and oscillator for broadcast purposes.[11]

Technologies that underpin mobile radio were first put to work in the 1890s on behalf of oceangoing ships, which had previously relied on carrier pigeons and flags for their communications. In 1899, the R.F. Matthews became the first ship to request emergency assistance using a wireless apparatus (Marconi's system). [12]

After broadcast or "wireless," communication was first developed; rights to use a particular frequency of the electromagnetic spectrum were allocated through a "first-in-time" principle, as were many private property rights under the common law. One who wanted to broadcast simply appropriated a suitable frequency; one who came later found another, unused frequency.

Rights established through the first-in-time principle were not, however, recognized and enforced consistently, and many conflicts arose. These conflicts were addressed through legislation in the jurisdictions which had begun radio operations. For instance, the American Congress passed the Radio Act of 1912,[13] which attempted to solve the problem of too many

7 A German physicist; He was the first to prove that you could transmit and receive electric waves wirelessly. Although Hertz originally thought his work had no practical use, today it is recognized as the fundamental building block of radio. Every frequency measurement is named after him (the Hertz); A short history of radio

8 William Gosling, *Radio Spectrum Conservation* (Newnes, 2000) p3

9 An Italian Creator; Spent most of his working life in England where he introduced many of the first uses of wireless telegraphy to European navies. His radio apparatus is widely considered to be the reason that over 700 people survived the Titanic disaster in 1912— instead of dying as they likely would have if ships at sea were still using carrier pigeons to communicate over great distances.

10 Credited with being the "Father of American radio." DeForest was a direct competitor to Marconi at the turn of the century (1899), when he was the chief scientist at the U.S.'s first radio firm—American Wireless Telephone and Telegraph—until Marconi took over the company's assets in 1912 after a series of financial scandals. Although he held 300 patents, DeForest's greatest technological contribution is considered to be his 1906 "Audion" vacuum tube.

11 Patrick S. Ryan, 'Application of the Public Trust Doctrine and Principles of Natural Resource Management to Electromagnetic Spectrum' [2004] 10 Michigan Telecommunications and Technology Law Review

12 FCC, *A short History of Radio with an Inside Focus on Mobile Radio* (Winter 2003- 2004) available at https://transition.fcc.gov/omd/history/radio/documents/short_history.pdf accessed on 15th April 2016

13 Was the first US federal law requiring all seafaring vessels to maintain 24-hour radio

broadcasters vying for too few frequencies by prohibiting broadcasting without a license. The United Kingdom (UK) attempted to regulate spectrum in 1904 by passing the Wireless Telegraphy Act[14] which inter alia, covered the use of radio for a comprehensive range of communication.

B. Determining Rights to Spectrum

As pointed out above, the regulation of the spectrum should be undertaken in the public interest, assuring equal access and opportunity for all people. The question of whether spectrum is a unique resource that belongs to the public, or one that can be privately owned like any other property is therefore pertinent. Most people assume that public ownership of spectrum is axiomatic—a starting point. Not surprisingly, most countries consider the radio frequency spectrum as an exclusive property of the state.

The idea of public ownership is a product of history and politics as much as it is of the characteristics of the electromagnetic spectrum itself. [15]

The importance and scarcity of the electromagnetic spectrum justified both the goal of broadcast regulation-a "commitment to the public interest"- and the means to that end-a form of public ownership in which electromagnetic spectrum is essentially owned by the government, and, through licensing, is leased or temporarily granted to broadcasters. The concept of public ownership and service to the public interest is manifested through regulation of the structure of the broadcast industry through administrative allocation of rights to use the electromagnetic spectrum for broadcast, and through regulation of the content that may be broadcast.[16] The co-existence of the public and private aspects of spectrum is reflected in the diverse regulatory models used for regulation.

1. The Public-Trust Doctrine

This doctrine is based on common or public ownership. It requires that certain property be used for public benefit, because of either its unique characteristics or its essentially public nature. It may mean that the owner of otherwise privately-owned property is required to provide public access or it may also preclude private ownership altogether. It is based on English common law, where common property was held by the sovereign in trust for the citizens.[17]

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watch and keep in contact with nearby ships and coastal radio stations. The Act also required all amateur radio operators to be licensed. The conflicts between amateur radio operators and the U.S. Navy and private corporations, and the sinking of the RMS Titanic led to the passage of the act. The Act set a precedent for international and federal legislation of wireless communications. It was later repealed by the Radio Act of 1927.

14 Came after the Telegraphy Act of 1967 ; It laid down that no person should establish a wireless telegraph station or instal or work any apparatus for wireless telegraphy without first securing a licence from the Postmaster-General. See Assa Briggs, *The History of Broadcasting in the United Kingdom Vol 1 : The Birth of Broadcasting* (OUP, 1961)

15 Kristylyn Corbett, 'The Rise Of Private Property rights in Broadcast Spectrum' [1996] 16 Duke Law Journal 61

16 ibid

17 Ibid ; see also generally Randy T. Simmons, 'Property and the Public Trust Doctrine'[2007] *PERCPolicy Series* Issue 39 ; Carol M. Rose, *Property and Persuasion :*

Sax claimed, "Of all the concepts known to American law, only the public trust doctrine seems to have the breadth and substantive content which might make it useful as a tool of general application for citizens seeking to develop a comprehensive legal approach to resource management problems"[18]. He identified three restrictions the public trust doctrine places on government action: first, the property subject to the trust must not only be used for a public purpose, but it must be held available for use by the general public; second, the property may not be sold, even for a fair cash equivalent; and third, the property must be maintained for particular types of uses.[19]

The Radio Act of 1912 of the USA contained the seeds of the Public Trust Model in America. Although it did not explicitly rely on public ownership, it introduced administrative allocation of the broadcast spectrum, which is central to the public trust model. In addition, provisions of the Act led to a situation in which spectrum became even more scarce making increased government control desirable.[20]

The public trust doctrine was historically applied to rivers and seashores to protect navigation, commercial, and fishing rights[21]. Today, its advocates have far more grand plans for the doctrine. Public access and the impossibility of autonomous private ownership is one such advocacy that formed the basis of the administrative management of the electromagnetic broadcast spectrum.[22]

Throughout most of the history of radio communication, spectrum was treated as a common property resource owned and controlled by governments as trustees for the public. But long before digital technology, commentators had begun questioning the efficacy of spectrum regulatory bodies such as the American Federal Communications Commission, Australian Communications and Office of Communications of the United Kingdom.

Economists such as Ronald H. Coase[23] ridiculed and criticized the approach employed by most states as paternalistic. They argued that governments in their attempts to avoid market inefficiencies by centralized decision making akin to communist-style centrally-planned

Essays on the History, Theory and Rhetoric of Ownership (Westview Press, 1994)

18 Joseph L. Sax, 'The Public Trust Doctrine in Natural Resource Law: E□ective Judicial Intervention' [1970] Michigan Law Review 68(3): 471–566

19 Randy T. Simmons, 'Property and the Public Trust Doctrine'[2007] *PERCPolicy Series* Issue 39 at p11

20 While the Act gave the Secretary of Commerce authority to license broadcasters, it had not given him authority to provide for the exclusive assignment of frequencies or to deny a right to use the electromagnetic spectrum. Without a means to exclude new broadcasters, the rapid proliferation of commercial radio broadcasters in the 1920s created "chaos,"' as new broadcasters appropriated new frequencies as quickly as they could build stations, and as existing broadcasters changed their frequencies and hours of broadcasting without warning. The disorganization prompted broadcasters, with the leadership of then Secretary of Commerce Herbert Hoover, to call for legislation to replace the Radio Act

21 Randy T. Simmons, 'Property and the Public Trust Doctrine'[2007] *PERCPolicy Series* Issue 39

22 Corbett (1996) supra

23 Is famously credited with coining the 'Coase theorem' ; See generally, Ronald Coase , 'The Federal Communications Commission'[1959] *2 Journal of Law and Economics* 1-40

programs were in fact increasing inefficiencies and unnecessary delays and in doing so, were truncating economic experimentation, stifling innovation, and substituting inefficient theoretical models for natural economic progress.[24] Coase was very critical of the FCC and its allocation-by-fiat methodologies. He wondered why spectrum should be centrally planned when the rest of our economy was market-based.[25] This critique has taken several decades to emerge, but it has advanced rapidly in recent years, particularly among economists.[26]

The FCC Chairman Michael Powell described this system of regulation as a paternalistic, "mother may I" relationship:

> While the wireless world has changed rapidly, government spectrum policy continues to be constrained by allocation and licensing systems from a bygone era. Change is inhibited by the, 'mother may I' phenomenon-businesses must go to the FCC for permission before they can modify their spectrum plans to respond to consumer demand.[27]

The proliferation of this kind of thinking by economists, liberals and politicians, saw the beginning of the possible treatment of spectrum as private property.[28]

2. Spectrum as Private Property (Exclusive Access)

The first argument in favor of a private property rights (spectrum trading) approach to was apparently made by Herzel in 1951.[29] Thereafter, Ronald Coase added his voice to this rally in 1959.[30] Other economists and lawyers have since had a lot to say on the subject.[31]

Privatization of spectrum, the exclusive initial assignment of private property rights, is the traditional means of making spectrum available to private owners such as cellular network and broadcast media operators. The argument is that exclusivity promotes owners

24 Patrick S. Ryan, 'Application of the Public Trust Doctrine and Principles of Natural Resource Management to Electromagnetic Spectrum' [2004] 10 Michigan Telecommunications and Technology Law Review at 287-288

25 Coase (1959) supra

26 Ryan (2004) supra

27 Michael K. Powell, Broadband Migration III: New Directions in Wireless Policy, Remarks at the Silicon Flatirons Telecommunications Program, University of Colorado at Boulder (October 30, 2002), *available at* http://www.fcc.gov/Speeches/Powell/2002/spmkp212.html accessed on 28th may, 2016.

28 Examples of others apart for Coase and Powell

29 Leo Herzel, 'My 1951 Color Television Article'[1998] *The Journal of Law & Economics*

30 See generally, Ronald Coase , 'The Federal Communications Commission'[1959] 2 *Journal of Law and Economics* 1-40

31 See Lawrence White, ''Propertyzing' the Electromagnetic Spectrum: Why It's Important, and How to Begin,'[2001] in J.A. Eisenach and R.J. May(Eds.), *Communications Deregulation and FCC Reform: Finishing the Job,* (Kluwer, 2001) ; Michael Heller, 'The Tragedy of the Anticommons: Property in the Transition from Marx to Markets' [1998] 111 *Harvard Law Review* 621-625 ; Yochai Benkler, 'Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment' [1997] 11 Harvard Journal Law & Tech

and operators' long term investment in large scale networks and guarantees high quality services.[32] Licenses are granted by National Regulatory Authorities (NRAs) in accordance with national laws and rules, either directly following an operator's application, through a 'beauty contest'[33] procedure, or through auctions. The licensee has the sole right to use this spectrum according to the assignment rules, either on a nationwide basis or within a defined geographical region, over a significantly long period of time (could be upto 20 years). It is commonly acknowledged that such exclusive use of dedicated spectrum will continue to be the preferred way of spectrum usage by operators.[34]

Spectrum trading is practiced, to some degree, in Australia, New Zealand, Guatemala and the United States of America (USA). Proponents of this model believe that the market can more efficiently allocate spectrum to those who need it.[35] However, trading is premised on the same standard as spectrum auctions and provides spectrum to those that can best afford it. In addition, some companies have begun to speculatively buy spectrum with no intention of using it, but as an investment for future sale.

It has been argued that auctions derive the most efficient use of spectrum because "the market" would not permit inefficient use.[36]Persons buying spectrum at competitive prices would know how best to put it to the most use.

> Spectrum auctions assure that, above all, use of the spectrum is attributed to those with the most capital to invest in acquiring it. In many cases this has led to the creation of communication networks that severely limit the ability of its users to create and innovate as spectrum owners often heavily control the sort of devices that can be used on these networks and what these devices can do. This spectrum management practice has also led to the creation of a spectrum rights industry where corporations simply buy spectrum as an investment for future re-sale, impeding the ability of other people to use it.[37]

The auction in New Zealand for instance, the method has been largely informed by the Radio Communications Act of 1989.[38] For existing licensees it has been suggested that the auctioning of warrants should effectively convert existing usage privileges into ownership

32 Coase (1959), supra; Gerald R. Faulhaber and David Farber, 'Spectrum Management: Property Rights, Markets, And The Commons' in Lorrie Faith Cranor & Steve S. Wildman (Eds.), *Rethinking Rights and Regulations: Insitutional Responses to New Communications Technologies* (MIT Press, 2003)

33 Here, multiple applicants compete for a license and are compared to one another. Sometimes they are accompanied by public hearings where the general public can intervene. This means that, uses of the spectrum can be publicly evaluated; standards related to the common good developed, implemented and adhered to; and citizens can play an active role in judging an application's worthiness. This method for assigning spectrum is not full proof because an application can be made to appear to adhere to standards or satisfy the demands of citizens to a greater degree than he actually does.

34 Nokia, *Optimising Spectrum Utilisation towards2020* (White Paper, 2014)

35 ITU, *Introducing Spectrum Trading* (ICT Regulation Toolkit, dec 2006) available at https://www.itu.int/ITU-D/treg/Events/Seminars/2006/ceotraining/documents/3Dec_Session_C_Spectrum%20Trading.pdf accessed on 25th June 2016

36 APC, *Open Spectrum for Development* (Oct, 2010)

37 ibid

38 Public Act no 148 of 1989; available at http://www.legislation.govt.nz/act/public/1989/0148/latest/DLM195576.html accessed on 25th June 2016

rights. Proponents of the private property model perceive it as capable of solving the three problems of spectrum management - allocation, assignment and dynamic adjustment -simultaneously as they are driven by market forces: .[39]

So far, there is only limited experience with privatisation of spectrum. However, serious conceptual objections have been raised, including the pervasiveness of externalities, the non-competitive nature of wireless markets and the fact that large portions of spectrum are used by non-profit organisations or for purposes that defy market pricing. Moreover, where international frequency coordination is necessary and spectrum is allotted to regions, a private market mechanism may raise serious equity issues.[40]

Whereas some of these issues could probably be overcome by appropriate institutional design, privatisation is not a panacea for all problems.[41] However the marketization of spectrum has been limited and there is still a perception that property rights in spectrum lie with the public.[42]

3. Spectrum as Commons: The Open Access System

Besides the perception of spectrum as public and private property, there are those who argue for the management of spectrum as a commons through open access. Scholars like Benkler argue that open wireless applications are more dynamic for use in healthcare, mobile data, inventory management and mobile payments.[43]Open spectrum management is an approach that is based on sharing and open spectrum policy would allow various users to utilise whatever parts of the spectrum are available without obtaining permission from anybody beforehand. This as Benkler argues is in line with the innovation model while licensed spectrum replicates the telephone system model.[44]Recent developments in dynamic spectrum, television white spaces and cognitive radio discussed below seem to support this proposition.[45]Sharing the spectrum in such a way would create a "spectrum commons" and would require a simple set of rules for communicating with one another and making decisions.[46]

The concept of the spectrum commons is similar to the idea of natural resources and grazing lands are shared among several users or roads that are shared by travellers. The problem with commons is that they tend to be over-used with nobody investing in their development.[47] The

39 Johannes M Bauer, 'Spectrum Management, Private Property Rights or Commons' [2015] *Change*

40 ibid

41 ibid

42 Gerald R. Faulhaber and David Farber, 'Spectrum Management: Property Rights, Markets, And The Commons' in Lorrie Faith Cranor & Steve S. Wildman (Eds.), *Rethinking Rights and Regulations: Insitutional Responses to New Communications Technologies* (MIT Press, 2003)

43 Yochai Benkler, 'Open Wireless Vs.Licensed Spectrum: Evidence from Market Adoption' [2012] 26 *Harvard Journal of Law and Technology* No. 1

44 ibid

45 Infra,D: Spectrum as a Finite Resource

46 APC, *Moving with the Times: Opening Spectrum so that we can all Communicate* (24th Jan 2011) available at https://www.apc.org/en/spectrum/news/moving-times-opening-spectrum-so-we-can-all-commun accessed on 15th June 2016

47 See Garett Hardin, 'Tragedy of the Commons' [1968]Vol 162 *Science* New Series No.

way proposed to deal with this is using simple standards on how communications devices interact to devise a mode for sharing the common spectrum resource among users. In order for a spectrum commons to exist, a portion of the spectrum must be allocated as such and the necessary rules developed for its management.[48] The best example of a spectrum commons is Wi-Fi or wireless internet. The portion of the spectrum used by this technology has been allocated for unlicensed in many jurisdictions use and a variety of communication devices can use it as they please. [49]

There are a variety of methods for allocating spectrum for shared use, each differing slightly in their approach to administration and transaction (the negotiation that enables sharing). One emerging example is a model whereby a section of spectrum (such as that used by analogue television) is left open for unlicensed use instead of being assigned for a specific use.[50] Rather than communicating through an intermediary, communication devices are designed to communicate directly with one another.

There are a number of advantages with this approach such as: limited bureaucracy; less need for massive capital investment to build large wired networks; ease in introducing new technology; greater potential for national/local/community ownership of communications infrastructure; potential for commons-based approaches to spectrum management to be phased in gradually[51].

This notwithstanding, this technology is currently limited to computers. Some projects are being developed to adapt cellular phone technology to new forms of infrastructure.[52] As interest in developing the commons aspect of spectrum grows on the part of regulators and others grows, new technology will be created to meet this interest.[53]

4. Constitutional Basis of Spectrum as Property

Spectrum as a form of property has constitutional basis at Article 40 of the Constitution of Kenya 2010 which provides for the right to property. The Constitution provides for public, private and communal property so however one perceives spectrum, there is solid basis for it. Under Article 40, every person has the right individually or in association with others, to acquire and own property of 'any description'[54] in any part of Kenya[55]. Property of any description is broad enough as to encompass radio frequency spectrum. As such, individual rights to spectrum, lawfully acquired, are protected under the Constitution and may not be

3859; Also, Forbes, Free Cellphone Bandwidth and the Tragedy of the Commons (2016) available at http://www.forbes.com/sites/timworstall/2016/02/24/free-cellphone-bandwidth-and-the-tragedy-of-the-commons/#5ea7a1d57dd7 accessed on 12th June 2016

48 William Lehr, Jon Crowcroft, 'Managing Shared Access to a Spectrum Commons'[2005] *IEEE* (Dyspan, Baltimore)

49 Evan Light, *Open Spectrum for Devlopment* (APC, 2010)

50 ibid

51 William Lehr, Jon Crowcroft, 'Managing Shared Access to a Spectrum Commons'[2005] *IEEE* (Dyspan, Baltimore)

52 ibid

53 ibid

54 Article 40 (1) a

55 Article 40 (1) b

deprived arbitrarily by the State. This is further buttressed by Article 34 of the Constitution which provides for freedom of media and further that that broadcasting and other electronic media have freedom of establishment, subject only to licensing procedures that are necessary to regulate airwaves and other forms of signal distribution and that are independent of control by government, political interests and commercial interests.[56]

5. The World Trade Organizations' Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)[57] on spectrum

The World Trade Organization (WTO) seeks to promote free markets and trade liberalization through multilateral trade negotiations and agreements aimed at eliminating trade barriers. TRIPS was concluded in the Uruguay Round in 1994. It seeks to protect intellectual property rights by promoting uniform rules among member states. Intellectual property rights relevant in the ICT sector such as patents for communication equipment and rights to software fall within the purview of TRIPS. It has been argued that TRIPS perpetuates inequalities by harbouring technological protectionism through stringent intellectual property protection in a context where the countries of the North generate innovations and the countries of the South acting as market for such innovations.[58]Despite some developing countries having been vociferous critics of Intellectual property rights, the tides have since changed with countries like India, China, Brazil becoming leaders in production of books, development of agricultural biotechnology among others and hence move to support protection of such Intellectual Property rights[59]. The TRIPS agreement is nonetheless expected and continues to affect the evolution of telecommunication services at the global level, factors that are critical as far as spectrum management is concerned.[60] In addition, WTO agreements[61] have contributed

56 Article 34(3)

57 See WTO, *Overview: The TRIPS Agreement* available at https://www.wto.org/english/tratop_e/trips_e/intel2_e.htm accessed on 25th June 2016

58 See Alan S Gutterman, 'The North-South Debate Regarding the Protection of Intellectual Property Rights' (1998) 28 Wake Forest L. Rev. 89, 104 for a discussion of the tension between the North and the South regarding Intellectual property. By South we mean, developing countries with less developed technologies particularly African countries. Other countries in Asia and Latin America and other economies that may be said to be in transition have since began producing technovations owing to improving technology. See, de la Torre, Augusto; Didier, Tatiana; Ize, Alain; Lederman, Daniel; Schmukler, Sergio L.., 'Latin America and the Rising South: Changing World, Changing Priorities' Latin America and Caribbean Studies;. Washington, DC: World Bank (2015). The report argues that the recent rise of developing economies in the Latin America and the Caribbean region (formerly called the South due to their development levels) has since changed the narrative thereby necessitating a relook of the North-South dichotomy. However, we argue that though might be true for such economies, the North-South divide narrative still holds true for most developing countries in Africa.

59 Philip G. Altbach, 'The Subtle Inequalities of Copyright : Power Without Responsibility' (1992 Logos, Volume 3, Issue 3, **pages** 144 – 148) accessed 3 September 2016

60 For instance, the TRIPS Agreement places barriers against the use of compulsory licensing with respect to patents or patented information while recognizing the suitability of the same in enhancing access to technologies and competition. This is discernible from Article 31 of the TRIPS Agreement which appears to list instances or conditions when compulsory licensing of such technologies may be employed.

