Regulating radio-frequency spectrum for the digital economy: Issues of economic regulation for the electronic communications sector

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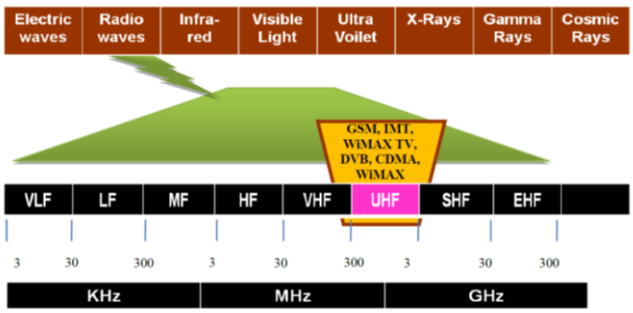
1. Introduction: economic regulation of spectrum

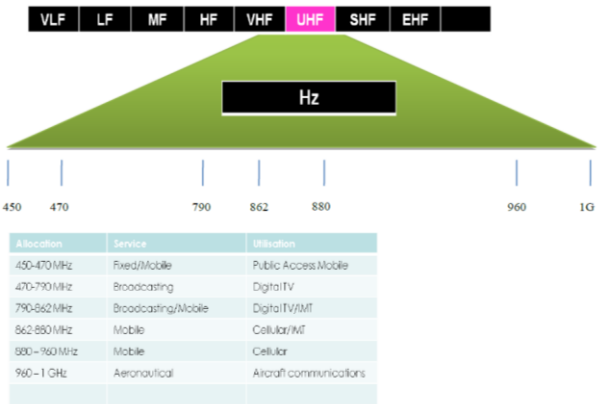
The broader research being conducted on spectrum regulation by the various authors seeks to understand the logic of existing and proposed spectrum policy and regulation approaches, in the context of the emerging digital services and media markets in South Africa. It focuses on questions pertaining to mobile broadband access for consumer markets, for particular social sectors such as the education sector, and for uneconomical areas such as rural towns. It delves into the need for spectrum regulation to grow digital services markets (e-transactions, e-government, e-health, e-education) and digital media markets. It considers regulatory approaches that could see new entrants benefit from spectrum assignment in ways that impact positively on end users in the public services sector, while creating new opportunities for traditional players such as mobile operators and Internet service providers (ISPs). For this conference paper, only a limited number of these issues are discussed.

2. The current state of radio-frequency spectrum regulation and questions for the future

From the general guidance on spectrum allocation to specific uses given by the ITU, see Figure 1a below, the South African regulator ICASA has allocated spectrum as per Figure 1b below. This spectrum allocation is historical and a new phase of spectrum regulation is needed (i) as the digital dividends (DD1 and DD2) are opened up; and (ii) as demand grows for specific uses in particular segments of the radio-frequency spectrum, such as demand for mobile broadband or demand for nomadic broadband used in WiFi hotspots.

Figure 1a.ITU international spectrum allocation **Figure 1b.ICASA SA spectrum allocation**





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Source: *Zimri, 2013 as adapted from Cave, 2002*

Source**:** *Zimri, 2013*

Traditional spectrum licensing models (first come – first served, beauty contests, command and control) gave exclusivity for spectrum that has economic value (high demand, IMT or access spectrum) to a limited number of operators i.e. MTN, Vodacom, Telkom, Cell C, Neotel and WBS. Following the initial award of GSM spectrum licences (900MHz) to mobile operators Vodacom and MTN in the 1990s, spectrum assignment has received limited attention in the last decade, with mobile operators awarded licences to operate in the 1800MHz band (GSM) and the 2100MHz band (3G). The fixed-line entrant, Neotel, was awarded a licence to operate CDMA in the 800MHz band and licences were awarded to iBurst, Sentech and the two fixed-line operators for wireless broadband services (WiMAX) in the 2.6GHz and 3.5GHz bands (Song, 2010, Kedama, 2014). The historical spectrum assignment has not fostered competition nor contributed to reduced prices for mobile voice and broadband access, possibly due to artificial scarcity. Allocation of spectrum for next-generation broadband and for novel uses and technology innovation in, for example, cognitive radio, is beginning to emerge on the agenda, but the pace of regulation is very slow.

