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RADIO SPECTRUM REFORMS AND ASSOCIATED EFFECTS ON MARKET LIBERALISATION

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A thesis submitted in fulfilment of the requirements for the degree of Master of Arts, in ICT Policy and Regulation

University of the Witwatersrand

2016

Abstract

There is a common opinion among researchers and experts that efficient management of radio spectrum plays a vital role in ensuring universal access to telecommunications services. The objective of this study was to identify radio spectrum reforms and their associated effects on market liberalisation. It was postulated that appropriate radio spectrum reforms would be catalysts for market liberalisation. The evolution of command-and-control approaches in relation to market-based approaches was assessed.

The research involved literature critique, review of policies as that relates to history of radio spectrum management in South Africa and across the world, and radio spectrum regulations analysis in South Africa. Interviews of radio spectrum industry experts and documents study of the evolution of telecommunications regulatory environment with respect to radio spectrum management and market liberalisation were also used as main sources of research.

The purpose of the literature critique, review of policies, regulations and documents was to identify hints of radio spectrum reforms and measure qualitatively the extent of market liberalisation. While interviews of radio spectrum industry experts were used to ascertain industry response to strides made as far as radio spectrum and market liberalisation in South Africa.

It was observed that initially, in most parts of the world and in South Africa, market liberalisation progressed quickly despite appreciable correlation with radio spectrum reforms. Early radio spectrum reforms, such as the establishment of an independent regulator of the industry and radio spectrum, had contributed to some level of market liberalisation with creation of oligopolistic telecommunication market, and had increased to radio spectrum by Vodacom, MTN and Cell C having access to both 900 MHz and 1800 MHz bands. However, perpetual practise of command-and-control, an efficient radio spectrum management encouraged hoarding.

The literature review and interview provided seven main contributions of reforms in the form of strides. These strides formed the basis for the research framework: 1) establishment of an independent regulator of the industry and radio spectrum, 2) increased access to radio spectrum, 3) service and technology neutrality on radio spectrum, 4) essential facilities to enable sharing, 5) market-based approaches radio spectrum pricing: AIP, 6) service-based competition versus infrastructure-based competition, and 7) non-rival, non-exclusive usage of radio spectrum.

The conclusion is that increasing access to radio spectrum and the independent regulator were not primary determinants of market liberalisation. An analytic framework has been used to show that market liberalisation reached a plateau phase, with a few incumbents becoming dominant and creating an oligopolistic market structure. It is at this point that further market liberalisation could be stimulated by additional radio spectrum reforms. The command-and-control approach remains the main bottleneck source for access and efficiency in radio spectrum management, which encourages rival and exclusive use of

radio spectrum. It has been observed that market-based radio spectrum reforms have also entrenched rivalry and exclusivity in the use of radio spectrum. Radio spectrum reforms that encourage non-rivalry and non-exclusivity, such as open-access to radio spectrum, are highly recommended in this research.

DEDICATION

I dedicate this work to my family and friends who were a pillar of my strength. A special gratitude to my mother, Agnes who taught me to work hard for the things I aspire to achieve. I also want to thank my son Tumi, for his support, inspiration and encouragement especially during difficult moments. I give a special thanks to my best friend Nkele Phiri. Finally thank you to the following people: Moseamo Sebola, Yolisa Kedame and Zanele Sibiya, who have supported me throughout the process.

ACKNOWLEDGEMENTS

I wish to acknowledge and commend my supervisors, Dumisa Ngwenya and Dr. Mncedisi Bembe whose academic rigour, sagacity and supportive nature helped me to pull through.

DECLARATION

I, Cynthia Leungo Lesufi, declare that this research report is my own, unaided work. It is submitted in partial fulfilment of the requirements of the degree of Master of Art in ICT Policy and Regulation at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

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Cynthia Lesufi

30 March 2016

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CHAPTER ONE: RADIO SPECTRUM REFORMS AND MARKET LIBERALISATION

1.1 INTRODUCTION

This chapter introduces the research topic and background information with particular focus on telecommunications impacted by radio spectrum reform and the effect on market liberalisation.

The research seeks to explore the required radio spectrum reforms necessary to enable South Africa to fulfil national objectives as defined in the National Development Plan (NDP) and South Africa Connect (the National Broadband Policy), which among others includes market liberalisation. This is necessary to achieve universal access for broadband services. It is acknowledged that South Africa Connect objectives will be achieved through a combination of wired and wireless technologies (DoC, 2013). However, the focus of this research limits the scope to wireless networks only.

In terms of the NDP and South Africa Connect, there is a need to improve competition in the industry in order to reduce the cost of communication, while achieving universal access. To achieve this, further market liberalisation is required. According to the NDP and South Africa Connect policy documents, ineffective radio spectrum management causes a bottleneck or limitation to competition in the market. Even in the case of South Africa and other countries in the world, market liberalisation initially occurred without radio spectrum reforms making much strides. However, it appears that after a plateau phase of market liberalisation, radio spectrum reforms can be employed as a necessary catalyst for stimulating further liberalisation. This is the reason behind conducting this research as a means to explore the case for radio spectrum reform in South Africa.

1.2 BACKGROUND

The emerging mega trends in communication, such as cloud computing and big data, are arguing over networks with ubiquitous accessibility and dynamic management. Especially in wireless communication, the introduction of smartphones and tablets is behind the exponentially growing popularity of rich content (example: online gaming, mobile TV and social networks. The end user's demand for rich content can be fulfilled by the availability of broadband networks (GSMA, 2015).

Broadly, there is a requirement for high quality broadband networks for all by 2030, with the capability to support high data traffic speeds. This can be facilitated by radio spectrum reform and market liberalisation (DoC, 2013). It has therefore been identified that one of the main ingredients necessary towards creating an enabling environment to achieve ubiquitous accessibility to the broadband network is through efficient allocation and assignment of radio spectrum (spectrum management reforms) (DoC, 2013).

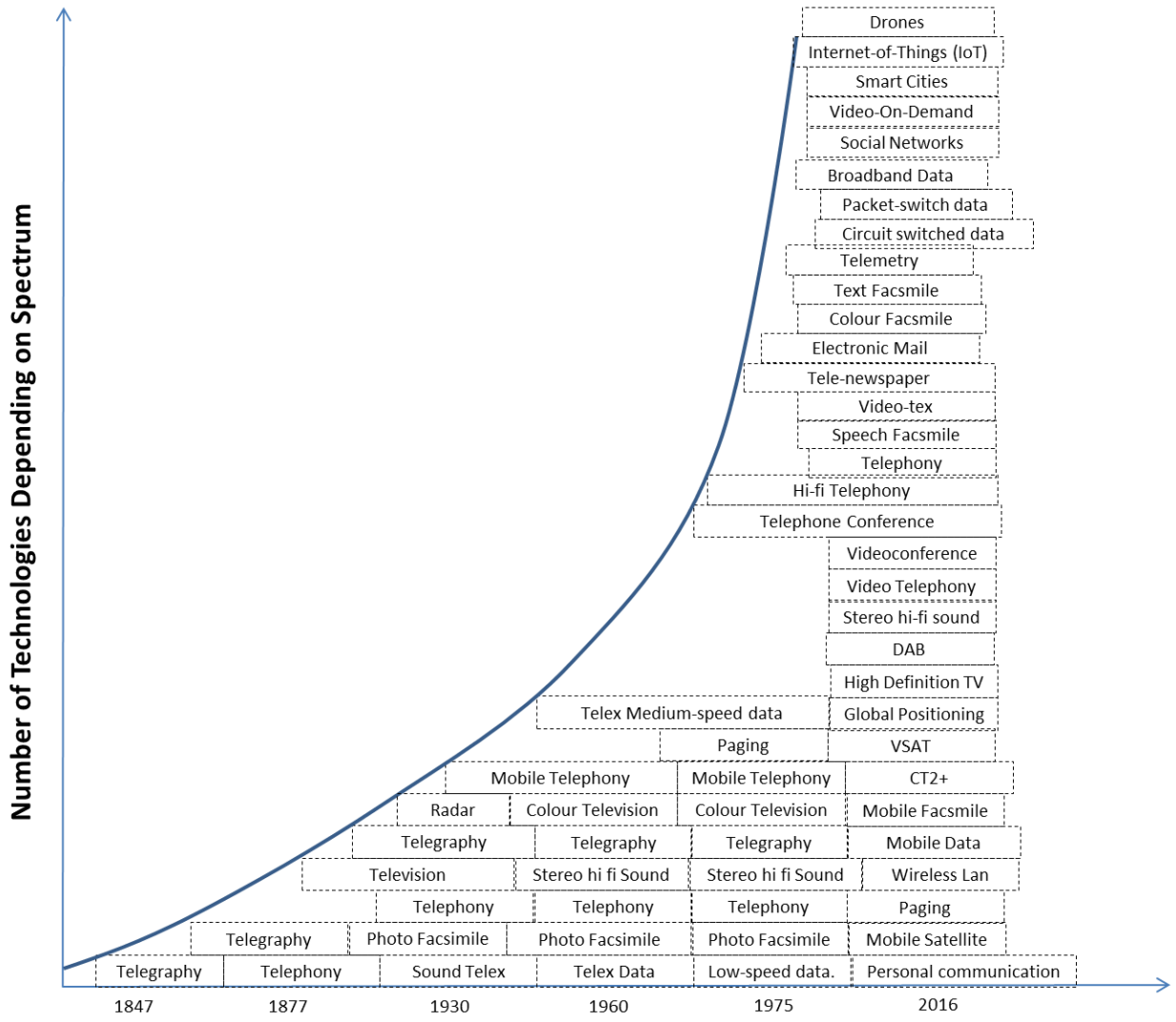
Furthermore, radio spectrum reform is required because of the increased number of technologies that now depend on it as compared to earlier years as seen in Figure 1.

Telecommunications and broadband is believed to be a vital element in setting the country's economic growth back on track. This assumption is supported by research done on broadband contribution to GDP growth, which confirms a 10% increment in broadband penetration has a potential to result in an additional 1.38% in GDP growth (Qiang & Rossotto, 2009). These results are only applicable for countries with a low to middle-income majority. While for OECD countries, a 10% increase in broadband penetration is proportional to a range of between 0.9 and 1.5 percentage points increase per-capita GDP (Czernich, Falck, Kretschmer, & Woessman, 2009). As mentioned above, radio spectrum reforms are among the necessary catalysts to enhancing broadband penetration.

Ordinarily, radio spectrum reform is viewed as an evolution away from the command-and-control approach to radio spectrum management. Regulators in most countries have followed a command-and-control approach in radio spectrum management about ten decades ago, which is a prescriptive approach (Cave, Doyle, & Webb, 2007). In the South African context, this was a well-supported approach for government institutions (military, police, emergency agencies, etc.) and state owned companies (SOCs) such as Sentech, Transnet, Telkom and Eskom. The support was based on their assured monopoly status in the market. For example, prior to the 1990's only SOCs were able to use radio spectrum for microwave point-to-point links.

In the mid-1990s, South Africa embarked on a programme for managed market liberalisation of the telecommunications sector. In implementing this programme, the allocation and assignment of radio spectrum was still based on command-and-control as opposed to market-based approaches (Zimri, 2013). For example, prior to 2005, only Telkom was assigned radio spectrum to build infrastructure for interconnection and wireless backbone links. This meant that private companies were obliged to rely on Telkom and other incumbents for provisioning of wireless backbone links, forcing a vertically integrated market structure

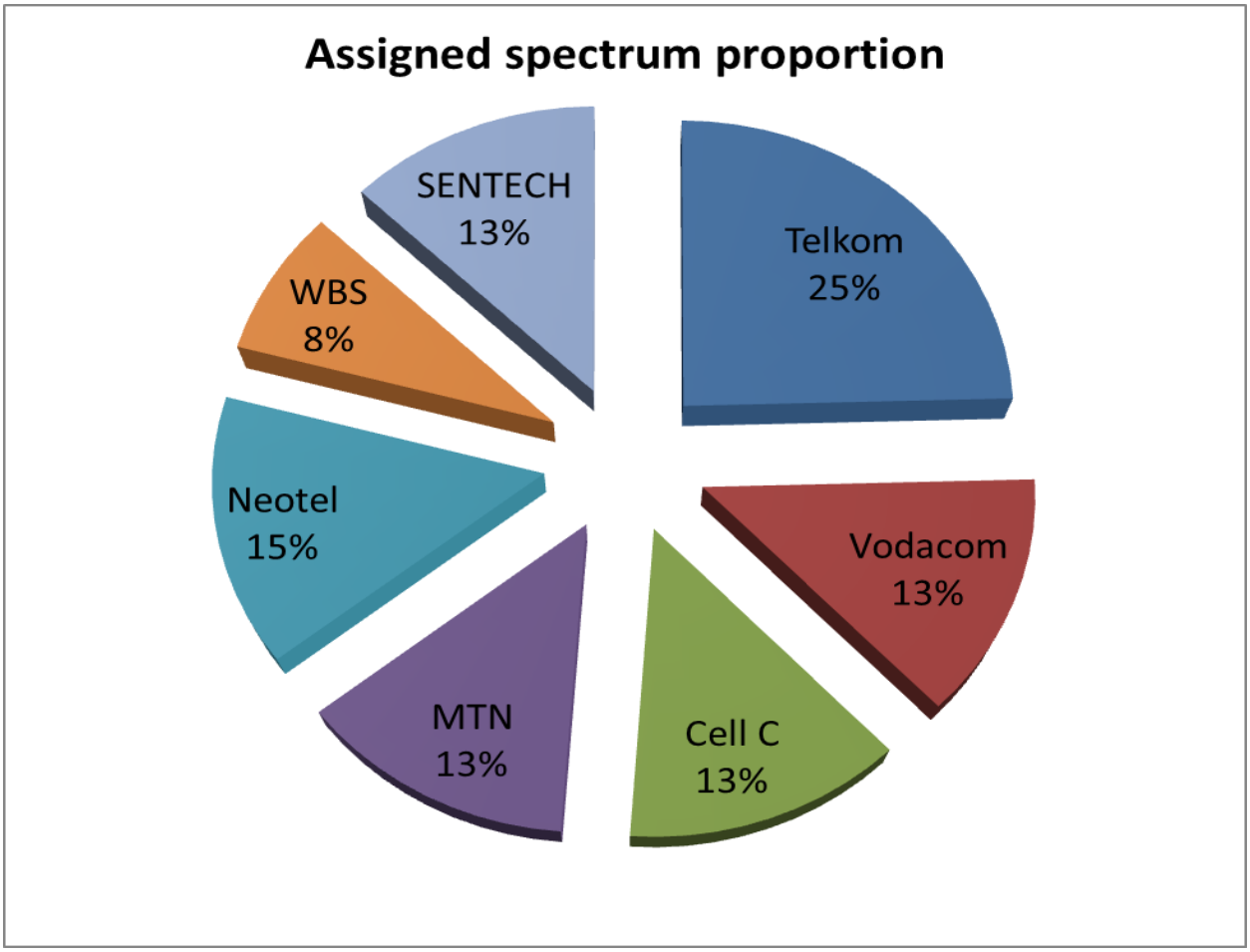
Figure 1: Radio spectrum dependency trend



Source: Researchers' own

Similarly, Telkom exclusively used radio spectrum and technology for the last mile as opposed to interconnections as it given to the mobile operators prescribed by radio spectrum licences. The Global System for Mobile (GSM) was a prescribed technology for the 900 MHz and 1800 MHz radio spectrum bands assigned to MTN and Vodacom and later Cell-C (RSA, 2001). Following the same command-and-control approach, the Independent Communication Authority of South Africa (ICASA) licensed the radio spectrum to operators in 2001 through a ministerial policy directive for the provision of 3G services (RSA, 2001).

Figure 2: Radio spectrum assignment proportion of South Africa



Source: Ngwenya

The command-and-control approach in radio spectrum management has resulted in inefficient allocation and assignment of radio spectrum in an oligopolistic market structure, where a few operators dominate the market. Only about 600 MHz of the 1167 MHz radio spectrum allocated by the International Telecommunication Union (ITU) for broadband is currently assigned to a few operators in South Africa (Ngwenya, 2011).

MTN, Vodacom,Telkom and Cell C‘s network all account for 75% geographical coverage, well over 95% population coverage and mobile penetration of 136.2% (BMT, 2013). There are roughly 400 potential network and service licensees who have no access to radio spectrum (ICASA, 2014a). The current radio spectrum regulatory regime by ICASA does not present a fair platform for these licensees to compete for radio spectrum access. This explains the low level of competition, and consequently the high cost of communication, low penetration and low adoption of broadband in South Africa in the context of the

majority of South African population spending 4, 6% of their total household expenditure on ICT products (StatsSA, 2015). Figure 2 depicts the South African radio spectrum holdings that provided wireless broadband services from the year 2000 to 2010.

As the demand for more radio spectrum or access to radio spectrum increases as depicted in Figure 1, it is clear that the traditional command-and-control approach in radio spectrum management will become inadequate and create artificial scarcity of radio spectrum.

1.3 STATE OF REGULATORY ENVIRONMENT IN SOUTH AFRICA

1.3.1 Market liberalisation

According to the ITU, market liberalisation has to do with long-term competition to ensure sustainable markets. The main supporting arguments for market liberalisation and competition are low costs, low entry barriers and innovation (ITU, 2005b).

South Africa embarked on a managed liberalisation process since 1996, which started with a white paper on telecommunications (RSA, 1996a). The white paper was the first policy document to be adopted by South Africa on telecommunication related matters in the dawn of democracy in 1994. Other than the need to enable private operators in the market, the white paper made provision for radio spectrum management issues. It further made provision for the need for a regulator that would be responsible for radio spectrum regulation and licensing in the public interest (Horwitz, 2001).

The result of the Policy white paper was the promulgation of the Telecommunications Act No. 103 of 1996. The objects of this Act included, among others, universal access and services to telecommunications, limited competition in the telecommunication industry, protection of telecommunication users and consumer interests, and efficient use of radio spectrum (RSA, 1996b). The Act further established the South African Telecommunication Regulatory Authority (SATRA) with the authority to “control, plan, administer, manage, and license the radio spectrum” (RSA, 1996b).

Prior to the Act of 1996, as part of managed liberalisation, the market was opened for two mobile operators (MTN and Vodacom) in 1994. Later in 2001, Cell-C was introduced as the third mobile operator. The year 2006 saw the introduction of Neotel, making it the second national operator for fixed services. Neotel’s introduction aimed to act as a competitor for Telkom. This was part of the continuation of the managed liberalisation process following the 2001 ministerial policy directions. In terms of the Telecommunications Act of 1996, Telkom was granted an exclusive period for provisioning of backbone and interconnection infrastructure (Horwitz, 2001).

It is important to note that even though the market was being liberalised, command-and-control in management of radio spectrum continued to be entrenched. For example, the radio spectrum and technology used by the mobile operators had to be issued as part of the service licence. Radio spectrum for microwave backhaul and point-to-multipoint,

ranging from 6 GHz to 38 GHz, as well as radio spectrum for wireless local loop was exclusively given to Telkom. Several other radio spectrum licences were issued by decree through first-come-first-served or other non-market-based methods (Kedama, 2014).

1.3.2 Moving from Convergence to the Broadband Era

In trying to keep pace with convergence, the South African Government published a Convergence Bill in 2003. The Bill started with the provision of the government's position towards convergence, which was later enshrined in the Electronic Communications Act. In addition, there was promulgation of the ICASA Act, which merged the former separate telecommunications and broadcasting regulators to create ICASA (RSA, 2000).

These two pieces of legislation became the primary legislation for the management of radio spectrum in the convergence era in South Africa. This legislation facilitated flexibility in the licensing framework where the prescriptive way of assigning radio spectrum was removed and replaced with a flexible approach through the introduction of technology neutrality in the licensing regime.