61 For instance, see the World Intellectual Property Organization (WIPO) which has

to accelerating the convergence of various sectors such as telecommunication, entertainment and electronic equipment industry all of which are relevant in spectrum management.[62]

C. Role of the International Telecommunication Union (ITU)

Radio is ideally a responsibility of governments, but it has important international aspects; radio links, mobile radio stations and interference cross frontiers.[63] Consequently it is managed by a complex and sometimes overlapping series of international, regional and national authorities. At the top is the International Telecommunications Union (ITU).[64]

The ITU is a specialized United Nations agency that harmonises spectrum allocation and provides for a global collaboration on spectrum use. If a country joins the ITU, and virtually all countries have done so, its government undertakes to ensure that radio stations within its jurisdiction do not cause harmful interference to radio stations in other countries that are operating in accordance with international agreements.[65]

The ITU has among its major purposes the avoidance of radio interference and the equitable and efficient use of spectrum and orbital resources. This mission is conferred mainly to its Radio Communication Sector (ITU-R).[66]ITU-R develops and adopts the Radio Regulations, a voluminous set of rules that serve as a binding international treaty. It essentially governs the use of spectrum by allocating spectrum to some 40 different services around the world. ITU-R also acts as a central registrar of international frequency use, recording and maintaining the Master International Frequency Register which currently includes around 1 265 000 terrestrial frequency assignments, 325 000 assignments servicing 1 400 satellite networks, and another 4 265 assignments related to satellite earth stations.[67] With these resources, ITU-R coordinates efforts to eliminate harmful interference between radio stations of different countries and promulgates recommendations on technical and operation matters to improve the use of spectrum and of geo-stationary orbits for radio communication services. The ITU-R also sponsors World Radio communication Conferences (WRC) once every three to four years, which update the Radio Regulations in response to changes in the needs and demands for spectrum.[68]

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sought to harmonize and create a strong patent protection regime through the Paris Convention.

62 See, International Trade Centre UNCTAD/WTO, 'Trade in information technology products and the WTO Agreements: current situation and views of exporters in developing countries' (Geneva: ITC, 1999). <https://www.wto.org/english/tratop_e/inftec_e/infotech.pdf> accessed 08 September 2016.

63 David J. Withers, *Radio Spectrum Management: Management of the Spectrum and Regulation of Radio Services* (2nd Edn) (IEEE, 1999)

64 See www.itu.int/

65 Withers (1991), supra

66 See in general: http://www.itu.int/ITU-R accessed on 28th May, 2016.

67 ibid

68 International Telecommunication Union, Background Paper: Radio Spectrum Management For A Converging World, RSM/07. February 2004, para 2.1, at 6.

After a set of spectrum bands have been allocated for a service by ITU, each nation adopts some or all of those bands for service within its jurisdiction. Based on these allocations, a national table of frequency allocations or "band plan" is developed by a national regulatory administration that has been tasked with the function of spectrum management.[69] Accompanying rules are also sometimes developed alongside each band in order to define the particular band's licensing, operating and technical rules. The national regulatory administration then assigns licences to users giving them the exclusive right to operate on a specific frequency in a specific location or geographic area and under specified technical conditions (power, antenna height among others).[70]

Spectrum is usually assigned using one of several approaches.[71] Traditionally, where demand for spectrum within a particular band is considerably less than supply, most regulators have adopted a "first-come, first served" approach. However, where spectrum demand exceeds supply, regulators are required to choose between competing applicants. Comparative hearings or "beauty contests" are occasionally used to allow regulators to make a licensing decision based on an established set of criteria, which may include the financial stability of the applicant and its technical competence – among other factors.[72] In some cases, lotteries may be used to award licences through random selection.[73] Increasingly, however, regulators have turned towards spectrum auctions to award licences.[74] Spectrum auctions can be considered to be one of the biggest spectrum policy innovations in recent times. As already alluded to above New Zealand was the first country to authorize auctions of both "apparatus licences" and "spectrum rights".[75] Since then, a growing number of countries have used auctions to assign commercial spectrum licences where there have been competing licensees. For example, 13 out of the 33 countries that had assigned spectrum for *Universal Mobile Telecommunications Service* (UMTS) services by 2002 had used auctions.[76]

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69 ibid; although most countries consolidate all spectrum management functions in one body, some countries maintain a separate regulatory approach towards different categories of spectrum users. For example, in Canada and Australia, spectrum management is performed by one administration, however, the granting of broadcast licenses are regulated by a different administration.

70 International Telecommunication Union (n 5)

71 For a discussion of the wide variety of approaches to national spectrum management, see for example the FCC'sReview of Spectrum Management Practices at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-229047A1.pdf accessed on 28th May, 2016.

72 See ITU, Radio Spectrum Management for a Converging World (ITU New Initiatives Programme 16th-18th Feb 2004) available at https://www.itu.int/osg/spu/ni/spectrum/RSM-BG.pdf accessed on 27th June 2016; SEOR-ECRI, Auctions and Beauty Contests, A Policy Perspective (April, 2002) available at http://www.bmg.eur.nl/fileadmin/ASSETS/bmg/ECRI/Maasland/Auctions_and_Beauty_Contests.pdf accessed on 27th June 2016

73 Martin Cave, William Webb, *Spectrum Management: Using the Airwaves for Maximum Social Benefit* (Cambridge University Press, 2015) at Chap 4(para 3.2)

74 Syed Atif Jilani, Spectrum Allocation Methods: Studying Allocation through Auctions, Journal of Economics, Business and Management, Vol. 3, No. 7, July 2015, at 742-743. See also (July/August 2003). International Telecom Union. Third-Generation (3G) Mobile – A Status Report. *ITU News*. [Online] available: http://www.itu.int/itunews/issue/2003/06/thirdgeneration.html accessed on 28th May, 2016.

75 Johannes Bauer, supra

76 UMTS Forum at http://www.umtsforum.org/ accessed on 28th May, 2016. For more information on auctions and auction design see Melody WH, Spectrum auctions and efficient resource allocation: learning from the 3G experience in Europe. (2001) Info, 3:5-10.

1. Radio Conferences

The ITU organizes World Radio communication Conferences (WRC) every three to four years. The recent most conference was held on 2nd-27th November 2015 in Geneva, Switzerland, while the next will be held in 2019. It is the job of WRC to review, and, if necessary, revise the Radio Regulations, the international treaty governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits. Revisions are made on the basis of an agenda determined by the ITU Council, which takes into account recommendations made by previous world radio communication conferences.[77]

The general scope of the agenda of world radio communication conferences is established four to six years in advance, with the final agenda set by the ITU Council two years before the conference, with the concurrence of a majority of Member States.[78]

Under the terms of the ITU Constitution, a WRC can:[79]

- revise the Radio Regulations and any associated Frequency assignment and allotment plans;
- address any Radio communication matter of worldwide character;
- instruct the Radio Regulations Board and the Radio communication Bureau, and review their activities; and
- Determine Questions for study by the Radio communication Assembly and its Study Groups in preparation for future Radio communication Conferences.

There must be a considerable degree of international uniformity in the allocation of spectrum to services. Spectrum management cannot be effectively carried out without the collaboration of other administrations. Moreover, spectrum can only be used efficiently if allocations are harmonised, and where necessary, if assignments are coordinated between administrations.[80]

Certain frequency bands are used exclusively, worldwide or regionally, by a single group of users operating under the oversight of an international body.[81] In a few instances, the choice of frequencies within those bands for specific stations has been moved from the administration of the national government to the international body, although the function of formally assigning the frequencies remains with the administration. [82]

More generally, administrations collaborate with neighbouring administrations informally and usually bilaterally, to resolve potential and actual interference problems. Within Europe, the European Conference of Postal and Telecommunications Administrations (CEPT), in

77 ITU, WRC available at http://www.itu.int/en/ITU-R/conferences/wrc/Pages/default.aspx accessed on 5th June 2016

78 ITU, World RadioCommunication Conferences (WRCs) available at http://www.itu.int/en/ITU-R/conferences/wrc/Pages/default.aspx accessed on 28th June 2016

79 ibid

80 David Withers (1999), supra

81 For example, frequency administration in some bands that are used worldwide for communication with civil airliners, primarily for air traffic control, are managed by the International Civil Aviation Organization (ICAO). Another would be NATO Joint Civil Military Frequency Agreement (NJFA) for NATO countries.

82 David Withers (1999), supra

which almost all European countries participate, has this among its functions.[83] Similar bodies serve other regions, such as the Inter-American Telecommunications conference (CITEL),[84] the Asia-Pacific Telecommunity (APT)[85] and the Arab Telecommunications Union[86]. In Africa there is the African Telecommunications Union (ATU)[87] and the East African Communications Organisation (EACO)[88] further down, for the East African Community.

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83 *See*www.cept.org. CEPT was established on June 26, 1959, as a coordinating body for European state telecommunications and postal organizations. It was responsible for the creation of the European Telecommunications Standards Institute (ETSI) in 1988. It has three main components namely; Electronic Communications Committee (ECC) - responsible for radiocommunications and telecommunications matters; Secondly, the permanent secretariat of the ECC is the European Communications Office (ECO) European Committee for Postal Regulation (CERP, after the French "*Comité européen des régulateurs postaux*") - responsible for postal matters and the Committee for ITU Policy (Com-ITU) is responsible for organising the co-ordination of CEPT actions for the preparation for and during the course of the ITU activities meetings of the Council, Plenipotentiary Conferences, World Telecommunication Development Conferences, World Telecommunication Standardisation Assemblies

84 *See*www.citel.oas.org Inter-American Telecommunication Commission or Comisión Interamericana de Telecomunicaciones (CITEL) was originally created as the Inter-American Electrical Communication Commission at the Fifth International American Conference in May 1923. Its role is to coordinate telecommunications related mandates of the OAS General Assembly and those enacted during the Summits of the Americas.

85 *See*www.aptsec.org APT was established by a treaty concluded in Bangkok in March 1976 and came into force in February 1979. The APT is an intergovernmental organization and operates in conjunction with telecom service providers, manufacturers of communications equipment, and research and development organizations active in the field of communication, information and innovation technologies.APT serves as the organization for information and communications technology (ICT) in the region. The APT covers 38 member countries, with 4 associate members and 131 affiliate members in Asia and the Pacific region.

86 See www.itu.int This is the ITU office in the Arab region.The Arab Regional Office in Egypt was established in 1991. It serves 22 Member States, ITU Sector Members, and Associates in the Arab region.

87 *See*www.itu.intATU is the first inter-governmental organisation dedicated to fostering ICT infrastructure development in Africa's search for prosperity. It combines countries and mobile telecommunications providers in an attempt to dramatically increase development of the continent's information and communication technology (ICT) infrastructure The Union has a mission to promote rapid development of info-communication in Africa to achieve universal access and service as well as full interconnectivity among countries. Its vision is to be a full and active participant in the global information and knowledge society.

88 *See*www.eaco.int/ EACO is regional organization that brings together national ICT regulators, operators, services providers (in the telecommunication, broadcasting and postal sub-sectors) ICT training institutions and other stakeholders in the communication sector within Burundi, Kenya, Rwanda, Tanzania and Uganda.
The broad objective of EACO which was established in 2000, is to strengthen and promote cooperation among the five EAC Countries in the development and provision of postal, telecommunication and broadcasting services in East Africa and Headquartered in Kigali, Rwanda.

Through the ITU, administrations consult with other global organisations with a concern for radio, including ICAO, the International Maritime Organisation (IMO), the World Meteorological Organisation (WMO) and the International Amateur Radio Union (IARU) and many others.

D. The Management of Spectrum Frequencies and their Uses

1. Management of Radio Spectrum Frequency

The management of radio frequencies is effected at national level as each State chooses and assigns radio frequencies (and orbital positions to its space) stations as it wishes, mainly from amongst the radio frequencies allocated by the ITU. The ITU is mainly concerned with the allocation of radio frequencies among various radio communication services, and not among its member States. [89]The general legal principle with respect to the international management of radio frequencies (and the orbital positions) is contained in the provisions of Article 44, (formerly Art. 33) of the 1994 ITU Constitution as amended by the 1998 Plenipotentiary Conference.[90]

The ITU Radio Regulations allocate particular bands of radio frequencies to each specifically defined radio communication service. For the purpose of frequency allocations, the world has been divided into three regions and these allocations are included in the Table of Frequency Allocations of the ITU Radio Regulations.[91]

An ITU Radio communication Conference may distribute or allot a particular allocated band of radio frequencies to different countries. This process is also called *a priori* planning or "engineering" of the radio frequency spectrum.[92] The decisions of such a WRC are included as "allotment plans" in the ITU Radio Regulations. However, it has been done, so far, only in the case of allotment plans for very limited services and bands. The rarity of such plans is attributable to; the unwillingness of major ITU member States to accept any restrictions on their freedom of action in the use of the radio frequency spectrum and to a largely ineffective

89 Ram S. Jakhu , 'International Regulatory Aspects of Radio Spectrum Management: Implications for Developing Countries like India+' (Proceedings of the 2nd Annual Workshop Held at the Indian Institute of Management, 2000)

90 The article states that, Members shall endeavour to limit the number of frequencies and the spectrum used to the minimum essential to provide in a satisfactory manner the necessary services. To that end, they shall endeavour to apply the latest technical advances as soon as possible; (2) In using frequency bands for radio services, Member States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbit, are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries".

91 Article 5 of the ITU Radio Regulations, available at http://life.itu.int/radioclub/rr/art05.htm accessed on 29th June 2016

92 Ram S. Jakhu, supra

participation and influence by the developing countries in the decision-making process in the ITU. [93]

The countries assign radio frequencies to their particular stations in accordance with their national radio regulations, which are required to be in conformity with the ITU Radio Regulations. If the allocation is an international process by nature, the assignment is a national process. In practice, each country (Administration) chooses and assigns a particular radio frequency to its radio stations, as it deems convenient for its interests, keeping in mind that each ITU Member State is required "to avoid causing harmful interference to services rendered by stations using frequencies assigned in accordance with the Table of Frequency Allocations." [94]

Radio frequency (RF) is any of the electromagnetic wave frequencies that lie in the range extending from around 3kHz to 300GHz, and usually refers to electrical rather than mechanical oscillations. [95]Electromagnetic waves are defined by their special characteristics, such as frequency, wavelength and amplitude. The frequency refers to the number of waves generated in a set period of time and is measured in hertz (Hz). 1 Hz means one wave per second, 1 kHz (kilohertz) means one thousand waves per second, 1 MHz (megahertz) means one million waves per second, 1GHz (gigahertz) means one billion waves per second and so on.[96]

Wavelength is the distance between two waves. There is a fixed mathematical interrelation between the frequency and the wavelength. The higher frequencies have shorter wavelengths and the lower frequencies have longer wavelengths. The wavelength also indicates the ability of the wave to travel in space. A lower frequency wave can reach longer distances than a higher frequency wave. Radio waves are usually specified by frequency rather than wavelength.[97]

The radio frequency spectrum (which is simply referred to as spectrum) is only a comparatively small part of the electromagnetic spectrum, covering the range from 3 Hz to 300 GHz. It includes a range of a certain type of electromagnetic waves, called the radio waves, generated

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93 Ryszard Struzak, *Introduction to International Radio Regulations*(Lectures given at the School on Radio Use for Information And Communication Technology Trieste, 2-22 February 2003) at p22-25 available at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/38/098/38098197/ accessed on 30th June 2016

94 See ITU, Radio Spectrum Management for a Converging World (ITU New Initiatives Programme 16th-18th Feb 2004) available at https://www.itu.int/osg/spu/ni/spectrum/RSM-BG.pdf accessed on 27th June 2016

95 J. Jespersen and Fitz-Randolph, *From Sundials to Atomic Clocks: Understanding Time and Frequency*
(2nd Edn) (Dover, Mineola, New York, 1999)

96 National Institute of Standards and Technology, *Fundamentals of Time and Frequency* (CRC Press LLC, 2002) available at http://tf.nist.gov/general/pdf/1498.pdf accessed on 22nd June 2016

97 ibid

by transmitters and received by antennas or aerials.[98]

2. The Uses of Spectrum Frequencies

The radio spectrum is the home of communication technologies such as mobile phones, radio and television broadcasting, two-way radios, broadband services, radar, fixed links, satellite communications, among others due to its excellent ability to carry codified information (signals). It is relatively cheap to build the infrastructure which can also provide mobility and portability. Depending on the frequency range, the radio spectrum is divided into frequency bands and sub-bands, as illustrated below.[99]

Radio Frequency[100]

Frequency Band	**Frequency**	**Wavelength**
ELF (Extreme Low Frequency	30-300 Hz	10,000-1000 km
VF (Voice Frequency)	300-3000 Hz	1000-100 km
VLF (Very Low Frequency)	3-30 kHz	100-10 km
LF (Low Frequency)	30-300 kHz	10-1 km
MF (Medium Frequency)	300-3000 kHz	1-0.1 km
HF (High Frequency)	3-30 MHz	100-10 m
VHF (Very High Frequency)	30-300 MHz	10-1 m
UHF (Ultrahigh Frequency)	300-3000 MHz	100-10 cm
SHF (Superhigh Frequency)	3-30 GHz	10-1 cm
EHF (Extreme High Frequency)	30-300 GHz	1-0.1 cm
Decimillimeter	300-3000 GHz	1-0.1 mm
P Band	0.23-1 GHz	130-30 cm
L Band	1-2 GHz	30-15 cm
S Band	2-4 GHz	15-7.5 cm
C Band	4-8 GHz	7.5-3.75 cm
X Band	8-12.5 GHz	3.75-2.4 cm
Ku Band	12.5-18 GHz	2.4-1.67 cm
K Band	18-26.5 GHz	1.67-1.13 cm
Ka Band	26.5-40 GHz	1.13-0.75 cm
Milimeter Wave	40-300 GHz	7.5-1 mm
Submilimeter wave	300-3000 GHz	1-0.1 mm

Source: Table [101]

98 ibid; Behrouz A. Forouzan, *Data Communications and Networking* (4th Edn) (McGraw-Hill, 2007) at 205

99 Dr Stephan Lucyszyn, *Frequency Spectrum and Applications* (Imperial College London, 2006)

100 IEEE, *Frequency Spectrum* as drawn from Dipak L. Sengupta & Valdis V. Liepa, *Applied Electromagnetics and Electromagnetic Compatibility* (Wiley&Sons, 2006) Appendix B: Frequency Band Designations

101 Ibid.

In theory, different communication technologies could exist in any part of the radio spectrum, but the more information a signal is to carry, the more bandwidth it needs. In simple terms, bandwidth is the range of frequencies that a signal occupies in spectrum. For example, an FM radio station might broadcast on the 92.9 MHz frequency, but requires 0.3 MHz (equivalent of 300 kHz) bandwidth – the spectrum between the frequencies 92.8 and 93.0 MHz inclusive. Other stations cannot broadcast on these frequencies within the same area without causing or receiving interference.[102]

For planning purposes, the spectrum bands are divided into channels. The bandwidth of spectrum channels can vary band by band. VHF Band II, the home of FM radio, for instance, is sliced up in 100 kHz-wide channels. An FM station requires 300 kHz bandwidth, therefore each FM radio station takes up three spectrum channels. In the case of television broadcasting, the agreed bandwidth of a channel is 8 MHz in UHF Band IV/V. The bandwidth requirement of an analogue TV programme channel happens to be the same as the bandwidth of one spectrum TV channel, namely 8 MHz.[103]

Lower frequencies have less bandwidth capacity than higher frequencies. This means that signals that carry a lot of information (such as television, broadband or mobile phones) are better placed in the higher frequency bands while simple radio (audio) signals can be carried by the low frequency waves. Since low frequencies travel long distances but have less bandwidth capacity, placing one television channel (which uses a lot of bandwidth) in the UK in the lower frequency bands would mean that most of the Long Wave and Medium Wave radio services from Northern Europe to Sub-Saharan Africa would be squeezed out.[104]

The ITU's procedures have been abused during recent years due to the increase in demands and competition among applicants.[105] The ITU Radio Regulations oblige the ITU member States to limit their demands for radio frequencies and orbital slots to the minimum necessary to provide services. However, the ITU is not a supranational organisation and cannot enforce its Regulations over the sovereign States that form it. Since such Regulations generally remain unenforced, the objective of efficient and equitable use of resources also remains unfulfilled.

In the case of satellite telecommunications, the main problem is the so-called issue of "paper satellites," which refers to satellite systems which exist on paper only, but not in reality. In many of these cases, the system exists only in a project form, or sometimes not even that, and the only intention on the part of the notifying country is to obtain utilisation rights through early registration with ITU of desirable radio frequencies and orbital positions, as such rights are mostly acquired on the "first-come first-served" basis. These "paper satellites" are sometimes designed to be marketed under some sort of lease or rent arrangements to those States or companies that might not be in a position to acquire appropriate registrations with

102 BBC, *The Spectrum and its Uses: A Simple Guide to the Radio Spectrum* (Sep, 2006) available at http://downloads.bbc.co.uk/rd/pubs/spectrum/bbc-the-spectrum-and-its-uses.pdf accessed on 6th June 2016

103 ibid

104 ibid

105 Ram S. Jakhu, supra

the ITU. Excessive notification filings with the ITU of such "paper satellites" have started costing the ITU extensively because of the increased workload of the Radio communication Bureau.[106]

There are other users of spectrum beyond the broadcasting and internet arena. These include hospitals; security (police and the armed forces); and mobile money transfers. These uses may further complicate the regulation of spectrum. With regard to security, the increase of terrorism activities in remote parts will affect the way spectrum is used for surveillance and unmanned aerial vehicles in dangerous zones.

E. Spectrum as a Finite Resource

Spectrum is a finite resource- each country has only a finite range of frequencies which, when used up, create an obstacle to the growth of its telecommunications sector. [107]In a given frequency band within a specified location, there will be a physical limit to the amount of use possible; two entities cannot use the same frequency at the same time in the same place without cancelling out or interfering with both transmissions. Additionally, spectrum cannot be assigned indiscriminately to anyone who claims it and as such has witnessed excess demand over supply. This notwithstanding, frequency is not exhaustible, neither can it be depleted. Frequency exists only because it can be generated.

Since spectrum is scarce, the number of licences, and therefore entrants, is limited. In this regard, spectrum is analogous to land- its location and area is given, but its productive capability is dependent upon the technology being used.[108] Essentially, the availability of spectrum and the efficiency of its usage contribute fundamentally to the achievable capacity and performance of radio networks.[109]

There is therefore a classic conflict between the needs of a growing and developing human society and the electromagnetic spectrum, with which those needs have to be met. Indeed, there is a real danger that the radio spectrum will be the first of our finite resources to run out, long before oil, gas and mineral deposits.[110]

There are a number of pertinent question: How then we can supply the much needed radio services to society, while avoiding or managing the limitations? At the time of licence expiry, should new entrants be allowed to compete for resources; or should incumbents be allowed to preserve their frequencies? Should licence holders be allowed to engage in spectrum trading and how should the regulators guard against spectrum hoarding for speculative purposes?