Particular spectrum bands are listed as 'high demand' because these are the bands that mobile and broadband operators require to build next-generation mobile and wireless broadband networks, using the higher frequencies in urban environments and the lower frequencies in rural environments. These high demand bands include the 450-470MHz, the 690-800MHz, the 2.3GHz, and the unassigned portions in the 2.6GHz and the 3.5GHz bands. A frequency migration process is required, which could take several years. A frequency migration plan has been finalised and ICASA is proposing to do a complex migration feasibility study. A further development is the investigation into the possible approval of technologies that use white spaces to provide broadband services, including TV white spaces. White spaces are those spectrum channels that are under-utilised and can be accessed by other services without causing interference. These white spaces can be detected using technologies like dynamic spectrum access or cognitive radio.

Heightened demand for spectrum and therefore also for spectrum regulation is experienced in two components of the broad electronic communications sector:

(1) Telecommunications infrastructure: The shift to Internet-based communications creates opportunities for all services and media to migrate into the digital communications environment in parallel with traditional counter-based services or face-to-face services. The nature of supply and demand in these new digital services markets is not well researched as regards the implications for spectrum regulation. What is known is that major services such as e-commerce and e-banking, e-government, e-education and e-health will require high speed broadband, which will need high demand spectrum to operate effectively. By way of example: Three aspects of historical spectrum regulation have stifled the emergence of e-education in South Africa: (a) universal service and access obligations in spectrum licences have proved inadequate in taking Internet to schools; (b) no new entrants were invited to apply for spectrum, not even Internet service providers, despite their apparent interest in building wireless infrastructure networks in the early 2000s; and (c) regulation has tended to

focus on incumbent market players, rather than on required outcomes. With respect to e-health, we can learn from research on e-health projects in India, where many sites have connectivity, but very few have wireless broadband connectivity, preferred connectivity for rural health projects (Ramukumar, 2011, p. 10):

> All of them used bandwidth of 1 Mbps or less at the point of care. … This is in a sharp contrast with expectations that remote sites of most projects would have utilized the country's base of over 560 Million mobile + DSL landline connections. …

(2) Since broadcasting content can be delivered over Internet Protocol ('IP') networks, including fixed line and mobile networks (provided that sufficient spectrum is assigned to mobile operators), the question arises as to whether broadcasters (including community broadcasters) would benefit from allocations of broadcast spectrum and broadband spectrum. What spectrum will be awarded to broadcasters to enable high definition content? The trend towards Internet-based communication creates the opportunity for all communications (voice, broadcast, video, other) to be via the Internet – also referred to as 'triple play' or 'multi-play' in a converged electronic communications sector. How can the economic regulation of spectrum foster greater access and reduce the divide with respect to digital media markets? Furthermore, terrestrial TV signals are transmitted by a monopolist, Sentech, whose prices are unregulated and whose processes of managing terrestrial signal distribution on behalf of broadcasters are not regulated. How could regulation of this monopolistic market promote competition among broadcasters? These are important issues raised for regulatory attention, but not examined in this paper.

This paper briefly comments on the logic of proposed spectrum policy and regulation methodologies, in the context of the emerging digital services markets in South Africa.

3. Overview of spectrum regulatory approaches – need for a new framework for spectrum licensing, spectrum sharing, spectrum trading, spectrum pricing

In order to take advantage of the digital dividend and provide the spectrum needed for advanced telecoms and broadcast infrastructure, African regulators will need to focus on both economic (market) and development (public value) needs. In particular, regulators must address the problem of artificial scarcity (hoarding), which has arisen from traditional spectrum licensing models (Ikeda, 2002) and avoid creating new barriers to entry through mechanisms such as auctioning (Klemperer, 2002). This poses a challenge as market-facing models and public value models (such as command and control or open access models) (Marcus, Nett, Scanlan, Stumpf, Cave & Pogorel, 2005) would need to operate side by side and the contradictions between the selected models would need to be carefully worked out.