The legislation further centralised the radio spectrum management to the minister and the regulator. In terms of section 3(1) (a) of the Electronic Communications Act 2005 (ECA), the minister is responsible to make policy for radio spectrum (RSA, 2005). The legislation further grants the minister the power to approve the South African national radio spectrum band plan. In terms of section 34(1) of the ECA, the minister is empowered to represent the country at the International Telecommunications Union (ITU), a United Nation's agency, where allocation of radio spectrum to different radio communications service is agreed (RSA, 2005). It is also the responsibility of the minister to represent the country in regional and international coordination of radio spectrum, which deals with interference issues (RSA, 2005).

On the other hand, ICASA is given the responsibility to control, plan, administer and manage the radio spectrum, and to grant, amend, renew, transfer, and revoke radio spectrum licenses in terms of section 4 (3) (c) (e) of the ICASA Act of 2002 and sections 30 and 31 of ECA (RSA, 2005) and (RSA, 2000). In terms of section 34(2), the regulator is further mandated to develop the national radio spectrum band plan, which has to be approved by the minister (RSA, 2000). For five years 2009-2014, both the Department of Communications and ICASA made a number of proposals in the form of policy directions and regulations in an effort to release the high demand radio spectrum, a process that to date is yet to be concluded. This has put at risk the realisation of policy goals as stipulated in the National Development Plan of 100% broadband access by 2030, more so the broadband targets as pronounced in SA Connect, National Broadband Policy (NDP, 2012, p. 190) and (DoC, 2013, p. 18).

In addition, the delay has resulted in a policy and regulatory vacuum on radio spectrum management and has further caused confusion in the ICT sector. One of the reasons for the confusion and delay is the South African scenario where there is the misperception that regulator and policy maker have concurrent jurisdiction on radio spectrum management. In point of law, the legislation states that the Minister may make policies on

matters of national policy applicable to the ICT sector, and related legislation in relation to radio spectrum, this provision gives the minister the power to make recommendations through policy (RSA, 2005). The legislation further states that the regulator controls, plans, administers and manages the use and licensing of the radio spectrum. This provision of the legislation gives the regulator the power to decide and implement a framework a licensing framework to assign radio spectrum (RSA, 2005). This explains the observed conflict between political and business interests.

The proposals in the published draft Invitations to Apply (ITAs) on application of radio spectrum licence for the purpose of providing broadband wireless access services in 3.5 GHz and 2.6 GHz. Proposed draft policy directions on electronic communications services in high demand radio spectrum on one hand continues to entrench the traditional approach of command-and-control on radio spectrum assignment, on the other hand is introducing radio spectrum reforms, as discussed below.

1.3.3 Recent developments in radio spectrum regulations and policy

In May 2010, ICASA issued facilities leasing regulations. The purpose of the regulations, among other things, is to provide for the requirements for the leasing of communications facilities (ICASA, 2010a). This gave effect to open-access as a reform as provided for in section 43 of the ECA. Section 43 provides for obligation to lease communication facilities. This was an effort by the regulator to introduce reforms through facilities leasing, a regulatory tool that has elements of sharing.

In 2009, because of global development and interest around WiMAX networks offering another means of offloading traffic, ICASA issued an ITA for licensing the remaining portion of the 2.6 GHz and 3.5 GHz bands. The ITA entrenched traditional centralised command-and-control, a prescriptive approach with some radio spectrum reforms. Firstly, the ITA specified the kind of network to be rolled-out for the radio spectrum to be assigned. Secondly, it provided that radio spectrum would be used for providing municipal broadband wireless access (ICASA, 2010b). Thirdly, the ITA, proposed auctions as the preferred method to award radio spectrum in South Africa. This was the first time a market-based approach was considered for radio spectrum licensing in South Africa, which was an attempt by the regulator to introduce radio spectrum reforms (ICASA, 2010b).

Draft regulations outlining the procedure and criteria for granting high demand spectrum accompanied the ITA. The ITA was later withdrawn by the regulator. The principles were later incorporated in the radio spectrum regulations of 2011 (ICASA, 2011b).

The rationale behind the withdrawal was that there is a need for the re-evaluation of assignment methods, where band design needs to be reconsidered given the technological developments (ICASA, 2010d). Part of the debate at the time in the telecommunication sector was around whether auction is an accepted method to assign high demand radio spectrum. Sections of government, including the minister, were not in favour of auctions as the method to assign high demand radio spectrum for South Africa, which resulted in delays to assign radio spectrum.

On 27 August 2010, ICASA published regulations on radio spectrum license fees, which provides that Administrative Incentive Pricing (AIP) will be the method to be used for radio spectrum fees, a method already adopted by countries such as the UK in 1998 (ICASA, 2010e) . AIP is a pseudo-market-based approach used by the regulator to charge annual fees to the radio spectrum licensees. It is more relevant in an environment where radio spectrum trading rules are not clearly articulated (Marcus, 2012).

AIP radio spectrum licence fee regulation by ICASA is another stride towards market liberalisation. This reform is not inherently prescriptive AIP because it is driven from an administrative approach through its implementation. It does not exclusively remove some of the characteristics of command and control. Through AIP, ICASA will determine the price for the radio spectrum through a standardised prescribed formula as opposed to the market directly.The rationale behind ICASA's adoption of AIP is to continue the modernisation of radio spectrum regulations and keep abreast with international developments and trends of ensuring radio spectrum efficiency and to discourage spectrum hoarding (ICASA, 2010e).

AIP regulation attempted to address challenges brought by a legacy of radio spectrum assignments. Legacy radio spectrum refers to the radio spectrum assigned to government entities such as Telkom and Sentech through first-come-first-served and beauty contest methods before the regulator became empowered. The approach of first-come- first-served and beauty contest encouraged radio spectrum hoarding and led to inaccurate evaluation of radio spectrum by the regulator and some inefficiency in terms of usage of radio spectrum as scarce natural resource by these entities. Since the implementation of the regulation, Telkom returned some of the radio spectrum it was not efficiently using and Sentech returned all its high demand assigned radio spectrum (Kedama, 2014). The implementation of AIP regulation by ICASA in 2012 partly succeeded, firstly in placing a more accurate evaluation on radio spectrum holdings. Secondly, the regulation introduced greater efficiencies, particularly where radio spectrum assignments for access networks were used for point-to-point links (Kedama, 2014). Thirdly, the regulation assisted in implementing the "use it or lose it" principle to mitigate radio spectrum hoarding.

Subsequently, in an effort to implement the converged legislation ECA, the minister published the draft policy directions on the use of digital dividend and licensing of high demand radio spectrum in 800 MHz and 2.6 GHz bands in 2011 (RSA, 2011). To date this policy direction is still a draft and is yet to be finalised by the minister, which resulted in another delay in assigning radio spectrum required for broadband services.

The 2011 draft policy direction on electronic communications services in high demand radio spectrum introduced some radio spectrum reforms. Firstly, it directed ICASA to assign radio spectrum licensees to potential operators who will participate in the contribution to broad-based black economic empowerment. Secondly, ICASA was directed to issue radio spectrum to new entrants (RSA, 2011). Thirdly, the draft policy direction directed ICASA to consider radio spectrum auction as an assignment method to assign high demand radio spectrum (RSA, 2011). This is another attempt by the policy to introduce radio spectrum reform.The policy directions also pronounced that in order to

ensure efficient usage of radio spectrum, the possible usage of TV white spaces technologies should be explored by ICASA (RSA, 2011)**.**

1.3.4 Radio spectrum reforms in the broadband era

At the end of 2011, ICASA resuscitated the process to release the high demand radio spectrum, this time excluding 3.5 GHz in the combinational assignment of 800 MHz and 2.6 GHZ. ICASA issued another ITA on draft assignment plan for the combinational licensing of 800 MHz and 2.6 GHz, the process that was halted pending finalisation of policy direction by the minister.

The ITA attempted to introduce aspects of radio spectrum reforms by firstly, introducing radio spectrum sharing, which further introduces flexibility in radio spectrum usage. The attempt was made through the reservation of 20 MHz radio spectrum in the 2.6 GHz band for radio spectrum commons for the purposes of sharing and self- managing the radio spectrum by users. The sharing in this regard should be achieved by users on agreed rules or per prescribed rules by ICASA (ICASA, 2010b). Secondly, the pronouncement of assignment of 40 MHz radio spectrum in the 800 MHz band and 70 MHz radio spectrum in the 2.6 GHZ band in order to provide network services on a wholesale open-access with the purpose of allowing other entities to provide services (ICASA, 2011a).

Subsequently in March 2011, ICASA published radio spectrum regulations to revise the radio regulations issued in terms of Radio Act of 1952. The purpose of these regulations among, other things is to prescribe ways and requirements for awarding radio spectrum licences for competing applications or to meet the demand in cases where there is not enough radio spectrum (ICASA, 2011b).

In 2013, ICASA published the radio spectrum migration regulations and radio spectrum migration plan. The purpose of these Regulations and Plan was to establish the framework by which ICASA can migrate users of radio spectrum under the national radio spectrum plan (ICASA, 2013a). The radio spectrum plan sets out the intentions of the regulator with regard to future migrations of users.

1.4 GLOBAL TRENDS IN RADIO SPECTRUM REFORMS AND MARKET LIBERALISATION

1.4.1 Command-and-Control

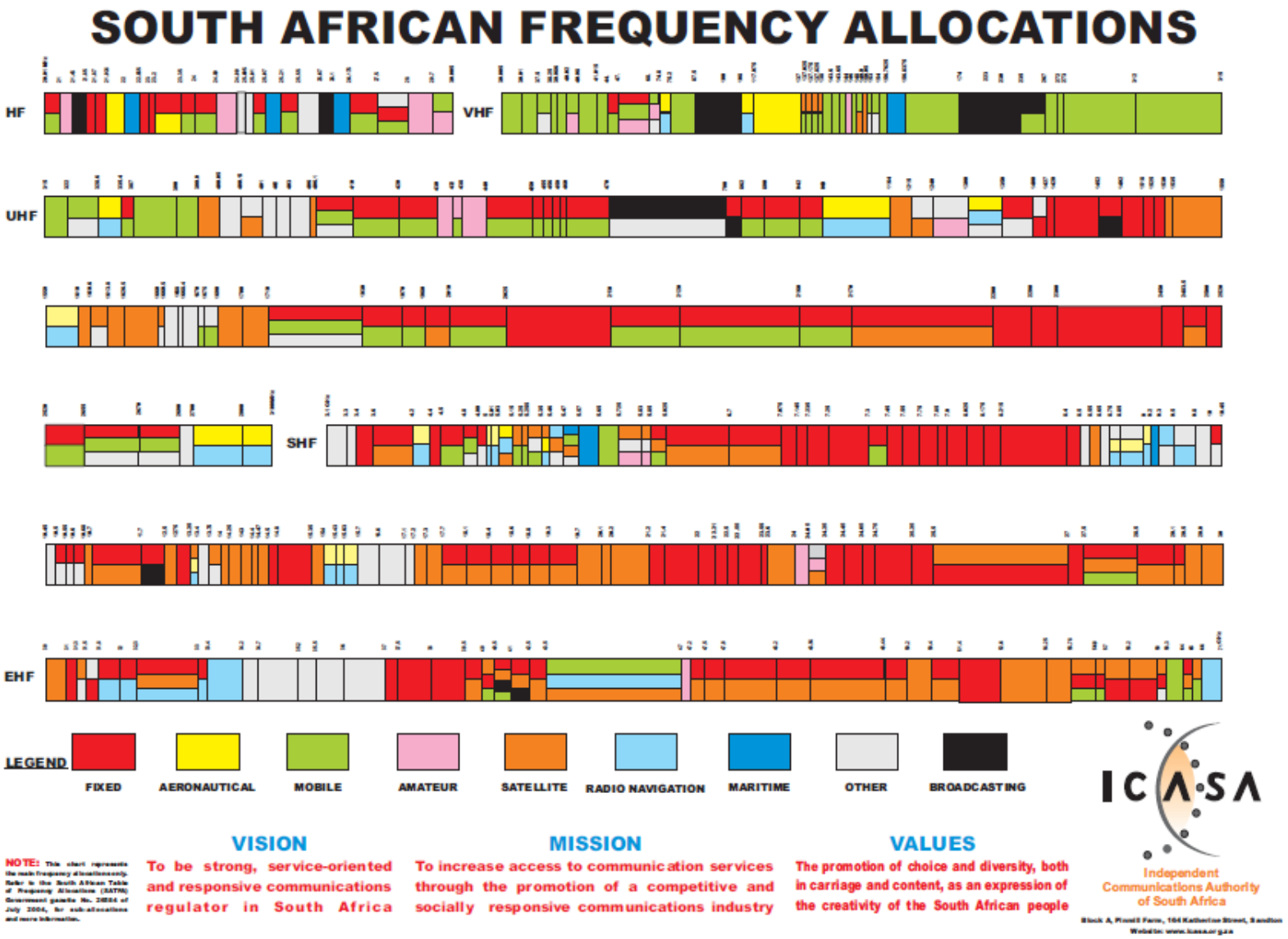
Globally radio spectrum allocations and assignment have been based on a command-and-control philosophy, which is a traditional radio spectrum management approach that supports a rigid procedure for radio spectrum assignment and allocation. For example, this means allocating one specific service on a specific band. An example of this is the television (TV) broadcasting allocation that cannot change over space and time (Olafsson, Glover, & Nekovee, 2007).

However, for the past few years there have been several important improvements that informed radio spectrum reforms such as radio spectrum commons, radio spectrum property rights, and radio spectrum auctions with an attempt to move towards market-based approaches. This has also included the technological development to enhance radio spectrum reforms such as dynamic radio spectrum access and cognitive radio in the radio spectrum policy and regulatory domain to accelerate opportunistic uses of radio spectrum (Chapin & Lehr, 2007). Through radio spectrum reforms, both the specific assignments to specific transmitters can and have changed, as well as the allocation in terms of the 700 MHz and 800 MHz digital dividends.

To date the command-and-control assignment approach continues to be employed even in markets that are perceived to be liberal. Both developing and developed countries such as the UK, USA, New Zealand, India, South Africa and Nigeria have used and are still using the command-and-control approach despite introduction of market-based methods such as auctions. Figure 3 is the radio spectrum chart published by ICASA based on the command-and-control management approach employed in South Africa.

Under the command-and-control approach, these countries have assigned radio spectrum on a “first-come-first-served” basis since the demand for radio spectrum was considerably less than supply. However, where radio spectrum demand exceeds supply, there was a need to choose between competing applicants. In that instance, countries will opt to use comparative hearings or “beauty contests” as an option for assignment of radio spectrum. This approach is based on some specific requirements, such as the financial and the technical capacity of the applicant (ITU, 2004). In some cases on employment of command-and-control approach, lotteries were also used to award radio spectrum licences where the method used will be random selection of applicants (ITU, 2004).

Figure 3: South African radio spectrum allocation chart



Source: Chiwewe & Hanker, 2015

For example, in the United States of America, the national regulator, the Federal Communication Commission (FCC), has the centralised authority of assigning and allocating civilian radio spectrum. In the early years when the regulator attempted to implement the Telecommunications Act, it adopted a variety of methods to assign radio spectrum for commercial use, such as first-come-first-served basis and comparative hearings to assign radio spectrum (ITU, 2004). The approach was, where there was more than one applicant for a portion of available radio spectrum, the regulator used an alternative method referred to as comparative hearings method. In this method, the applicants are afforded an opportunity to motivate why they should be awarded radio spectrum instead of the other applicants (GAO, 2003). In 1983, the FCC allocated the

radio spectrum for the first generation of mobile technologies/networks using command-and-control. It used the radio spectrum, which was originally designated for the use of broadcasting service. This process of reallocation of the radio spectrum from broadcasting services effectively gave birth to the mobile industry in the US (GAO, 2003).

The USA did not only assign radio spectrum through beauty contests. It also employed lotteries as a method to assign radio spectrum. In the 1980s Congress authorised the FCCto use lotteries to assign radio spectrum which allowed the regulator to randomly award radio spectrum licensees from a qualified applicant pool (GAO, 2003).

The United Kingdom also applied and is still applying command-and-control methods to manage radio spectrum. Initially with the Radiocommunication Agency (RA), an Executive Agency of the UK Department of Trade and Industry responsible to manage radio spectrum allocations and assignment has used a command-and-control approach (ITU, 2004). The philosophy for the command-and-control approach is that the radio spectrum is allocated for a particular application, for example, the television broadcasting allocation that cannot be changed quickly (Olafsson, Glover, & Nekovee, 2007), although one of the primary purposes of the ITU WRC meetings is to coordinate changes in allocations. However, these changes happen relatively gradually. The radio spectrum license will further specify the type of technology and the use of that radio spectrum with administrative costs of radio spectrum management activities by the regulator in a form of AIP.

Prospective players would be expected to hand in proposals to the regulator and reciprocally, the regulator would select the proposal considered to meet the expected economic and social benefits in terms of the Wireless Telegraphy Act of 1998. This was later changed in 2003 when a new regulator was formed in terms of the Communications Act of 2003 referred to as the Office of Communications (Ofcom). Ofcom then became responsible for management of civil radio spectrum and awarding of radio spectrum licences, authorising users to operate over a specific band and geographic area (Department of Trade & Industry, 2001).

Asian countries like India (since 1992) had also employed radio spectrum assignment using the command-and-control approach, in the early years of introduction of wireless communication. The Indian approach included identifying the ‘best use’ of the radio spectrum band, by choosing users for example on a on first-come-first-served basis or through beauty contest method (Sridhar & Prasad, 2011).Their approach also included amongst others (Sridhar & Prasad, 2011):

- the setting of prices and efficiency achievement or consumer benefits by interventions such as setting roll-out obligations (to cover a certain percentage of the License Service Area (LSA) within a stipulated period) and
- introducing the “use it or lose it” principle to mitigate radio spectrum hoarding by radio spectrum licensees.

The Indian traditional approach also includes the duration of the radio spectrum licence which is a twenty year radio spectrum license given concurrently with a service licence.

Actual assignment of start-up radio spectrum was based on availability and was on a first-come-first-served basis for all radio spectrum licensees.The command-and-control approach was successful in achieving early rollout and rapid growth of mobile telephony in India (Sridhar & Prasad, 2011). However, the approach had some flaws and vulnerabilities in that radio spectrum was not equitably assigned to users. The weakness of first-come-first-served was confirmed by the Supreme Court verdict in February 2012. The court recognised the first-come-first-served and beauty contests method of assignment of 2G radio spectrum licenses as arbitrary and deliberately designed to favour certain undeserving candidates (India, 2012). The verdict led to a decision by the court on the following (India, 2012)**:**

- to cancel all 122 radio spectrum licenses awarded through beauty contests method.
- the regulatory to make fresh recommendations to the Department of Telecommunications on the assignment of radio spectrum.
- delink radio spectrum from service licenses through auctions, as has been done in the 3G licenses case.

Thus, the court forced radio spectrum reforms upon the regulator, Telecom Regulator Authority of India (TRAI).

Similar to many developed nations, the African continent was also no stranger in following the trend of employing the command-and-control approach to manage radio spectrum. The Nigerian Communications Commission, the regulator in Nigeria in the late 1990s held comparative hearings and beauty contests to award radio spectrum to four operators to provide GSM services just like South Africa (Doyle, et al., 2001). The process, which was cancelled and replaced by radio spectrum auction when the allegations of corruption associated with the process, erupted at that time (Doyle & McShane, 2001).

1.4.2 Radio spectrum reforms and market-based approaches

According to the ITU, radio spectrum reform is an attempt by regulators to move from the traditional approach of command-and-control towards a market-based approach perceived to be flexible radio spectrum assignment (ITU, 2004). Forms of radio spectrum reforms adopted by countries includes amongst others, radio spectrum auctions, market-based approaches which includes novel ways of defining radio spectrum property, radio spectrum commons, radio spectrum trading and dynamic radio spectrum assignment to allow flexible ways of using radio spectrum which will result in radio spectrum efficiency.