Therefore, licencing regimes and renewals need to take account this critical challenge of

106 ITU Press Release on the Paper Satellites Problem, Scrambling for space in Space: ITU Plenipotentiary to Tackle Paper Satellite Problem (2002) available at http://www.itu.int/newsroom/press_releases/2002/21.html accessed on 1st July 2016

107 David Mataen,*Africa: The Ultimate Frontier Market: A guide to the business and emerging opportunities in emerging Africa* (Harriman House Ltd, 2012)

108 Martin Cave &William Webb, *Spectrum Management: Using the Airwaves for Maximum Social and Economic Benefit* (Cambridge University Press, 2015)

109 Yochai Benkler, 'Open Wireless Vs.Licensed Spectrum: Evidence from Market Adoption' [2012] 26 *Harvard Journal of Law and Technology* No. 1

110 William Gosling, *Radio Spectrum Conservation* (Newnes, 2000)

spectrum scarcity and manage the distribution of frequency in a manner that minimizes waste and promotes practices for the efficient and equitable use of the same. Current rules for frequency allocation follow a very complicated and time consuming process for their implementation. These rules are discussed every three to four years at the World Administrative Radio Conference. Ideally, all spectrum is allocated presently, and it would be understandable to draw the conclusion that there exists no spectrum room for allocation.[111]

A number of studies[112] have shown that a considerable amount of spectrum is allocated, but not used. A good example is spectrum allocated for military purposes. It may also be that spectrum allocated maybe utilized in some places but not in others. This analysis has bred the notion of "Hic and Nunc" - in spite of frequency allocation, frequency may be available at one location and at a given instance. [113]A good example is TV bands which may be completely unused in some areas as opposed to others. The same is true for cellular connectivity.

Another key study[114] has shown that spectrum may be allocated, but underutilized. Many frequencies allocated to governments (for military use, communication and satellite) are underutilized. The idea is to incentivize the reallocation and reuse of these frequencies so as to meet efficiency ideals and avoid wastage of the resource. A number of mechanisms have been proposed and are already being employed to avoid a spectrum crisis.[115] A number of ways (discussed below) have been devised to optimize the use of spectrum.

1. Spectrum Clearing

This is freeing up unutilized/underutilized spectrum for allocation to better use, or to assign it to licencees with better incentives for its use. The most common method of doing this is by allocating it to other users who are increasingly demanding more spectrum.

Spectrum between 400 MHz and 6 GHz for instance, is best suited for mobile applications as lower bands would require antennas too large to be integrated into mobile devices, and higher bands would limit cell sizes. This entire range of "good" spectrum, however, is already allocated to a number of different services and technologies, such as broadcast, aeronautical, satellite, defence, public safety and other commercial and non-commercial services; many of which do not utilise that spectrum intensively.[116]

Kenya, which had assigned the 400MHz, 700MHz, 800MHz, 2.3-2.7 GHz etc to the government, is freeing up those bands for 4G mobile broadband, WiMax and WiFi. In most cases, clearing spectrum requires significant investment and/or lengthy development time.

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111 Jacques Palicot, *Radio engineering: From Software Radio to Cognitive Radio* (Wiley-ISTE, 2013)

112 See Dirk Grunwald, 'How New Technologies can turn a

113 Jacques Pilot (2000), supra

114 Dirk Grunwald, 'How New Technologies can turn a Spectrum Crisis into a Spectrum Opportunity[2011] *Wireless Innovation Alliance* p15-23

115 See e.g., Jen Zander, *Low Cost Broadband Access- Key Research problems and Business Solutions* (ISART, 2004); Paramvir Bahl et al, 'White Space Networking with Wi-Fi like Connectivity'[2009] Vol 39 *Sigcomm Computer Communication Review* No. 4; Cohen et al, *Spectrum Management for Science in the 21st Century* (Washington DC National academics Press, 2010

116 Nokia, *Optimizing Spectrum Usage Towards 2020* (White Paper, 2014)

These developments have led to three phenomena. Developments in the use of digital media has yielded the following:

a) Digital dividend

Around the world, countries are migrating their broadcast television systems from analogue transmitters and receivers to digital ones. This is important to the current discussion for three reasons.[117]

- Digital broadcasting utilises the spectrum more efficiently, generally allowing for six channels in the space where one analogue channel could exist. This provides opportunity for new broadcasters to come online.
- The spectrum freed by this digital transition can then be used for new purposes. In some countries it is being auctioned for provision of high-speed wireless internet. It could also be used to set aside spectrum for unlicensed and unregulated public use.
- In order for this transition to be successful, all television broadcasters will need to install new transmitters, all television consumers will need to purchase new televisions or special receivers, and new policy will need to be developed to manage the transition and the new system that will result from it. This imposes a significant financial burden on both broadcasters and consumers. It is necessary to introduce dedicated funding to ensure digital transition can occur without introducing new barriers to communication.

b) Television white spaces

Analogue television transmitters are very powerful and not very accurate. For this reason, there are usually a limited number of over-the-air television stations in any country and often fewer in small nations where television signals in urban centres in different countries can interfere with one another. In order for them to function correctly, these transmitters have been given a large amount of "protected" space between one another. With the use of new kinds of radio devices such as cognitive radios, these "protected" spaces – referred to as "white spaces"- can be used to create a spectrum commons. The United States and the United Kingdom have already begun to allow unlicensed use of these "white spaces" with broader debate occurring in the European Union.[118] Introducing open spectrum management in this way can occur immediately without affecting pre-existing communication networks.

c) Cognitive radios

These are also called software-defined radios or "smart" radios use computers in order to more accurately distinguish between radio signals. This allows for greater efficiency in the use of spectrum.

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117 APC, *Moving with the Times: Opening up Spectrum o that we can all Communicate*(24th Ja 2001) available at https://www.apc.org/en/spectrum/news/moving-times-opening-spectrum-so-we-can-all-commun accessed on 20th June 2016

118 APC, *Open Spectrum for Development* (Policy Brief; Oct,2010) available at https://www.apc.org/en/system/files/OpenSpectrumPolicyBrief_EN.pdf accessed on 20th June 2016

2. Spectrum Sharing

This is simultaneous usage of a specific radio frequency band in a specific geographical area by a number of independent entities, leveraged through mechanisms other than traditional multiple- and random-access techniques. There are three physical dimensions to share spectrum: time, space and geography.[119] Spectrum sharing techniques can be used to optimise spectrum utilisation and, more importantly, to provide opportunities for operators to access additional spectrum, which is typically allocated to other radio services and thus not available via traditional exclusive licensing. This way different spectrum sharing options are complementing network capacity.[120] Spectrum sharing is cost and time-wise, a very efficient means to gain at least partial access to additional spectrum resources for use. Spectrum sharing techniques can be administrative, technical or market based.

3. Spectrum Pooling

Spectrum pooling/ frequency grouping, initially proposed by Mitola[121], is the bringing together of unused spectral bands whose use in a group of frequencies belongs to licenced primary users. One use of this technique is for primary users of a spectrum allocation to be able to rent out use of unused parts of their allocation to secondary users, in system in which multiple radio licensees will coexist within a single allocation of spectrum space. [122]The goal of this notion is to increase spectrum use without any modification in the use of licenced spectral bands, availing an otherwise unavailable spectrum to a larger number of users and for an increased number of uses.[123]

4. Spectrum Overlay

This insertion technique is equivalent to opportunistic spectrum access. It consists of detecting blanks/ holes in the spectrum and then inserting the signals of the secondary users in the detected holes. If upon sensing in the spectrum that the primary user is not active, the secondary user makes use of the channel to send his own signal, otherwise the secondary user will remain active. While it may be a complicated and uncommon process, it is a novel experiment to afford as much opportunity to different users as possible, in a limited amount of spectrum.

5. Unlicenced Spectrum

An example of this is WiMax which is a wireless communications standard designed for high speeds over long distances.[124] While it has not been widely deployed yet, WiMax and

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119 ICT Regulation Toolkit, *Spectrum Sharing* available at www.ictregulationtoolkit.org/sectionexport/pdf/accessed on 20th June 2016

120 Nokia, supra

121 Dr. Joseph Mitola III, Fellow of the IEEE; recognized globally as "the Godfather" of software radio and cognitive radio technologies on which smart phones are based.

122 T.A Weiss& F.K. Jondral, 'Spectrum pooling: an innovative strategy for the enhancement of spectrum efficiency' [2004] *IEEE Communications Magazine* 42 (3): S8.

123 Majed Haddad and Aawatif Hayar, Spectral Efficiency of Spectrum Pooling Systems [2010] 2 *IET Communications* Issue 6 at 733-741 available at https://arxiv.org/pdf/0705.3025.pdf accessed on 21st June 2016

124 Sanida Omerovic, *WiMax Overview* (White Paper, University of Ljubljana) available at

similar technology could serve as an infrastructure for a spectrum commons as it can be implemented on a large scale without licensing spectrum to any particular entity.[125]

F. Spectrum and Development

Every thirty months, the amount of information that can be transmitted over a wireless internet connection has the potential to double. Wireless could be the way to provide affordable broadband to millions of people currently living with poor connectivity. However the policy and regulation related to spectrum needs to be efficient, accountable and well-informed.

Developing countries have less investment in wireless infrastructure than do many developed countries. If there exists more efficient spectrum management regimes, there may be potential for larger payoffs (in relative terms) from spectrum than in developed countries.[126]

Communication and information services in the developing world have experienced explosive growth. Between 1980 and 2005 the number of phones (fixed and mobile) multiplied 30-fold (while population grew by one-half and real Gross Domestic Product (GDP) more than doubled) and their share in the world's stock of phones more than tripled to about 60 percent.[127] This largely resulted from economic and sectoral reforms, starting in the late 1980s and gradually extending to most developing countries, which led to private-led, increasingly competitive telecommunications markets.[128]

Fast growth in large emerging markets, notably China, India, and Brazil, masks slower development in other economies. Progress has been made reaching out to rural areas and the urban poor, but in many countries these groups still lag in relative terms. More advanced communication and information services have become available through the Internet, but are only reaching the better-off population groups.[129]

Wireless connectivity offers great potential to deliver internet and telephone connectivity in developing countries. Strategies for meeting information and communication technology (ICT) development goals in developing nations can be designed according to the various approaches to communication and to the needs and current capacity available in each locale[130]. Most communications policies around the globe have, however, been developed according to models based on the economic, political and social realities of North American and Europe[131].

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http://www.lait.fe.uni-lj.si/Seminarji/s_omerovic.pdf accessed on 30th June 2016

125 ibid

126 Björn Wellenius and Isabel Neto, *Managing the Radio Spectrum: Framework for Reform in Developing Countries* (Policy Research Working Paper 4549)(Worldbank, 2008)

127 See BjörnWellenius, "Extending communication and information services: principles and practical solutions."[2006] In I*nformation and Communications for Development: Global Trends and Policies*(Washington, DC: World Bank) pp 41-55

128 Wellenius & Neto (2008), supra

129 ibid

130 Ibid.

131 Evan Light, 'Open Spectrum for Development: Policy Brief ' (Association for Progressive Communications 2010) www.apc.org/ accessed 1September 2016

Above all, these models are based on the premise that large private companies must build expansive national wired infrastructures. Thus, law and regulation has evolved with the understanding that these wired networks are the main communication infrastructure and that wireless networks connect through them. Such wired networks, however, do not exist in many developing countries and do not necessarily need to be built.

The Open Base Transceiver Station (Open BTS) project in the United States has developed a small solar-powered device that creates a simple, affordable and portable cellular telephone network.[132] By connecting it to a high-speed wireless internet connection, cell phones in remote areas are connected to the global telephone network. Built on open source software and inexpensive hardware, it should be easily adaptable to different languages and could be a practical tool for extending wireless service to remote and rural communities using spectrum as the main link instead of a costly and invasive wired infrastructure.[133] It could also be used to connect such communities to one another where pre-existing telephone networks do not exist or are prohibitively expensive[134].

Between 2008- 2009, Uruguay distributed solar-powered One Laptop per Child (OLPC) XO laptops to 100% of their primary school children who attend public schools. All public primary schools were also connected to the internet and to one another. The federal water authority installed potable water plants (for treating water and making it drinkable) in a number of remote communities, many of them without electricity. Parents in these communities learnt to manage their own water purification systems through online tutorials they access through the laptops of their children.[135] These laptops rely on unlicensed access to the spectrum in order to talk with one another (creating new forms of collaboration) and to share scarce internet connections.[136]

In another city - Vienna, Austria, FunkFeuer[137] is a community-based non-commercial wireless mesh network that covers the entire metropolitan area (2.2 million people).[138] It is also active in the Austrian cities of Graz, Weinviertel, Bad Ischl. Guifi.net is another community-based non-commercial wireless mesh network operating in Catalonia, Spain.[139] It covers over 6,000 km of the region, providing free internet access to over 16,000 locations. This strategy relies on individuals to share their personal internet connections in order to

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132 *See*www.openbts.orgOpenBTS.org is an open source software project dedicated to revolutionizing mobile networks by substituting legacy telco protocols and traditionally complex, proprietary hardware systems with Internet Protocol and a flexible software architecture. This architecture is open to innovation by anybody, allowing the development of new applications and services and dramatically simplifying the setting up and operation of a mobile network.

133 David A. Burgess et. al. 'The Open BTS Project'(3 August 2008)http://cs.ru.ac.za/ accessed on 2 September 2016

134 Ibid

135 Ibid.

136 Ibid.

137 German for "free radio"

138 Evan Light, 'Open Spectrum for Development: Policy Brief (n. 136)

139 ibid

create a shared network.[140] Instead of each household paying for their own connection, costs and responsibility can be shared. An unlicensed portion of the radio spectrum serves as the link between all members.[141]

III. Spectrum Management and Regulation in Kenya

A. History

The origin of radio frequency spectrum as a resource in Kenya may be traced to section 86 of the Kenya Posts and Telecommunications Corporation (KP & TC) Act, Cap 411 of the Laws of Kenya (Now repealed). The relevant section provided that no person could operate a radio communication service without applying for a licence from the Managing Director of the Kenya Posts and Telecommunications Corporation established under section 3 of the Act. The Managing Director had powers to issue licences, ensure compliance with the conditions, renew such licences and even revoke them if conditions of issue were breached. The Kenya Posts and Telecommunications Corporation was thus, the regulatory authority charged with the authority of assigning, managing and regulating spectrum in Kenya in the period under review. The KP & TC Act was repealed in the year 1998 by Act No. 2 of 1998, the Kenya Information Communications Act (KICA) of 1998 which created the Communication Commission of Kenya (CCK) to replace the defunct Kenya Posts and Telecommunication Corporation. The CCK was the new regulatory authority charged with the management of spectrum. The CCK took over the mandate of assigning and managing radio frequencies. There was also a shift in the policy guidelines over the years. In 1997, the Ministry of Transport and Communications issued the Postal and Telecommunications Sector Policy Statement which sought to enhance governance in the sector. Indeed, it was this policy statement that prompted the enactment of the KICA 1998 so as to give it more power. This Policy Statement was revised in 1999. The government gazetted the Information and Communications Technology Policy Sector Guidelines. These policy guidelines effectively and formally charged the CCK with the mandate of regulating the whole communication sector by recognizing it as the converged regulator of the ICT sector. Convergence of the ICT sector necessitated this development. The Kenya Information Communications Act 1998 availed the regulatory framework governing the overall communication sector and particularly spectrum management. This Act was amended in 2009 to take into account the dynamic nature of the sector culminating into the Kenya Communications (Amendment) Act 2009. Kenya passed a new Constitution in 2010 which had provisions on access to information and freedom of the media which necessitated a review of the statutes and regulations to conform to the Constitution. As a result, the Kenya Information Communications Act was amended to align with Articles 33 and 34 of the Constitution of Kenya.[142] The subsequent amendments led to the Kenya Information and Communications (Amendment) Act 2013.

140 ibid

141 ibid

142 Article 34 of the Constitution of Kenya 2010 which provides for freedom of media is also relevant. In particular, article 34 (3) stipulates that broadcasting and other electronic media have freedom of establishment, subject only to licensing procedures that are necessary to regulate airwaves and other forms of signal distribution and that are independent of control by government, political interests and commercial interests.

The 2013 amendments to the Act were followed by a rebranding of the regulatory body from CCK to Communications Authority of Kenya (CA) in June 2014. This rebranding was informed by the need to assert its independence of CA as demanded by Article 34 of the Constitution of Kenya 2010 and to cater for its added scope which included regulation of the whole ICT sector over and above the areas its predecessor CCK used to regulate namely, telecommunications, courier and postal services and radiofrequency spectrum.

Kenya has an administrative mode of spectrum regulation, also known as the command and control approach. The Communications Authority of Kenya (CA) licenses various spectrum users as and when they apply. The licences the authority issues have conditions attached to them, which a licensee is bound to comply with.[143] Failure to comply with the conditions on the licence attracts legal liability for the party in breach.[144]

B. Uses of Spectrum

The essence of spectrum management and regulation in any country is to ensure the achievement of various objectives such as economic efficiency (value for money), ensure coordination and harmonization of the various users of spectrum, create a level playing field among the various spectrum users, and enhance consumer protection. The thrust of the foregoing is that there are various users of spectrum, and in this respect various uses, which as a matter of principle, ought to be harmonized and coordinated. At the risk of overemphasizing the point, we must state that spectrum is a finite resource just like land and other natural resources. However, given the ever burgeoning expansion of technology and innovation, there is increased need for spectrum rights among various players in the market. It is not only the government that requires spectrum but so does the private sector as it depends on spectrum space to carry its content. Local communities who do not fall within the mainstream users of spectrum may need to access spectrum for communication at the local levels. This is imperative considering that the Constitution of Kenya 2010 places a premium on stakeholder participation and access to information.[145]

The main uses of spectrum in Kenya include:

1. Television and FM radio broadcasting
2. Satellite Communications
3. Cellular mobile telecommunications
4. Maritime radio services
5. Emergency and disaster communication services (VHF/UHF communications for police and firemen, HF communications for relief agencies)
6. Space based communication such as Weather forecasting
7. Air traffic control
8. National Defence and public safety
9. Global Positioning Systems (GPS) and remote controls
10. Keyboards, wireless computer mice and headphones.

143 Section 36 (2) of the Kenya Information Communication Act.

144 ibid.

145 Article 10 of the Constitution on national values calls for public participation while Article 35 provides for the right to access to information held by the State or state organs/agencies.

Tensions that may arise from the competing interests of players in the spectrum realm makes it imperative that the relevant regulatory agency provide an administrative framework to guide the sharing of this spectrum. This need cannot be gainsaid considering that diverse users of spectrum have asymmetrical power relations with private and public actors flexing more muscle than communities. CA is vested with the mandate of enabling the allocation of spectrum to the various users. While allocating the spectrum rights to the various users, the CA takes into account the respective needs, breadth and nature of the use. To illustrate, a television station carrying audio-visual content will require higher levels of bandwidth compared to radio which only carries audio content. Similarly, the national defence in charge of national security will need more bandwidth that is more secured compared to that required for remote controls.

In seeking to meet this objective, the CA has adopted various approaches to secure the interests of various users. These include planning,[146] licensing and monitoring. It must be stated that these approaches have not been adopted or employed in isolation but rather in a concerted fashion. CA not only plans on the various allocations of spectrum to users but also gives out licences to private users of spectrum in the market and also monitors their use. For instance, media stations and telephone service providers as users of spectrum are allocated radio frequencies through a licence. In return for the granting of the licence and since they mainly constitute private users in the market, they pay a licence fee annually.

What is more, their use of the allocated frequencies is usually closely monitored or supervised by the CA to ensure conformity and compliance with the restrictions and provisions in the licence.[147] A user who operates outside the provisions as stipulated in the granted licence may be subject to sanctions which include fines or revocation of the licence.[148] In addition, the licence holder, in this case the user of spectrum, must apply for an annual renewal of the licence which must then be reviewed by the CA. The supervisory and monitoring work of the CA extends to and is also specifically done during the scrutiny of the renewal of the licence as CA has to satisfy itself as to compliance with the stipulated conditions before renewing such licence.[149]Spectrum licences seek to restrict the purpose for which an assigned spectrum is employed. The National Table of Radio Frequencies Allocation[150] avails the various conditions that must be followed in the use of any assigned spectrum.

Some of the objectives of monitoring the use of frequency by CA include:

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146 The assignment of frequencies by the Communications Authority (CA) is usually predicated upon a frequency plan, compatibility with other neighbouring systems, and the allocation of frequencies by the International Telecommunication Union (ITU), and an analysis of neighbouring rights. This frequency planning however, begins at a higher level, namely at the ITU level in the annual World Radio Conference whereby resolutions of the allocation of frequency band are passed.

147 This power derives from section 36 of the Kenya Information and Communications Act 1998 (as amended in 2009).

148 Section 36 (4) of the Kenya Information Communication Act.

149 For instance, a licensee cannot make any material change to a license station or even vary the parameters set out in a granted licence without the written consent from the CA. This extends to changing physical infrastructure such as varying the height of a tower to enable greater coverage.

150 Avail as Annex

a) To verify or ascertain the utilization of the allocated frequency- this is important since as already stated, spectrum is a finite and scarce resource which needs to be properly and optimally utilized. Consequently, it would be imprudent were a user of spectrum who has been granted a licence to 'sit on' the spectrum use or hoard it to the exclusion of others.

b) To address consumer complaints- this objective has the final goal of enhancing consumer protection and may thus be couched as a means to an end rather than an end in itself. This flows from the position that a licence to exploit spectrum is granted to private users who may only be concerned with profit making. Given that such actors act in their own interest only, they may act against public interest. The government pursues other social-political goals besides attaining economic efficiency or maximizing profits. These include equity. Since there is always an inherent risk of harm against the ultimate consumer who represents the citizen in a country by a private spectrum user, it is necessary for a regulatory agency, such as the CA, to monitor the use. Consumers who have been harmed or who may have particular complaints against a licensee spectrum user may file such complaints with the CA which then considers and addresses the complaints. This objective can only be achieved by way of monitoring.

c) Identify the source of signals- this is meant to locate the origin of suspect signals and deal with them thereby facilitating the undisturbed and interrupted reception of signals. Towards meeting this end, the CA has recently unveiled the Spectrum Management and Monitoring System (SMMS).151 This innovation is meant to act as a complement and an upgrade to the monitoring role performed by satellite stations as discussed above.

d) Identify the ownership of particular installations-This may be useful in identifying persons engaged in infractions and violations of the spectrum licence.