Spectrum management approaches for the next decade should invite the participation of more players – from traditional spectrum users building very large scale national or regional networks to new entrants, who could build smaller, localised networks that address local needs, such as broadband access networks for education and health facilities. Wellenius and Neto (2005) have critiqued the traditional rule-based spectrum management practices,

which give insufficient attention to the economics of wireless services and ICT use. What is required therefore is 'a new system for spectrum management…that permits different models of spectrum licensing (the traditional administrative, unlicensed and new market-based approaches) to coexist so as to promote economic and technical efficiency…' (Cave, 2008). Such a system should allow new market entrants operating in the digital services and media markets, to build or access small wireless networks. This view is supported by Cave (2008), who states that spectrum regulation and economic regulation should have the common goal of pursuing the long-term interests of the end users of technologies and services – not market players or government, but the ones at the 'end of the spectrum'. Thus, in approaching the reform of spectrum regulation, the objective should be creating a competitive environment that supports sustained growth of the digital media and services markets, not profitability for only a few firms. Foster (2010) argues that spectrum regulation should consider both economic and public value.

> *In choosing how much spectrum to allocate and for whom, regulators not only place emphasis on market valuations and economic efficiencies but also on social, development and cultural goals. Market mechanisms do not necessarily or easily take public policy priorities into account…Measuring (this) value requires the development and assessment of economic, financial, and infrastructure models; a deep understanding of local markets and sectors such as* ***education****, banking and manufacturing and an understanding of the interaction of the sectors with new technologies* …(Foster, pp. 14–17).

Future sectors where broadband demand is likely to be high include the public education and health services, where public value considerations arise with respect to spectrum assignment for promoting broadband availability for public use. However, the spectrum needs for broadband diffusion in these sectors, through adoption of technologies like WiMax, VOIP and IPTV, and for extensive utilisation of e-books and other broadband-enabled access devices, have not been widely researched to inform regulatory decision-making on the African continent.

Various models for spectrum assignment have been adopted, with relative strengths and weaknesses: first-come, first-served (economically efficient if no scarcity); beauty contest (subjective decision); lottery (not economically efficient); auction (economically efficient but may set barriers to entry); combinatorial (any appropriate combination of the other models) (Marcus, *et al*, 2005). Furthermore, market-based mechanisms that should be considered include auctions, secondary trading, administrative incentive pricing and liberalised usage of frequencies (Marcus, *et al*, 2005).

4. A complex future for frequency migration and spectrum regulation

The regulatory transition in spectrum, as discussed above, is complex and requires a well-designed strategy to ensure that the various components of the transition (migration) are effective, that the interests of the various stakeholders are met and that the broader public or national interest in economic development is served. Balancing this range of interests will require the sector regulator to consider the strategic utilisation of a variety of regulatory measures, including spectrum licensing, spectrum trading, spectrum sharing, open access

spectrum and spectrum pricing arrangements. Since there has been limited spectrum regulation in the recent past and no finalisation of the draft policy and regulations for assignment of high demand spectrum, it is relatively difficult to understand and analyse the advantages and disadvantages of the approaches mentioned above. One possible approach is to examine the policy and regulatory measures proposed in 2011, as a way of gaining insight into the options available to the regulator for the future.

In December 2011, the sector policy-maker (Ministry of Communications) and the sector regulator (ICASA) introduced proposals for further assignment of high demand spectrum in the 800 MHz and 2.6 GHz bands. Two years later, the policy directive has not been finalised. This has delayed the finalisation of ICASA's spectrum assignment plan and the invitation to apply for licences (ITA), resulting in delays in licensing highly sought after spectrum. Such assignment is important for promoting broadband connectivity as required by the demands of digital services markets in a 21st century economy, as well as for realising the goal of broadband connectivity for all, as expressed in various policy documents such as the National Development Plan 2030 and the National Broadband Policy 2013. One of the reasons cited for the delay (Kedama, 2014) is the outcome of the World Radio Conference (WRC) 2012, which officially made an allocation of the 700 MHz band, the second digital dividend (694-790 MHz) or (700 MHz band), to mobile services in Region 1 (includes Africa), giving an opportunity to assign and license the 700 MHZ and 800 MHz in the same regulatory process. While the draft policy and regulation were never finalised, they provide an important perspective on the views of the policy-maker and regulator, as a way of thinking through the issues that will arise in the next phase of spectrum regulation.

5. Findings and analysis with respect to proposed spectrum policy and regulation 2011

We examine the 2011 proposals as a basis for providing insight on future options for regulation of spectrum. The draft policy direction with respect to high demand spectrum (Ministry of Communications, 2011) aimed to promote wholesale open access to network infrastructure, while proposed regulation offered three spectrum licence packages for the high demand bands 800MHz and 2.6 GHz (ICASA, 2011). However, new broadband infrastructure market entrants were not explicitly envisaged, as Sentech and Neotel were candidates for two of the three licences, with the third licence possibly set aside for a new entrant. There was also lack of clarity on whether the licensees would be able to provide infrastructure only, or also provide services. Proposed universal access licence obligations required licensees to cover a large proportion of rural South Africa in terms of both geographic and population coverage (licensee 1: 70% geographic coverage in 5 years of which 50% must exclude the three largest metropolitan municipalities; licensees 2 + 3: 50% population coverage in 4 years).