There appear to be two waves of radio spectrum reforms. The first wave was pushed by the increase in radio spectrum using technologies e.g. smart phones, mobile devices, laptops, video-on-demand services, videos in high definition etc. The second wave was pushed by supply and demand for broadband by wireless technologies to support infrastructure networks for wireless technologies to deliver services to the end-users as depicted in Figure 1 (ITU, 2004) and (ITU, 2012a). Moreover, the so-called “industrial internet of things” that is industrial revolution 4.0 and the Internet of things (IOT) also pushed the second wave of radio spectrum reforms. This paradigm shift has forced regulators across the globe to turn towards radio spectrum reforms, which are more

flexible and can accommodate current and future requirements for industrial internet of things and broadband. Early attempts of radio spectrum reforms started with radio spectrum auctions, a market-based approach to license radio spectrum (ITU, 2012a).

1.4.2.1 First wave of radio spectrum reform pushed by increase in use of radio spectrum by technologies

a) Radio spectrum auctions

Gradual increase of technologies using radio spectrum brought about new ways of assigning radio spectrum such as monetising usage of radio spectrum. Monetisation was in a form of market-based approaches such as auction of radio spectrum and radio spectrum property rights. The licensing of radio spectrum through market-based approach authorise competitive bidding. The first introduction for auction as a reform was in the mid-1930s and in the 1990s, was adopted as the shift from administrative assignment by the US government to assign radio spectrum (ITU, 2004). This has led to most of the developed countries such as the UK, USA, and Germany (amongst others) becoming leaders in radio spectrum auctions (Cramton, 2001) and (Hazlett, 2003). Radio spectrum auction as a reform started to monetise the use of radio spectrum.

New Zealand is the first country to apply auctions as an approach to assign radio spectrum in 1990 through the selling of radio spectrum. By 2010, already 132 countries had employed this approach to assign radio spectrum. India auctioned its 3G radio spectrum in April 2010. Countries such as Colombia, UK, USA, Argentina, India, Australia and Hungary, have widely adopted auctions as policy to assign high demand radio spectrum (Jilani, 2015). At the same time, India auctioned radio spectrum to operators to provide three services in 2010 (Tripathi & Prasad, 2013).

According to Nahlik and Jamison (2007) auction of radio spectrum is a process where firms bid on each parcel and are committed to buy the parcel if they “win” the auction. The ITU sees radio spectrum auctions as one of the biggest radio spectrum policy changes to ever be adopted by regulators to manage radio spectrum for market-based approaches (ITU, 2004) and (Nahlik & Jamison , 2007).

With this view from the ITU, the centralized administrative techniques often called command-and-control with beauty contests and first-come-first-served basis used by regulators in many countries to assign radio spectrum at a particular period started to be under scrutiny (ITU, 2004). Questions started to be asked, such as whether these methods are an efficient way of managing radio spectrum. In an attempt by regulators to reform radio spectrum management, they introduced a market-based approach in the form of auctions of radio spectrum as a method to license radio spectrum.

However, the auction of radio spectrum as a reform did not address the deregulation of radio spectrum. True, as regulators in many countries have not relinquished the centralised functions of radio spectrum management such as allocation and assignment of radio spectrum using command-and-control through prescribing the type of mobile services to be provided. This can be observed in countries such as USA, UK, Netherlands, Australia and Switzerland. These countries adopted the radio spectrum

auctioning method, which was still prescriptive in terms of the service to be provided by winners of the radio spectrum (Sokol, 2001).

Regulators in many countries to date are still using the centralised radio spectrum management method; this is independent of whether it is through the national regulator or government. This applies to markets perceived to be liberal such as the US, UK, India, Australia, New Zealand, Nigeria where radio spectrum management is still centralised.

There are a number of compelling reasons as to why regulators choose to use auctioning methods as a way to award radio spectrum. Some argue that radio spectrum auctioning leads to more efficient outcomes than administrative techniques. Another reason could be that auctioning is perceived to be more transparent and objective than both the beauty contests and first-come-first-served methods (Regulation Toolkit, n.d). This means that the risks of corruption in the process are significantly reduced, as well as being a more cost-effective process. For example, the FCC projected the cost of administrative hearings to be more costly than that of employing auctions, which may results in a lack of service delivery (Sokol, 2001).

New Zealand, through its Radio Communications Act of 1989, became the first country to authorize auctions method in 1990. Countries such as Australia and UK followed New Zealand in adopting market-based approaches to assign radio spectrum whilst USA moved to towards this approach a bit later. The rationale for the move was to ensure that radio spectrum gravitates towards those who value and make use of it (Marcus, et al., 2005).

In the UK, radio spectrum auctions were introduced in 1998, where radio spectrum was auctioned for commercial used with the first auction carried out in 2000 for the 3G radio spectrum (NATO, 2001).The auction process managed to raise about GBP 23 billion and introduced the fifth player to offer GSM services for the UK (NATO, 2001). Regulatory interventions in the form of roaming conditions were added in the radio spectrum licence. The new entrant will be allowed to use the incumbent networks to offer services while it is rolling out its own network infrastructure (NATO, 2001).

On the one hand, the USA's first auction was carried out in July 1994. The radio spectrum was auctioned for narrowband Personal Communication Service (PCS) licenses (Chakravorti, Sharkey, Spiegel, & Wilkie, 1995). By 2010, the FCC had already conducted over 80 spectrum license auctions with over US$52 billion in revenue generated and deposited in the US Treasury (Kelly & LaFrance, 2012). The market-based approach of auctions of radio spectrum resulted from the mass adoption of mobile services, which resulted in a conducive environment for innovation and investment in the US (Kelly & LaFrance, 2012).

On the other hand, the Indian government started auctions in 1992, with auctioning 900 MHz radio spectrum to provide GMS services, and in 2010, there was an auction for 1800 MHz radio spectrum (Sridhar & Prasad, 2011). India further auctioned radio spectrum for 3G and broadband wireless access in the period 2012 to 2013 for 800 MHZ and 900 MHz (Tripathi & Prasad, 2013).

For India, it appears that the use of radio spectrum auctions had been motivated by the desire to raise revenues as well as to ensure transparency in the assignment of radio spectrum licenses (Kokil & Sharma, 2006). Even though the rationale for radio spectrum auction was to maximise revenue for India, competition in downstream markets was also a policy and regulatory goal (Tripathi & Prasad, 2013). While the 2G radio spectrum in 800/900/1800 MHz bands were licensed either through first-come first-served basis or beauty contest method in India (Sridhar & Prasad, 2011).

Almost all assigned radio spectrum in India without auction is "technology specific", which means that they can provide mobile services using GSM or CDMA technologies with respect to the specific band (Tripathi & Prasad, 2013, p. 166). While the radio spectrum awarded through auctions is "technology neutral", meaning that radio spectrum licensees are free to use any technology to provide services. These radio spectrum reforms for assignment of radio spectrum have resulted in the mobile network coverage (providing 2G services) in almost every part of India. On the contrary, insignificant mobile network coverage is available in the case of 3G services (Tripathi & Prasad, 2013).

Operators are however making progress in trying to roll-out 3G network infrastructure in many parts of India with Long Term Evolution (LTE) based 4G service slowly entering the Indian market in the 2.3-2.4 GHz band (Tripathi & Prasad, 2013). Recently, Bharti is reported to have launched 4G networks in 296 towns across India (ETTelecom.com, 2015).

b) Radio spectrum property rights

With value placed on radio spectrum through its awarding using market-based approach, the licensing policy and regulation allowed the concept of defining "radio spectrum rights of use" (radio spectrum property rights) by licensees as another form of radio spectrum reform (ITU, 2012a). This approach allows radio spectrum licensees to gain ownership of radio spectrum.

A novel way of defining property rights allows flexible use of radio spectrum, which will lead to innovation and ultimately more spectral efficiency (Peha, 2007). Through this approach, radio spectrum can be traded in secondary markets. However, it has been observed that there is no common approach for the procedure used for trading in different countries. For example, in Australia and New Zealand, the property rights are clearly stated with respect to technical or core parameters that prescribe significant level of emissions (Sridhar & Prasad, 2010). However, if this level is exceeded, the radio spectrum licensee that owns the technology responsible for the interference is expected to either employ interference mitigation procedures or deactivate the operation (Sridhar and Prasad, 2010). Similarly, the licensee is given authority to act as it sees fit; this may include changing the type and the form of the services offered, given that the interference requirements are met.

Through the promulgation of the Radiocommunication Act of 1989, New Zealand is one of the first countries to usher in radio spectrum reform in the form of property rights

through assignment of radio spectrum in a tradable form to facilitate the markets (ITU, 2004).

The New Zealand's regulator established a management rights regime with the intention of decentralising radio spectrum assignment. Under the rights regime, radio spectrum rights are created and have maximum terms of 20 years (Foster & Alden, 2008). The 2G and 3G radio spectrum, radio spectrum for fixed wireless access and broadcasting radio spectrum in the VHF and UHF TV bands was assigned under the management rights regime (Foster & Alden, 2008).

In the UK, a property rights regime was introduced through a radio spectrum framework review, which envisaged the opportunity to accomplish a reform that will birth a balance between traditional and market-based methods of radio spectrum management (Ofcom, 2006). With this framework, Ofcom's approach was to shift radio spectrum policy towards a flexible system of radio spectrum management. Through the liberalisation of radio spectrum usage rights and radio spectrum trading where radio spectrum licensees will trade in an open market and change the use thereof (Ofcom, 2006).

Most of African countries have a perception that radio spectrum belongs to government. Therefore, the adoption of radio spectrum property rights has not been realised in this region**.**

1.4.2.2 Second wave of radio spectrum reform pushed by supply and demand for broadband

a) Radio spectrum trading

Increased traffic on wireless networks increased the demand for radio spectrum to enable roll out of infrastructure for broadband services, which thus led to increased financial value for radio spectrum through trading (ITU, 2012a). Moreover, Radio spectrum trading in secondary markets is understood to be one other flexible radio spectrum assignment mechanism that can be used to address the growing demand for more radio spectrum. This reform entrenched element of monetisation to radio spectrum policy and regulation. According to the ITU, radio spectrum trading refers to the transfer of usage rights between parties in a secondary market. Trading may happen through sale, lease, or other trading options. Through this radio spectrum reform, participants of the market assume the responsibility that is usually performed by regulators of assigning of radio spectrum and how it supposed to be used (ITU, 2012a).

Trading transactions are initiated voluntarily by a radio spectrum license holder who wants to sell some of their radio spectrum and once a buyer is found, and the financial transaction is completed, the new owner of the radio spectrum obtains the spectrum usage rights (Marks, Williamson, Burns, Doyle, & Cave, 2006, p. 2) and (Bastidas & Stine, 2013).

Introducing trading in radio spectrum over time gives authority to the market to assume the responsibility of assigning radio spectrum and determining its usage (Bastidas & Stine, 2013) and (ITU, 2004). While liberalisation of radio spectrum use entrusts the

responsibility of assignment and allocation to radio spectrum users, similarly the market will usually conclude on the usage of the radio spectrum (Bastidas & Stine, 2013). This illustrates the relationship that exists between radio spectrum trading and liberalisation of radio spectrum for the creation of market.

New Zealand and Guatemala are the first countries to adopt a radio spectrum trading reform approach. New Zealand adopted the radio spectrum trading assignment approach in 1989 through the implementation of the Radiocommunication Act of 1989.

For Guatemala, the *Superintendencia de Telecomunicaciones ('SIT')* the regulator has three days to approve trades of radio spectrum. While for the US, the FCC can process radio spectrum trades within one day provided certain requirements are meet such as competition, the legitimacy and ownership issues are beyond board (ITU, 2004).

The UK introduced radio spectrum trading in 2004 as a key element of their market-based reform. The Wireless Telegraphy Act of 2006 together with the Wireless Telegraphy Radio Spectrum regulations of 2004 provided the legal and policy framework for radio spectrum trading in the UK (ITU, 2004). The framework outlined the conditions under which radio spectrum trading is permissible. It further gave effect to Article 9 of the EU Framework Directive 2002/21/EC ('the Framework Directive') on radio spectrum trading for European countries (Ofcom, 2013). The UK, in 2004, introduced radio spectrum trading for other services such as the national and regional Business Radio ('BR'), broadband fixed wireless access and terrestrial fixed and point-to-point links. Taxi operators and couriers with radio spectrum licenses were also given an authorisation to trade radio spectrum (ComReg, 2015). This radio spectrum reform led to the increase with regard to radio spectrum that can be tradable in the UK, with tradable licences increasing from about 1,500 to 50,000 (Ofcom, 2009). Trading created an incentive in the management of the radio spectrum through making radio spectrum that was previously used for public usage for commercial users (Ofcom, 2009).

While radio spectrum trading in Europe is widely practiced, in developing countries such as India, commercial users have little incentive to trade radio spectrum. According to Indian policy, no trading is allowed for radio spectrum assigned in 900 MHz and 1800 MHz (Sridhar & Prasad, 2011).

Even though the 2010 National Telecom Policy introduced spectrum trading, this radio spectrum reform is yet to be implemented in India. With about three to four operators having almost 80% of the market share, using radio spectrum assigned to them through administrative approaches (Purnendu, Tripathi, & Prasad, 2013).Contrarily, other operators were assigned radio spectrum through market mechanism.

The National Telecom Policy of 2012 not only introduced radio spectrum trading but also proposed new policy positions such as technology neutrality, liberalisation of radio spectrum and delinking radio spectrum from service licence. This enabled radio spectrum pooling, sharing and later enabled the optimal utilization of radio spectrum through (Purnendu, Tripathi, & Prasad, 2013).

b) Radio spectrum commons

There is a high demand of radio spectrum by internet host providers and individuals for Wi-Fi (Wireless local area network (WLAN) and other low-power devices (key fobs, garage openers) and the evolution of radio spectrum reforms (ITU, 2012a). The evolution of reforms led to the emergence of flexibility in using radio spectrum reforms through open-access, unlicensed radio spectrum and radio spectrum commons as supported by researchers has also managed to capture attention of regulators in recent years (Lehr & Crowcroft, 2005) and (ITU, 2012a).

Managing radio spectrum through commons is to allow a radio spectrum to be used by many while allowing joint-ownership of the resource with no exclusive ownership given to a single entity (Brito, 2007) and (ITU, 2012a). The usage of radio spectrum is however, subject to adherence to a set of rules such as maximum power level and lawful usage of a particular technology (ITU, 2004).

In some instances, licence exemption is used as a commons approach. If it is used, it is usually in limited bands for short-range applications. However, significant innovation has emerged in these bands (e.g. Wi-Fi) which have led some to call for more radio spectrum to be made available and managed in a similar manner. Radio spectrum commons as a radio spectrum reform can be seen as a manifestation of radio spectrum property rights in that a number of radio spectrum users in that particular band can have property rights.

New Zealand is the first and the only country, which has licensed radio spectrum for commons in a form of “managed radio spectrum park” licence (Cave, Minervini, & Mfuh, 2008). South Africa attempted the introduction of managed radio spectrum park through ICASA’s draft assignment plan for combined licensing of 800 MHz and 2.6 GHz a propose which was later withdrawn. The draft plan proposed the reserving of 20 MHz in the 2.6 GHz for “managed radio spectrum park” (ICASA, 2011a).

The radio spectrum under this approach was assigned on a first-come-first–served basis along with applicable licence administration fees for resource rental and management charge (ITU, 2004). UK has also authorised 50 MHz radio spectrum commons to give effect to radio spectrum sharing with the FCC controlling the power limits (Brito, 2007).

c) Dynamic spectrum access

While the debate on the scarcity of radio spectrum continues, technological development has managed to find a way to offer itself as a solution to increased access to radio spectrum through dynamic spectrum access (DSA). This development further supports the reformed approach of regulating radio spectrum through DSA (Mfupe , Masonta , Olwal, & Mzyece, n.d). DSA refers to accessing radio spectrum with dynamism while having the capability to change utilisation of radio spectrum guided by a number of technical factors (Zhao & Sadler, 2007). DSA allows multiple users to share the same radio spectrum another technique of radio spectrum, which increases access to radio spectrum. DSA may be viewed as a radio spectrum reform that presents an opportunity to circumvent an authorisation process that is usually applied to use radio spectrum while at the same time allowing sharing (ICASA, 2015b).

DSA facilitates flexibility in radio spectrum management through technology to enable efficient usage of radio spectrum usage. It further provides incentive to facilitate a number of reforms such as radio spectrum trading, radio spectrum commons and sharing (Anker, 2010). The DSA approach would for example permit a service provider to use licence exempt devices to offer services. The usage of radio spectrum will be through active management of individual use of the radio spectrum (Mfupe, Masonta, Olwal, & Mzyece, n.d).

On one hand, the development of 'Software Defined Radio (SDR)' allows the user(s) to use or switch to different radio spectrum in a dynamic manner without large increases in the cost of equipment and thus allowing the operation of dynamic spectrum access (Singh, Sign, & Kang , 2013). According to Masonta, Mzyece & Ntlatlapa (2013) cognitive radio networks seek to deploy DSA regulation approaches.

Cognitive radio building as contained in SDR architecture, a benefit intelligence to ensure efficient resource utilization is realised (Masonta, Mzyece, & Ntlatlapa, 2013). This regulatory approach is seen as a solution to address the current threat of radio spectrum scarcity, Cognitive Radio systems (CRS) are widely proposed to build DSA-based secondary networks for secondary users with low priority (Masonta, Mzyece, & Ntlatlapa, 2013).

Since radio spectrum sharing is perceived as an approach that allows radio spectrum to be used most efficiently in radio spectrum management, the DSA as an approach promise to increase radio spectrum sharing among competing service providers and thus overcome the problem of scarcity of radio spectrum and ensuring efficiencies in radio spectrum usage (Chapin & Lehr, 2007). Moreover, DSA according to Chapin and Lehr present an incentive of using DSA according to is that it allows real-time trading of spectrum access rights and use of high-power transmissions at times when the primary users of a radio spectrum in a particular band and location are inactive (Chapin & Lehr, 2007).

Since this form of radio spectrum reform is in its early stages of development, the USA is one of the few countries that are currently permitting DSA. The regulator has made one block of radio spectrum in the 700 MHz band to be auctioned with the condition that public safety services would be able to pre-empt its usage in case of any emergency/ public safety requirements for the purposes of allowing DSA (Garg, Dua, & Chandra, 2013).

Another area, which is currently in the process of development, is dynamic sharing of TV white spaces. The whole purpose of this is to use the broadcast radio spectrum left in between channels during planning purposes to avoid interference to ensure efficiency. According to Garg, *et al. (*2013) the usage of this radio spectrum can only be feasible through low power systems, which, on a pre-emptive basis, can be considered for shared usage with the TV radio spectrum.

In the case of DSA, the so-called "smart radio" technologies such as cognitive radios and software-defined radios are seen as tools to enable the exploitation of unused radio spectrum. They are further seen as main technologies in achieving objectives of efficient

usage and flexibility in spectrum management (Bernthal, et al., 2007). Hence, radio spectrum reform views the DSA as another way to support radio spectrum sharing and result in radio spectrum efficiency with the sole purpose of combating the rigid approach of command-and-control model (Bernthal, et al., 2007)**.**

1.5 SUMMARY OF RESEARCH PROBLEM

The biggest problem for telecommunications and broadband penetration in South Africa is effective competition and an inability to achieve national objectives of stimulating the economy and universal access as stated in the National Broadband Policy. This results in high costs of communication. According to RIA with 1GB data package South Africa is ranked at 16th of out 47 in African countries terms of pricing (ICTafrica.net, 2016).

The current radio spectrum reforms regulatory frameworks encourage a vertically integrated market structure dominated by four mobile operators that have access to high demand radio spectrum. This resulted in market problems such as infrastructure sharing bottlenecks, concentrated broadband infrastructure in urban areas, entrenched exclusivity rights to radio spectrum etc.Therefore, further liberalised market would be required to deal with the undesirable market structure and address the market problems of ineffective competition faced by South Africa. The NDP and SA Connect claim that radio spectrum is a bottleneck for competition in the industry and, hence, an inhibitor of market liberalisation.