In order to achieve this monitoring task, the CA has up to seven fixed radio monitoring stations in Nairobi, Mombasa, Garissa and Kitale. Plans are underway to increase the number of fixed radio monitoring stations to eleven, with others being fixed in Nakuru, Kisumu, Eldoret and Nyeri.[152] Besides these, the CA also has five mobile monitoring facilities within the country. All of these monitoring stations are usually linked and interconnected to a central facility at the National Control Centre (NCC) which is a facility located at the main CA headquarters.[153] This is meant to enhance and facilitate remote operation of the various stations across the country.

C. Major Players in the Spectrum

The major players in the spectrum arena include the CA, the Communication Information & Technologies Authority ICTA, the civil society, spectrum users who include the public institutions, private companies and individuals.

151 <http://www.ca.go.ke/index.php/archive-news/94-news/376-authority-launches-new-spectrum-management-system> accessed 05 September 2016.

152 ibid.

153 Ibid

1. Communications Authority of Kenya

As noted from the foregoing, CA is the leading player in the management and regulation of spectrum in Kenya. It has a role in the planning, licensing of spectrum users and monitoring of the use of such spectrum by users as discussed in the preceding section. Whilst fulfilling this mandate, the CA is expected to ensure: it complies with the requirements and standards set by the ITU for Kenya, ensure the efficient utilization of spectrum in a sustainable manner so that it meets the needs of the present and the future, develop a national radio frequency plan that takes stock of the subsisting and future likely use of spectrum, encourage efficiency in use of spectrum so as to encourage the introduction of innovative communication services, making use of the various tools of spectrum management, and develop a National Table of Frequency Allocation[154] which should be available to the public.

The National Table of Frequency Allocation, also known as the National Radio Frequency Plan, is meant to meet various objectives including but not limited to: compliance with ITU regulations and standards, identification of frequencies that not only facilitate competition but also facilitate the rollout of broadband services, and review of tools of spectrum management.

2. ICT Authority (ICTA)

The other player in the spectrum management arena is the Information Communication Authority which is a state agency founded with the sole responsibility of managing publicly funded ICT infrastructure projects on behalf of the government. Examples of such ICT projects include the open access Wireless Broadband Network which depends on spectrum. Indeed, wireless broadband internet depends on radio frequency/spectrum to avail infrastructure for its rolling out. ICTA manages ICT projects and is a player in spectrum management and regulation in Kenya.[155]

3. Various Spectrum Users

These may include mobile phone operators, TV and radio operators, national defence, among other users. They are major players because without their presence and interest in spectrum, there would be no market to regulate and manage.

4. Civil Society, Interest Groups and the Public

Various lobby groups concerned with ICT policy formulation and regulation have merged which may covertly purvey diverse interests. Indeed, spectrum management and regulation has gradually elicited interest from civil society and other interest groups which frequently forward petitions and proposals for consideration to the CA. In addition, citizens as consumers are also players in as far as the constitutional imperative of public participation has to be fulfilled in the formulation of laws and policies. Further, how spectrum is managed and regulated is of concern to the public whose members have every right to be heard and participate in the formulation of the regulatory and policy framework of spectrum.

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154 See the attached Table. Source www.ca.go.ke

155 Ministry of Information and Communication, 'Information and Communication Technology (ICT) Sector Policy Guidelines' (2014) 24.

D. The Regulatory Framework in Kenya

The regulatory framework governing spectrum management in Kenya is varied and straddles various economic sectors. There are also issues of access and competition. Two main regulatory agencies have a stake in spectrum management. The first one is the CA which is the primary regulator charged with spectrum management generally, functions include allocation, licensing, regulation, and supervision. The second agency concerned with spectrum management is the Competition Authority of Kenya (CAK).Unbridled exercise of power by market players, using spectrum raises competition concerns as such private players can abuse their market positions. In order to stem possible abuse, eliminate market distortions, enhance market competition and allocate spectrum for the benefit of consumers, CAK plays a role in regulation. Various policies, laws and regulations have been put in place for spectrum management and regulation in Kenya as the discussion below illustrates.

1. Policies

a) Communication Technology Policy Guidelines 2006[156]

The policy framework that informs radio frequency spectrum management is the National Information and Communication Technology Policy Guidelines of March 2006. These policy guidelines set out the broad policy objectives, and strategies for achieving those objectives. The objectives set out by the policy framework include: enhanced national security and defence; sustainable conservation of natural resources; enhanced emergency preparedness against disasters; efficient national and international transport systems; efficient and affordable telecommunication services; enhancement of social and economic progress; efficiency in the dissemination of educational information and entertainment; and research and development.[157] In order to achieve these objectives, the policy framework also sets out the strategies to achieving them. They include: optimal planning, allocation and assignment of radio frequency spectrum; encouraging spectrum sharing among different users where such sharing would not compromise service delivery, life or public interest; encouraging use of alternative non-spectrum technologies; moving towards a market-based approach to spectrum management to take care of the increasing demand while ensuring that spectrum fees do not become onerous to operators; development of radio communication standards that are in line with international standards; and requiring the use of spectrum efficient technologies and techniques.[158] Other strategies include: possible exemption of government security agencies and institutions using spectrum in availing strategic public services from the payment of frequency fees; availing mechanisms to enable stakeholders to provide inputs to ensure up to-date spectrum management; and notification of users of spectrum of any conditions and circumstances that would result in migration of services to other radio frequencies.[159]

156 See Kenya Gazette Notice Vol. CVIII-No. 24.
157 National ICT Sector Policy Guidelines of 2006 at p. 41.
158 ibid 42, 43.
159 ibid 43.

b) Draft Wireless Broadband Spectrum Policy Guidelines 2014[160]

This Draft policy, though not adopted, brings to the fore important principles which if adopted will influence and shape spectrum management in Kenya. The principles outlined can be summarised as follows:

1. *Make spectrum management dynamic and responsive to user needs*, for example, by ensuring a regulatory framework which fosters competition, growth and innovation in the use of spectrum, and promoting universal broadband access;
2. *Enable and encourage spectrum to move to its highest value use or uses*, for example through trading or third-party authorisation;
3. *Use the least cost and lease restrictive approach to achieving policy objectives*, in particular minimising the cost (to government, licensees and the public) of planning, licensing, allocation/assignment and compliance measure. This would require regulatory effectiveness, taking into account technological developments;
4. *Make access to spectrum simple*, including using market mechanisms or other mechanisms as the regulator deems appropriate;
5. *Promotion of efficient technologies*, including use of spectrum efficient technologies and techniques will be encouraged;
6. *Engage in public consultations*, ensuring that stakeholders provide inputs to ensure that spectrum management is responsive to technological advances and user demand;
7. *Exemption from fees*, in particular exempting national security, public safety and emergency services from spectrum usage fees;
8. *Encourage deployment of services in rural areas*, such as discounting incentives in the pricing of spectrum in rural and marginalised areas;
9. *Provide clarity on rights and access to spectrum*, including for licence durations and renewal terms, changes to spectrum use, interference, the rights and obligations of government (charges, conditions on use, licence withdrawal and monitoring and enforcement), and procedures for access to spectrum;
10. *Prevent over-concentration of spectrum in the hands of a few*, providing for safeguards to prevent and/or address over-concentration of spectrum in the hands of a few operators that would prevent existing operators or new entrants from acquiring and actively using spectrum;
11. *Promote research and innovation*, for example developing the test-and-trial regime;
12. *Adopt technology & service neutrality*, promoting this where relevant in specified bands;
13. *Promote efficient use of spectrum*, ensuring that efficiency takes into account not only economic factors but technology development, public good and international obligations;
14. *Enable provision of national broadband services*, providing for government initiatives to increase penetration and participation of service providers in universal service; and
15. *Monitor and enforce*, ensuring regular review to respond to interference issues that may arise in a liberalised spectrum management environment.

The ICT Policy of 2006 provides that frequency spectrum, being a scarce public resource, will be managed in line with public policy objectives so as to make it available to all users. It further provides that while doing so, there will be an attempt to maintain a balance between

160 Accessed 6 June 2016
http://www.information.go.ke/wp-content/uploads/2014/03/DraftSpectructionPolicy.pdf

private and public interest but in case of conflict, the latter will prevail.[161]

2. Laws and Regulations

a) Laws

The main legal framework relating to spectrum management and regulation is the Kenya Communications Act 1998 (as amended by the Kenya Information and Communications (Amendment) Act in 2009 and again in 2013.[162] Other than establishing the Communications Authority of Kenya (CA), the Act also lays down the method and procedure through which the CA manages spectrum. The CA is mandated with the management of the scarce radio frequency spectrum assigned to Kenya by ITU, a function that necessarily entails the planning and assignment of spectrum to various users. In carrying out this task, the CA basically conducts national coordination with the objective of enabling the harmonious sharing of frequencies by various users and services.[163] Besides this, the CA also conducts frequency coordination at both the international and regional level with the view of eliminating harmful interference of spectrum users in various jurisdictions. In this regard, section 36 of the Kenya Information and Communications Act 1998 makes it mandatory for all frequency users to obtain a licence from the CA. These licences which must be periodically regularized by the user through regular payment of the prescribed renewal fees.[164] The CA makes use of this application for renewal to ascertain that the spectrum user has been complying with the conditions set out in the licence before granting renewal of the licence.

The procedure for licensing radio frequency users is informed by regulations promulgated by the CA in line with section 36 of KICA -Frequency Licensing Procedures 2009/2010.[165] The licensing procedure is handled by the Frequency Spectrum Management department at the CA which is charged with the planning, assignment, licensing, monitoring and coordination of all spectrum resource in Kenya. The rationale for promulgating these regulations to guide licensing for spectrum users is the desire to have documented procedures and requirements for licensing so as to avoid arbitrariness and reduce opportunities for corruption.[166] With the licensing procedures in place, a prospective spectrum user readily knows the process of obtaining a licence and this reduces transaction costs and makes it easy to conduct business. Notably, the Frequency Licensing Procedures are only meant to be a work in progress and as such, they are malleable and are subject to review on an annual basis as and when circumstances demand. This flexibility of the regulations is particularly important when one considers the dynamic nature of the telecommunications sector. In particular, the Regulations have provisions that guide the licensing of various users such as low power wireless system (family radios), amateur radio, aircraft radio station licences, maritime (ship) licences, private HF/VHF/UHF radio networks, and fixed cellular mobile and paging services.[167] At the end

161 National ICT Sector Policy Guidelines of 2006 at p. 41.
162 Cap 411A.
163 <http://www.ca.go.ke/index.php/frequency-spectrum> accessed 05 September 2016.
164 Section 36 of the Kenya Information Communications Act.
165 Communications Commission of Kenya 'Frequency Spectrum Management: Frequency Licensing Procedures 2009/2010'. The Regulations were promulgated before the rebranding of the CCK to CA.
166 ibid 2.
167 ibid 3-8.

of the regulations are the prescribed forms which are used when making an application for the licence. Besides, the regulations give the CA the authority to approve the type of equipment to be utilized by the particular spectrum user so as to guard against inefficiency. It also has the authority to demand that vendors and users of various equipment ensure that such equipment comply with the Kenyan market guidelines and conditions.[168]The rationale for providing for the licensing of spectrum users is to manage market players 'use of a finite resource that ought to be managed properly. Through regulation, CA is able to ensure maximum and efficient use of the resource and cater for the competing uses for the resource taking care of public interest. A gap in regulation would lead to interference with the spectrum use, thus making its use impossible and inefficient.[169]

The spectrum fees charged for the licence and renewal of such licence are normally a function of the type of service that the frequency user intends to offer.[170] The applicable fees are also documented in the Frequency Spectrum Fees Schedule which began taking effect from the 1st of July 2012.[171] A party whose spectrum use has been interfered with may also file a complaint with CA by way of duly filling a Radio Interference Complaints in the prescribed form, to enable the regulatory agency to address the complaint.[172] This is a monitoring and supervision role that is assigned to CA over and above licensing. There is also the National Table of Radio Frequency Allocations[173] which basically lists out the various frequency allocations made to the various users and is geared towards transparency and inspiring market confidence.

The list of Access Frequencies Assigned to Operators is also availed as a public document. CA usually plans various frequencies that it shall assign to various users in the market after a period of 4 years[174] following the World Radio Conference which allocates frequency bandwidths to various countries around the world.

b) Regulations

The regulations further proscribe particular activities that are in violation of the granted spectrum license.[175]Licensee infractions include: operating or possessing unlicensed radio equipment; emitting excessive radio frequency power: operating or possessing non-type

168 Some of the conditions imposed on the type of equipment to be imported may be found in the Importation Type Approval and Distribution of Communications Equipment Regulations 2010. <http://www.ca.go.ke/index.php/sector-regulations> accessed 05 September 2016.

169 Such a possibility would be the only feasible result given that the primary role of spectrum regulation is to avoid or minimize interference.

170 Communications Commission of Kenya 'Frequency Spectrum Management: Frequency Licensing Procedures 2009/2010' 11.

171 Communications Authority of Kenya, 'Frequency Spectrum Fee Schedule' (2012) <http://www.ca.go.ke/index.php/frequency-spectrum> accessed 05 September 2016.

172 See Communications Commission of Kenya 'Frequency Spectrum Management: Frequency Licensing Procedures 2009/2010' for the complaint forms.

173 See Annex.

174 The International Telecommunication Union (ITU), a specialized agency of the United Nations holds a meeting every four years for the allocation of spectrum. The latest one happened in 2015.

175 See the National ICT sector Policy Guidelines and the various penalties laid down in the various subsidiary regulations herein discussed.

approved equipment: installing transmitters in a location other than the one authorized: programming a frequency other than the one authorized: and using equipment that has incorrect channel spacing, among others.[176] Failure to adhere to the requirements stated would lead to restriction of installation or radio communication of the operator or penalty of a monetary fine or 5 year imprisonment[177] and any other penalty as may be directed by the CA.[178]

Other Regulations that constitute subsidiary legislation and that have a bearing on the regulation of spectrum include: Tariff Regulations 2010;[179] the Fair Competition and Equality of Treatment Regulations 2010;[180] the Radio Communications and Frequency Spectrum Regulations 2010;[181] the Interconnection and Access Regulations;[182] the Dispute Resolution Regulations 2010;[183] the Compliance Monitoring, Inspections and Enforcement Regulations 2010;[184] the Licensing and Quality of Services Regulations 2010;[185] the Broadcasting Regulations 2009;[186] and the Consumer Protection Regulations 2010;[187]. All these regulations affect radio frequency spectrum regulation in various ways as they dictate the manner of usage of spectrum by users taking care not to fall foul of the various provisions in the regulations. They are currently being reviewed and some of the proposed changes include:

1. Tariff Regulations 2010

These regulations set out the framework for regulation of prices. The amendments in the regulations include a larger focus on licensees who are dominant in the market for the regulated services. They havemaintained an obligation for all licensees to file tariffs so that the Authority can build a database and monitor market trends; cclarified that tariff regulation may be for wholesale and retail tariffs; set objective of pricing as efficient economic costs; and introduced benchmarking as a methodology of price regulation, while not excluding cost modelling.[188]

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176 The various infractions are particular to the specific sector and are laid down in the various statutes and subsidiary regulations.

177 See section 15 and 17 Radio Communications and Frequency Spectrum Regulations 2010, www.ca.go.ke

178 See section 9 and 10 The Kenya Information and Communications (Compliance Monitoring, Inspections And Enforcement) Regulations, 2010www.ca.go.ke

179 Communications Authority of Kenya, 'Tariff Regulations 2010' http://www.ca.go.ke/index.php/sector-regulations> accessed 05 September 2016.

180 Communications Authority of Kenya, 'Fair Competition and Equality of Treatment Regulations 2010'.

181 Communications Authority of Kenya, 'Radio Communications and Frequency Spectrum Regulations 2010'.

182 Communications Authorioty of Kenya, 'Interconnection and Access Regulations'.

183 Communications Authority of Kenya, 'Dispute Resolution Regulations 2010'.

184 Communications Authority of Kenya, 'Compliance Monitoring, Inspections and Enforcement Regulations 2010'

185 Communications Authority of Kenya, 'Licensing and Quality of Services Regulations 2010'.

186 Communications Authority of Kenya, 'Broadcasting Regulations 2009'.

187 Communications Authority of Kenya, 'Consumer Protection Regulations 2010'.

188 http://www.ca.go.ke/index.php/sector-regulations> accessed 05 September 2016.

a) The Fair Competition and Equality of Treatment Regulations 2010,

These regulations grant the Authority powers to regulate competition matters in the Telecommunications sector *ex ante* and *ex post*. The amendments removed provisions that are better covered under other Regulations (such as those dealing with interconnection and accounting separation); cclarified concepts in assessment of relevant markets;amended definition of dominant telecommunications service provider and introduced the duty to consult with CAK before designating a licensee as dominant;set out treatment of abuse of dominance and other anti-competitive behaviour;set out the Authority's investigative powers; and pprovided for coordination with CAK in the performance of these functions.[189]

2. The (Radio Communications and Frequency Spectrum) Regulations 2010

These regulations provide a framework for spectrum pricing, allocation and trading. The proposed amendments include increased transparency of the available spectrum and the assigned spectrum rights (including the creation of a national spectrum frequency register;[190] spell out the methods that will be used to assign spectrum and the factors considered in the selection of the most appropriate assignment method;[191]clarify the principles for spectrum pricing;[192]strengthen regulation of spectrum sharing; and strengthen regulation of transfers of licenses and frequency rights, among others.[193]

b) The Interconnection and Access Regulations

The regulations set out the Interconnection and Access Regulations framework and provide a structured negotiating process and standards for interconnection agreements.The amendments to the regulations includereview of a dominant telecommunications service provider's obligations to prepare Reference Interconnection Offers and Reference Access Offers;[194]strengthen the access obligations of dominant providers;[195] and integrated capacity leasing with access to network facilities;[196]centralized resolution of disputes under the Authority's Dispute Resolution Regulations;[197] and rremoved or clarified clauses that were confusing.

3. The Licensing and Quality of Services Regulations 2010

These regulations established a licensing regime that facilitates market entry subject to appropriate controls. They set out a basic licensing procedure;pprovide a fast-track licensing procedure for less important licences[198]; pprovide that the number of a given type of licence should not be limited except due to scarcity or cost of resources or for national security

189 ibid.
190 ibid.
191 ibid.
192 ibid.
193 ibid.
194 ibid.
195 ibid.
196 ibid.
197 ibid.
198 Some of the less important licences include those relating to amateur radio services and remote controls as opposed to security and air traffic control.

reasons; pprovide for a competitive licensing process if the number of a given type of licence is limited; set out the procedure and standards for approval of licence transfers; revised confusing provisions on change of shareholding to focus instead on changes of control and coordination with CAK.[199]

4. The Broadcasting Regulations 2009

These regulations provide a framework for regulation of broadcasting licenses and content providers. The amendments in the regulations include: clarification of the procedure for license applications and requirements for a broadcasting license; grants the Authority discretion on the amount of local content which is attached to the license; separates accounts for public and private broadcasting; mandates broadcasters to provide equitable coverage of political parties during election campaign period; and has transitional provisions for the switchover from analogue to digital broadcasting, for the broadcasters issued with frequencies for free-to-air broadcasting to relinquish the those frequencies to the Commission.[200]

5. The Dispute Resolution Regulations 2010

These regulations established a procedural framework for efficient and effective resolution of disputes to resolve inter-operator issues, for example spectrum sharing that will affect competition.

Amendments include:procedural improvements to enhance the effectiveness and speed of dispute resolution; powers to make orders for costs and interim orders, subject to safeguards, and improved rules of evidence and other matters; ccreate the possibility for the Authority to appoint a panel of experts to hear a dispute; rremove the Authority's role as primary port of call for consumer complaints; oobligate licensees to operate fair and simple consumer complaint and dispute procedures and report to the Authority on them; and provide for consumer appeals to the Authority in case the licensee fails this obligation.[201]

E. Conflicts over Spectrum Use

Conflicts invariably arise between diverse users of spectrum and between those that have access and those that have no have access. Conflicts may also arise between the managers or the administrators of spectrum(the government) and the users of spectrum. The conflicts usually revolve around commercial disputes, political disputes or they may relate to physical interference with spectrum. For instance, a party that already has access to spectrum will want the status quo while those not benefiting from spectrum and wishing to access it (particularly new market entrants) will seek changes shifting the management of the resource. Not surprisingly, the existing spectrum management framework in any country reflects the balance of powers of the competing interests in a society. This is no different in Kenya.

1. Competition Issues

With respect to the competition aspects, CAK which is the body with the overall mandate

199 <http://www.ca.go.ke/index.php/sector-regulations> accessed 05 September 2016.
200 ibid.
201 ibid.

of ensuring fair competition in the market has a role. The CA is vested with the mandate of confronting instances of dominant abuse in the market as pointed out above and they invariably work in collaboration with CAK in handling such matters. There have been occasions where there has been conflict owing to the overlapping mandates. While CAK has the broader role of regulating the market to ensure fair competition in all sectors of the economy, the role of the CA in this respect is equally broad since it's the primary sector regulator and also has jurisdiction over competition issues in the telecommunication industry to ensure fair competition in the communications sector. This vesting of powers on specialist agencies may be justified of the basis that such agencies have better technical knowledge of the affairs of the relevant sector and are thus best suited to deal with instances of market abuse. This argument is tenable when one considers that the Fair Competition and Equality of Treatment Regulations 2010 discussed above guard against unfair competition within the telecommunication sector. The purpose and object of the Regulations is to avail a regulatory framework for the promotion of fair competition and equal treatment and protect against the abuse of market power or other anticompetitive practices.[202]

The Competition Act 2012 is however also relevant in spectrum regulation as it grants CAK powers to ensure fair competition in the market. Interestingly, section 5 of the Competition Act 2012 claims superiority over other sectoral laws in the event of a conflict between the Act and those other laws dealing with competition law issues. The potential conflict between the CA and CAK with regard to resolving competition law disputes is settled by section 4 (2) of the Fair Competition and Equality of Treatment Regulations 2010 which provide that in the event that matters fall concurrently within the jurisdiction of another statutory agency responsible for competition matters, the CA shall cooperate with the said agency. The Statute Law (Miscellaneous Amendments) Act, 2015[203] amended the Fair Competition regulations and now requires that CA consult CAK before determining a market player is dominant. However with regard to *ex ante* competition issues, CA still remains the sole regulator.