This licensing approach would exclude the possibility of many smaller players creating localised (possibly lower cost) wireless broadband networks for towns with small to medium-sized (50,000–100,000) populations. The remedy, contained in the draft proposals, is a hybrid model: (a) a wholesale open access infrastructure sharing model ('no locking', 'no

blocking', 'no retail') in the 800MHz and 2.6GHz bands, and (b) a 'managed spectrum park', which was envisaged as a spectrum sharing model, exclusively in the 2.6GHz band. The model proposed a combination of beauty contest and auction approaches for the award process. Interviews conducted in 2013 and 2014 revealed the following weaknesses in the erstwhile spectrum regulation models:

5.1. Comment 1: Supply and demand side studies to inform regulation

The proposed spectrum policy (Department of Communications, 2011) and regulation (ICASA, 2011) points to the broader economic and social objective of spectrum assignment, to 'grow the economy by improving the education system, health and government system amongst others….and to stimulate the usage of broadband services to promote economic development and growth acting as an enabler for further social benefit' (ICASA, 2011), but is not explicitly informed by a supply and demand side analysis for e-services and associated spectrum needs for broadband. The National Broadband Policy 2013 (Department of Communications, 2013) makes a strong case for universal broadband access and service. The risk is that regulation would be informed almost exclusively by market-based views, with limited reference to public value considerations. A key issue is that spectrum licenses have historically been awarded only to the fixed and mobile operators and broadcast players, while ISPs have been granted electronic communications network service (ECNS) and electronic communications service (ECS) licences, which do not include spectrum assignment. Thus, ISPs cannot build small, localised wireless networks or create competition in the wireless broadband market to service low-income environments in cities and rural towns.

Furthermore, municipal broadband infrastructure is being built by four metropolitan municipalities and the Gauteng provincial government has recently awarded a broadband infrastructure tender, but service provision has yet to be launched. Provincial (and municipal) governments will face challenges of last-mile connectivity to schools, clinics and low-income households, where access to spectrum is a barrier (personal communication, Hero, 2011). These are the broader group of players with potential future requirements for spectrum assignment, hence supply side studies are needed for regulators to understand the requirements that will inform assignment.

Historically, sectors that have fuelled broadband Internet use include commerce, trade and banking, with social networking pushing through as a strong new sector of demand (Abrahams & Goldstuck, 2012). It is therefore argued that regulatory decision-making should also be informed by an understanding of demand-side factors, even where it is focused on regulating the supply side.

5.2. Comment 2: Clarity of regulatory models

The models of wholesale open access and managed spectrum parks used in the draft regulations were not clearly defined for the industry to share a common understanding and as a result operators and other interested parties had their own different interpretations. One of the active manufacturers in the technical regulatory environment stated that 'these models are untested and complex and can only be successful through thorough discussion among all stakeholders'. (MA3, 20 January 2014).

5.3. Comment 3: Clarity on the role of government or SOEs in wholesale open access

There are mixed reactions about the involvement of SOEs, but many interviewees agreed that universal broadband connectivity is only possible through a contribution from public funding. The question is how government should best be involved, whether through participation of the state owned entity or by making funds available. However, the proposals lack clarity on the involvement of state owned entities such as Broadband InfraCo and Sentech and raises the question of whether 'they need to be funded properly cause the National Broadband Network (NBN) can be done properly at the back of a state owned entity' (AC1, 11 December 2013) or whether SOEs should be involved at all: 'government involvement in making this country a digital country should be focused on the demand side and leave the supply side to the market forces' (IN3, 26 November 2013). 'Broadband in rural areas cannot be done without infrastructure sharing, spectrum pooling, and government involvement', according to a manufacturer, who nevertheless voiced strong disagreement that Sentech should receive free spectrum in the 800 MHz band (MA1, 08 January 2014). The government entities themselves are not sure where they feature in these new spectrum licensing models.