Command-and-control has been the primary approach for radio spectrum management. The regulator has been unable to release the required radio spectrum for broadband, despite numerous attempts, due to command-and-control approach, which brings conflict between government and the regulator. The command-and-control approach adopted in South Africa has resulted in an artificial scarcity of radio spectrum, arguably, the greatest challenge for the telecommunications industries not only in South Africa but also across the globe. The approach is also not able to address the radio spectrum demand-supply problem and competition problem in the industry. There are about 400 potential service providers waiting to access radio spectrum to provide broadband services. Command-and-control and other regulatory weaknesses have created an oligopoly market structure, which has elements of anti-competitive behaviour of incumbent operators. The approach has also resulted in the hoarding of radio spectrum by players of the market. For example, 2.6 GHz radio spectrum were assigned to Sentech for a number of years without sufficiently being used and in the end returned to the regulator, an end-result that can be viewed as a lost opportunity for the telecommunications sector.

In recent years, market-based approaches have also been introduced. However, most of these approaches, similar to command-and-control, have entrenched exclusivity in allocation of radio spectrum. Therefore, further liberalisation in the market would require further radio spectrum reforms that are flexible and encourage inclusivity. However, clear identification of the challenges for radio spectrum reform and specific recommendations have been carefully identified and prescribed in a coherent manner.

1.6 PURPOSE STATEMENT

The purpose of this research is to understand applicable radio spectrum reforms i.e. command-and-control and pure market-based approaches in order to prove the existence of a relationship between radio spectrum reforms and market liberalisation. The hypothesis is that command-and-control and pure based approach encourage exclusive rights to radio spectrum users.

The study will evaluate the perspectives of the operators, vendors, industry experts, research institutions, regulator and policy maker in further adding to the understanding of reforms and market liberalisation.

The analytic approach will enable the study to draw conclusions on the impact of radio spectrum reforms on competition, thus ensuring universal access and services to broadband services by 2030 as completed in the NDP and “South Africa Connect”.

1.7 MAIN QUESTION

The primary question is to what extent command-and-control has and radio spectrum reforms employed in South Africa supported market liberalisation for achieving universal access and service to broadband services?

1.7.1 Sub-questions

In order to respond to the primary question, the following questions are posed:

- **Q.1.** How does current policy and regulatory radio spectrum management approaches in South Africa assist towards achieving universal access to broadband services?
- **Q.2.** Are current radio spectrum regulatory approaches of licensing radio spectrum, largely on an exclusivity basis, capable of encouraging competition and ensuring infrastructure sharing?
- **Q.3.** Are there any alternative radio spectrum regulatory approaches to licensing radio spectrum to encourage competition?
- **Q.4.** Would alternative radio spectrum regulatory approaches to licensing radio spectrum assist in addressing the cost associated with the usage and access of broadband services?
- **Q.5.** What are regulatory interventions that ICASA can possibly adopt to limit the possibility of consolidation of markets to distort competition and hinder universal access to broadband?

CHAPTER TWO: REVIEW OF RADIO SPECTRUM MANAGEMENT

2.1 INTRODUCTION AND BACKGROUND

This chapter seeks to explore and review academic literature on the employment of different radio spectrum reforms to assign radio spectrum for efficiency in the management of radio spectrum. It also explores in academic literature the pros and cons of radio spectrum reforms and their effect on market liberalisation and competition. It further creates a conceptual framework that will be used to deliver the analysis of the study in chapter five.

The literature reviewed in this this study will provide a guide on the direction to be followed based on the problem it has identified in chapter one and that will essentially channel the study (Ellis & Levy, 2009).

2.2 STIMULUS FOR REGULATING RADIO SPECTRUM

Recommendation ITU-R SM.1046-1 states that radio spectrum is a limited natural resource of great economic and social value (ITU, 2005a). Furthermore, it is a key strategic asset for both developed and developing nations with a rapid increase in demand (ITU, 2012).Thus, management of radio spectrum has to be optimal with regulation and policy to ensure maximisation of the benefits presented by this strategic asset (Doyle, 2007).

Telecommunications infrastructure supported by efficient radio spectrum management has the potential to contribute positively to both social and economic development of societies (ITU, 2012a). However, the supply and demand for radio spectrum by technologies pose a threat to the conventional way of managing radio spectrum. Therefore, the optimal allocation of it to users is an important element for market liberalisation and through this, development can be achieved (Wellenius & Neto, 2008, p. 3) and (Qiang & Rossotto, 2009).

As shown in chapter one, literature has revealed that there are two approaches that can be applied to manage radio spectrum by regulators; that is command-and-control and market-based mechanisms. The command-and-control approach is the conventional approach and the market-based approach is the reformed way of managing radio spectrum (Regulation Toolkit, n.d) and (Wellenius & Neto, 2008).

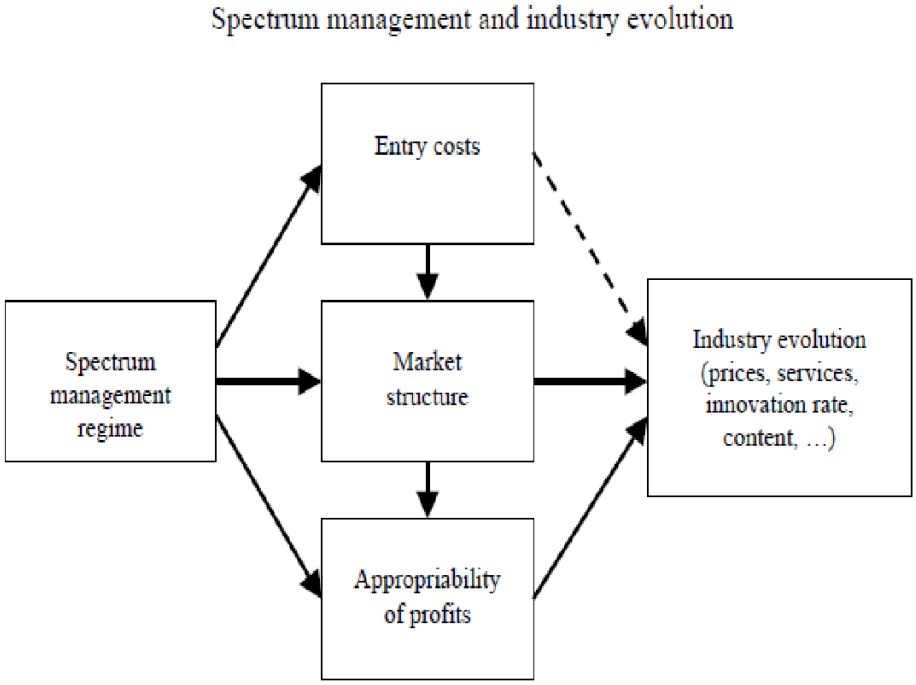
Literature has also presented the reason for using both approaches as ways to access radio spectrum. The rationale behind conventional radio spectrum regulation and reforms is to protect harmful interference amongst services of adjacent radio spectrum and neighbouring geographical areas. Economic and technical efficiency also needs to be achieved (Regulation Toolkit, n.d) and (Wellenius & Neto, 2008).Therefore, efficient and effective management of radio spectrum becomes an important aspect of radio spectrum management principles in terms of the ITU. According to Cave, Doyle & Webb (2007) the

main reason to manage and regulate radio spectrum is to enable countries to protect their society from any abuse of market power and to provide a framework for the management of shared resources.

Literature further indicates that radio spectrum management regimes have an effect on how the industry evolves, ways of accessing radio spectrum influences prices, as well as entry costs and of services (Hazlett, 1998).They further have an effect on the market structure as well as how effective market players can create innovation (Bauer, 2002, p. 11). Therefore, one can conclude that there is a relationship between radio spectrum reforms and markets liberalisation as shown in Figure 4.

The other key reason for managing radio spectrum is to maximize the value that society derives from radio spectrum. The value can be achieved by allowing many different users to make use of radio spectrum while ensuring that there is less harmful interference for socially and economically desirable outcome (Cave, Doyle, & Webb, 2007), (Stine, 2005) and (Anker, 2013). Shared radio spectrum usage allows for more available radio spectrum for users and lower access to barriers for new entrants.

Figure 4: Linkage between spectrum management, market structure and its effects



Source: Bauer, 2002

While there is wide support for radio spectrum policy and regulation in order to enhance the efficient utilisation of radio spectrum due to its scarcity (Cave, 2002), and (Sridhar and Prasad, 2012). Scarcity and harmful interference are not necessarily the only reasons behind the need for radio spectrum regulation. Literature further shows that there are

other issues such as competition, quality of service, access and consumer protection. All these issues make radio spectrum management remain a relevant and necessary policy and regulatory intervention for the telecommunications markets liberalisation.

Radio spectrum regulation similarly becomes necessary, as it propels the standardization of equipment and transmission methods (ITU, 2004). Basic effective regulation is accomplished through the harmonisation of allocation and assignment of a particular frequency band to specific services. For example, the allocation of 470- 862 MHz to the broadcasting service across all ITU regions. The adoption of this approach in turn assures that there is a mass market for radio equipment available at a cheaper price and facilitates radio services across continents of the world (ITU, 2004).The benefit of this impact is directly proportional to the end user's affordability and access. This is because service providers would not have any justification to pass on high costs.

The ITU states that fast growing wireless communications has made it necessary to manage radio spectrum through administrative regulations of *ex ante* as opposed to *ex post* as prevention of harmful interference is better than curing it afterwards (ITU, 2004). Therefore, for efficient management of radio spectrum, it is vital that regulators put in place effective and efficient regulatory framework for desirable outcomes.

As mentioned in above paragraph, traditionally, regulators across the globe managed most the radio spectrum through command-and-control. Command-and-control uses administrative process such as beauty contest, first-come-first-serve, comparative hearings and lotteries to award radio spectrum to users (Abrams, Kedama, Naidu, & Pillay, 2014) and (Matheson & Morris, 2012). Its initial intention was to prevent harmful inferences between services and as an approach it was relevant because the demand for radio spectrum was not as high as it is currently (Cave, Doyle, & Webb, 2007).

Typically, the definition of command-and-control is a government-centralised approach where radio spectrum is awarded to a user for specific use on an exclusive basis (Anker, 2013). The usage of radio spectrum is usually prescribed by the regulator with one type of service allowed for a particular radio spectrum band. Command-and-control is characterised by two main elements - protection of services from harmful interferences and harmonisation.

The command-and-control approach will use an ITA as in the case of South Africa for high demand radio spectrum, where demand exceeds the available radio spectrum. The ITA will for instance outline the required criteria for the applicant to meet in order to qualify for the award of the radio spectrum. The required criteria might include technical requirements, such as the speed of infrastructure deployment, project viability, radio spectrum efficiency, and other innovative requirements.This is true if the requirements have the ability to ensure that competition is stimulated in the telecommunication sector (Marcus, et al., 2005).

According to Cave, Minervini, & Mfuh (2008) command-and-control as an approach managed to facilitate allocation and assignment across all three regions of the ITU. The benefit also filtrated at the regional level with regions of the world benefiting in terms of

economies of scale regarding equipment manufacturing. The effect of this, is realisation of competition and liberalisation of the telecommunication markets (Cave, Minervini, & Mfuh, 2008) and (Cave, 2006). For markets, command-and-control further managed to ensure expansion of the telecommunications infrastructure to ensure universal services. In some instances, it further brought some level of competition in many markets for mobile telephones.This approach resulted in market structures of three to four mobile operators in most countries globally, a stride which brought some level of competition (OECD, 2014). Command-and-control also ensured basic efficiency in radio spectrum management usage by different radio communications services without experiencing harmful interferences (ITU, 2004).

In addition, command-and-control approach was successful in creating telecommunication infrastructure as a network industry allocating and assigning of radio spectrum to provision of 2G services (ITU, 2004). The success of mobile telephony in Africa is a classic example of how command-and- control managed to create a network industry (Aker & Mbiti, 2010).

According to literature, the command-and-control approach is static and inflexible, with a regulator holding all the rights to use frequency while authorising usage to the licensees (Ard-paru, 2010) and (Masonta, Mzyece, & Ntlatlapa, 2013). The licensee has the exclusive right to use the radio spectrum with all the imposed conditions. This implies that to ensure that there is efficient radio spectrum management; users of radio spectrum will be given a licence that will indicate a particular frequency and an area using a prescriptive approach of command-and-control (ITU, 2004).

As shown in chapter one, the 900 MHz, portion of 800 MHz, 1800 MHz, and 2100 MHz bands were allocated for Code Division Multiple Access (CDMA) GSM and 2G services. The assignment of these bands was conducted through command-and-control; this is especially true in ITU region one of which Africa is a member. Many of these 2G radio spectrum bands were technology specific (in this case 2G communication). The notion of technology neutrality did not apply; hence, much of the spectrum was restricted for the use of GSM technology (2G technology). In these radio spectrum bands, operators were allowed to use GSM technology to provide mobile services.

On the downside, command-and-control as an approach does not support market liberalisation as it tends to promote monopolies, and they have the potential to protect the interests of incumbents over those of consumers. Embedded in this approach is the notion that radio spectrum should be given free since it is a state-owned resource (Macmillan, 2004), (ITU, 2004) and (Sokol, 2001).

Command-and-control as an approach is also rigid; it presents less opportunity to change the radio spectrum assignment that provides minimal incentives for radio spectrum users to innovate (Hazlett, 2003) and (Masonta, Mzyece, & Ntlatlapa, 2013). It further tends to have a high entry barrier to the latest technologies in radio spectrum assignment (Masonta, Mzyece, & Ntlatlapa, 2013). This high entry barrier is the reason behind the spectral inefficiency in wireless networks. The latest technologies not only have

advantages of spectral efficiencies, but also further promote radio spectrum sharing between different services (Doyle, 2007).

The notion of putting value to the radio spectrum is ignored when command-and-control is employed. However, when there is a demand in terms of available radio spectrum, the licence will typically be awarded to the applicant that made the request first (Hazlett, 2003) and (Cave, Doyle, & Webb, 2007).

Command-and-control approach has the potential of stifling growth in the wireless communications market, because it does not manage to achieve the full objective of maximising the benefits that can be derived from radio spectrum due to its rigidity (Cave, Doyle, & Webb, 2007). Typically, the regulator will decide on both the use of the band, called allocations, and on which organisation can use the band, called assignment (Cave, Doyle, & Webb, 2007, p. 4). In many countries, these methods have created markets structures that are mostly dominated by monopolies and duopolies. They also created a situation, which makes it difficult for new entrants to enter the market with infrastructure sharing bottlenecks, entrenched exclusivity rights to radio spectrum and infrastructure concentration in urban areas (Stine, 2005).

The command-and-control method is further prone to political interference with the potential to make it difficult to keep up to pace with rapid advances in technological development and it is also unfriendly to commercial interests as it favours politicians (Somdyala, 2012). Moreover, it is a slow and wasteful approach of managing radio spectrum. This is supported by what happened in the USA, where it took the FCC almost two years to assign a third cellular network (Cramton, 2001). South Africa has also experienced a similar thing, with the process of releasing both the 800 MHz and 2.6 GHz radio spectrum that has been debated for more than eight years now since 2008. This approach is partly to be blamed in creating an artificial radio spectrum scarcity through its inefficiency in spectrum usage (McHenry, Tenhula, McCloskey, Roberson, & Hood, 2006) and (Qiang & Rossotto, 2009, pp. 79-89).

The literature also indicates that in addition to the approach's potential to create markets which are dominated by incumbents, it further presents a number of limitations such as the possibility of significant parts of the radio spectrum hardly being used (Cave, Doyle, & Webb, 2007) and (Ard-paru, 2010). This encourages hoarding of radio spectrum by licence holders because of the lack of incentives to radio spectrum holders to maximise the value of radio spectrum. It is also seen as an approach that is quite slow to respond to changes in markets and technologies as a result of its rigidity (Anker, 2013) and (Macmillan, 2004).Therefore, the application of command-and-control cannot be viewed as a solution to increased access to radio spectrum.

As mentioned in chapter one, South Africa, like many other countries, has awarded radio spectrum licenses to operators using the traditional methods such as command-and-control. This resulted in the scarcity of radio spectrum to be used to deliver wireless broadband services in the hands of few operators. Some of the radio spectrum license

holders have not used such radio spectrum to rollout networks. The relevant example is the 2.6 GHz radio spectrum, which was assigned to Sentech. However, Sentech never used it until it was returned to ICASA in 2013. According to the regulator, the same applies for the 800 MHz radio spectrum which was licensed to WBS which was never used until the company was acquired in 2015 (Interview, 22 May, 2015).

2.3 FLEXIBILITY AND EFFECIENCY OF RADIO SPECTRUM USAGE

Over the past decade, the increased demand for radio spectrum, convergence, facilitation of open-access to radio spectrum to promote competition and innovation has led to market-based and flexible approaches to radio spectrum management (Horne, 2009). It is argued that the key purpose of radio spectrum management is to maximise the value that can be gained from It. Literature presents an argument that flexibility in radio spectrum regulation allows increase access to radio spectrum by many users while ensuring that there is no harmful interference (Cave, Doyle, & Webb, 2007) and (Forge, Horvitz, & Blackman, 2012).

According to Forge, et al. (2012) radio spectrum reforms are expected to ensure efficient radio spectrum management as depicted in figure 5. Through the introduction of reforms, regulators formulate regulatory interventions to provide users with the right to use radio spectrum through licenses, which will indicate a particular frequency and an area using different radio spectrum reforms. Radio spectrum reforms such as radio spectrum auctions, radio spectrum trading, definition of property rights and radio spectrum commons or radio spectrum sharing, are regulatory tools, which can increase access to radio spectrum (ITU, 2004). Customarily, these regulatory tools for access to radio spectrum are used to respond to demand and supply of radio spectrum needs.

2.3.1. Flexible approaches responding to demand and supply of radio spectrum needs

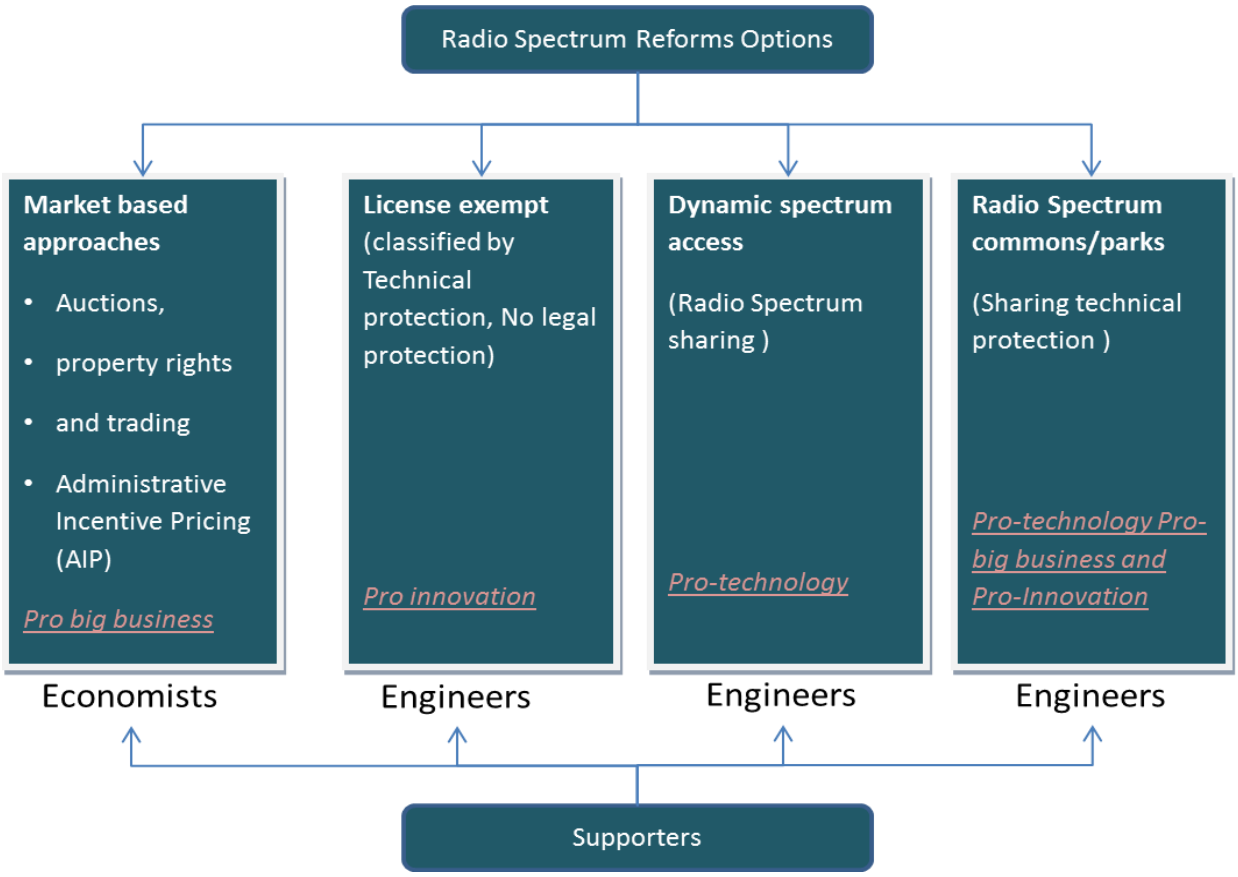
According to literature, a market-based approach to radio spectrum management is based on market forces as opposed to the administrative approach of command-and-control, and is favoured by economists as shown in Figure 5 (Marcus, et al., 2005). The proponents of market-based approaches argues that radio spectrum should be managed through markets forces since administrative approach has no value to management and it results in wasted radio spectrum" (Coase, 1959). Economists believe in establishing a market for radio spectrum, where their theory is advocating access to radio spectrum by those who value it and ensures efficiency.