CA works in conjunction with various entities and stakeholders.[204] The Cabinet Secretary is in charge of ICT overall and works with the National Communications Secretariat and the relevant Parliamentary Committee responsible for Communication and Information on legislative matters. The parliamentary committee can summon the Cabinet Secretary to provide information on all matters relating to spectrum management and regulation. The National Communications Secretariat is responsible for research and development of the ICT policy which is then handled by the Cabinet Secretary.[205]

Decisions made by CA may be challenged at the Appeals Tribunal and this may be done by service providers, broadcasters, vendors and telecom operators among others. The Appeals Tribunal adjudicates any disputes arising from the application of the enabling legislation by the CA.[206] CA also has various departments under it such as the Content Advisory Agency and the Universal Access Advisory Agency which are responsible for coming up with

202 Section 3 of the Regulations.
203 No. 25 of 2015 Laws of Kenya
204 Ministry of Information, Communication and Technology, 'National ICT Sector Policy Guidelines' (2014) 3.
205 ibid 23.
206 ibid 24.

regulations to give effect to the law.[207]

2. Jurisprudence

A discussion on the legal and regulatory framework in Kenya would be incomplete without an assessment of the jurisprudence emanating from the courts and other tribunals that constitute the legal system in Kenya. This is because the decisions emanating from these bodies represent the interpretation of the law and sometimes even serve to inform policy and future laws. It should however be noted at the outset that the issue of spectrum management has not elicited many disputes in the courts until now. However, as greater awareness of the sector and the benefits of spectrum are widely appreciated, there is the likelihood of increased litigation on this subject as various actors contend for spectrum rights and challenge administrative decisions by the statutory agency and tribunals. Litigation and dispute settlements on this relatively nascent area of law in Kenya will serve to enrich the discourse, inform policy and contribute to growth in this area of the telecommunication sector, hopefully resulting into better spectrum management. We discuss below some cases that have come before the courts.

a) Communications Commission of Kenya & 5 Others v Royal Media Services & 5 Others Petition No. 14 of 2014.

In this case, decided by the Supreme Court of Kenya, the respondents were contesting the decision of the CCK (before it was CA) to allocate a Broadcast Signal Distribution licence (BSD) to Pan African Network Group Kenya Limited (PANG), a company that was fully owned by foreigners. The Court was also tasked to determine whether the CCK had infringed the fundamental rights and freedoms of the media houses in denying them the BSD licence. A BSD licence basically gives power to a company to conduct digital transmission of program content. The media houses had formed a company known as National Signals Network (NSN) and tendered for the BSD licence which was denied by the CCK. The company made an application contesting the decision to the Public Procurement Appeal Review Board which upheld the decision of the CCK. The company, still dissatisfied with the decision moved the High Court for relief and the High Court held that the NSN was not entitled to the BSD licence by virtue of merely having invested massive broadcasting infrastructure over several years. This prompted the respondents to move to the Court of Appeal which held that owing to the massive investments by NSN, the company had a legitimate expectation that it would be granted the BSD licence. Consequently, the Court of Appeal revoked the BSD licence that had been granted to PANG and ordered the CCK to grant the respondents a licence. The appellants herein appealed arguing that the body mandated with the issuance of licences, in this case the CCK, was an independent body by dint of Article 34 of the Constitution of Kenya 2010. They further argued that in light of the history whereby licensing of frequencies was tainted by patronage and corruption, the independence of the body had to be jealously protected.

Some of the findings of the Court in this decision that are particularly relevant to the issue of spectrum management is that though the respondents had been promised that they would be granted a BSD licence by the Minister in the ICT Policy of 2006, the Court stated

207 ibid.

that the same could not found a basis for allocation of licences. The Court was of the view that licensing was a function strictly within the province of the CCK and not the ministry and the promise could not found a legitimate expectation for the granting of the licence. Further, the Court emphasized that Article 10 of the Constitution of Kenya 2010 that lists the national values and principles of governance which bind all State organs demanded the CCK to consider the principle of sustainable development while granting the licence. Being a national value and principle of governance under Article 10 of the Constitution, the Court stated that this obligated the CCK to seek to balance the public interest, the private interest and the interests of the international sector while considering applications for licensing. The Court also stated that the issuance of licences is an administrative decision falling squarely under Article 47 of the Constitution which lays a basis for judicial review and that issuance of licence must thereby meet the requirements stipulated therein. These requirements include fair administrative action and procedural propriety.

From this decision, a few issues relating to spectrum regulation arise. One, the mandate of licensing as per Article 34 of the Constitution of Kenya 2010 and the relevant legislation (KICA) is strictly within the province of the Communications Authority (CA) and the same cannot be exercised by any other entity. Two, in considering applications for licences, the CA ought to take into account public, private and international interests and seek to balance them whenever possible. Three, the decisions of the CA are administrative decisions and thus amenable to judicial review whenever they fall short of the requirements set out under Article 47 of the Constitution.

a) Royal Media Services Ltd v Attorney General & 2 others [2013] eKLR

In this case, the petitioner was a private limited liability company operating radio and Television stations in the country which sued the Attorney General and the Communications Authority among other parties alleging a violation of Article 34 of the Constitution of Kenya 2010 which provides for the freedom of the media. The petition was prompted by a public notice that had been issued by the regulatory authority demanding the petitioner cease broadcasting in violation of the frequency licence conditions. The regulatory authority stated in the notice that all frequency licensees were under an obligation to comply with the conditions attached to the licence and further that no operation of radio frequency transmitters could be properly conducted without a valid licence. The authority alleged that some of the radio stations belonging to the petitioner were being operated without a valid licence. The authority demanded a surrender of those frequencies failing which, it would take action. The petitioners on their part argued that they had been allocated the radio frequencies by the Authority and that since Article 34 of the Constitution of Kenya 2010 contemplated a new regulatory agency to succeed the then Authority, the regulatory authority had no legal mandate to demand compliance or take any action.[208] In the very least, the petitioners argued, a new body as contemplated by the Constitution had to first assume office and only such body could validly take any action against them. The petitioners further argued that in view of Article 33 which provides for the freedom of media, the continued harassment by the regulatory authority which was not the duly licensed body under Article 34 of the Constitution was akin to a

208 page no 5.

violation of their right to freedom of the media and their right to property under Article 40. The Court framed the issue as revolving around whether the regulatory authority as it was then was duly constituted to regulate the airwaves in light of Article 34 of the Constitution; and whether the notices issued were a violation of the petitioner's fundamental rights. The Court held that though the new contemplated body had not assumed office, the law never contemplated a vacuum and the transitional provisions in the Constitution meant that the regulatory authority as constituted at the time had the mandate to regulate the industry. On the second issue, the court held that in light of the first issue, the regulatory authority did not violate the petitioner's right and fundamental freedoms since it gave them appropriate notice, which is a requirement for fair administrative action. Notably, the court recognized that spectrum is a scarce public resource that ought to be managed well to ensure that it benefits the public as a whole. The court quoted the United States Supreme Court in *Red Lion Broadcasting Co. v FCC*[209] on the basis for regulation of airwaves where it stated:

> Before 1927, the allocation of frequencies was left entirely to the private sector, and the result was chaos. It quickly became apparent that broadcast frequencies constituted a scarce resource whose use could be regulated and rationalised only by the Government. Without government control, the medium would be of little use because of the cacophony of competing voices, none of which could be clearly and predictably be heard. Consequently, the Federal Radio Commission was established to allocate frequencies among competing applicants in a manner responsive to public convenience, interest and necessity.

The High Court also relied on a statement made by the Privy Council in *Observer Publications Limited v Campbell "Mickey" Mathew et. al*[210] to the effect that airwaves (spectrum) are public property whose use must promote public interest. Given that the regulatory authority issued 'Notices of Violation' to the petitioner, the court held that due process satisfying fair administrative action was followed. Based on the nature of spectrum as alluded to above, the Court held that the authority was under a legal mandate to ensure that licensees adhere to the terms of the licence failure to do which justified it to take action as required by law.[211] In particular, the court rejected the argument by the petitioner's counsel that interference was a normal hazard rather holding that a determination of the same was within the province of the regulatory authority.

From the above decisions, it appears that the courts have been affirming the regulatory authority (CA)'s legal mandate in ensuring the proper management of the scarce resource (spectrum) so long as it is done within the law.

Other court decisions that have had a bearing on spectrum management include *Royal Media Services Limited v Telkom Kenya and Others Milimani* HCCC No. 15 of 2000 which was an application by the petitioners seeking an order to restrain the defendants from interfering with their equipment and frequencies, an application that was dismissed.

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209 395 US 367 [1969].
210 [2001] 10 B.H.R.C. 252.
211 Ibid

F. Spectrum, Investment and New Technologies

Spectrum as a scarce resource constitutes a key infrastructure upon which technology is founded. As stated at the outset, spectrum is basically radio waves which enable the transmission of messages and information through the air at no cost.[212] Virtually all technologies in modern day employ spectrum as an essential resource. Indeed, it may rightly be stated that spectrum is the lifeblood of technology in any nation. This is especially so in this age where there has been an exponential increase in the use of wireless communications and the internet. Spectrum forms the basis of all wireless infrastructural systems which in turn form the vast majority of information technology systems.[213] To illustrate, there has been an increasing use of laptops, mobile phones, tablets, and television among other technological gadgets that have needed increased spectrum usage. These technological applications are not likely to abate going forward but may only increase even as technological advancements become more complex. So long as the uses of wireless devices continue to increase, there will be consequent need and pressure on spectrum, which will necessitate even more technical efficiency of the resource.[214]

Given the inter-linkage between spectrum and technology with the former being a key driver and enabler of the latter, it then follows that spectrum is a *sine qua non* for technology access.[215]To enhance access to technology for socio-economic development in the information age, there is need for proper usage of spectrum which also enhances access and equity.

1. Encouraging Investment

In order to enhance access to technology and to drive economic development in an information age, there is need for increased investment. Increased investment in the area of ICT is dependent on the availability and affordability of spectrum. As such, a legal-institutional framework that provides incentives for uptake of spectrum by market players is likely to lead to increased investment in a nation thus contributing to increased economic development.[216] Just like it is with other natural resources, an appropriate mix of the legal and regulatory framework is one that creates an enabling and conducive environment to enable increased investment in the sector. The framework must not create barriers to spectrum access but should promote its exploitation through clear licensing procedures that are transparent and accountable[217]. On the other hand, given the importance of spectrum as a resource and its usefulness in the various strategic sectors such as security, transport and health, it is important that the public interest imperative is taken into account. Further, since spectrum is a public good, the government licenses and regulates its use to address

212 Ibid
213 Muruiki Muriethi, 'Open Spectrum For Development: Kenya Case Study' (Association for Progressive Communications (APC) August 2010) www.OpenSpectrumKenya_EN%20(1).pdf accessed 2 September 2016
214 Ibid
215 Ibid
216 ITU, ICTs As Enablers of Development: A Microsoft White Paper'(December 2004) www.itu.int assessed 4 September 2016
217 ITU, 'ICT Regulation Toolkit | Impact of Convergence accessed 3 September 2016 www.ictregulationtoolkit.org

equity concerns and provide a level playing field for actors.[218] A public good is amenable to usage by all the members of the public and is supposed to be exploited for public benefit. However, there is an inherent conflict between the need to fuel private investment in the ICT sector so as to promote economic development and the need to ensure that all persons have equitable access to information and technology which are dependent on spectrum access.[219] It is not surprising therefore that an appropriate model for regulating spectrum is a continuing quest the world over. Indeed, many jurisdictions still use a combination of the command and control approach, the market-based approach which features spectrum auctions and licensing; and a license-exempt approach (spectrum commons).[220] None of these approaches is effective, adequate or suitable at all times and each of them is suitable based on the goals and circumstances of the case. An awareness of the existent tensions between equity or public interest and the need for access and technical and economic efficiency must therefore guide and inform the regulatory framework on spectrum.

2. Intelligent Technologies

The traditional mode of regulating spectrum has been geared towards demarcating technologies into different frequency bands so as to avoid interference. Indeed, the avoidance of interference is the main reason why there is usually need for regulation of spectrum. For instance, frequency bands for television or radio are usually separated from that used for mobile internet connectivity to prevent interference and thereby enable high quality of service.[221] However, given the increasing need for spectrum and its finite nature, it follows that with time, there is huge pressure on the available resource. Fortunately, advancement in technologies have made it possible to device other means of increasing more usage of the same spectrum to generate revenue.[222] In order to achieve this technical efficiency, there is need to employ various available intelligent technologies[223]. The use of these technologies that are able to make use of the same frequency band enable spectrum sharing thus enhancing access. As such, there is need to support and use new technologies that make it possible for different users to use the same frequency band.

An example of an intelligent technology that enables spectrum sharing thus making better usage is the cognitive radio technology that provides wireless broadband services in the white spaces between TV frequencies.[224] White spaces in television frequencies refer to the

218 Ibid
219 Ibid
220 Martin Cave, Fulvio Minervini and Windfred Mfuh, 'Review of the Literature on Market□based Methods of Spectrum Management: (2008)Report to the ITUwww.itu.int assessed 3 September 2016
221 International Telecommunication Union, Background Paper: Radio Spectrum Management For A Converging World, RSM/07. February 2004, para 2.1, at 6.
222 Ibid
223 There is no objective definition howeveran intelligent system is a machine with an embedded, Internet-connected computer that has the capacity to gather and analyze data and communicate with other systems. Requirements for an intelligent system include security, connectivity, the ability to adapt according to current data and the capacity for remote monitoring and management.
224 J Mitola & GQ Maguire, 'Cognitive radio: making software radio more personal' (1999) 6(4) IEEE Personal Communications Magazine 13.

unused parts of spectrum in Television broadcasting.[225] The cognitive radio technology is able to utilize this unused spectrum in television broadcasting for wireless broadband services. Another example is the Ultra-Wide Band (UWB) technology that is able to transmit low power radio signals across a wide variety of frequencies, support short range applications and locate radars by sharing frequency with other applications without any harmful interference. Other intelligent technologies are the software defined radios.[226]

The shared radio spectrum use is sure to enhance access of spectrum to the citizenry thereby enhancing their access for technology that is central to their socio-cultural and economic development. Persons will then be able to afford wireless broadband services over shared frequencies. This would also facilitate infrastructure sharing by operators thereby saving their costs and in turn reducing the cost passed on to the consumer, a situation that would uplift the peoples' standards of living besides promoting spectrum uptake.[227]

3. Shared Spectrum: Security vis a vis New Technologies

Maximum usage of spectrum to enhance access of technology will necessitate the need for spectrum sharing as already stated. However, whenever different users share a common resource such as spectrum security concerns are bound to arise. As already mentioned, technological advances such as cognitive radio have made spectrum sharing a reality.[228] Spectrum sharing means that different stakeholders with various priorities access a common resource albeit within clearly delineated parameters. There are various security and enforcement challenges that arise in a case of spectrum sharing[229]. They include confidentiality, integrity of the data, availability, privacy, compliance, access control and non-repudiation.[230]

The security threats inherent in spectrum sharing means that the regulatory framework must also contain provisions that seek to contain the security threats. These measures could be both preventive and remedial in nature.[231] With regard to preventive measures, this may be done through spectrum access control where access by users considered security threats is controlled or even denied. On the other hand, punitive or remedial measures are mainly

225 Ibid

226 *See*www.wirelessinnovation.org Software Defined Radio is defined as Radio in which some or all of the physical layer functions are software defined. Software defined radio (SDR) technology brings the flexibility, cost efficiency and power to drive communications forward, with wide-reaching benefits realized by service providers and product developers through to end users

227 Martin Cave, Fulvio Minervini and Windfred Mfuh, 'Review of the Literature on Market□based Methods of Spectrum Management: (2008) Report to the ITU www.itu.int assessed 3 September 2016

228 A.S. Jamwal & G. Kaur, Cognitive Radio: 'An Emergent trend for better Spectrum Utilisation' [2013] Vol 2 International Journal of Computer Applications Technology and Research Issue 3 p229 - 231

229 J. M. Park, J. H. Reed, A. A. Beex, T. C. Clancy, V. Kumar and B. Bahrak, "Security and Enforcement in Spectrum Sharing," in *Proceedings of the IEEE*, vol. 102, no. 3, pp. 270-281, March 2014.
doi: 10.1109/JPROC.2014.2301972www.wireless.vt.edu

230 Ibid.

231 Ibid.

targeted towards remedying or eliminating malicious behavior upon the occurrence of a potentially harmful event through punitive action.[232] This is meant to act as a deterrence mechanism. A combination of the two measures is important to ensure that those who are able to navigate through the preventative measure and cause a security threat are dealt with by the law through punitive measures. Some of the punitive measures include denial of access to spectrum and monetary penalties that are commensurate with the breach.[233]

232 Ibid.
233 Ibid

IV. SPECTRUM, ACCESS TO TECHNOLOGY AND ACCESS TOINFORMATION

The penetration of new technologies and the dynamic effects of convergence are changing the way consumers use communication services and availability of content from the traditional platforms to new platforms through mobile phones and other portable devices through the internet.[234] The digital television transition (DTT) led to the freeing up of spectrum for new market players to enter into the broadcasting industry.[235] Consumers can now access and view audio and visual content through multiple platforms such as digital terrestrial broadcasts, satellite, cable or Internet Protocol (IP) and Over-the-Top (OTT) television.[236]

A. Allocation of Radio Spectrum: Competition in the Broadcasting Industry

Technological developments affect the conditions of competition as they alter: the range and quality of services; the underlying costs; the extent of barriers to entry (new technologies provide new means by which the market is contested); the ability of customers to switch suppliers; and pricing mechanisms. For instance, technological developments allow for provision of pay per view services. It has been argued that spectrum is public property that belongs to the commons[237]. However, unlike other natural resources' commons that are used up, electromagnetic spectrum is a non-depletable resource.[238]The use of old technologies may render it 'consumed' as it is unavailable for other users.[239] It therefore follows that with technological innovation of, use of spectrum can reach an equilibrium of "sustainable consumption"[240]despite its finite nature.

234 Competition Law and Policy OECD, 'Competition Issues in Television and Broadcasting' (2013)DAF/COMP/GF(2013)13

235 Deloitte & Touche, 'Competition Study – the Broadcasting industry in Kenya' (2012) http://www.ca.go.ke/index.php/research accessed 12th July 2016

236 Competition Law and Policy OECD n. 1

237 Patrick S. Ryan, 'Application of the Public-Trust Doctrine and Principles of Natural Resource Management to Electromagnetic Spectrum' (2004) 10 Mich. Telecomm. & Tech. L. Rev. 285. http://repository.law.umich.edu/mttlr/vol10/iss2/1

238 Ibid

239 ibid

240 ibid

Radio Spectrum Allocation in Kenya 2012[241]:

Frequency Operator	% Spectrum Allocated	% Spectrum used	% Average Share of Listening	Ratio of share of listening to share of frequencies used for own service
Royal Media Services	15%	21%	34%	1.67
Radio Africa	6%	13%	6%	0.47
Kenya Broadcasting Corporation	20%	10%	18%	1.71
Nation Media Group	2%	5%	6%	1.34
Digitopia	4%	4%	2%	0.49
Kalee Ltd	1%	2%	3%	1.31
Others	52%		45%	
Total	**100%**		**100%**	

From the study conducted, it emerged that while total of 436 frequencies are allocated by the Communications Authority of Kenya, only 129 frequencies, or 30% of the total spectrum allocation in Kenya, was not in use. Therefore it leaves room for new technology to identify the dormant spectrum for the Communications Authority to reallocate or for spectrum sharing using better technology that can identify when the spectrum is not in use.[242]

B. The Role of Spectrum in Access to Technology

Technology can be transformative and through technological innovations, spectrum can be available for more users. Digital technologies using the mobile phone have invariably led to more households gaining access and sharing information digitally. They have traditionally been shared by a number of industries, including broadcasting, mobile communications and the military.[243] At the World Radio Conference in 1993, spectrum allocations for second

241 Deloitte & Touche, 'Competition Study – the Broadcasting Industry in Kenya' (2012) http://www.ca.go.ke/index.php/research accessed 12th July 2016

242 Ibid

243 ITU, 'All about the Technology' (ITU 2011)accessed on 17th July 2016 http://www.itu.int/osg/spu/ni/3G/technology/

generation (2G)[244]mobile were agreed based on expected demand growth at the time.[245] This led to the expansion of the spectrum capacity by allowing the use of current 2G spectrum blocks for third generation (3G) technology and allocating 3G spectrum to an upper limit of 3GHz[246].