5.4. Comment 4: Lack of spectrum strategy

The majority of operators welcomed the progress made by the regulator, acknowledging that the proposed regulation coupled with the Invitation to Apply (ITA) was a step in the right direction but cited a number of areas of concern that require further investigation before implementation. These include the absence of spectrum strategy to direct and guide the regulator on how to license spectrum, which spectrum, for what services, to whom, how much. The fact that e-services like e-health, e-education and other government services are not specifically mentioned and what spectrum is set aside to achieve connectivity arises from the lack of spectrum policy or strategy. An interviewee noted that 'the regulation was too broad and talking in numbers, the regulation must drill down and mention e.g. which municipalities require what ICT services and what kind of infrastructure exist currently, do a proper needs analysis' (PR22, 20 January 2014).

5.5. Comment 5: Introduction of secondary markets and spectrum sharing

The draft radio regulations proposed the introduction of secondary markets such as spectrum trading, subletting and spectrum leasing but unfortunately these were taken out of the final radio regulations document that was published at the end of March 2011. Unfortunately the regulator missed an opportunity of assisting the smaller players who do not want to build their own networks from scratch to provide services in areas that do not make business and economic sense for the incumbents. As one academic stated, 'looking at the demand versus supply, the introduction of wholesale open access is justified for operators who don't have to build their own networks but want to have access to spectrum as and when needed like secondary markets where spectrum is used and regulated on a website for operators to use for specific periods' (AC1, 11 December 2013). Some of the operators and academics suggest that instead of licensing more operators, the regulator should assist the incumbents, create a level playing field, and assist those that entered the

market last by removing regulatory hurdles and creating secondary markets for spectrum trading and spectrum sharing, for example to enable a few large ISPs to collectively build small localised WiFi access (hotspots) in peri-urban and rural towns. Each of these ideas requires further research.

5.6. Comment 6: Introducing services-based competition

The view was expressed that in general there should be competition at both infrastructure and services level, but in areas that are economically not viable it is better to have competition at service level than infrastructure (PR22, 13 January 2014). Services-based competition could encourage the formation of consortiums of operators and ISPs or other types of consortia and investment.

Many other issues have to be taken into account in the process of regulatory design, including the limited availability of capital and other resources for new entrants to be competitive; proper needs analysis and coordination from all stakeholders is necessary to ensure that the market addresses those gaps that can easily be accommodated by the market so that the true-access gap is clearly defined.

5.7. Comment 7: Spectrum trading and pricing perspective

According to a limited number of interviewees conducted in 2014, the market would be welcoming to sharing underutilised white spaces in spectrum with secondary users provided it does not cause interference. Interference would cause degraded service, resulting in lower revenue and unsatisfied customers and undermine the ability to give guaranteed quality of service.

In relation to underutilised spectrum, the view was expressed that this should be sold directly to secondary users as a means of earning revenue with minimal involvement from the regulator to avoid delays (conversation with industry expert, February 2014). In the current arrangements, the spectrum will need to be given back to ICASA as they are responsible for assignment. The regulator agrees that spectrum needs to be used more efficiently and believes that all bands can be used for spectrum trading as every band is underutilised dependent on geographical areas. Spectrum trading is seen as long overdue and current legislation does not prevent it, except to the main telecommunications operators (conversation with regulator, February 2014).

The regulator believes the best pricing model for the market is a cooperative scheme as with infrastructure sharing, the highest profit can be attained. Infrastructure sharing assists in minimising the costs associated with installing and maintaining new infrastructure. The regulator can be involved in enforcing a cooperative pricing model, however if they are involved, they cannot select whom the spectrum is awarded to and the bids may appear unfair (conversation with regulator, February 2014).

Research was conducted on secondary user pricing strategies in a cognitive radio environment for spectrum trading in 2013. The simulation results showed that the competitive pricing strategy produces a higher profit than the market-equilibrium pricing strategy. However, a cooperative pricing model and strategy could encourage greater

utilisation of spectrum based on spectrum sharing. These are key issues for regulatory consultation and decision-making.

6. Conclusion and recommendations

This paper adopts the view that the transition of emerging economies from services-based to knowledge-based economies will require major innovations in creating private and public value through advanced electronic communications infrastructure. Historically, spectrum assignment in South Africa has been considered from the perspective of assignment to fixed and mobile operators, and broadcasters. Seldom, if ever, has spectrum regulation been considered from the perspective of the rapidly growing demand for broadband-enabled services and transition to an Internet-enabled services sector.