Literature asserts that market-based approach allows radio spectrum to be traded like a commodity, where owners can buy, sell, subdivide and aggregate units of radio spectrum (Marcus, et al., 2005). Moreover, the approach allows for more efficient assignment and flexible approach of managing radio spectrum (Marcus, et al., 2005). Through market-based approaches, the regulations are flexible and market-oriented, which is contrary to the inflexible and static characteristics associated with command-and-control (Masonta, Mzyece, & Ntlatlapa, 2013) and (El-Moghazi, Whalley, & Irvine, 2014). Contrary to the

notion of sharing of resources, Cramton (2001) and (Cave, Minervini & Mfuh (2014) assert that market-based approaches provide the licence holder with ‘large’ exclusive usage rights to radio spectrum.

In terms of these approaches, the radio spectrum can be traded, bought and sold in the secondary markets. This approach allows flexibility with regard to usage and spontaneous response to constantly changing technological environment. According to the proponents of market-based approach, the priority of this approach is technology and service neutrality (Cave, Doyle, & Webb, 2007) , (Marcus, et al., 2005) and (Hazelett, Ibarguen, & Leighton, 2007). Thus, literature postulates that through the market-based approach, radio spectrum can be neutrally used by different technologies and priority is not placed on any technology (Cave, Doyle, & Webb, 2007). Consequently, the market-based approach can be seen as another form of regulatory intervention that can be used by regulators to increase access to radio spectrum.

Figure 5: Spectrum assignment approaches



Source: Bohlin, Forge, & Renda, 2007 refined by researcher

Literature asserts that the introduction of market-based approaches resulted in market liberalisation for the telecommunication sector (Wellenius & Neto, 2008), (Hazelett, Ibarguen, & Leighton, 2007) and (ITU, 2004). Consequently, the application of a market-based approach minimises the regulators' involvement in radio spectrum usage with the market driving management of radio spectrum (Marcus, et al., 2005). It appears that the elements which best describe this approach is market orientation and flexibility to access radio spectrum. The proponents of these approaches view command-and-control as the most inefficient way of assigning radio spectrum because of its static approach of managing radio spectrum (Foster & Alden, 2008).

Similar to command-and-control, the market-based approach has a number of classes to be employed when radio spectrum is licensed. For the purpose of this research, only auctions, radio spectrum property rights and radio spectrum commons will be analysed. This is due to the high demand of radio spectrum for wireless communications services and the contributions that the telecommunications sector makes to the economies of countries. Market-based approach has trended worldwide especially in developed economies as a method to access radio spectrum (Cave, Doyle, & Webb, 2007) and (Marcus, et al., 2005).

Under the market-based approaches, licensees can transfer frequency to other parties through market mechanism. The proponents view radio spectrum as a commodity to be traded in the market (Bastidas & Stine, 2013) and (ITU, 2004). The market-based approach is an access method to radio, which incentivises users of radio spectrum to buy radio spectrum from secondary markets (Bastidas & Stine, 2013). It also incentivises the assignee an exclusive right to use frequency. The powers of the regulator to alienate radio spectrum are transferred to the users and these powers include the right to sell, lease, and transferred radio spectrum through this reform tool (Wellenius & Neto, 2008). Users are also expected to adhere to imposed conditions on the use of the radio spectrum to avoid harmful interferences, such as the standard of devices (Cave, Doyle, & Webb, 2007). Thus, it incentivises users with flexibility in using radio spectrum as opposed to the command–and-control approach. The end result of the application of market forces is that they become the deciders of radio spectrum access and efficiency.

a) Radio spectrum auctions

As shown in Figure 5, auction is one of the market approaches, which can be used to access radio spectrum. According to (Sokol, 2001) theory of auctions is that, radio spectrum as an asset is transferred from a seller to a buyer. An auction is defined as a "market institution which explicitly sets rules to establish resource allocation and prices on the basis of bids from market participants" (Mcafee & McMillan, 1987, pp. 699-738). In some instances, auctions are employed because some products have no standard value (Sokol, 2001).

There are different types of auctions that can be employed to achieve a particular outcome in a market. Types of auctions include (Mcafee & McMillan, 1987):

- English auction - the price of the product is raised continuously until one bid remains,

- Dutch auction - the converse of an English auction in that from the beginning a high price is announced by the auctioneer and continues to reduce the price until a bidder accepts the price,
- First Price Sealed auction - the highest bid wins the product after bidders submit sealed bids.
- Second Price Sealed auction - bidders are told that the highest bid wins the product but will not pay the price equal to their bids but to the highest second bid.

The proponents of this approach argue that auctions are flexible public policy tools that can be used to attain specific policy objectives such as raising revenues. However, Cramton, et al. (2011) maintains that regulators should use auctions to assign radio spectrum efficiently and create competition and worry less about raising revenue as broadband services usage have huge potential to contribute positively to the economy.

Literature asserts that auctions can use to address previous mistakes of guaranteeing access to radio spectrum by state-owned entities. This can be done through the setting aside of radio spectrum for specific groups of society e.g. women, small firms, the disabled etc., as in the case of the USA resulting in efficiencies (Cave, Minervini, & Mfuh, 2008), (Caicedo & Weiss, 2009) and (Banks, Olson, Porter, Rassenti, & Smith, 2001). However, the setting aside of radio spectrum in most case has resulted in entries with fewer offerings than incumbents (Cramton, Kwerel, Rosston, & Skrzypacz, 2011, p. 171).

The rationale behind auctions is that markets are seen as a more efficient way of assigning radio spectrum to maximize its use, rather than the rigid way of allowing regulators or administrators to assign radio spectrum (Cave, Doyle, & Webb, 2007) and (Wellenius & Neto, 2008) and (Cave & Foster , 2010). Proponents of market-based approaches see radio spectrum auctions as making the process of radio spectrum licences more efficient and transparent as opposed to the command-and-control approach (Cramton, 2001), (Jilani, 2015),(Cave, Doyle, & Webb, 2007), (Cave & Foster , 2010) and (Mcafee & McMillan, 1987).

Literature postulates that these regulatory tools will ensure that the resources are placed at the hands of those who value it (Cramton, 2001). While achieving transparency and fairness in assigning radio spectrum since the procedures to award the ownership and pricing will be documented (Prat & Valleti, 2001), (Banks, Olson, Porter, Rassenti, & Smith, 2001) and (Cramton, 2001). Literature further claims that auctions have the potential to stimulate investment and encourage efficient usage of radio spectrum. Therefore, this reform best describes efficiency in radio spectrum management.

Proponents of radio spectrum auction believe that it has the potential to foster innovation and competition (Cave, Doyle, & Webb, 2007), (Banks, Olson, Porter, Rassenti, & Smith, 2001) and (Cramton, Kwerel, Rosston, & Skrzypacz, 2011). However, competition and innovation can only be realised if entry into auction is encouraged since incumbents are most likely to bid aggressively to deter new entrants to provide wireless services

(Cramton, Kwerel, Rosston, & Skrzypacz, 2011). At the same time, Cramton, et al. (2011) argue that auctions can bring social value in that incumbents may be given an opportunity to own more radio spectrum and leverage off their existing infrastructure to a new generation of services.

Radio spectrum auctions can further assist governments to address challenges of the concentration of infrastructure in urban areas (Cramton, 2001), (Jilani, 2015) and (Mcafee & McMillan, 1987). The objective is that only feasible governments and regulators have explicitly stated the conditions before the beginning of the auction process (Jilani, 2015). In countries where there is no competition among players, approaches such as auctions are employed to assign radio spectrum to address such a problem.

Different auction formats are employed as a form of regulating players in the market. These formats force the players to behave in a particular manner. For instance, through Sequential auctions, a participant can choose to sell multiple objects simultaneously to maximise benefits (Leme, Syrgkanis, & Tardos, 2012). While with Single-round, sealed bid auctions are usually employed to maximise social benefits (Doyle & McShane, 2001). Therefore, usually countries will choose a particular auction format to address a particular challenge.

While auctions as market-based approach have benefits, they also have disadvantages. Administrative approach theorists argue that auctions can increase the price of radio spectrum, which has to be ultimately borne by consumers. Similarly, this approach can also lead to radio spectrum hoarding, where the radio spectrum can be bought but not used, which has the potential to restrict a potential buyer from offering competitive services (Banks, Olson, Porter, Rassenti, & Smith, 2001) and (Cramton, 2001).

In as much as auctions are seen as the best approach to maximise the value of radio spectrum through mobilizing revenue, as an approach, it can equally create little adverse impact for consumers (Wellenius & Neto, 2008) , (Ard-paru, 2010) and (Cramton, 2001). According to a KPMG report, an Indian auction of 3G radio spectrum for wireless broadband resulted in 17 million new subscribers realized every month after the auction. Despite this huge subscriber base, the mobile penetration rate remained very low in India. This was coupled with uneven tele-density for urban and rural areas and by poor quality of service especially, in dense urban areas (KPMG, 2006).

Radio spectrum auctions can result in selling radio spectrum, which makes it difficult to reassign in the new future. In the main auctions, an approach encourages exclusivity in radio spectrum access and ownership of an outcome, which is not desirable given the growing demand for bandwidth by different technologies.

b) Radio spectrum property rights approach

The approach employs rights to the licensee to allow assigned radio spectrum to be used by a number of operators in that radio spectrum can be sold or lent to third parties (Macmillan, 2004), (Hazlett, 2001), (ITU, 2004) and (ITU, 2012a). De Vany, Eckert, Meyer, Hara & Scott (1996) postulates that spectrum property rights regime can be defined in three elements clear rights that are compatible with radio spectrum, development of a mechanism to enforce property rights and use rights to the spectrum owned by governments. In the radio spectrum property rights regime, the dimensions of rights and obligations in a radio spectrum licence among others includes a radio spectrum band that is available for use, area, license duration led; the type of service to be provided, etc. (Foster, 2006). According to Ard-paru (2010) an alienation right is defined as ownership that can be sold, leased, or transferred. For example, the frequency auction in the primary market and frequency trading in the secondary market provide ownership of frequency for the owner to trade. Normally, the alienation right is defined by the authority, regulator, or administrator (Ard-paru, 2010).

Proponents of market-based approaches argue that this is the best method to assign radio spectrum. They also made conclusions through literature that the shortage of radio spectrum comes from outdated rigid radio spectrum policies (Coase, 1959), (Wellenius & Neto, 2008), (Hazlett & Munoz, 2008) and (Hazelett, Ibarguen, & Leighton, 2007). Through these policies, regulators give radio spectrum licensees exclusive access to radio spectrum. Pro commons and market-based approaches argue that the exclusive access to radio spectrum results in most of the radio spectrum left idling most of the time when there is no transition happening. They, therefore, argue that for extreme radio spectrum reform, spectrum efficiency and increase access must be enabled (Masonta, Mzyece, & Ntlatlapa, 2013), (Coase, 1959), (Wellenius & Neto, 2008) and (Hazlett, 2003).

The radio spectrum property rights approach is more about auctioning the rights to use radio spectrum, not necessarily the spectrum itself, to improve assignment and allocation of spectrum. It is seen as a method that allows flexibility in the use of radio spectrum, which in return employs incentives to make economically efficient use of radio spectrum. It further allows the reuse of communications facilities such as transmitters, receivers and spectrum itself (De Vany, Eckert, Meyer, Hara, & Scott, 1996). Proponents of this market-based approach postulates that the relaxation of regulation of radio spectrum usage where the market plays a vital role can lead to radio spectrum efficiency through private ownership (Matheson & Morris, 2012).

Proponents of this model support it because the existence of property rights provides incentives for radio spectrum license holders to use radio spectrum (Furubton & Pejovich, 1972, pp. 113-1162). Consequently, the model influences the behaviour that the market players thus the promotion of innovation is realised. The utility function will be associated with an individual decision maker and will further provide the liberty to pursue different options in putting the goods in question to use (Furubton & Pejovich, 1972). Similarly, efficiency becomes a positive input for usage of radio spectrum resulting in customer satisfaction in terms of price and quality.

Literature further theorises the support of this approach because property rights are important for successful economic development since freedom of usage if given through ownership (Sheehan & Small, 2002). Efficiencies of property rights depend on clearly defined rights where owners have exclusive use of their property and this right must be transferable (Kerekes , 2011, pp. 315-338). Property rights are characterised by the following: duration; flexibility; exclusivity; transferability; and divisibility result in economic development (Sokol, 2001). It is argued that property rights result in management power, ability to have income, and benefit as well as the ability to sell and alienate interest (Sheehan & Small, 2002).

Literature on radio spectrum property rights draws a conclusion that radio spectrum scarcity is created by rules created by regulators on the manner in which radio spectrum can be used as per the license issued for a particular portion of radio spectrum. These imposed restrictions create artificial radio spectrum scarcity. Property rights clearly defined in a spectrum licensing regime will attract demand as investors will want to invest their resources as result of incentive of ownership given to the licensee (Coase, 1959), (Wellenius & Neto, 2008) and (Hazlett, 2003).

Proponents believe that renting radio spectrum does not drive efficiency, however, exclusive property rights through control of the usage does compensate the owner (Benjamin, 2007). This is supported by (Peha, 2007) who argues that radio spectrum users should have the right to keep their radio spectrum and lease and rent it to others as this will allow flexibility in radio spectrum management. This radio spectrum assignment approach assists in deploying the most efficient technology without any delay, as the regulator will not be expected to grant any approvals (Benjamin, 2007).

In the same vein, the property rights approach is not totally viewed as a panacea for resolving challenges faced by radio spectrum management. This approach has its own disadvantages too. The fact that the spectrum ownership is now with the licensee prevents regulators from imposing standards (Hwang & Yoon, 2009). It creates exclusive ownership of radio spectrum which can be a problem given the scarcity of supply and demand associated with this natural resource. The challenge, which might arise, is radio spectrum hoarding which can hamper prospects of competition in the market. The duration of a license is another aspect that makes this approach a not-so-suitable solution to everything (Ard-paru, 2010). There is an argument that spectrum rights should not be permanent, as renewal of rights will allow the regulator to intervene whenever there is market failure as soon as the time for renewal arises. An example of this is harmonization of unused spectrum which increases the value of that spectrum through releasing it in blocks (Peha, 2007), (Milgrom, 1985) and (Gent, 1999).

c) Radio spectrum trading in secondary market

Radio spectrum trading is another market-based tool for radio spectrum management. Similarly, with radio spectrum trading market forces are managing access to radio spectrum (Ofcom, 2009) and (ITU, 2004). The actual trade may take a number of forms, including sale, lease or other options. With the radio spectrum trading approach, trading transactions are initiated voluntarily by a licensee who wants to sell some of their radio spectrum and once a buyer is found, and the financial transaction is completed, the new owner obtains right to utilise radio spectrum usage (Caicedo & Weiss, 2009). This approach establishes a secondary trading market of supply and demand with market forces not only determined by access but also setting prices (Caicedo & Weiss, 2009) and (ITU, 2004).

For application of this market-based tool to succeed, the framework should be clearly outlined with entities to participate in the known market. The participants can be summarised as follows: licensee, licensee requester, radio spectrum exchange and market maker (Bastidas & Stine, 2013). This framework further demonstrates the transparency and efficiency associated with market-based approaches for radio spectrum management.

Moreover, the proponents theorises radio spectrum management approach where regulators play a lesser role to ensure access with the market determining allocation and assignment of radio spectrum (Cave, Minervini, & Mfuh, 2008). They believe that trading as a reform can foster market liberalisation through the introduction of competition where there will be increased access to radio spectrum as facilitated by the markets. Relation between spectrum trading and liberalisation of spectrum is vital in the process of creating the spectrum market (ITU, 2004).

Trading in radio spectrum management add value in that there is optimal use of the resource and efficient access to it (ITU, 2012a). Users are in the best position to determine their current and future requirements of radio spectrum, hence market forces as a radio spectrum manager. Proponents argue that market-based approaches prevent hoarding while promoting efficiency, resulting in positive benefits for consumers. Theory further argues that market-based tools allow dynamism in relation to change of use of radio spectrum as influenced by technological development. (Wellenius & Neto, 2008). It is also viewed as a reform which encourages competition in the market as new entrants can access radio spectrum in the markets (Oxera, 2012).

Radio spectrum trading has the potential of perpetuating monopolies in a market where secondary trading is allowed. Market structure can be determined by the markets through transfer of ownership of radio spectrum. It has the potential of creating ineffective competition for markets and encourages exclusivity and rivalry, the tragedy of anti-commons (Wellenius & Neto, 2008) and (ITU, 2004).

d) Administrative Incentive Pricing

As mentioned in chapter one, AIP is a pseudo-market-based approach used to recover administrative costs of radio spectrum management through radio spectrum license fees paid by users (Marcus, et al., 2005) and (Lundborg, 2013). AIP is one of the techniques used to determine the price radio spectrum by regulators. Regulators will set prices for radio while looking at cost opportunities to bands that are congested with incentivised properties.

According to the ITU, AIP is based on the economic rationale that market-based pricing of radio spectrum will lead to more efficient and productive use of radio spectrum as a resource (ITU, 2012).

Even though this is a market-based approach, it is still prone to radio spectrum inefficiencies. Firstly, if radio spectrum fees price are set too high, this may result in underutilization of radio spectrum. Secondly, if prices are set too low, this may result in hoarding and congestion, therefore finding the right balance is critical to ensuring efficiency (Doyle, 2007, p. 1). Literature postulates that the main aim of AIP is to ensure that radio spectrum is used efficiently. It may also be used to correct the imperfections of auction designs, incomplete information and transactional costs to ensure radio spectrum efficiency (Marcus, et al., 2005).

Even though AIP has an effect in shaping the market, it also has an impact in public finances because radio spectrum charges can be treated as a source of revenue for governments (Marcus, et al, 2005). In the absence of a well-functioning radio spectrum market, AIP can act as an opportunistic cost, which helps to ensure that radio spectrum is at high value usage (Minervini & Piacentino, 2006).

AIP as opportunistic pricing for radio spectrum prevents users of spectrum from hoarding it. It further encourages users to use radio spectrum in an optimal manner. AIP also provide an alternative to less congested frequency bands. It further encourages radio spectrum users to move to more spectral and efficient equipment (Minervini & Piacentino, 2006), (Doyle, 2007), (Marcus, et al., 2005) and (Lundborg, 2013).

AIP can potentially act as an impediment if prices for radio spectrum are set too high for new market entry (Lalitha & Nawaz, 2011). It does not facilitate competition, but it favours incumbents players with little opportunity created for market entry.