C. Access to Information

Access to information, a constitutional right under the bill of rights in Kenya's 2010 Constitution[247] has been made possible through use of spectrum through broadcasting to mobile communications. Increased use of spectrum has facilitated the development of better and more innovative technology.[248]

Broadcast media for instance, has undergone a variety of transformations, with satellite and cable irrevocably altering viewing habits by exposing viewers to more information than they have been accustomed.[249] More recently however, mobile applications have transformed the face of broadcast.[250] The on-demand model that is soon to be complimented by an "on-the-go" and "interact" model, enabled by more sophisticated mobile solutions.[251]

The onset of digital TV and High-Definition Television (HDTV), has led to more efficient use of spectrum (as discussed above), giving way to more television channels and stations to operate.[252] In Kenya for instance, the switch-over from analogue broadcasting that begun in 2013 has resulted in the number of TV stations tripling to over fifty from less than twenty in

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244 *See*www.itu.intSecond generation (2G) digital cellular systems were first developed at the end of the 1980s. These systems digitized not only the control link but also the voice signal. The new system provided better quality and higher capacity at lower cost to consumers.Three primary benefits of 2G networks over their predecessors were that phone conversations were digitally encrypted; 2G systems were significantly more efficient on the spectrum allowing for far greater mobile phone penetration levels; and 2G introduced data services for mobile, starting with sms text messages. 2G technologies enabled the various mobile phone networks to provide the services such as text messages, picture messages, and MMS (multimedia messages). All text messages sent over 2G are digitally encrypted, allowing for the transfer of data in such a way that only the intended receiver can receive and read it.
After 2G was launched, the previous mobile telephone systems were retroactively dubbed 1G. While radio signals on 1G networks are analog, radio signals on 2G networks are digital. Both systems use digital signaling to connect the radio towers (which listen to the handsets) to the rest of the telephone system.

245 ITU, 'All about the Technology' (ITU 2011)accessed on 17th July 2016 http://www.itu.int/osg/spu/ni/3G/technology/

246 Ibid

247 Article 35

248 ITU, 'All about the Technology' (ITU 2011)accessed on 17th July 2016 http://www.itu.int/osg/spu/ni/3G/technology/

249 Deloitte & Touche, 'Competition Study – the Broadcasting industry in Kenya' (2012) http://www.ca.go.ke/index.php/research accessed 12th July 2016

250 Ibid

251 Chris Minas, The Guardian, available at https://www.theguardian.com/media-network/media-network accessed on 2nd June 2016

252 Deloitte & Touche, 'Competition Study – the Broadcasting Industry in Kenya' (2012) http://www.ca.go.ke/index.php/research accessed 12th July 2016

2012.[253] More people have got access to connectivity and are better informed.

D. Convergence of Technology

Convergence basically refers to the ability of different networks to carry the same kind of services or in the alternative, the ability of a single network to avail various kinds of services. It is simply the coming together of telecommunications, broadcasting and computing into a single digital bitstream.[254] It represents the expansion of services in the traditional services as a result of market trends. Some of the factors that have led to increased convergence include the need to look for new markets for products and technological advancements that have made it possible for new players to enter the market into the technology industry.[255]

Within the context of regulation however, convergence means the coming together of previously disparate industry-based laws, regulations and policies into a single coherent whole or regulatory framework. Indeed, regulatory convergence sometimes implies agency convergence where the governmental agencies charged with regulation of the related sectors are sometimes collapsed into one to improve efficiency. This has happened where telecommunications, broadcasting and content have been brought under one agency acting through various functioning units or departments. For instance, in Kenya CA has various functional units or departments dealing with Universal Access, and Spectrum Management among others. Convergence is bound to increase even as the subsisting networks continue getting modified so as to begin offering new services in response to market demands. For instance, there is the alteration of electric power networks to enable them offer broadband services, and the upgrade of telephone networks to offer Asynchronous Digital Subscriber Line (ADSL).[256]Cable television providers are also offering internet access, consumer services and broadcast services as a single package.[257] On the other hand, a mobile phone provider may also offer video services, data subscription and voice services. In short, the impact of convergence has been to create new opportunities for investment by market players and enhance the maximum usage of spectrum while at the same time meeting market demands.[258]

Convergence has also had an impact on the way in which regulators conduct their work. Convergence presents obstacles since it challenges the once commonly held view that there are clear functional differences between various services and industries.[259] The best means of licensing spectrum users in light of convergence is no longer clear nor are the existing regulations adequate. One of the means that regulators have begun using to confront the challenges presented by convergence is shifting to a technology-neutral treatment

253 Ibid

254 A Gates, 'Convergence and Competition: Technological change, industry concentration and competition policy in the telecommunications sector' (2000) 58 (2) University of Toronto Faculty of Law Review 83.

255 V Grover & P Vaswani, 'Partnerships in the US telecommunications industry' (2000) 43 (2) Communications of the ACM 81.

256 ITU, 'ICT Regulation Toolkit | Impact of Convergence accessed 3 September 2016 www.ictregulationtoolkit.org

257 Tirus Muya Maina, 'A Review of Convergence in Information and Communication Technology'International Journal of Scientific Footprints 2014; 2(3): 8 0 –98

258 Ibid

259 Ibid

of technology infrastructure.[260] Regulators are introducing regulations and other legal frameworks intended to govern the various aspects of convergence through a technology-neutral and flexible approach. Another way has been to modify the structure of the regulatory authorities charged with regulating spectrum by giving them the legal mandate to regulate the various sectors that form the subject of the convergence.[261] It is also possible to confront the challenge of convergence through an accommodation of convergence in the legal framework. However, this approach is limited to countries that have no market barriers to new entrants and no restrictions on the type of services that are offered.[262] Operators may well offer various services over various platforms in competitive markets, but the same may be tedious and complex owing to the various licences that will have to be sought and the regulatory oversight and monitoring that will be required by all the relevant institutions.[263]

Below we discuss examples of convergence in the broadcasting and mobile sectors.

1. Broadcasting

In places lacking a television set, mobile broadcast has filled the gap. A majority of the young people for example, have no TVs in school, but they have laptops, mobile and broadband consuming content, with which they regularly stream content on mainstream broadcast media platforms.[264] All this is done while posting on such social media platforms as Whatsapp, Twitter, Facebook and Youtube. Additionally, is the concept of mobile TV, although not yet a clearly defined media, is at the forefront of the changing the broadcast landscape. Similarly, mobile broadcast has been taken beyond a small, handheld screen; highlighting the potential that mobile broadcast has to change the market for mobile services.[265]

2. Mobile Systems

Mobile products are now being packed with projecting capabilities, allowing the user to watch anything on any surface and to share the viewing experience with those around them. Coupled with the launch of the fourth generation of mobile phone technology (4G), streaming broadcast on mobile handsets produces higher quality content, a more engaging experience and more immersive viewing experience.[266]This is one of the most significant changes in the

260 IT infrastructure refers to the composite hardware, software, network resources and services required for the existence, operation and management of an enterprise IT environment. It allows an organization to deliver IT solutions and services to its employees, partners and/or customers and is usually internal to an organization and deployed within owned facilities.

261 ITU, 'ICT Regulation Toolkit | Impact of Convergence accessed 3 September 2016 www.ictregulationtoolkit.org

262 Ibid

263 Ibid

264 John Carey and Martin C. J. Elton, 'When Media Are New: Understanding the Dynamics of New Media Adoption and Use' (New Media World) http://dx.doi.org/10.3998/nmw.8859947.0001.00http://quod.lib.umich.edu/ accessed 3 September 2016

265 Chris Minas, How mobile technology is changing the face of broadcast' The Guardian,(21 July 2013) available at https://www.theguardian.com/media-network/media-network accessed on 2 September 2016

266 4G is the fourth generation of wireless mobile telecommunications technology, succeeding 3G. A 4G system must provide capabilities defined by ITU in IMT Advanced.

broadcast experience since the introduction of colour TV.[267]Kenya has similarly embraced the 4G technology and the CA has since authorized Mobile Network Operators (CA) such as Safaricom, Airtel and Orange to test the 4G technology in their existing networks[268]. The testing of the 4G technology had sparked controversy between MNOs and the CA[269], when the CA published a gazette notice of its intension to allocate the 800 band to Safaricom[270]. It changed the narrative from allocation of the 4G technology from one operator to various MNOs and different market players that would benefit from a frequency sharing arrangement[271]. The CA has since changed its position arising from the competition concerns and allocating the 4G LTE to 3 MNOs that can afford the same[272].

Radio broadcast is progressing in a similar way by allowing users to personalise their listening experience. Spotify[273] recently added radio to its existing mobile app, which now includes the ability to create stations based around an artist, album or playlist, with additional songs being chosen that are similar to the ones that the user has selected.[274] No doubt many of the other radio broadcast stations will follow and launch their services as mobile web or app solutions in order to cater for the next generation of radio audiences who will expect a mobile experience.[275]

Mobile is rapidly expanding the different types of content that people are able to engage with; new apps and devices are adding greater capabilities in how broadcast can be accessed.[276] In other words, the availability of broadcast is changing, as well as our viewing habits. Channel owners are increasingly looking for new and more diverse distribution platforms in order to maximise reach in a more fragmented media landscape. The mobile industry is providing the platform and innovative technologies to help channel owners utilise their content in new ways and reach out to today's audience.[277] Mobile is breaking traditional barriers to consumption of content and driving broadcast forwards.

Potential and current applications include amended mobile web access, IP telephony, gaming services, high-definition mobile TV, video conferencing, 3D television.Two 4G candidate systems are commercially deployed: the Mobile WiMAX standard (first used in South Korea in 2007), and the first-release Long Term Evolution (LTE) standard (in Oslo, Norway, and Stockholm, Sweden since 2009). See www.itu.int

267 ibid

268 See ITNewsAfrica,'Kenya:CA approves mobile operators to test 4G technology'(24 April 2015) http://www.itnewsafrica.com/ assessed 3 September 2016

269 Business Daily, 'Safaricom downplays Airtel's 4G licence fears' (4 September 2015) http://www.businessdailyafrica.com

270 Official Gazette 21 August 2015 Vol._CXVII-No_.88 (N…0 MHz)

271 Business Daily, 'Airtel Demands a share of Safaricom Internet Frequency ' (4 September 2015)http://www.businessdailyafrica.com

272 Business Daily, ''Top three mobile operators to pay Sh2.5bn each for 4G licence' (4 September 2015)http://www.businessdailyafrica.com

273 Is a Swedish commercial music streaming, podcast, and video service that provides digital rights management–protected content from record labels and media companies.

274 Chris Minas, How mobile technology is changing the face of broadcast' The Guardian,(21 July 2013) available at https://www.theguardian.com/media-network/media-network accessed on 2 September 2016

275 Ibid

276 Ibid

277 Jane Sasseen, 'Digital: As Mobile Grows Rapidly, the Pressures on News Intensify'(Pew Research Center) http://www.stateofthemedia.org/2013 assessed 3 September 2016

Mobile broadband traffic seems likely to continue to nearly double every year, driven particularly by the increasing penetration and usage of tablet devices and smart phones. With the current trend of near-doubling every year, over the next decade mobile broadband traffic may grow by a factor of 1000. [278]A significant part of this traffic will be local indoor traffic and will go through unlicensed frequency bands wherever available and accessible. Unlicensed radio currently offers up to 500 MHz of spectrum (2.4GHz and 5GHz) for open access, with even further bandwidth at 5GHz potentially available in the next couple of years.[279] While Wi-Fi further evolves into High Efficiency LAN[280]it is expected to provide higher peak rates and throughput per area in dense scenarios. At the same time, long term evolution (LTE) for unlicensed bands may offer an even more efficient and better integrated option to offload traffic into unlicensed spectrum.[281]

Essential benefits include the fact that short distance Wi-Fi connections will provide faster data speeds, and will offer the opportunity to take away a bulk of (primarily indoor) traffic from Mobile Broadband (MBB) access and backbone networks, thus ensuring that cellular network capacity is reserved for high-value traffic.[282]Another area where mobile systems have cause ripples is the Mobile Money Transfer particularly in Kenya. Mobile Money Transfer (MMT) is an innovation arising from the convergence of the traditional banking sector, to transfer of money using the Information and Communications Technology (ICT) infrastructure of the Mobile Network Operators (MNO)[283]. The MNO infrastructure becomes a channel for funds transfer between customers of one or multiple MNOs to both the cellular terminals or to business organization to pay, or procure goods or to bank account to transact through the bank account[284].

E. Emergent Trends in Radio Spectrum use

1. Dynamic Spectrum and TV White Space

From the above discussion, it is evident that not all the radio frequency spectrum allocated in actual practice is actively used in space and time. CA has recognized this flaw and hence the attempt to monitor the spectrum use using a spectrum management and monitoring system.[285] However, other methods are available to alleviate this disparity in spectrum use such as the concept of Dynamic Spectrum Access (DSA) proposed by researchers and policy makers which allows devices to use unoccupied portions of spectrum without interfering

278 Nokia, *Optimising Spectrum Utilisation towards 2020* (White Paper, 2014)
279 ibid
280 Licenced Access Network
281 Nokia, supra
282 Muriuki Mureithi 'State of Competition in Mobile Telephony: mobile money transfer (MMT) services in Kenya" in The State of Competition Report: mobile money transfer, agricultural bulk storage and milling, and the media sectors in Kenya' (2011) IEA Research Paper Series No. 1/2011,Institute of Economic Affairs, Nairobi. http://www.ieakenya.or.ke accessed 20 December 2014.bid
283
284 Ibid.
285 Communications Authority of Kenya,'Authority launches new spectrum management system' (CA 27 July 2017) Available on www.ca.go.ke accessed on 27th July 2016

with the licensee's transmissions.[286]These new technologies enable a more flexible utilization of spectrum that is not in use with traditional spectrum management techniques.[287] TV White space constitutes part of the unused spectrum TV spectrum which can be made available using innovative techniques[288] such as DSA.[289] Wireless devices can also use DSA techniques such as sensing and geo-location databases to learn about available TV channels for wireless communication.[290]

This can help resolve the issue of underutilized spectrum. By employing these techniques, wireless technologies and management techniques can be efficiently employed to replace artificial spectrum scarcity with naturally occurring spectrum abundance and ensure that consumers and their devices have wireless bandwidth when and where they need it.[291]

Arising from the tests that have been undertaken by Microsoft, the first globally-harmonized opportunity to use DSA technologies will be in the TV band white spaces – unused VHF and UHF TV channels that can be used to deliver broadband access over wider areas than possible using today's Wi-Fi spectrum, with excellent range and obstacle penetration characteristics. It is no wonder then that TV White Spaces are referred to as "Super Wi-Fi".[292]

2. Cognitive Radio

Cognitive Radio is a new emergent research area in spectrum. It is a kind of radio network which enhances the existing software defined radio, whose physical layer behaviour is largely defined on software.[293]The concept of cognitive radio was first proposed by Joseph Mitola III[294] in a seminar in Stockholm in 1998 He later published an article[295] with Gerald Maguire Jr. in 1999. He described this novel idea in wireless communications as, "the point in which wireless personal digital assistants (PDAs) and the related networks are sufficiently computationally intelligent about radio resources and related computer-to-computer communications to detect user communications' needs as a function of use context and to provide radio resources and wireless services most appropriate to those needs".[296]

This enables the current fixed spectrum channel assigned by the administration to be utilized

286 Aakanksha Chowdhery et . al, 'Characterizing Spectrum Goodness for Dynamic Spectrum Access' Available at https://www.microsoft.com/en-us/research/project/dynamic-spectrum-and-tv-white-spaces/ accessed 16th July 2016

287 Dirk Grunwald, 'How New Technologies can Turn Spectrum Crisis in Spectrum opportunity'(2011) Available at www.wirelessinnovationalliance.org accessed 26th July 2016.

288 Ibid.

289 Chuck Needham and Ranveer Chandra, 'Dynamic Spectrum Access and TV White Spaces' 30 November 2015 Available at https://www.microsoft.com/en-us/research/project/dynamic-spectrum-and-tv-white-spaces/ accessed 16th July 2016

290 Ibid.

291 Ibid

292 ibid

293 A.S. Jamwal & G. Kaur, Cognitive Radio: 'An Emergent trend for better Spectrum Utilisation' [2013] Vol 2 International Journal of Computer Applications Technology and Research Issue 3 p229 - 231

294 Fellow of the IEEE; Is recognized globally as "the godfather" of software radio and cognitive radio technologies on which smart phones are based, and has over 40 years experience to his role as co-founded of Federated Wireless.

295 Joseph Mitola et al, 'Cognitive Radio: Making Software Radios More Personal'[1999] IEEE

296 ibid

by new users. For instance, most of the spectrum assigned to TV channels is idle a lot of the time, while wireless network users share a small range of spectrum, which is inadequate. When there are many wireless users at a time, the network gets congested because of the limited channel. With the spectrum access opportunities provided by the cognitive radio network, the wireless network users are able to share the idle spectrum of TV channels, on the condition that their access does not interfere with the normal TV channel.[297]

Cognitive radio has the following characteristics[298]

i) It is aware of its environment and its capabilities which are very crucial as it is able to sense the unused spectrum. An unused spectrum has different sensing temperature compared to one in use due to difference in interference and frequency band. An unused spectrum can be sensed using this frequency band difference which cognitive radio is very well suited to do by sensing spectrum holes[299].

ii) It is able to independently alter its physical layer behaviour based on its previous experience and its current environment.[300]

iii) It is capable of performing the complex adaptation strategies according to the cognitive cycle.[301]

With these capabilities, when the spectrum environment changes around the cognitive user, it is capable of sensing these changes and independently changing its physical layer settings such as transmission power, channel selection among others to address constraints or requirements of the users.[302]

One of the major concerns with cognitive radio is the networks' vulnerability by being open to all the users - authorized or unauthorized.[303] Since the network is freely accessible, users can interrupt the primary authorized users by interfering between their spectrum. A cognitive radio should then have some security mechanisms to recognize the users of the network. It should also be imparted with encryption techniques to communicate securely. To address these security issues regulatory bodies must have some provisions or policies on spectrum use, safety and security.[304]

Additionally, there is the issue of secondary users interfering among themselves. Since there is very limited unlicensed band available that can be used by anybody, these bands are overloaded and heavily used because it is much easier and cheaper for users to access the. Sharing should be done on "first come first served" basis or through some other allocation

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297 Chris Minas, How mobile technology is changing the face of broadcast' The Guardian,(21 July 2013) available at https://www.theguardian.com/media-network/media-network accessed on 2 September

298 Ibid, as drawn from; Simon Haykin, 'Cognitive Radio: Brain-Empowered Wireless Communications'[2005] IEEE Journal on Selected areas of Communication

299 Spectrum holes/ spaces are created where an unused band is present. All channels are classified into different spectrum holes. These are; White spectrum holes which are not fully used; Grey spectrum holes which are partially used and Black spectrum holes which are fully used.

300 A.S. Jamwal & G. Kaur, Cognitive Radio: 'An Emergent trend for better Spectrum Utilisation' [2013] Vol 2 International Journal of Computer Applications Technology and Research Issue 3 p229 - 231

301 Ibid

302 Ibid

303 Ibid

304 Chris Minas, How mobile technology is changing the face of broadcast' supra

techniques on network sharing on priority basis to increase the spectrum utilization.[305] Moreover spectrum sharing can be done by giving each secondary user a time quantum for his network use and requiring them to hand over the network for use by others. [306]
The key challenge in implementing a cognitive radio network is allocation of frequency bands to different users. Licensed users generally have stable frequency band whereas unlicensed users use dynamically allocated bands. It is quite difficult to distribute unused frequency bands which reside between stable bands as it may interrupt the primary users. There must be some heuristic algorithms to allocate a sequence of dynamically changing band which also keep these bands away from stable bands.[307]

3. Drones

These may not be a new creation, but their use of them has only recently become very popular. A drone is basically an unpiloted air or space craft. To the military, they are Unmanned Aerial Vehicles (UAVs) or Remotely Piloted Aerial Systems (RPAs).They are used in situations where manned flights are considered too risky or difficult. [308]C. Each aircraft can stay aloft for up to 17 hours at a time, loitering over an area and sending back real-time imagery of activities on the ground.[309]
This technology is mainly employed by the military for intelligence, surveillance and reconnaissance craft, some light enough to be launched by hand, to medium-sized armed drones and large spy planes.[310] Drones are seen by many in the military as delivering precision strikes without the need for more intrusive military action. However, they are not without controversy.[311] The drone has become central to U.S. national security strategy, which has switched from counter-insurgency in the city to counterterrorism from the skies.[312] The United States' Department of Defense' MQ-1 Predator, perhaps the most well-known of all military drones used today, [313] was designed in response to a requirement to provide persistent intelligence, surveillance and reconnaissance information combined with a kill capability to the war fighter.[314] Its deathly name conjures images of a science-fiction dystopia where robots hover in the sky and exterminate humans on the ground. Of course, this is no

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305 ITU, 'ICT Regulation Toolkit | Impact of Convergence accessed 3 September 2016 www.ictregulationtoolkit.org
306 ibid
307 ibid
308 BBC, Drones: What are they and how do they work? Available at http://www.bbc.com/news/world-south-asia-10713898 accessed on 30th May 2016
309 ibid
310 ibid
311 Hundreds of people have been killed by the strikes by the USA in Pakistan - civilians as well as militants, causing outrage. One of the deadliest attacks was in March 2011 when 40 were killed, many believed to be civilians at a tribal meeting.(sic), BBC (available at link in N.10)
312 See Jason Rineheart, Perspectives on Terrorism : Counterterrorism and Counterinsurgency [2010] Vol 4 *Terrorism Research Initiative* No.5 available at http://www.terrorismanalysts.com/pt/index.php/pot/article/view/122/html accessed on 30th May 2016
313 It has a wingspan of 55 feet, a length of 27 feet, and can reach speeds of up to 135mph.
314 Andrew Callam, 'Drone Wars : Armed Unmanned Aerial Vehicles' [2010] Vol XVIII *International Affairs Review GWU* No. 3

longer science-fiction.[315] British forces also use a variety of remotely piloted aircraft such as the Hermes 450 UAV in Iraq and Afghanistan, as well as smaller UAVs to help check for roadside bombs ahead of patrols.[316]
Drone technology would not be possible without strides in radio technology. Nikola Tesla first demonstrated the remote control of vehicles at the end of the nineteenth century. On a pond in Madison Square Garden in 1898, the inventor and showman remotely controlled a boat with a radio signal. This was the first such application of radio waves in history, meaning that Tesla's Patent No. 613,809 was the birth of modern robotics.[317]

The result has been decades-long research into the concept and development of new and better drone technology. Today, drones are not just being used by the military, but by the police and private investigators to collect information, intelligence and therein combat crime and protect life.[318] Unsurprisingly, technology enthusiasts have learnt the mechanics of creating drones and are creating them for their own leisure and personal consumption. Computer geeks including children are increasingly appropriating this technology at home and creating amazing miniature drones.[319] Of course the downside to this popularity of drones to the civilian sector then is that it is easy for such activity to get out of hand. For instance, these drones have major vulnerability. Examples[320] of hacking of remote controlled cars illustrate the vulnerability of these vehicles to cyber-attacks. New cyber-security technologies are needed to deal with attacks that can commandeer vehicles and cause physical damage. A serious incident in this area can influence public opinion and cause a major setback for this emerging field.[321]
In Kenya, despite their potential benefits the use of drones was banned in November 2014 due to security concerns. A news drone was launched a few minutes before the President's arrival at Nyayo National Stadium during Independence Day celebrations, causing considerable panic owing to the terrorist attacks the country had experienced in the recent past.[322]Individuals had used drones to film private functions such as wedding. The Kenya Civil Aviation Authority (KCAA) indicated that the ban was to be in place for one year until rules were made to regulate their use.[323] To date, KCAA is yet to publish the rules.