What does this mean for the 21st century regulator? Regulating for a digital economy means regulation that will bring ubiquitous, high-speed household broadband access, as well as public access in schools to advance e-education and in clinics to advance e-health, in conjunction with the emergence of a digital economy in the private services sector. This requires an e-services-oriented regulatory approach rather than an industry-oriented regulatory approach.

The next phase of spectrum regulation must adopt regulatory approaches that address the needs of traditional market segments, such as mobile services, and see new entrants benefit from spectrum assignment. A spectrum assignment approach that invites new entrants would potentially give greater value to consumers, as well as to large users in the public services sector, for example contributing to the broadband foundation infrastructure needed for e-education for over 12 million learners in South African public schools, or further afield for e-health in urban and rural clinics on the African continent. Even understanding the scarcity of resources for building capital-intensive networks, spectrum regulation can encourage new entrants and competition at localised levels through spectrum sharing and services-based competition.

Three related issues arise for consideration by policy-maker and regulator: (1) The policy-maker must clearly and explicitly set out the strategy for spectrum assignment and its thoughts on utilising spectrum policy to promote private and public value in greater detail than in the National Broadband Policy 2013. It should clarify its thinking on the utilisation of licensed and unlicensed spectrum to promote broadband access; (2) the regulator must conduct supply and demand side studies to better understand the implications for the economic regulation of spectrum to achieve innovation in digital services and markets and to present clarity on its regulatory and licensing approaches; and (3) the regulator must carefully consider the strengths and weaknesses of specific approaches to spectrum licensing, spectrum trading, spectrum sharing, open access spectrum and spectrum pricing, whether these should be cooperative or competitive pricing models.

6.1. Spectrum strategy

The policy-maker should explicitly include public value considerations, not just universal access considerations, in its strategy design, in order to balance market interests and public interest. Considerations must include meeting the needs of consumers of sector services and advancing the capacity of the sector as a whole. Such strategy must support the intentions of the National Broadband Strategy 2013 to encourage the regulator and the market to find innovative ways of getting high-speed broadband to public institutions such as schools, to households in rural areas and middle- to low-income communities, and to give greater push to commercial e-services.

6.2. Economic regulation of spectrum for digital services and media markets

Significantly stronger integration of ICT is needed as a platform technology for the future development of the broad services sector. The ICT, media and services sectors together create the foundations for economic advancement and for future generations of innovators and entrepreneurs, in particular in the education sector. Thus, spectrum assignment should incorporate a services-oriented approach, rather than an exclusively industry-oriented approach. Furthermore, attention should be given to the spectrum as one of several components of the broadband ecosystem, building co-terminous regulation of the key elements of the ecosystem.

The regulators should consider the strengths and weaknesses of various regulatory approaches, possibly combining market-based assignment (to create private value) and a limited form of command and control (to promote public value), where the latter may be required to provide infrastructure in uneconomic areas. An options analysis of various formal mechanisms for the deployment of licensed and unlicensed spectrum, as well as for spectrum trading and spectrum sharing should be conducted, setting out the advantages and disadvantages of each option, not limited to the previously proposed open access models and managed spectrum park ideas. It has been argued that the market will only sustain three to four major infrastructure providers to build national and regional broadband networks (industry interviews 2013 to 2014). The regulatory analysis should consider how to construct a licensing regime that encourages Internet Service Providers (ISPs) and other ECNS licensees and small-scale investors (collectively regarded as new entrants) to build localised wireless infrastructure networks, in a capital-intensive, but resource-limited market. The detailed research should be set out explicitly in a regulatory discussion paper for consultation and public comment.

6.3. Spectrum pricing approaches

The regulator should not set out with the sole intent of gaining revenue, thus considering only regulatory tools such as spectrum auctions and beauty contests. It should adopt a position of valuing spectrum, regulating pricing in such a way to ensure that spectrum is effectively utilised to get high-speed broadband connectivity to consumers, to public institutions and low-income households, through the design of spectrum pricing models that

will enable greater investment in broadband. This may include a combination model of competitive pricing for spectrum trading and co-operative pricing for spectrum sharing.

This research is significant for a continental audience. For African regulators, it presents some foundational ideas to consider hybrid forms of spectrum regulation and pricing to promote both private and public value.

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