2.3.2. Open access based radio spectrum management

a) Radio spectrum commons

According to Brito (2007), a commons as a reform creates a platform where a resource common owns and provides a platform for the control of radio spectrum multiple users. This radio spectrum regulatory approach is characterised by rules and procedures that set parameters on usage of radio spectrum. While in terms of the ITU, the radio spectrum commons approach means no one has exclusive rights to radio spectrum anyone can

use a portion of it subject to certain rules such as maximum power level and lawful usage of a particular technology. An example of a radio spectrum commons is the assignment of radio spectrum for amateur radio service.

Commons or parks are based on the notion of radio spectrum sharing. There is a belief that radio spectrum is not a commodity and is not scarce but rather misallocated (Forge, Horvitz, & Blackman, 2012) and (Brito, 2007). In the commons approach, regulation should be on technology and communication that enables the sharing of rather than on radio spectrum itself. This approach facilitates the break away from treating radio spectrum as private property that should be owned but employs universal communication privilege (Lehr & Crowcroft, 2005).

Commons is a reform which increases access to radio spectrum by allowing sharing by an unlimited number of players to use the same radio spectrum with no ownership rights required (Brito, 2007) and (Lehr & Crowcroft, 2005). The FCC defines commons as follows: “a model that allows unlimited numbers of unlicensed users to share frequencies, with usage rights that are governed by technical standards or etiquettes but with no right to protection from interference” (FCC, 2002, p. 30).

The proponents of this approach challenge the spectrum property rights assignment favoured by market-oriented and trading of radio spectrum believers. As they don’t believe in ownership of radio spectrum but rather the sharing of a resource.They, however, agree with the market-oriented approach on the issue of command-and-control as being an inefficient way of assigning spectrum (Brito, 2007).

The radio spectrum commons approach compares radio spectrum to grazing land and other shared resources. Under this model, the common element for justification of spectrum efficiency is sharing where devices can coexist or cooperate without ownership attached to the resource (Peha, 2007).

New sharing technologies make it easy for many users to share a particular portion of radio spectrum without causing any harmful interference, which results in rendering ownership of rights and control from government and operators in radio spectrum management unnecessary. According to Brito (2007) Time-Division Multiple Access (TDMA), the use of etiquette such as “listen before speak” (LTB) allows the sharing of radio spectrum by multiple users through the division of the radio spectrum use into different time slots.

The proponents of this regime propose an “open-access” or commons regime calls for anyone to use radio spectrum as long as they are not causing any harmful interference. They further suggests that control of radio spectrum by government and ownership thereof, through radio spectrum trading, falls away if this approach is employed as a form of spectrum assignment (Brito, 2007).

Proponents of the commons model argue that this approach presents greater opportunities for efficiency and innovation while increasing access through sharing (Brito, 2007) and (Bauer, 2002). It further presents an incentive of the possibility to change the use of radio spectrum by users. On the other hand, licensed radio spectrum typically

sits idle when the license-holder is not transmitting (Brito, 2007) and (Ard-paru, 2010). Commons model precludes warehousing of radio spectrum, and has the potential of avoiding the disadvantage of an exclusive use model (Lehr & Crowcroft, 2005).

With commons, there is greater possibility of congestion and interference because of multiple users of radio spectrum. Further to that, there is the possibility of compromised services quality (Ting, Wildman, & Bauer, 2005).These disadvantages do not support innovation and has the potential of discouraging radio spectrum in that users would face uncertainty and would further lack interest to invest in new technologies or services. Radio spectrum commons can result in overuse, interference, and under investment (FCC, 2002).

With poorly designed system of commons, “although economically more feasible for some, would only lead to undue hardship” for other radio spectrum users (Ting, Wildman, & Bauer, 2005), (FCC, 2002) and (Peha, 2007).

Commons method does have aspects of command-and-control, in that government through the regulator, have to set rules of operation as the owner of radio spectrum. The framework for commons is characterised by set rules with enforcement agencies with sharing as objectives for access to radio (Forge, Horvitz, & Blackman, 2012).

b) Radio spectrum reform through game changing technology

It is generally agreed that the available radio spectrum might not be able to meet the demand of the bandwidth by the recent end-user devices that deliver broadband services. For example, the ITU have estimated that, based on global traffic, a range of 1340 to 1960 MHZ of spectrum is required for broadband services by 2020, a clear indication that radio spectrum demand for wireless services is on the rise (ITU, 2013a).

For this reason, there is a shift in thinking that radio spectrum management regime needs to evolve to meet the demand for broadband services through the introduction of radio spectrum efficiency approaches, such as DSA using cognitive radio system technologies (Chapin & Lehr, 2007). The IEEE defines cognitive radio systems as a technology that can intelligently detect which communication channels are in use and which are not in a given frequency band, and instantly move into vacant channels while avoiding occupied ones (Lee, et al., 2010).

The proponents of the DSA approach sees the regulation of radio frequency through static ways of allocating spectrum of exclusive use of the frequency band, resulting in spectrum underutilisation in time and space (Chapin & Lehr, 2007, Anker, 2010, (Masonta, Mzyece, & Ntlatlapa, 2013) and (Zhao & Sadler, 2007).They postulate that DSA is a radio spectrum reform through game changing technologies for additional capacity in the radio spectrum. Dynamic approach guarantees flexibility through third-party usage of frequency bands assigned to a certain licensee (Chapin & Lehr, 2007) and (Masonta, Mzyece, & Ntlatlapa, 2013).

Dynamic radio spectrum access is linked to the opportunistic accessing of TV white spaces of digital TV by using cognitive radio system (Nekovee, 2010). TV white spaces is the “portions of radio spectrum left unused by broadcasting service which may be used for other services on a secondary basis, i.e. on the condition of not disrupting broadcasting services and not claiming protection from them” (ITU, 2013b, p.2).

According to Marcus (2012) the operation of dynamic spectrum approach is achieved through a geo-location white space database of primary users of the radio frequency band, authorising the usage of such bands at specific times with allowed transmitter power. Similarly, Chapin and Lehr state that the main characteristic of dynamic spectrum access is a hierarchy of radio spectrum access rights classified as the primary user, a radio spectrum licensee who is protected from interference and secondary users (Chapin & Lehr, 2007). Usually the right to use radio spectrum is given to a single licensee unless there is a co-assignment in that particular band. A regulation may set out rules that will enable the possibilities of platforms, that envisage sharing and shared access to radio spectrum based on innovative technologies such as cognitive radio innovative technologies (ITU, 2008).

South Africa concluded a TV white space trial in 2013. Google as the operator for the geo-location database conducted the trial, the Tertiary Education Network supplied the backhaul connectivity with the CSIR as trial license holder where the results demonstrated that it was possible to achieve communication using TV white spaces without causing harmful interference (Stucke, 2015). Stucke (2015) suggests possible regulatory regimes for DSA as licence exempt as used in the case of the USA and UK. Dynamic spectrum access has the potential to succeed in delivering quality services if a hybrid regulatory approach for dynamic spectrum access wherein licence-exempt is used in conjunction with managed spectrum (Stucke, 2015).

DSA as an approach to access radio spectrum allows for sharing in a sense that even though radio spectrum is assigned to a licensee, the next user can also access radio spectrum. The access can be realised through market-based approach such as trade and lease, which is made possible by radio spectrum property rights and technology neutrality regimes. This approach further brings about flexibility in radio spectrum regulation as the right to use whatever technology neutrality to provide any service neutrality, which is adopted as the principle in this approach of radio spectrum assignment (ITU, 2008).

In spite of cognitive radio technologies fast emerging as the next generation wireless networking platform, issues of security such as different attacks from malicious users are overlooked in the research.These attacks may happen in the form of jamming with malicious intent of distorting normal secondary communications (Ren, Wang, Du, & Xu, 2012). There is also the possibility of a denial of service attack which may happen in the form of emulating characteristics of primary users of the spectrum band (of evacuating the secondary users from the radio spectrum band and capturing the band (Ren, Wang, Du, & Xu, 2012). Even though DSA has been used successfully in achieving certain policy goals such as universal access, it is not favoured for commercial services as service quality is not guaranteed (Stucke, 2015). There is also a possibility of eavesdropping by emulating characteristics of secondary users. Hence, it is an important aspect to build

sensing and detection of the attacks from malicious users to ensure an efficient and secure DSA system (Zargar, Weiss, Caicedo, & Joshi, 2009).

2.4 RADIO SPECTRUM REFORMS AND MARKET STRUCTURE

While radio spectrum plays a critical role in the provision of electronic communications services, it is a limited resource, which can only be assigned to a number of network operators (RSPG, 2009) and (Doyle and Smith, 1998). Inclusive mobile communications market structures are key issue for policy makers and regulators. Access to radio spectrum is substantial economies of scale in building network facilities for industry players (OECD, 2014). Therefore, management of radio spectrum also become a key issue for regulators. Typically, in managing radio spectrum, regulators will design plans, which show how to ensure access to radio spectrum guided by the policy goals.

The process of ensuring radio spectrum access typically determines the market structure through the number of network operators that are able to deliver competitive communications services. Radio spectrum can further be accessed through MVNOs or resellers to provide services to the end users. For example, South Africa through managed liberalisation policy, managed to assign radio spectrum to three mobile operators including two fixed line operators as well as IBurst and Sentech to provide wireless broadband services. There is also quite a number of MVNOs in the South African market, while (OECD, 2014) most of the OECD countries have at least three mobile network operators (MNOs) that operate nationally to provide services.

Hence, countries usually place a limit to the number of licenses, which can provide wireless services (OECD, 2014). These have led to the creation of oligopolistic market structures with a small number of players dominating the market, considering that each player has the power to influence the price.

Lack of radio spectrum has the potential of holding back competition in the electronic communication network and service markets. Similarly, the traditional radio spectrum gatekeeper can actively and passively ensure that radio spectrum become an entry barrier for market entries (ICASA, 2014a). According to Marcus, et al., (2005) levelling of the playing field for competitors is as equally important as interference free radio spectrum and usage of radio spectrum efficiently as these are important elements of regulation to ensure sustainable market competition.

Even though competition in the mobile sector is perceived to be aggressive and viable compared to the fixed service sector, access to radio spectrum can be used by operators to distort competition to the detriment of the end-users where policy objectives such as universal access and affordability can be compromised (RSPG, 2009). Therefore, regulators should exercise more care when employing radio spectrum reforms to ensure that effective competition is realised through proper regulatory interventions.

Literature states that the scarcity of radio spectrum most often creates an oligopoly market structure, therefore radio spectrum should be assigned in a manner that creates

a market structure that maximises possible degrees of competition is realised (Marcus, et al., 2005).

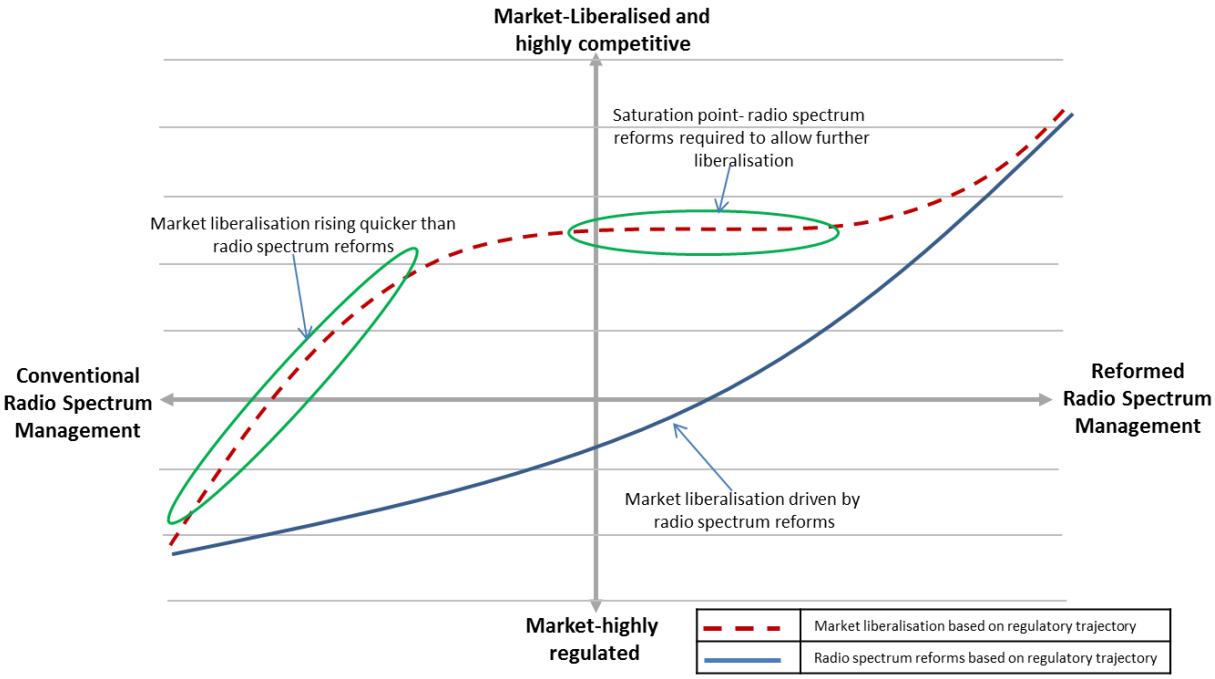
2.5 RELATIONSHIP BETWEEN RADIO SPECTRUM REFORMS AND MARKET LIBERALISATION – A CONCEPTUAL FRAMEWORK

The literature has shown that there is a direct correlation between market liberalisation and radio spectrum reforms. However, market liberalisation is not always dependent on radio spectrum reforms (Tripathi & Prasad, 2013). Most markets have implemented market liberalisations without reform of radio spectrum. South Africa is a classic example where market liberalisation with little intervention on radio spectrum reforms has been experienced.

Figure 6 depicts the relationship between spectrum reforms and market liberalisation. This relationship forms part of the conceptual framework for this study. As observed in the figure, the x-axis describes the evolution in radio spectrum management (from command-and-control to full realisation of radio spectrum reformation, while the y-axis represents market liberalisation. The red dash line in the figure shows the market liberalisation-based regulatory approach. This is when the regulatory intervention is focused on achieving market liberalisation with less focus on radio spectrum reformation. This approach is capable of rapidly liberalising the market. However, in the end, this liberalisation cannot be sustained. Hence, the saturation point shown in the graph, which represents the plateau of market liberalisation. The literature further substantiates this; it claims that in the telecommunication sector, because of supply and demand, there will come a point where access to radio spectrum becomes a bottleneck for effective competition (ITU, 2007) and (Melody, 1980).

On the contrary, the solid blue line represents regulatory interventions that prioritise radio spectrum reform while marginalising market liberalisation. In this approach, the liberalisation of the market is minimal; however, it is a necessary stride in ensuring further market liberalisation. The graph further shows that when radio spectrum reforms are making strides, further growth in market liberalisation can be realised. There is a depiction of this phenomenon at the end of the dashed and solid lines, where there is a disruption plateau phase to further allow market liberalisation. The literature emphasises this phenomenon when it states that radio spectrum reform will be a necessity to allow further market liberalisation (Melody, 1980) and (Tripathi & Prasad, 2013). The result will be a liberalised market with the following characteristic: low costs, low entry barriers and high innovation.

Figure 6: The conceptual framework



Source: Researchers's own

The literature addressed in this chapter has shown that excessive radio spectrum reforms have the potential to yield negative results for the markets. Wellinius and Neto (2008) postulate a phased approach in employing radio spectrum reforms to address challenges of command-and-control for developing countries. They post a number of strategies to address challenges posed by the administrative approach for managing radio spectrum, i.e.

- allowing greater flexibility for radio spectrum use
- allowing technology neutrality when radio spectrum is assigned
- constant updating of national table of allocation to align with international table of allocation
- for high demand radio spectrum auctions to be a standard method of assigning radio spectrum
- introducing other market tools such as radio spectrum trading in secondary market
- introducing market discipline for public radio spectrum use, e.g. AIP as a method for radio spectrum fees (Wellenius & Neto, 2008).

Literature however, cautions that there is also a need to strike the right balance through the creation of market liberalisation regulation for radio spectrum reforms (Hazelett, Ibarguen, & Leighton, 2007). This will ensure that radio spectrum reforms are supported to enable effective competition, innovation and ensure quality of service.

2.6 SUMMARY AND CONCLUSION

With respect to the issue of the relationship between radio spectrum reforms and market liberalisation, there is a consensus that radio spectrum reforms are crucial for efficiency in radio spectrum management. However, there are divergent views in terms of access to radio spectrum by users to achieve efficiency. Certain scholars believe that radio spectrum should be exclusively assigned to users, whereas others believe in the open-access principle to radio spectrum. The following chapter explains the research methodology considered for the study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the detailed theoretical framework underpinning the research as introduced in chapter two. It contextualises the study, research approach, and states the research gap. It explains the research objectives and poses the research questions. It further presents the data analysis strategy to be employed and the instruments to be used to collate the data for the research. In conclusion, it illustrates how the results of the data analysis will be presented.

3.2 RESEARCH GAP

Radio spectrum reforms have been reviewed based on the traditional radio spectrum allocation and assignment approaches such as command-and-control, market-based approaches and open access. The objective is to facilitate radio spectrum sharing such as licence exempt, radio spectrum commons and spectrum parks. However, to the best of our knowledge, there is a lack of studies focusing on the relationship between radio spectrum reforms and market liberalisation.

3.3 RESEARCH LIMITATION

This research includes some technical aspects of radio spectrum reforms. However, it is not the intention of the study to address technical issues associated with spectrum reforms. The focus is on the policy and regulatory aspects of these reforms rather than functionality and interpretation.

3.4 RESEARCH APPROACH

The research methodology employed in this study is guided by the problem statements, the nature of the data available, body of knowledge, and data available (Ellis & Levy, 2009).

In this research, the problem is on the conceptual level of spectrum management policy and regulations. Suitable data should contain the rationale and clearly describe the interactions between the regulator and other stakeholders involved in considering the employment of different spectrum reforms in the South African context. The research approach employed in the collection of empirical data was qualitative, not quantitative.

This research is non-numerical, but rather descriptive and uses words which mean the approach followed is qualitative. This allowed for more detailed investigation on the implications of employing different reforms It is able to answer questions such as who is

affected, why are they affected, what factors are involved, do individuals react or respond differently to one other, or not they not (Brynard & Hanekom, 1997).

Qualitative researchers often depend on four methods of gathering data, namely, participation in the settings, direct observation, in-depth interviews and analysis of responses (Nelson, Silverman, and Thomas, 2011). Therefore, this research adopted in-depth interviews and analysis of responses as an approach to gather data.

The aim was to describe the radio spectrum reforms and their implications through the use of nonnumeric data such as words as described by (Chinnathambi, Rajaseker, & Philominathan, 2013). Radio spectrum reforms are defined normally in national policies and regulations of countries. This made numeric data a non-useful method for collecting data as numbers will not be elaborate enough on issues of radio spectrum reforms. This was especially so, considering the manner in which radio spectrum reforms are perceived in relation to competition, market structure and universal access to wireless broadband services.

In addition, it was also impossible to quantify policy and regulatory issues in terms of numeric data. The conceptual framework of the report relates to relationships between radio spectrums reforms, competition, universal access, and affordability. These relationships will be assessed through regulation and policy by exploring available documents containing radio spectrum management issues relating to the reforms and competition.

Since competition and radio spectrum reforms are theoretical frameworks that underpin this research, different radio spectrum reforms including disruptive technologies and innovation on radio spectrum management will be critically analysed. The critical analysis will provide theoretical frameworks for understanding the constructs that impact on the employment of radio spectrum reforms in relation to competition.

The strategy followed is a naturalistic inquiry, through the studying of a real world situation. This has allowed openness to whatever emerges with no predetermined findings. In this regard, radio spectrum reforms have been critically analysed with the pros and cons of adopting either of these approaches clearly outlined and what impact they have on competition.

3.5 RESEARCH DESIGN AND RATIONALE

Research design articulates what data was required to conduct this research, and which methods were used to collect and analyse the collected data (van Wyk, 2012). It further articulates how this process managed to answer the research question of whether current South African radio spectrum reforms support market liberalisation. It also serves as an enrichment of the chapters of the research.