315 Understanding Empire, The Rise of the Predator Empire: Tracing the History of US Drones available at https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/ accessed on 30th May 2016
316 ibid
317 ibid
318 BBC, Drones: What are they and how do they work? Available at http://www.bbc.com/news/world-south-asia-10713898 accessed on 30th May 2016
319 ibid
320 *See the* Wall Street Journal, *Insurgents hack US Drones* (17th Dec 2009) at http://www.wsj.com/articles/SB126102247889095011 ;BBC, *Are Drones the next target for hackers?* (6th Feb 2014) At http://www.bbc.com/future/story/20140206-can-drones-be-hacked ; Security Week, *Design Flaws expose Drones to Hackers* (30th Sep 2015) at http://www.securityweek.com/design-flaws-expose-drones-hacker-attacks-researcher
321 IEEE, Six Trends in Robotics and their Implications, available at http://spectrum.ieee.org/automaton/robotics/home-robots/six-recent-trends-in-robotics-and-their-implications accessed on 1st June 2016
322 Emily Johnson, *Kenya basically bans all drone use — despite potential benefits they may yield.* (15 December 2015) available at http://www.pri.org/stories/20151215
323 ibid

4. Information Robotics

A crucial development in spectrum's role in information and technology is in the area of Robots.[324] These are computer programmed, remote controlled machines capable of carrying out a series of actions automatically. Robots have infiltrated the human world. They were built one by one over time, now they are all around us.

Robots can leverage clouds to do massive data processing and exchange information with other robots in real time[325]. Cloud robotics has the potential of freeing robots from computing constraints and giving them "big enough brains" to deal with challenging situations that they could not deal with before. Advances in big data are also being embraced by the robotics community to deal with the massive data generated by sensor-rich robots. [326]

F. Public Interest

Mobile broadcast is taking off and channel owners and content owners alike are facing the exciting challenge of racing to be first.[327]The emergent trends in radio spectrum use discussed above also herald exciting times for users of spectrum. The question however, is not about the advances in technology to make this possible, but how the services should be designed and how they will be used, especially with regard to the public. Ultimately, the service providers need to ensure they provide the best content and an engaging experience – all on the target audience's platform of choice. This will ensure their business is set, is quality, is appropriate and is prepared to reach the next generation of consumers even in the long-term.[328]

With the number of mobile-connected devices soon due to exceed the number of people on earth, broadcasters must respond to the changes in viewing habits in order to meet consumers' expectations of experiencing a more engaging, interactive and tailored broadcast experience.[329] Administrations need to take account of the shift to market based spectrum utilization, to ensure that the citizens are getting quality broadcasting, are not being unfairly exploited and are receiving maximum benefit possible, in terms of access to information and technology.[330]

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324 IEEE, Six Trends in Robotics and their Implications, supra.Drone is commonly known as Unmanned Aerial Vehicle (UAV). It is an aircraft without a human pilot on plank. The vehicle is controlled automatically by computers, or it can also be operated by the remote control. On the other hand,A robot is a machine, which is a mechanical or essential artificial agent. It is an electro-mechanical machine that is directed by a computer program or electronic circuitry. Robot is basically a system that contains sensors, control systems, manipulators, power supplies and software all working together to perform a task.

325 Ibid.

326 IEEE, Six Trends in Robotics and their Implications, available at http://spectrum.ieee.org/automaton/robotics/home-robots/six-recent-trends-in-robotics-and-their-implications accessed on 1st June 2016

327 The Guardian, *How Mobile Technology is changing the face of broadcast* (31st Jan 2013) available at https://www.theguardian.com/media-network/media-network-blog/2013/jan/31/mobile-changing-face-broadcast accessed on 22nd June 2016

328 ibid

329 Ibid

330 OECD, Competition Issues in Television and Broadcasting (26th April, 2011) available at http://www.oecd.org/daf/competition/TV-and-broadcasting2013.pdf accessed on 27th June 2016

CA has licenced over ten vernacular TV stations[331] and over twenty vernacular radio stations.[332] This has been in an effort to make available information processing and transmission to all areas of the country, especially the rural areas, which might not access national broadcasting stations.[333] Moreover, with the advent of devolution, counties have been empowered to establish local radio and TV stations to serve the needs of the local communities with regard to access to information, technology and entertainment. The CA has therefore made strides in adhering to basic calls of public interest.[334]

Public interest can also look out for the markets amongst themselves. It has been argued that while the new technology opens up new opportunities for efficient use of spectrum, using either of these technologies appears to violate the license rights of current licensees. It also appears to be incompatible with a property rights market regime as well.[335] Proponents of these technologies claim that they should be deployed in the context of a commons model, in which all can use the spectrum whenever they want, as long as we adopt simple rules to keep out of each other's way. In this view, property rights are the problem, not the solution because "building fences" of property rights violates the commons principle.[336]

The discussion on the policy and regulatory framework above elicits an over-emphasis on the market, efficiency and big players. This can lead to both the neglect of the broader public interest to avail information and to further marginalization of small players such as community radio operators who are not aligned to big media.[337]

In the policies, laws and regulations, citizen interests are limited to public participation in crafting the instruments. There is no discussion on the availability of spectrum for use in the public interest for availing information outside the market place. This is despite the stated 2006 policy intention to avail for all users; balance public and private interests and address the asymmetries that make private interests dominant over public ones yet this is a public resource.

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331 Including: QTV and Pwani TV(Swahili), Inooro TV, Kass TV(Kalenjin), Njata TV(Embu),

332 Including :Kameme FM, Inooro FM and Coro FM (Kikuyu), Metro East FM (Hindi), Chamgei FM, Kass FM, KitwekFM (Kalenjin), Radio Ramogi (Luo), Mulembe FM (Luhya), Mbaitu FM (Kamba), Star FM (Somali), Bahari FM (Swahili), Egesa FM(Kisii) and Muuga FM (Meru)

333 Open Society Media Program, *Mapping Digital Kenya* (5th Feb 2013)available at ahttps://www.opensocietyfoundations.org/sites/default/files/mapping-digital-media-kenya-20130321.pdf accessed on 24th June 2016

334 Facilitating the process of making Television and Radio available to Kenyans who would ordinarily not have accessed such services.

335 Gerald R. Faulhaber and David Farber, 'Spectrum Management: Property Rights, Markets, And The Commons' in Lorrie Faith Cranor & Steve S. Wildman (Eds.), *Rethinking Rights and Regulations: Insitutional Responses to New Communications Technologies* (MIT Press, 2003)

336 ibid

337 Vernacular radio stations licensed are run by mainstream media and the issue of whether the local voices are heard is a pertinent one.

V. INTERNATIONAL PERSPECTIVES ON SPECTRUM REGULATION

Spectrum regulators within municipal jurisdictions are charged with the responsibility of managing the use of spectrum among the various users and thus determining the various uses. These municipal regulators act on the international framework laid down by the ITU in the form of radio regulations to guide the utilization of spectrum.[338] This is not to say that national regulators are tied inflexibly by the ITU Radio Regulations. Indeed, they have some discretion while crafting their national policies but within the wider confines of the recommendations.[339] The reason for international cooperation regulation in spectrum management stems from the very nature of spectrum as a resource, namely that it traverses national boundaries. While each country would want to use the spectrum to the maximum, given it is a shared resource that must be guarded from interference which compromises its utility, national authorities must cooperate with others in regulation.

Owing to the discretion accorded to the various national authorities, there is disparity in terms of spectrum management in various countries. Essentially, national authorities engage in planning in order to determine the uses and users of spectrum in the respective country. Through this, the countries determine the mode of regulation, the mode of allocation of spectrum, the role of government and other diverse actors, subject to the prevailing law and policy[340]. The extent and reach of the planning that a particular country engages in is a function of the mode of regulation and allocation adopted by such country. For countries that choose to rely more on the market, there is likely to be less administrative interference in spectrum management. In this section, we examine the various modes of spectrum management adopted by a select number of countries with a view to studying some of the best practices that may be adopted by Kenya to ensure proper spectrum management that enhances access to technology and information while taking care of equity imperatives.[341]

A. United Kingdom

Spectrum management in the UK is split between Ofcom[342] and Government. Before the establishment of Ofcom in 2003, all spectrum was managed by government with the Ministry of Defence charged with management of spectrum used by the military while the Radio communications Agency was in charge of other civil uses of spectrum. Following the passage of the Communications Act in 2003, most of the responsibilities of the Radio communications Agency were passed onto Ofcom save for spectrum then used by bodies of the Crown as no licence had been issued owing to state immunity concerns. Some of the Crown bodies

338 Bruno Deffains & Thomas Welter, 'Spectrum Property Rights: From Theory to Policy' (2013) 1 <http://extranet.sioe.org/uploads/isnie2013/deffains_welter.pdf> accessed 10 September 2016.

339 ibid.

340 ibid.

341 Some of the various modes of spectrum management adopted by countries include the command and control approach, a market-based approach or a commons approach. For a comprehensive review of the tension between the public interest and the market imperatives in spectrum management, see Leo Herzel. "Public Interest" and the Market in Color Television Regulation' (1951) University of Chicago Law Review.

342 Ofcom is a statutory body set up under the Office of Communications Act 2002 to regulate spectrum that does not belong to Crown bodies in line with the Communications Act 2003 and the Wireless Telegraph Act 2006.

include the Department of Transport, the Department of Business Innovation and Skills for meteorology, space and science applications, satellite and the Home Office charged with emergency services.[343]

The Wireless Telegraph Act of 1999 introduced the concept of spectrum pricing by allowing the regulatory authority to charge users a fee meant to enable the proper management of spectrum as opposed to recovering the costs of licensing to the government. This administrative spectrum pricing was later extended to several other sectors and users. At present, Ofcom undertakes period fee reviews to ensure that the fee charged is not significantly out of sync with the opportunity cost of its use.[344]

According to the Cave Report[345] to the government in 2005 on the application of the administrative spectrum pricing to the public sector, policy decisions regarding the value of spectrum ought to be within the province of user departments which should operate on the 'user pays principle.'[346] The Cave Report recommended that user departments would engage in making decisions regarding assignment as opposed to being a function exercised centrally. This means that it is the user departments that drive the usage of spectrum by absorbing the market cost of spectrum. The UK government has since adopted this policy. Notably, the Cave Report was seeking an economically efficient model by ensuring that user departments maximize efficiency in usage.[347]

In principle, a market-based pricing based on the opportunity cost of spectrum use was formally adopted in the public sector in 2010. Nonetheless, a market based pricing is normally unable to free up spectrum to enable other uses, essentially spectrum access. Spectrum clearance to enable further access is by nature a complex and expensive process that takes time, effort and resource to accomplish.[348] The complexities in terms of cost associated with freeing up spectrum space may well be internalized by receipts that derive from the sale of spectrum. However, it may be prudent to have a policy in place for availing funds to cater for initial costs of spectrum release, a policy that ought to be made known to the various user departments.[349]

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343 Department of Culture Media and Sport, 'The UK Spectrum Strategy: Delivering the best value from spectrum for the UK' (2014) 19. <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf> accessed 09 September 2016.

344 ibid 24.

345 See Martin Cave, 'Independent Audit of Spectrum Holdings' (2005) 3 <https://www.google.com/?ion=1&espv=2#q=Cave+Report+on+spectrum+policy+in+the+UK> accessed 26 July 2016.

346 Department of Culture Media and Sport, 'The UK Spectrum Strategy: Delivering the best value from spectrum for the UK' (2014) 24, 25. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf accessed 26 July 2016.

347 ibid 25.

348 This is demonstrated by the Ministry of Defence's technical and remedial works that it undertook with a view to enabling the release of some spectrum space.

349 Martin Cave, 'Independent Audit of Spectrum Holdings' (2005) 3 <https://www.google.com/?ion=1&espv=2#q=Cave+Report+on+spectrum+policy+in+the+UK> accessed 09 September 2016.

At least one thing can be gathered from the foregoing. The exigencies of the public expenditure and public sector in general make it less prepared to respond to market forces and mechanisms.[350] It is difficult to state with certainty that the various user departments in the UK have the ability to pay the market rates of the spectrum they need for their use and release unwanted spectrum as well acquire new spectrum in line with their needs. This position is arguably not unique to the UK but must also be the case in other countries that have a similar model of spectrum management.

There might be need to ensure that there are incentives in the market to enable those holding onto spectrum to make efficient use of it and release unwanted spectrum for usage by other players. While this market-based pricing appears to be concerned with economic efficiency, it is not entirely out of tune with equity and access.[351] As highlighted, once mechanisms are developed to incentivize the market players to release unwanted spectrum for usage, this will enhance access to spectrum.[352]

Another useful innovation that is being pursued in the UK by the Ministry of Defence is the creation of a spectrum database to enable the rationalization of spectrum usage.[353]The Defence Ministry is the largest holder of spectrum space in the UK. The information contained in the databases helps the ministry in identifying the users of spectrum bands to enable its efficient use and determine spectrum that can be released and shared thus promoting access. According to an analysis done by Ofcom, a number of user departments do not have up to date databases indicating the various users of spectrum, a fact that contributes to hiding spectrum that would otherwise be released and possibly shared.[354] As a result, Ofcom is in the process of creating a single source of information (database) to enable the identification of frequencies in use and their various locations so as to determine those in use. This will help better and more efficient management of spectrum, avail a database that will form the basis of charging for spectrum users and enable the release of unneeded spectrum. In the future, Ofcom intends to establish geo-location databases that will interface with those spectrum databases to be formed, so as to support Whitespace technologies and thus facilitate spectrum dynamic access. Further, this will enable prospective users of spectrum to interrogate the database for any available spectrum and easily identify the person responsible for authorizing the use of spectrum, further enhancing access.[355]

As part of its spectrum release plans, the UK intends to release up to 500 MHz of public sector spectrum below 5GHz by the year 2020. More importantly, the government plans to release this spectrum through a coordinated approach to ensure that there is no oversupply or shortage in the market that would affect the value of the spectrum. In this respect, it intends

350 ibid.

351 We consider this to be so since a market-based pricing ensures economical usage of spectrum thereby letting up free spectrum space that may be used by others thus enhancing access.

352 However, equity concerns may not be fully catered for since a market-based mechanism, being an economic model, simply allocates resources to the competitive players alone while neglecting the suboptimal and non-competitive market players.

353 Ibid.

354 Ofcom (2013): http://stakeholders.ofcom.org.uk/binaries/consultations/spectrummanagement-strategy/summary/spectrum_management_strategy.pdf accessed 26 July 2016.

355 ibid.

to release this spectrum in line with commercial spectrum releases by Ofcom to ensure that users do not purchase sub-optimally. Ofcom has the mandate of releasing or selling this spectrum in the market as it is vested of the requisite technical and resource capacity.[356]

Besides, the UK has been engaged in spectrum auctions for nearly two decades, a practice it considers as delivering the best value of spectrum.[357] This is however the case only where there are well informed bidders and a properly designed auction. The UK however noted that the amount of spectrum that is available for auction is limited and considers the need to encourage auctioning through incentivizing spectrum users to release some of the spectrum that they are not using. Since all proceeds from spectrum auctions go to the government, an allowance for a retainer of some of the proceeds from the auction by the releasing spectrum user may just constitute the much needed incentive.[358] Spectrum auctions are a market-based mechanism that relies on allocative efficiency of the market, and rarely takes into account equity concerns. In an auction, only users that are best placed to pay more (highest bidders) are likely to get access to the spectrum. This may result in a situation of overconcentration of spectrum in the elite to the detriment of other persons, and especially the larger segment of the public mostly in the rural areas.[359]

Important also with regard to spectrum and access to technology is the initiative by the UK government to manage spectrum in a manner that promotes innovation and growth. Proceeding from the premise that spectrum is an invaluable tool for various technologies and that companies require spectrum to conduct their tests, research and development, Ofcom has been engaged in the issue of non-operational licences. The availing of these licences to enable the technical testing of new uses of spectrum is informed by the government's Information Economy Strategy, which enjoins Ofcom to investigate the viability of creating an automated and online geo-location database. The database is meant to provide on-demand and short term spectrum licences to facilitate research and development into new technologies aid in the development of technology and innovation and enhance access to technology is concerned.[360]

B. New Zealand

New Zealand presents a unique and interesting case study for a comparative analysis of spectrum management for the sole reason that it was the first country in the world to conduct spectrum trading. Spectrum trading was introduced in New Zealand in 1989.[361] However, until 1987 spectrum management in the country was through the command and control approach, also known as the administrative management method. This is whereby a regulator controls the usage of the spectrum resource by allocating licences with conditions to users on how to use the spectrum.[362] Advances in technology and the increased need for

356 Department of Culture Media and Sport, 'The UK Spectrum Strategy: Delivering the best value from spectrum for the UK' (2014) 28. <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf> accessed 09 September 2016.

357 ibid 30.

358 ibid.

359 ibid.

360 ibid.

361 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'4

362 ibid.

the usage of spectrum has gradually made it increasingly difficult for countries to continue to rely on administrative management mechanisms and in turn consider other market-based mechanisms. In New Zealand, the administrative approach to spectrum management worked efficiently since there were few users of spectrum and due to then relatively restricted entry into the telecommunications sector.[363] However, market reform characterized by liberalization allowing more market players who needed spectrum for their operations, necessitated a relook into how spectrum was managed to enhance access and provide value.[364] There has since developed a more open and competitive market environment and a paradigmatic shift in the manner and mode of spectrum management.[365]

This shift is discernible from the 1980's announcement by the New Zealand government that it sought to move away from the then subsisting system of first come first served assignment, which barely coped with deregulated environment to a market-based approach.[366] As a consequence, the government proposed a spectrum management system predicated on tradable spectrum rights. The Cabinet adopted the spectrum trading model which subsequently came into effect on 1 April 1989.[367] Significantly, the legislation that was passed did not do away with the subsisting administrative licensing regime but rather introduced a market based mechanism of spectrum trading to co-exist with the subsisting regime.[368]

As with virtually all other regulatory regimes, there is always a policy debate between flexibility and control. At one end, is usually the desire for the regulatory agency in charge of the telecommunication industry to have a firm grip of the industry normally done through strict regulation of rights.[369] On the other end is usually the need for flexibility in spectrum management by the regulator to ensure that it is dynamic enough to be able to respond to technological and changing demand patterns. This is always the tension among policymakers as far as spectrum regulation is concerned with each country finding its level through implementation.

The New Zealand regulatory framework essentially provides for three types of property rights which necessitate both creation and registration. These property regimes are: management rights, apparatus licences, and spectrum licence rights.[370]

Under the management rights property regime, the band manager issues local sub-licences and avails the exclusive right to management of a nationwide band of frequencies for up to a period of 20 years. It usually occurs within certain interference limits.[371] The apparatus licences which are non-tradable continue or operate with respect to the blocks of spectrum which are yet to have management rights created over them. On the other hand, under

363 ibid.
364 ibid.
365 ibid.
366 ibid.
367 See the Radiocommunications Act 1989 of New Zealand <http://www.legislation.govt.nz/act/public/1989/0148/latest/DLM195576.html> accessed 24 July 2016.
368 ibid.
369 See the policy debate regarding the best spectrum management approaches between command and control approach and the market-based approach.
370 Ministry of Business, Innovation and Employment <http://www.rsm.govt.nz/>accessed 24 July 2016.
371 ibid.

spectrum licence rights regime, the spectrum manager issues licences which afford the holder of such licence the right to use spectrum within the given band and within a specified geographical location. Usually, under this regime, there is unlimited range of uses to which this spectrum may be put into, save for where constraints are necessitated by interference.[372]

In order to transition to spectrum trading or the issuance of trading licences, the government favoured progressive realization or transfer of licences. Since the government had the original title to all management rights, it has since 1995 availed itself of the auction method of assignment of licences to users. Upon this primary assignment of rights to spectrum, rights may then be freely traded. As such, even for spectrum managers, it remains solely their discretion to determine whether to trade their spectrum rights or not and the factors to guide such trading. Further, the New Zealand regulatory regime places neither barriers to entry into the telecommunication sector nor restrictions on activities that may be conducted by spectrum users or operators. In addition, there exist no special licensing requirements with regard to spectrum and competition issues within the sector are governed by the general competition law.[373]

While New Zealand has a tradable market for spectrum and auctions even in spite of the existence of tenants, empirical evidence points to little usage of spectrum trading so far.[374] A number of reasons for the low uptake of spectrum trading exist, and they are worth examining in some detail, since they are relevant in informing us of the need and suitability of the mechanism for various circumstances. For one, since the primary method of assignment of rights is market-based (normally through auctions of licences),[375] trading in the secondary market, which is essentially a market based mechanism also, happens to be of little impact. In the second place, concerns still abound over the adequacy and effectiveness of competition law in addressing competition concerns given that there are no special regulations and agency specific to the sector.[376] This may possibly be due to the technical nature of the industry which makes it necessary for another layer of an agency and laws to ensure fair competition, over and above the general competition laws. Thirdly, since persons who buy spectrum happen to be operators normally concerned with the building of networks, they find little reason and incentive to sell the spectrum in the short-term.[377] Fourthly, there appears to remain nervousness in the spectrum industry relating to the expiry of the extant licences owing to the confusion with respect to the old and the new licences.[378] Fifthly, the low uptake of spectrum trading may be traced to the uncertainty relating to the manner of treatment of spectrum for purposes of international planning, since equipment availability compromises

372 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'4
373 ibid.
374 ibid.
375 An example of licence allocation through auction was the 700 MHz auction for 4G LTE cellular mobile services.
376 See Final Report: Allocation and Acquisition of Spectrum, Report Prepared for the New Zealand Ministry of Economic Development on Competition Safeguards in Relation to Initial Allocation of and Secondary Markets for Radiofrequency Spectrum in New Zealand at <http://www.med.govt.nz/pbt/rad_spec/competition-safeguards/report/> accessed 24 July 2016.
377 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'5.
378 ibid.

the utility of spectrum.[379]

In the end, it may be said that New Zealand presents a case study of a nation that has made use of spectrum trading in a bid to enhance access to spectrum and access to technology and ensure maximum economic efficiency of the resource.[380] There has not only been spectrum trading generally, but also trading between applications. This notwithstanding, it is still difficult to ascertain any marked difference in efficiency, at least at the moment.[381] As the uptake of this trading mechanism continues to take root, the evidence of any impact and efficiency of the mechanism will become more evident.[382] Suffice it to say that spectrum trading as a market based mechanism increases the efficiency of spectrum usage and enhances its utility.[383] For instance, spectrum trading in New Zealand made possible the rolling out of a fourth broadcast network that reached 70 percent of its population.