As Chinnathambi, Rajaseker, & Philominathan (2013) argues, the research design for this research showed various approaches used to solve a research problem of assessing

the effects of radio spectrum reforms to market liberalisation. It did so through sources and information related to the problem studied.

The research design presented an opportunity for this study to anticipate the appropriate research methodology and its tools to maximize the validity whether indeed there is a relationship between radio spectrum reforms and market liberalisations or not (Cohen, Manion, & Morrison, 2007).

Research design served as an orderly and carefully planned enquiry which followed a particular approach to verify the validity, reliability and truthfulness of the collected data from both document studied and interviews (Brynard & Hanekom, 1997). Therefore, this study will strive to achieve sentiments shared with regard to the research design by using relevant documents.

As Maxwell suggested, the process of "collecting and analysing data, developing and modifying theory, elaborating or refocusing the research questions, and identifying and dealing with validity threats took place simultaneously, with one process influencing all of the others" (Maxwell, 1997, p. 214). It should be noted that there were some modifications to the design of the study as new information was discovered during document studying, interviews and observations on the development of the ICT sector in South Africa. Hence the adoption of a flexible, non-sequential approach with a broader and less restrictive concept of "design" was adopted for the study "interactive model" (Maxwell, 1997).

Tools used to collect qualitative data for the research are document analysis of printed or electronic documents, interviews methods and case study. These tools assisted in capturing direct quotations about perspectives and experiences that affected stakeholders. Furthermore, it captured the following:

- Their perception on the implementation of policies and regulations relating to radio spectrum management in South Africa.
- Their understanding of how ICASA and the policy maker have embraced the radio spectrum reforms.
- Their views on how policy and regulation have impacted on market liberalisation for South African.

How ICASA's regulations can assist in achieving national policy objectives as expanded in the NDP and SA Connect of broadband for all by 2030.

3.6 RESEARCH QUESTIONS

The primary question is to what extent have command-and-control and radio spectrum reforms employed in South Africa supported market liberalisation for the purpose of achieving universal access and service to broadband services?

3.6.1 Sub-questions

In order to respond to the primary question, the following questions are posed:

Q.1. How does current policy and regulatory radio spectrum management approaches in South Africa assist towards achieving universal access to broadband services?
Q.2. Are current radio spectrum regulatory approaches of licensing radio spectrum, largely on an exclusive basis, capable of encouraging competition and ensuring infrastructure sharing?
Q.3. Are there any alternative radio spectrum regulatory approaches to licensing radio spectrum to encourage competition?
Q.4. Would alternative radio spectrum regulatory approaches to licensing radio spectrum assist to address the cost associated with the usage and access of broadband services?
Q.5. What are regulatory interventions that ICASA can adopt to limit the possibility of consolidation of markets to distort the competition and hinder universal access to broadband?

3.7 DATA COLLECTION

Common qualitative data-gathering techniques used for the purpose of this research includes interviews to obtain detailed information on radio spectrum reforms as articulated in policy and regulations to ensure universal and affordable broadband services. Documents were also studied as a second technique to collect data. Documents produced by the Department of Communications such as policies, legislations, reports and etc., regulations and discussion documents produced by ICASA on radio spectrum and other related issues. This does not preclude any government documents addressing issues in relation to this research.

International publications such as reports and manuals on radio spectrum reforms and wireless mobile markets were also studied for the purpose of collecting data. It is worth mentioning that each report or document studied as well as interviews as tools used for data collections presented advantages and disadvantages. The pros and cons ranged from level of insensitivity, opportunity to review during the collection process, and prejudice from both the researcher and stakeholder's participated in interviews (Mack, Woodsong , MacQueen, Guest, & Namey, 2011).

The resulting pieces of data took the form of text. As explained by Teddlie & Yu (2007) the purposive sampling method to select data was employed in the study, both documents and stakeholders were chosen for a purpose. The selection process for documents was based on the fact that those documents addressed issues of radio spectrum reforms and as well as issues of market structure and competition. The documents further outlined government's intention on how both regulation and policy should unfold with regard to radio spectrum management. Therefore the important characteristics of sources were the basis of the selection for the study.

3.7.1 Interviews

The objectives of the interviews as stated by Gill, Stewart ,Treasure, & Chadwick (2008, pp.291-295) are as follows: exploring the views, experiences, beliefs and/or motivations of affected stakeholders on governing approaches for radio spectrum management

reforms which may assist to achieve objectives as outlined in national broadband policy. An example of those objectives is universal access to affordable broadband services. Interviews were used as one of the methods to collected data. The interview process assisted in gathering detailed views, perceptions and insight of the participants. Interviews assisted to ascertain industry response to strides made as far as radio spectrum and market liberalisation in South Africa. Interviews play a vital role as sources for this research.

A recorder was used to do interviews. They are essentially three type of research interview that can be employed for qualitative research which is structured, semi-structured and unstructured interviews (DiCicco-Bloom & Crabtree, 2006, pp. 314-321). For the purpose of this research two types of interviews, structured and semi structured, were used. The reason of employing two types of interviews was to be flexible and derive more information that one can get from stakeholders who participated in the interview process. The whole process of the interview was to answer the following question: to what extent do radio spectrum reforms adopted by South Africa support market liberalisation? The interview process assisted in understanding the views of the stakeholders if the status quo in relation to radio spectrum reforms were to remain the same. And if so, would that ensure effective competition and ultimately lead to universal access to broadband services by 2030?

Interviews were in the form of in-depth face to face verbal interactions with the interviewees. Stakeholders consisted of representatives from mobile operators, a representative from ICASA, a researcher from the Council for Scientific and Industrial Research (CSIR), a representative from the Department of Telecommunications and Postal services (DTPS), an organisation representing interests of mobile operators - the Wireless Access Providers Association (WAPA), an organisation representing interests of mobile operators worldwide - GSMA, one expert representing the Vendor community and industry experts as well consultants doing work on various telecommunications issues, including radio spectrum as shown in Table 2.

During interviews, an empathic neutrality approach was adopted to ensure that there is understating without judgement. For example when operators were interviewed, there was some showing of openness, sensitivity and awareness in relation to issues that each operator might be dealing with at that particular moment. The same principle was applied when both the policy maker and the regulator were interviewed. The intention of the approach to was acknowledge the developments which were happening within the sector. It is common knowledge that government is busy with the development of an ICT integrated white paper; there are proposed mergers and consolidations by operators and some infrastructure sharing proposals. The regulator is also expected to develop an ITA that will ensure the release of high demand radio spectrum for broadband services. Similarly, the industry is also developing strategies on how to participate in ICASA's ITA process. These developments had a bearing on most of the issues addressed in this research. They also relate to challenges that are currently facing South Africa in radio spectrum management.

Interviews were very helpful in addressing the issues of radio spectrum assignment and allocation in South Africa, the bottlenecks associated with awarding the high demand radio spectrum and the impact of the delays and non-action on radio spectrum assignment from the policy maker and the regulator. The interviews were also flexible in that interviewees preferred a conversation rather than sticking to the questionnaire. An advantage that came with adopting a hybrid model of interviews that is, both structured, semi-structured and unstructured interviews is the flexibility aspect.

Predetermined questions were asked through a questionnaire. This represented the structured interview element. Elements of an unstructured interview were also present because questions such as the experience of the stakeholders in the telecommunications sector were asked. The purpose was to establish how well versed the stakeholder participating in the interview is with the South African telecommunications sector. Usually "unstructured interviews are generally considered where significant 'depth' is required, or where virtually nothing is known about the subject area" (Gill, Stewart, Treasure, & Chadwick, 2008, pp. 314-321). Because there is little research work done around South Africa's regulations on radio spectrum management, for this reason an unstructured interview was adopted as the preferred interview method..

The interviews employed a face-to-face approach with two interview approaches (structured and semi-structured). Brynard and Hanekom argued the approach of meeting face to face with the interviewee has a benefit in case there is the need to clarify a problem. This could be beneficial on the person being interviewed in that he or she might open up with a lot more information to the extent of even providing examples (Brynard & Hanekom, 1997). The stakeholders interviewed were asked questions for clarity on some of the predetermined questions which were sent to them prior the actual interview. They were also able to provide example of cases where some of the answers were relied upon. To be specific, Table 1 depicts the stakeholders which are interviewed.

Stakeholders for interviews were chosen on the basis that they will be in a position to provide different perspectives on the topic researched. The Regulator, 22/05/2015 was able to provide a regulator perspective on the effectiveness of radio spectrum reforms employed by ICASA for market liberalisation. Policy Maker, 23/01/2016 was able to provide a policy maker perspective in relation to radio spectrum reforms to be considered by ICASA to achieve objectives of SA Connect. While operators, Operator-A, 24/04/2015 Telkom and Operator-B, 14/05/2015 Cell-C were able to provide a perspective of small operators with smaller market shares compared to MTN and Vodacom about radio spectrum reforms employed and proposed by the regulator, and how radio spectrum reforms by the regulator entrenches the dominance of the big operators and how it improves effective competiveness of the sector. Both Operator-C, 26/05/2015 Vodacom and Operator-D, 26/05/15 MTN as operators with a bigger market share were able to provide their perspective on market-based approaches as effective for competition and do they believe that radio spectrum should be consolidated with them as they have the capacity to roll-out infrastructure.

Excerpt-F, 28/05/2015 WAPA also shared their perspective on radio spectrum commons as a method to ensure market liberalisation. While Expert-E, 28/04/15 GSMA was able to

provide their perspective on the South African market structure and competition, GSMA is of the view that the South African market does not have the capacity to handle any new entrants. According to Expert-E, 28/04/15 the existing market players have the capability to ensure market liberalisation with proper regulatory intervention. Expert-C, 21/04/2015, Lottery Board, Expert-B, Consultant 24/04/15, Expert-A, ZET Comms, 12/05/15 and Expert-D, 26/05/2015 were able to provide answers on how radio spectrum reforms will support market liberalisation. In conclusion, engaging Researcher, 29/04/2015 CSIR assisted in gathering views through thought leadership from research. For example, CSIR and some consultants were able to provide information that illustrated the research that is currently underway to improve efficiency in radio spectrum access and usage by different users. Their perceptive managed to balance the views expressed by operators, government and regulators as they have competing interests in radio spectrum management and regulation. An introduction of balance from a group which does not have a biased view like the other stakeholders with strong sectional interest on the aspect of radio spectrum management was achieved. In general, engagement with stakeholders through interviews assisted in establishing the perceptions and understating of the market. This is with regard to the effects of radio spectrum reforms to market liberalisation, as well as the importance of efficient regulation for radio spectrum efficiency.

Table 1: List of stakeholders who participated in the interview session

	Respondent	**Institution**	**Years of Experience**	**Interview date**
1	Regulator	ICASA	More than 15 years of experience in ICT engineering, policy and regulatory	22/05/2015
2	Policy Maker	DTPS	More than 15 years of experience in ICT engineering, policy and regulatory	23/01/2016
3	Operator-A	Telkom	More than 20 years of experience in ICT engineering, policy and regulatory	24/04/2015
4	Operator-B	Cell C	More than 20 years of experience in ICT engineering,	14/03/2015

			policy and regulatory	
5	Operator-C	Vodacom	More than 20 years of experience in ICT policy, regulatory and strategy management	26/05/2015
6	Operator-D	MTN	More than 20 years of experience in ICT engineering, policy and regulatory	26/05/2015
7	Expert-A	ZET-Comms	More than 20 years of experience in ICT engineering, policy, regulatory and strategy management	12/05/2015
8	Expert-B	Consultant	More than 20 years of experience in ICT engineering, policy, regulatory and strategy management	24/04/2015
9	Expert-C	Lottery Board	More than 20 years of experience in ICT engineering, policy, regulatory and strategy management	21/04/2015
10	Vendor	Ericsson	More than 20 years of experience in ICT engineering, policy, regulatory and strategy management	18/05/2015
11	Researcher	CSIR	More than 10 years of	29/04/2015

			experience in ICT engineering, policy, regulatory, and research	
12	Expert-D	Sentech	More than 10 years of experience in ICT engineering, policy and regulatory	26/05/2015
13	Expert E	GSMA	More than 20 years of experience in ICT engineering, policy, regulatory and strategy management	28/04/2015
14	Expert F	WAPA	More than 20 years of experience in ICT policy, regulatory and strategy management	28/04/2015

Source: Researcher's own

- **Advantages of Interviews**

Interviews as a method of collecting data were useful in understanding the evolution of radio spectrum reforms and market liberalisation. It also helped in keeping the interviewers on track and focused until completion. The method was also used in allowing interviewees to express what is important to them in relation to radio spectrum reforms. Face-to-face interviews also assisted in asking for clarity from the interviewees when required.

- **Disadvantages of Interviews**

Because the research employed both structured and unstructured methods to do interviews, there were times when interviewees who went off topic when responding to questions. As indicated above, the issue of radio reforms is currently topical in South Africa. The interviews took longer than the time allocated. In the end it created some difficult to report findings and compare data from different interviewees for the study. Most of the time interviewees were subjective in responding to questions.

3.7.2 Document Study

In order to strengthen the study and make the findings more credible, multiple secondary data was used. (Brynard & Hanekom, 1997) And (Okoli & Schabram, 2010) states that relevant literature review is important in that it assists researchers in making use of literature to determine the truth about the studied phenomena. (Taylor-Powell & Renner, 2003) Is of the view that literature is an account of what has been published on a topic by accredited scholars and researchers. In undertaking the literature review of this study, more focus will be given to information that could assist in exploring the issues about spectrum reforms, market structure and competition. This includes information from the following sources: the Internet, policies and legislation, relevant published books, unpublished dissertations and theses, research reports, official reports, documentation and speeches, and articles from academic journals. However, it will be possible to supplement the existing documents with information that could be gathered from the questions posed during face-to-face interviews, a closed or restricted form of questionnaire and any new information from observation.

Data will be collected from a variety of sources. Amongst those will be a survey of documents by ICASA, the regulator, to establish as to whether they have developed any programmes and strategies to meet the radio spectrum assignment efficiency requirements with the main aim of achieving broadband policy imperatives. To further share the regulator's experience with regard to the previous programmes and strategy employment on radio spectrum reforms, how will that have an effect on competition? A similar approach of a survey of documents by the Department of Communications and any other government policy documents and related research studies will be adopted with the same aim of establishing experience, behaviour and beliefs on radio spectrum management reforms to meet government policy objectives for 2030 in line with national broadband policy, South Africa Connect and the NDP. For the purpose of this research, data analysis ideally occurred concurrently with data collection. It assisted the researcher to generate an emerging understanding about research questions on radio spectrum reforms, which in turn informs both the sampling and the questions being asked on radio spectrum management.

Secondary data was also used in the form of international organizations such as the ITU. This data assisted in providing context for the global perspective of different radio spectrum reforms in relation to market liberalisation.

- **Advantages of document study**

Document study assisted in gathering more information which was not known before radio spectrum reforms. This method was relatively low cost because most of the documents analysed were government documents and ICASA's documents, which are readily available from the Internet. ITU documents are also available from the Internet and easily accessible. The documents studied were also a good source of background information on radio spectrum reforms and market liberalisation.

- **Disadvantage of document study**

Most of the documents studied were too long and time consuming to read. Most of the documents were stating the same issues that the study was looking at. Some of the documents presented radio spectrum reforms from a subjective point of view without any empirical evidence supporting issues stated.

3.8 DATA ANALYSIS FROM INTERVIEWS AND DOCUMENTS STUDIED

There is no prescribed ”right way” of analysing data in qualitative study (Kawulich , 2004, p. 96), (Leddy & Ormrod, 2005, p. 150) and (Taylor-Powell & Renner, 2003). The data analysis process involved making sense out of data recorded in text and in audio during interviews and the large number of documents studied. Literature suggests that “data analysis normally occurred concurrently with data collection to enable a researcher to generate an emerging understanding about research questions, which in turn informs both the sampling and the questions being asked” (DiCicco-Bloom & Crabtree, 2006, pp. 314-321), (Creswell, 2013) & (Leddy & Ormrod, 2005). Data analysis occurred concurrently with data collection, and the strategy assisted with making sense of research questions which interviewees were asked and making sense of documents studied. It further assisted in how to choose the document to be studied and how to make sense out of them in relation to spectrum reforms and competition.

As Kawulich (2004) stated, data analysis is critical in order to get the researcher more involved in the data and enable them to be familiar with it, as that will assist with identification of themes, patterns and relationships between data. Further Tellis (1997) states that data analysis is the least developed area and the most complex in case study approaches. With Taylor-Powell & Remer (2003) suggesting that the process of analysing data depends on the following elements: the questions the researcher wants to answer, the needs of those who will use the information and the availability of the resources to be used. For the purpose of this research data analysis will occur concurrently with data collection. The strategy assisted in understanding emerging issues which might arise relating to questions. The understanding of emerging issues was captured during the process; the sole intention was to improve questions asked on radio spectrum reforms and their effect on competition (DiCicco-Bloom & Crabtree, 2006). Since the questions to be asked on radio spectrum reforms were very direct, this approach might assist in discovering the new issues during interviews. It also helped improve and expand the research questions.

Progressive focusing strategy was also adopted, as was data analysis during data collection. This assisted in jotting down ideas with the intention of getting to understand the meaning of the text and how it might relate to other issues directly (Bitsch, 2005).

In addition, thematic analysis will be employed in this research as that will assist in looking across all the data to identify the common issues that recur, and identify the main themes

with regard to employment of different aspects of spectrum reforms and summaries all the views collected to formulate an opinion (Braun & Clarke, 2006).

There will be four stages of thematic analysis as pointed out by (Braun & Clarke, 2006) preliminary observations as the first stage, followed by identification of themes from the notes made and documents analysed and interviews, development of coding schemes is third, and lastly, coding of data. Data will be interpreted by attaching significance to the themes and patterns that were observed, prepare findings, and ultimately compile a detailed report with recommendations and propose adjustments.

Presentations of the filed work will also ensure that all the views, perceptions and experiences of the sampled interviewees about radio spectrum reforms and market liberalisation are presented in a form of themes created from the questions asked. Filed work will be supplemented by an in-depth analysis of the South Africa policy and regulatory framework in relation to radio spectrum reforms.

3.9 SUMMARY AND CONCLUSION

Research methodology chosen for this study is of a qualitative approach because of the nature of the problem being investigated. The descriptive approach is followed throughout the study to understand the implication of employing reforms for market liberalisation. Sampled interviewees and their vast ICT technical, regulatory, policy and strategy management are highlighted. Findings of the field work and document analysed will be reported in the next chapter.

CHAPTER FOUR: PERSPECTIVE OF ACHIEVING MARKET LIBERALISATION THROUGH SPECTRUM REFORMS

4.1 INTRODUCTION AND BACKGROUND

The research seeks to explore required radio spectrum reforms necessary to enable South Africa to fulfil national objectives as defined in the NDP and the National Broadband Policy, which among others, includes market liberalisation. This is necessary to achieve universal access for broadband services. This will be achieved through the collection methodology, which will include analysis of the data collected during interviews and documents analysis. The chapter was constructed through the adoption of a two-pronged approach, where document analysis and interview process were adopted for the purposes of collecting data. Therefore, document findings will be presented first and these finding will be followed by findings of the stakeholders and conclusions in this chapter.

Due to the high volume of documents available that require examination, sampling, purposive and interpretation techniques were employed. This was useful in aiding the selection of documents to be interrogated for the data collection process. The documents examined are more inclined towards radio spectrum management policy and regulations for broadband access and a roll-out in relation to competition and market structure.

In the case of interviews conducted with the stakeholders, a sampling approach was employed for selecting interviewees. The selection of the stakeholders to participate in the interviews was based on their experience. It was important to select interviewees who played or are currently playing in the South African electronic communications sector and those with an in-depth understanding of radio spectrum issues.

Document analysis is structured in three sections. The first section describes policies and legislation issues; the second section outlines for regulatory framework by the regulator, and the last is international reports.

4.1 POLICIES AND LEGISLATION

This section introduces the convergence of legislation and policy that entrenches command-and-control for the management of radio spectrum. This further included some elements of radio spectrum reforms embraced for the purpose of ensuring efficient spectrum management to realize the objective of Vision 2030 of affordable universal access of broadband for all.