Spectrum trading in particular raises competition concerns as highlighted above, given that there always exists an incentive for market players to hoard spectrum. This is whereby market participants accumulate spectrum so as to deny the emergence of any other competitor. This would work against enhancing efficiency and access to spectrum since much of it would be hoarded and not be utilized but merely kept for speculation purposes. As such, there is need for more stringent competition safeguards, even if possible at the sectoral level to guard against this vice and enhance access. Notably, New Zealand grapples with competition issues after the issuance of a licence.

With respect to the management rights regime in New Zealand, there appears to be devolution of interference management from the regulator to the management right owner.[384] The latter assumes the function and mandate of the administrative regulator in delineating the boundary conditions for its licensees. This mandate is however, restricted to the bandwidth within which such owner holds the management rights. By doing this, the owner reduces the burden of managing interference that would otherwise fall upon the regulator.[385]

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379 ibid.
380 ibid.
381 ibid.
382 ibid.
383 ibid.
384 ibid.
385 ibid.
386 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'4
387 ibid.

efficiently since there were few users of spectrum and due to then relatively restricted entry into the telecommunications sector.[388] However, market reform characterized by liberalization allowing more market players who needed spectrum for their operations, necessitated a relook into how spectrum was managed to enhance access and provide value.[389] There has since developed a more open and competitive market environment and a paradigmatic shift in the manner and mode of spectrum management.[390]

This shift is discernible from the 1980's announcement by the New Zealand government that it sought to move away from the then subsisting system of first come first served assignment, which barely coped with deregulated environment to a market-based approach.[391] As a consequence, the government proposed a spectrum management system predicated on tradable spectrum rights. The Cabinet adopted the spectrum trading model which subsequently came into effect on 1 April 1989.[392] Significantly, the legislation that was passed did not do away with the subsisting administrative licensing regime but rather introduced a market based mechanism of spectrum trading to co-exist with the subsisting regime.[393]

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388 ibid.
389 ibid.
390 ibid.
391 ibid.
392 See the Radiocommunications Act 1989 of New Zealand <http://www.legislation.govt.nz/act/public/1989/0148/latest/DLM195576.html> accessed 24 July 2016.
393 ibid.
394 See the policy debate regarding the best spectrum management approaches between command and control approach and the market-based approach.
395 Ministry of Business, Innovation and Employment <http://www.rsm.govt.nz/>accessed 24 July 2016.
396 ibid.

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397 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'4
398 ibid.
399 ibid.
400 An example of licence allocation through auction was the 700 MHz auction for 4G LTE cellular mobile services.
401 See Final Report: Allocation and Acquisition of Spectrum, Report Prepared for the New Zealand Ministry of Economic Development on Competition Safeguards in Relation to Initial Allocation of and Secondary Markets for Radiofrequency Spectrum in New Zealand at <http://www.med.govt.nz/pbt/rad_spec/competition-safeguards/report/> accessed 24 July 2016.
402 Marloes van Caspel, 'Spectrum Trading: Increasing the Efficiency of Spectrum Usage'5.
403 ibid.
404 ibid.

In the end, it may be said that New Zealand presents a case study of a nation that has made use of spectrum trading in a bid to enhance access to spectrum and access to technology and ensure maximum economic efficiency of the resource.[405] There has not only been spectrum trading generally, but also trading between applications. This notwithstanding, it is still difficult to ascertain any marked difference in efficiency, at least at the moment.[406] As the uptake of this trading mechanism continues to take root, the evidence of any impact and efficiency of the mechanism will become more evident.[407] Suffice it to say that spectrum trading as a market based mechanism increases the efficiency of spectrum usage and enhances its utility.[408] For instance, spectrum trading in New Zealand made possible the rolling out of a fourth broadcast network that reached 70 percent of its population.

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C. Mauritius

Mauritius presents another interesting case study for our purposes, not least because it is in the African continent, but importantly because its regulatory authority is clothed with much broader powers than other municipal regulators, particularly with respect to increasing access to information and communication services.[411] The nation has an ambitious plan to extend ICT services throughout the country. This is particularly significant and relevant because its main target is increasing access of spectrum to all, since spectrum founds the infrastructure for ICT services rollout. The 2001 ICT charter enjoins the Mauritius Information and Communication Technologies Authority (ICTA) to not just manage spectrum but ensure that ICT services are accessible to all. At the beginning, the ICTA conducted public consultation and identified

405 ibid.
406 ibid.
407 ibid.
408 ibid.
409 ibid.
410 ibid.
411 See the 2001 Mauritius' Information and Communication Technology (ICT) Act which vests the regulatory authority with the duty of enhancing access to ICT services by citizens.

the demand for offerings of broadband wireless access. Whilst doing this, the ICTA was well mindful of the need to harmonize its allocation decisions with the trends at the international level so as to avail itself of the benefits wrought by economies of scale.[412]

Mauritius largely employs the command and control approach in spectrum management. The spectrum manager, in this case the ICTA, avails each user with the right to use devices that comply with set special equipment standard. It also requires each user to transmit its frequency over a particular geographical location so as to prevent interference. The ICTA is able to do this by issuing licences and through type approval certificates that are issued for compliant equipment. This is largely similar to Kenya. Though there has been an evolution in terms of the regulatory framework from the 1988 Act through the 1998 and the 2001 Act, the country is not any different from the traditional command and control approach of spectrum management. It is the ICTA, as the regulator, which makes the decision on the use of a band and the transmission to be done within that band.[413] A tight control over spectrum usage, which is normally a feature of the command and control approach, facilitates interference management and may easily lead to technical efficiency of spectrum usage.[414]

It is useful to note that there have been reform efforts in the country as the nation endeavours to slowly move towards a market-based mechanism. This is a result of the recognition that technologies are now flexible which has made spectrum sharing, leasing and better usage possible For instance, software defined radios such as WiMAX, LTE, and 3G allow various technologies and frequency band of operation in a single box.[415] The traditional means of spectrum management such as the command and control approach employed by the ICTA insists on specifying conditions that serve to limit operators from taking advantage of the inbuilt flexibilities, thereby stifling innovation.[416] This impedes access to technology and may be ameliorated by introducing service neutral licence conditions so as to increase flexibility.[417] Other issues that are necessitating reforms, and they are germane to virtually all other jurisdictions including Kenya include the convergence of services which is presenting additional difficulties for regulators with respect to assignment of frequency bands. A regulator may find it difficult to know the best and most appropriate technology to deploy within a particular band.[418] Moreover, there are many technologies that lose out on spectrum access due to failure to comply with the relevant standards that have been set. As such, it is prudent for the ICTA to consider adding new tools to the already extant spectrum management toolkit.[419]

412 <https://www.icta.mu/radiocommunication/radioview.htm> accessed 09 September 2016.
413 ibid.
414 ibid.
415 For insights into spectrum sharing, see Adrian Foster & John Alden, 'Spectrum Sharing' in Trends in Telecommunication Reform (2008) 84. http://researchictafrica.net/PGCICTPR/PGCICTPR/Module_1_files/Spectrum%20Sharing.pdf accessed 09 September 2016.
416 Such is invariably the nature of a command and control approach or an administrative mode of spectrum management as the regulator has an overbearing influence and seeks to enforce the conditions attendant to the issued licences.
417 Neutral licence conditions serve to mitigate or eliminate the bottlenecks normally presented by such conditions in the first place, in the form of limiting the scope of spectrum usage.
418 https://www.icta.mu/radiocommunication/radioview.htm accessed 10 September 2016.
419 Given the inadequacies of the foregoing particularly in light of technological

D. Uganda

Spectrum management in Uganda is done by the Uganda Communications Commission (UCC) which has put in place measures to inform spectrum allocation and sharing for optimal economic development. The Uganda Communications Act of 2013, Cap 106 Laws of Uganda, authorizes the UCC to manage spectrum.[420] Fully cognizant of the utility of spectrum access by all users, the UCC has a fully-fledged office of Spectrum Management within the authority that is tasked with frequency planning, monitoring and enforcement, coordination the allocation of spectrum and regulation and administration of frequencies. In addition, this office is responsible for formulating regulations, fees structures, standards and technical parameters to govern the use of each band in a manner consistent with international obligations.

The UCC notes[421] that technological changes have led to market players to take advantage of the same and introduce new services that are in increased need of spectrum. It further admits that spectrum use and access is critical to not only Uganda's communications but also to the entire economy. As such, it has been involved in putting in place measures and policies geared towards enhancing flexibility and responsiveness to the varied needs of different spectrum users. For instance, the UCC has been involved in the promotion of spectrum efficient technologies such as narrow band transmission technologies. In addition, the UCC has been encouraging digital signalling, digital migration and trunking between cells that have high mutual traffic loads in a bid to reduce crowding that frequently occurs in mobile radio frequencies.[422] According to the UCC, the increased competition particularly in the ICT sector is presenting new challenges in as far as spectrum management is concerned.[423]

Spectrum management in Uganda takes an administrative approach, largely similar to Kenya's. Any person (including a registered company) that wishes to make use of radio spectrum in the rolling out of its services is required to acquire a service provider licence as well as a licence to utilize spectrum.[424] This requirement essentially extends to radio and television broadcasters and persons wishing to operate data radio and voice communication equipment. Importantly and relatedly, is the fact that the UCC also conducts type approval of equipment used to ensure that they comply with the technical standards.[425] The UCC requires an application for the licence of spectrum in case of broadcasters and mobile communication service providers to be accompanied by copies of technical specifications for all radio equipment and models that are to be operated.[426]

Complaints relating to interference with radio frequencies that are sought to be avoided by way of spectrum regulation are usually lodged with the Executive Director of the UCC in writing.[427] A complaint is normally made in writing to the Executive Director describing

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convergences, there is need for more regulatory tools and approaches.

420 Section 5 (1) c and 25 of the Mauritius ICT Act 2001.

421 See <http://www.ucc.co.ug/data/smenu/77/Spectrum.html> accessed 09 September 2016.

422 ibid.

423 ibid.

424 Section 21-25 of the Uganda Communications Act 2013.

425 http://www.ucc.co.ug/files/downloads/SM%20FAQs.pdf accessed 26 July 2016.

426 Section 21 and 25 of the Uganda Communications Act 2013.

427 ibid.

the nature of the interference for appropriate action to be taken. These complaints may either be hand delivered, sent through post or sent via email.[428] Upon receipt of complaints, the UCC acknowledges receipt and conducts investigations with a view to resolving such interference. Throughout the period of the resolution of the reported interference, the complainant is usually apprised of the developments in light of such interference.[429]

The UCC has also developed Radio spectrum Policy Guidelines to inform the management of this key resource.[430] Some of the policies outlined in the policy guideline include: prioritization and protection of special radio services such as maritime and emergency services; promotion of frequency sharing to enhance access; frequency re-farming or displacement of services to other frequency bands if need arises; authorization of frequency use through licenses; possibility of market-based approach to spectrum management such as lotteries and auctions where demands exceeds supply; promoting universal access of spectrum including in the rural areas; and the use of licence-exempt frequency bands.[431] Other policies in deal with: the short-range devices permitted in Uganda are those that operate at low power levels and over short range as recommended by the ITU; issuance of temporary frequency assignments for trials and for new technology experiments; review of frequency usage fees from time to time; use of appropriate monitoring and management systems and tools; spectrum access for research and development; frequency planning and allocations; use of internationally recognized equipment standards to facilitate an open market for products and reciprocity in the type approval equipment; encouragement of formation of professional installers and inspectors of equipment to assist in conformity assessment; spectrum transfer procedures; and facilitation of co-location and sharing of infrastructure.[432] Other policies relate to: the issuance of regulations on requirements for registration of satellite orbital slots and for radio transmitting equipment; and the allowance for a varying or amendment of regulations so as to widen the scope of the policy guidelines where it so demands or on grounds of public interest.[433]

In addition, according to the Policy Guidelines document, the regulatory body (UCC) is to abide by the following principles in spectrum management[434]: transparency in frequency allocation and assignments coupled with public consultations; technology neutrality through the use of varying proprietary ;certified and standard-based technologies; conformity with the ITU standards and the National Frequency Plans; release and awarding of spectrum or frequencies in good time; and harmony with overall national objectives.

E. Tanzania

Spectrum management in Tanzania is conducted by the Tanzania Communication Regulatory Authority (TCRA) which is a quasi-independent governmental body established for the purposes of regulating the communication and broadcasting services

428 ibid.
429 ibid.
430 http://www.ucc.co.ug/files/downloads/SpectrumPolicyGuidelines.pdf accessed 26 July 2016.
431 ibid 1,2.
432 ibid 4.
433 ibid 5.
434 ibid 9.

sector. TCRA is established under the Tanzania Communications Regulatory Act, No. 12 of 2003[435] to perform various functions, among them the management of the national frequency spectrum. The TCRA replaced the now defunct Tanzania Communications Commission and the Tanzania Broadcast Commission in 2003.

Some of the functions of the TCRA under the Act with respect to radio frequency management are[436]: the formulation and development of a spectrum management policy, the planning and allocation of spectrum; assignment and licensing of frequencies; enforcement and monitoring of spectrum usage; and offering administrative and legal support and international cooperation. In addition, there is the Electronic and Postal Communications Act (EPOCA)[437] and the Electronic and Postal Communications (Radio communication) Regulations[438] to enable the governance of spectrum.

The Authority lists a number of spectrum management goals including[439]: meeting international obligations; avoiding interference between radio systems; satisfying demand for access to spectrum by all kinds of users; protecting extant services whilst encouraging and facilitating the introduction of new technologies; and ensuring rational distribution of spectrum to support social, economic, security and defense requirements in line with national policies.[440]

Like its East African counterparts (Kenya and Uganda), Tanzania adopts an administrative/ command and control approach to spectrum management with TCRA having the mandate of licensing spectrum users. The Electronic and Postal Communications (Radio communications and Frequency Spectrum) Regulations 2011 in Part II provides for conditions to be satisfied for the grant of radio spectrum.[441] This implies that all users of spectrum must seek permission from the regulating authority. Indeed, Regulation 4 (2) is emphatic that no person shall use any portion of radio frequency spectrum without a valid licence from the TCRA.[442] Regulation 5 further provides that a licensee who has been assigned spectrum must keep up-to date records of radio communications equipment and corresponding network elements in a format approved by the authority.[443] In other words, the authority regulates not only the grant of a license to utilize spectrum but also sets technical standards and conducts type approvals of equipment used.

At a general level, radio spectrum may be assigned for both mobile and fixed wireless services, private business radio, fixed links, networks and broadcasting stations in accordance with its availability.[444] The TCRA is charged with the process and procedure for spectrum assignments and takes into account the following factors when assigning

435 Section 4 of the Act. <http://www.tcra.go.tz/> accessed 09 September 2016.
436 Section 6.
437 <http://www.tcra.go.tz/index.php/legislation> accessed 09 September 2016.
438 ibid.
439 <http://www.tcra.go.tz/index.php> accessed 09 September 2016.
440 ibid.
441 <http://www.tcra.go.tz/images/documents/regulations/radioCommFrequencySpectrum.pdf> accessed 09 September 2016.
442 ibid.
443 ibid.
444 ibid.

spectrum[445]: method of determining price; method of payment of the assigned fees; the advertisement of the proposed assignment; the extent of spectrum usage; the intensity of demand; availability of equipment for use in the band; and ranges of the band among other matters as the authority deems fit.[446]

Notably however, there is no licence-exempt use of spectrum under the Tanzanian legal regime.[447] Further, spectrum licences cannot be transferred, assigned or otherwise disposed off without a prior written consent from the authority.[448]

445 See, among others, the various conditions set out under Part II of the Electronic and Postal Communications (Radio communications and Frequency Spectrum) Regulations 2011.

446 ibid.

447 <http://www.tcra.go.tz/index.php> accessed 09 September 2016.

448 ibid.

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

Access to spectrum is very vital for access to technology and information. Availability and access to spectrum technology is also critical for economic development. Owing to technological advances, there has been an increased demand for spectrum which is finite and fixed in quantity, thus necessitating even better and prudent management that not only enhances economic efficiency but also takes into account equity imperatives. We have demonstrated that spectrum is a resource that is essential for humankind and that in the knowledge economy which many states are aspiring towards, technology is essential. Access to spectrum and its use for the benefit of all is therefore vital. Equity demands that all persons, both the well off and the not so well off, have access to the common valuable resource (spectrum), as they do air or water, even if not to the same extent. This is as a enabler for development as well as access to information which is a constitutional right. In this context, the needs of the low income individual will definitely be lower than those of a sophisticated and technologically savvy high income earner.

For instance, part of the reason for the digital migration was to ensure proper spectrum usage so as to ensure that the digital dividend that resulted would be applied to roll out broadband wireless services in the rural areas. The availability of Wi-Fi in rural areas and other places throughout the country will greatly contribute to positive economic development and is in line with Vision 2030 which cites ICT as a key pillar and an enabler of growth. It is likely to contribute to decreased poverty among people and improve their living standards. By embracing new technology will ensure spectrum is equitably managed and enhance access to internet and telephone communication to rural areas. Inequitable allocation of spectrum owing to emphasis on economic factors will impede these developments.

However, the ability of wireless networks to result in this improvement in peoples' lives is dependent on the availability and affordability of the right amount of spectrum. Fortunately, the same advancements in technology that brought about the increased need for spectrum are also making it possible to share the same spectrum in a manner that ensures its maximum utilization. This has made it possible for spectrum users to do more with less, or at least with the same amount of spectrum. Even as more spectrum resource becomes available and technological advancements continue, regulators in various countries must continue to grapple with the question whether the subsisting management approaches provide the best value of the resource to the people in terms of economic efficiency and equity. The increasing use of the Internet for information access and the convergence of services' provision - telecommunications, media, broadcast and Internet - underscores the importance of judicious management of electromagnetic spectrum which is the vehicle through which these interact. There is urgent need to bring out the public interest of spectrum in designing allocation mechanisms. Spectrum as a public good should be treated as a public trust with its allocation and use subjected to the test of its being applied for the best interest of the greatest number of persons. The example of another finite resource – land- is instructive in this respect. In allocating land the principle of the highest best use is applied. Regulators of spectrum should borrow a leaf from land and define the highest best use in spectrum relative

to optimality in use and include factors such as access to technology; access to information; and contribution to development. This is in addition to the issue of economic returns to the users which seems to have been over-emphasized. Whether assigned to private, public or community actors, the essence is to have the most productive use or utility to the largest part of the population..

One sensible approach that is discernible from some of the countries examined in the above comparative analysis is the granting of unlimited technical flexibility to spectrum licensees so as to set free more spectrum space and resources. This should be coupled with the power of licensees to enter into new lines of business so as to make maxim use of spectrum. While economic efficiency and equity imperatives frequently appear to conflict, this need not necessarily be so. As we see it, availing technologies that facilitate spectrum sharing not only enables economic efficiency thus causing more economic value of the resource, but also enables more people to access the spectrum by releasing unwanted and unused spectrum.

Further with the rising demand for spectrum in different sectors, allocation of spectrum through market mechanisms may not be a feasible method since certain sectors may not support the financial levy that MNOs can pay for coveted bands such as the 4G for sums up toKshs.2.5bn. Regulators should therefore adopt legal frameworks that are technology-neutral and flexible to support access of such bands to broadcasters when in idle use.

Adoption of spectrum sharing through TV white space technologies are a case in point and can increase the efficiency of spectrum use through spectrum sharing. The use of spare UHF frequencies by such technologies is an important opportunity which should be made available to other users with the regulators embracing technological innovation to ensure, use of spectrum can reach an equilibrium of "sustainable consumption' despite its finite nature. This would therefore also require that regulators adopt laws and regulations that do not favor certain technologies or networks over others as this may impede competition and increase costs to consumers. Competing providers should be free to offer a wide range of services on the network or platform of their choice.

In monitoring spectrum use to ensure optimality and efficiency, CA should, in addition to adopting the use of vehicles to monitor idle spectrum, move further to adopt the use of intelligent technologies such as unmanned aerial vehicles. These would be a more efficient and effective method and enhance the enforcement of revocation of spectrum licences where the users keep it idle.

B. Recommendations

The adoption of a transparent Monitoring and Enforcement mechanism is important as it will ensure that the CA can monitor the use of spectrum and revoke licences for unused spectrum frequencies post allocation. By using new technology as pointed out above, this will ensure that spectrum is equitably managed and enhance access to internet and telephone communication for those who have no access such as in rural areas. The development of a legal framework that is premised on technology neutrality will also go a long way in supporting technological innovation. The use of intelligent technologies can facilitate the development of 'smart centres'which use data in a variety of ways. This can lead to savings

by, minimising waste, manage transport routes, monitor access to telecommunication in the rural areas, map land ownership among others.[449] Such transformation is essential for improving service delivery.

449 Department of Culture Media and Sport, 'The UK Spectrum Strategy: Delivering the best value from spectrum for the UK' (2014) 19. <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287994/UK_Spectrum_Strategy_FINAL.pdf> accessed 09 September 2016.