4.2.1. National Development Plan 2030

The National Development Plan entails the vision for South Africa to eliminate poverty and lessen inequality by 2030 (NDP, 2012, p. 24). The Plan comprises of 15 chapters, wherein chapters 3 to 15 provide a summary of objectives and actions which will lead to

Vision 2030. The main goal of the Plan is to eliminate poverty and reduce inequality through different sectors which contribute to the South African economy.

Chapter 4 of the Plan discusses Economic infrastructure, which is important for the study to consider as it covers actions and activities that are required for the ICT sector to realise the Vision 2030. In particular, the NDP covers radio frequency spectrum for wireless mobile broadband. According to the Plan, by 2030, ICT will underpin the development of a network infrastructure which is universally available and accessible. Moreover, the Plan supports the development of an infrastructure that is accessible and that meets the needs of businesses, citizens and the public sector (NDP, 2012)

According to the NDP, the duopoly in the mobile market has resulted in Telkom dominating in the telecommunication backbone and fixed telephony market. The apparent dominance has been ineffectively regulated, consequently resulting in high costs for business and increasing costs of services and products (NDP, 2012). The Plan provides that for South Africa "to achieve its ICT policy goals, the country must have a coordinated, enabling plan and strategy with reviewing of the market structure and analysis of benefits and costs of duplicating or sharing infrastructure, given that the radio frequency spectrum on which mobile broadband depends is limited" (NDP, 2012, p. 191).

The Plan claims that radio spectrum is a scarce, natural resource that needs to be optimally assigned to meet the needs of the South African people and its economy. Therefore, streamlining the assignment of the radio frequency spectrum can assist in addressing the regulatory bottleneck in the deployment of wireless broadband. It further provides that a significant amount of spectrum will be made available through the migration of broadcasting services from an analogue to digital process, that radio frequency spectrum should be swiftly assigned to ensure the expansion of wireless services (NDP, 2012, p. 192).

The Plan further makes pronouncements on the mechanism that should be adopted on making the assignment of the radio spectrum that will be released as the result of the digital broadcasting migration process, the digital dividend. It puts emphasis on the transparent process of licensing the digital dividend spectrum. The licensing process should be accompanied by clear conditions where those applying for the spectrum need to indicate the type of services they will be providing (NDP, 2012, p. 194). With this, the Plan seems to suggest that the digital dividend spectrum will be licensed based on a technology-specific basis. This contradicts other parts of the Plan which support the flexible use of the radio spectrum. This part seems to support command-and-control for licensing radio spectrum.

It further suggests market-based approaches such as auctioning or reverse bidding of the radio spectrum as a form of licensing as well as radio spectrum trading. It also supports the policy that promotes the notion of technology neutrality for the licensing of radio spectrum. This should allow for flexible use and competition where incumbents will not be prohibited from gaining access to the digital dividend radio spectrum (NDP, 2012, p. 194). With this provision in the Plan, it shows the willingness to shift some aspects of radio spectrum reforms for the licensing of the radio spectrum.

In conclusion, the Plan outlines the phasing of priorities to create an enabling ICT environment to achieve Vision 2030. For the period of 2012 to 2015, the Plan provides the review of the ICT policy, which has not been done since 1995. In the process of the ICT policy review, the plans for assignment of digital dividend radio spectrum should be included with clear targets of monitoring and evaluation. It further highlights the policy issues which require urgent policy attention such as adjustment of market structure and removal of legal constraints to enable full competition in services (NDP, 2012, p. 195).

The Plan prioritizes the review of ICT policy, which in turn presents an opportunity for adoption of some aspects of radio spectrum reforms. Consequently, effective competition in the market through proper market review is ensured, which may result in driving the affordability of mobile broadband services.

4.2.2. National Broadband Policy "South Africa Connect"

South Africa Connect is a South African Broadband Policy that gives effect to Vision 2030 as envisaged in the National Development Plan. The policy outlines the plan of the government to develop a seamless information infrastructure for South Africa. It should be universally available, accessible and meet the needs of businesses, citizens and the public sector (DoC, 2013, p. 2). The Policy defines broadband as an "ecosystem of high capacity, high speed and high quality electronic networks, services, applications and content that enhances the variety, uses and value of information and communications for different types of users" (DoC, 2013, p. 18).

The Policy creates a framework to realize South Africa's broadband ambitions with three pillars of strategies: digital development, digital readiness and digital future. In each strategy, there are plans and actions outlined and attached to a responsible key stakeholder for the realisation of affordable and universal access of broadband services by 2030 for all South Africans. The Policy states that its purpose, amongst other issues, is to remove policy constraints, regulatory bottlenecks and other hurdles that create the slow diffusion of broadband in South Africa (DoC, 2013).

The policy acknowledges the increasing demand for radio frequency spectrum as a result of increasing reliance on mobile or wireless communications as stated in a number of scholarly documents (DoC, 2013, p.16). Similarly to the NDP, the Policy concludes that the delays in the broadcasting digital migration process in South Africa has resulted to non-realisation of effective competition and fewer contribution of ICT to economic development. The delay of policy and regulatory allocation and assignment of radio frequency spectrum results in a lack of competition and less return on investment in ICT (DoC, 2013, p. 16).

Table 2: South Africa Connect targets for accessing broadband services

Target	Penetration measure	Baseline (2013)	By 2016	By 2020	By 2030
Broadband access in Mbps user experience	% of population	33.7% Internet access	50% at 5 Mbps	90% at 5 Mbps 50% at 100 Mbps	100% at 10 Mbps 80% at 100 Mbps
Schools	% of schools	25% connected	50% at 10 Mbps	100% at 10 Mbps 80% at 100 Mbps	100% at 1 Gbps
Health facilities	% of health facilities	13% connected	50% at 10 Mbps	100% at 10 Mbps 80% at 100 Mbps	100% at 1 Gbps
Government facilities	% of government offices		50% at 5 Mbps	100% at 10 Mbps	100% at 100 Mbps

Source: DOC, p. 18

Section 4 of the Policy outlines a number of principles as envisaged in the NDP, which will enable the success of broadband as an evolving phenomenon. One of the realised principles is the introduction of open access in radio spectrum management. Open access has been identified as a means to enable sharing of infrastructure platforms by service providers (DoC, 2013). This is expected to allow competition at service and technology level, while facilitating service neutrality to allow flexibility in the usage of resources. This will further facilitate the flexibility in usage of common principles and standards, which are expected to enable interoperability and universal access to broadband services, while focusing on providing services in underserved areas and communities (DoC, 2013).

Section 8 of the policy provides the targets which are expected to be achieved to realise policy goals of vision 2030 as envisaged in the NDP in Table 2. Given the slow pace at which South Africa has moved in implementing policies in the electronic communications sector, sceptics see the targets set out in the policy as ambitious.

The policy states that the targets as provided for in Table 2 will be achieved through a combination of both wireless and fixed broadband technologies. To realise this, the Minister of Communications is expected to consider the viability and competitive impact

of the introduction of open access wholesale fibre and wireless broadband networks (DoC, 2013, p. 5).

South Africa Connect concedes that the South African electronic communication market structure is vertically integrated and this results in structural constraints that hamper effective competition (DoC, 2013. It suggests the importance of restructuring, which will be complemented by a flexible regulatory framework that will enforce open access principles/method. This restructuring will be a necessary catalyst towards the reduction of wholesale costs and will encourage service-based competition that will enable the roll-out of broadband (DoC, 2013, p. 4). However, the Policy is not clear on the issues of open access principles. It gives an impression that these principles will be enforced in both competitive and uncompetitive areas.

Section 12 presents the overview on the digital readiness pillar which lays the foundation for the South African broadband future. The section further acknowledges a point supported by literature that radio spectrum is a scarce resource that requires to be managed efficiently to realize its potential to provide wireless broadband services. This point is pertinent to South Africa, given the dominance of mobile access compared to fixed access (DoC, 2013, p. 34). Section 12 of the Policy further highlights that "the removal of all bottlenecks in the regulatory environment, re-allocation and assignment of broadband radio spectrum, encouraging radio spectrum sharing and increase access to license exempt radio spectrum" (DoC, 2013, p. 34).Through this section, the Policy indicates the support for some aspects of alternative radio spectrum reforms.

The Policy realises the importance of reviewing the radio spectrum licensing as envisaged in the NDP. To ensure continuous, effective competition in the electronic communication sector, the Policy is considering the adoption of alternative radio spectrum reforms in order to ensure that there is an effective market structure. This will assist in the realisation of universal and affordable wireless broadband services for all South Africa by 2030.

4.2.3. South African National Radio Spectrum Policy of 2010

The primary objective of the Policy is to provide ICASA a directive on how to promote the rational, efficient, and economic usage of the radio spectrum. This is while keeping pace with technological wireless developments guided by national governments policy objectives (RSA, 2010, p. 7).

In paragraphs 2.1.1 and 4.4 of the Policy, we observe some strides of radio spectrum reforms, which are the intentions of the policy - to increase the available amount of radio spectrum, where different radio communications services can share the radio spectrum. In paragraph 7.6 the Policy supports the employment of market-based approaches for instance (RSA, 2010 p.16).

However, the Policy in some parts continues to emphasise the centralised control of the radio spectrum. Paragraph 6.2, states that the rights to radio spectrum rest with the state and the regulator will grant licenses to use radio spectrum (RSA, 2010, p.14).

The Policy in paragraph 6 provides that usage of radio spectrum should be based on the technology neutrality principle in order to ensure competition among radio communications services, other stride of radio spectrum reforms (RSA, 2010 p.14).

4.2.4. Draft Policy Directions for Electronic Communications Services in High Demand Spectrum

In December 2011, the Minister of Communications issued a draft policy direction for high demand radio frequency spectrum (800 MHz and 2.6 GHz bands). The aim of the policy direction was to pave the way for the licensing process of high demand radio spectrum with the intention of achieving universal service and affordable broadband for all (RSA, 2011). The draft policy direction supports the combinational award or licensing of radio spectrum. The draft policy direction further provides that the process outlined will assist in achieving efficient radio spectrum usage and promote effective competition in the communications sector.

Paragraph 2.1.1 of the draft policy direction highlights the need for sharing the limited radio spectrum. The first step was to assign the 800 MHz radio spectrum on an open access basis, which should ensure access by multiple electronic communications licensees to high demand radio spectrum (RSA, 2011).

A market-based approach in the form of auctions can be considered as the last resort to license high demand spectrum. To facilitate the introduction of competition in the electronic communications sector, radio spectrum will be set aside for new entrants (RSA, 2011).

The draft policy further directs the regulator to conduct an inquiry on the possible use of white space technologies (RSA, 2011). The policy pronouncement in the draft policy directions made further strides towards radio spectrum reforms.

4.2.5. National Integrated ICT Policy Review Report

The Policy review panel of experts in March 2015 produced a report to the minister with a number of policy recommendations. The report made a number of recommendations, on various issues such as open access approach, infrastructure sharing, universal access to broadband services, market structure and competition and radio spectrum management.

a) Open Access systems and infrastructure sharing

The report noted that access to critical and essential infrastructure is of vital importance in achieving South Africa Connect policy objectives of universal and access broadband services for all by 2030. It further pointed out that there are a number of bottlenecks that exist in the electronic communications sector that negatively affect market competition, consequently limiting broadband services diffusion more than in its peer countries (DTPS, 2015).

The report, based on the issues noted, makes a number of policy recommendations which are needed to promote an access regime. This is followed by a clear access regime that is enforceable and that supports the reduction of universal access gap, creation of uniform access based on service and technology neutrality (DTPS, 2015, p. 36). The report further makes policy recommendations that call for an open access regime supported by the regulator. This is expected to affect access to the infrastructure, transparent services and access in a non-discriminatory manner (DTPS, 2015). The policy recommendations stated in the report take cognisance that radio spectrum is a scarce, natural resource that must be used effectively to ensure maximum benefits.

The report also explains the principle of infrastructure sharing as a way of promoting effective competition, avoiding duplication of infrastructure, and giving a reduction of cost of services in order to realize universal access of broadband services. The report recognizes the vertically integrated incumbents that continue to practice anticompetitive behaviour (DTPS, 2015).

The panel recommendation that infrastructure sharing must be regulated at all levels of the network supported a thorough market analysis into the behaviour of the dominant operators (DTPS, 2015). The report further makes a recommendation that encourages sharing of active electronic elements of the network or national roaming based on market competition analysis (DTPS, 2015). The policy recommendations recognise that the rigid way of assigning radio spectrum is the command-and-control approach. In this approach other radio spectrum reforms are supported, which results in the sharing of Radio Access Network (RAN) (DTPS, 2015).

b) Universal access and service

The report makes policy recommendations that state that there is a need to expand the current definition of universal service access, which is limited around availability, affordability, and accessibility. The expansion should include awareness and ability to ensure that users are empowered to realize the opportunities and benefits presented by electronic communications services. The panel notes what the National Broadband Policy states on Universal Service Access Fund (USAF) includes new innovative ways to fund infrastructure roll-out. The funding model recommends the need to share investment risk between the public and private sectors (DTPS, 2015, p. 42).

c) Market structure and competition

The report highlights the importance of reviewing the market structure to support the introduction of effective competition in order to achieve the policy outcomes as envisaged in the NDP and South Africa Connect (DTPS, 2015). The recommendations seem to support mergers and acquisitions; the report indicates that this is an innovative way for players in the electronic communication sector to access the radio spectrum (DTPS, 2015).

d) Radio spectrum management

The report states that market-based approaches ensure that the radio spectrum is placed in the hands of users who value it the most. This will realise efficiency in radio spectrum usage (DTPS, 2015). The report further highlights the pros and cons of market-based approaches. It states that market-based approaches such as auctions can deliver the best revenue for governments. It however, has the potential of favouring players with substantial resources (DTPS, 2015). For achievement of policy objectives, the report proposes the need to set aside some radio spectrum for small players.

The report makes recommendations for assigning radio spectrum using a hybrid model approach, which combines elements of traditional method of command-and-control, market approaches, and radio spectrum commons (DTPS, 2015). In general, the policy recommendations support the introductions of radio spectrum reforms to ensure efficiency in radio spectrum.

4.2.6. Electronic Communication Act, No 36 of 2005

The Electronic Communications Act is the primary legislation that governs the radio spectrum in South Africa. Section 2 in Chapter 1 outlines some of the primary objectives of the Act as to facilitate convergence in the electronic communications sector, technologically neutral licensing framework, ensure efficiency in radio spectrum, promote competition and promote open, fair and non-discriminatory access telecommunication networks and etc. (RSA, 2005).

It is clear from the objectives of the Electronic Communications Act that there is a correlation between the governing and licensing of the radio spectrum and competition which will result in affordable universal access to electronic communication services.

Chapter 2 in section 3 empowers the minister to make policies on matters of national policy applicable to the ICT sector in relation to the radio spectrum. Section 4 states that ICASA should make regulations in relation to the control and the use of the radio spectrum and licensing thereof (RSA, 2005). This provision implies that the legislation supports a centralized radio spectrum management approach. The system still has some elements of command-and-control with a bit of flexibility in the usage of radio spectrum through the doctrine of service-technology neutrality and interoperability as a result of the usage of common standards (RSA, 2005).

In section 6, the regulator is empowered to develop regulations which permit licence exemption for radio spectrum. This implies that operators can use the radio spectrum without having a license (RSA, 2005). This provision of the legislation paves the way for some elements of radio spectrum reforms with the combination of centralised radio spectrum management regime.

Section 30 of Chapter 5 states that the regulator controls, plans, administers, and manages the use and licensing of the radio spectrum. However, the minister has a role to play through the approval of the national radio frequency plan. The minister also

represents the country in the ITU (RSA, 2005). Section 30 further supports the centralized management of radio spectrum, where the regulation of radio spectrum management is again entrenched in command-and-control (RSA, 2005).

Section 31 (2a) provides that “a radio spectrum license may not be assigned, ceded or in any way transferred to any other person without the prior written permission from the regulator (RSA, 2005). This aspect supports a centralized regime of radio spectrum, which is favoured by the national radio spectrum policy of 2010. The Act, through section 31 (3a) and (3b), empowers the regulator to prescribe regulations to cater for situations where demand of radio spectrum exceeds supply. It further prescribes for a situation where there is a need to amend, transfer, renew, suspend, cancel and withdraw the radio spectrum licenses and permission to assign (RSA, 2005). To change a radio spectrum licence, the licence holder will have to get approval from the regulator. This provision of the legislation entrenches command-and-control.

4.2.7. Independent Communications Authority Act of South Africa Act

The main aim of the ICASA Act is to establish the electronic communications regulator. Section 4(c) of the Act empowers the regulator to control, plan, administer and manage the use and licensing of the radio spectrum (RSA, 2000). Section 4(e) grant the power to the regulator to issue, grant, renew, amend, transfer, and revoke radio spectrum licenses. These provisions of the Act which grant ICASA the power to control the radio spectrum seem to entrench the notion of centralised governance of the radio spectrum.

4.2 ICASA’S REGULATORY FRAMEWORK

4.3.1. Radio Frequency Regulations

ICASA published the radio spectrum regulations in 2011. The purpose of the regulations among other things was to establish a framework for the regulator to allocate and assign radio spectrum. The framework further presents standards and procedures applicable to all radio spectrum bands with the aim of allowing flexibility. The radio regulations provide procedures and criteria for awarding radio spectrum licences for competing applications. This should assist where there is insufficient radio spectrum (ICASA, 2011b, p. 9). The 2011 radio spectrum regulations embrace flexibility in management of radio spectrum in that it introduces some elements of radio spectrum reforms. Radio spectrum reforms are flexible in relation to processes and procedures for radio spectrum licenses.

Section 7 of the regulations provides that the regulator must always prepare an ITA when radio spectrum will be awarded on competitive basis (ICASA, 2011, p. 12). This section supports the provision of the ECA given in section 31 (3). The section further provides that the regulations should be prescribed to cater for situations where demand of radio spectrum exceeds available radio spectrum.

Section 10 outlines the procedure of transferring a radio spectrum licence, where the regulator is fully involved in the transfer process. This section even though it supports

some form of radio spectrum reform has elements of command-and-control in it. Paragraph 1 of section 10 states that the regulator should approve the transfer of a spectrum licence, licensees has no authority to transfer a license to another party without approval of the regulator (ICASA, 2011b).

Paragraph 2 provides that where the radio spectrum has been granted through a market-based approach such as an auction, the amount to be paid by the transferor must not exceed the value paid by the original licence holder (ICASA, 2011b, p. 15). This paragraph defeats the whole intention of market-based approaches of treating radio spectrum as a commodity and the theory of auction which is explained in (Sokol, 2014).

Through adoption of self-coordination and radio spectrum sharing, the 2011 radio regulations continue to embrace radio spectrum reforms and promote flexibility in radio spectrum management. Section 13 of the regulations states that radio spectrum licensees must agree among themselves on how to undertake coordination (ICASA, 2011b). Section 16 states that the regulator may require a licensee to share an assigned radio spectrum with other licensees and applicants may apply for the radio spectrum on a shared basis (ICASA, 2011b, p. 19).

4.3.2. The 800 MHZ AND 2.6 GHz draft Spectrum Assignment Plan for 800 MHz and 2.6 GHz bands

In December 2011 ICASA issued a draft radio spectrum assignment Plan to provide a framework for the combined assignment and licensing of 800 MHz and 2.6 GHZ bands. The assignment Plan was aimed at deriving economic and societal benefits characterized by coverage and capacity. The inclusion of the complementary bands ensures the effective use of the radio spectrum (ICASA, 2011a, p. 3).

The motivation for the framework was to further enable government policy objective of making affordable broadband services available to South Africans as contemplated in the 2010 Broadband Wireless Access (ICASA, 2010c). The assignment plan contemplated that the 2030 vision of achieving universal and affordable broadband services can be realized through roll-out of mobile infrastructure (ICASA, 2011a). It was the regulator's view that the combinational award or licensing of the bands 800 MHZ and 2.6 GHZ will surely bridge the digital divide.

The framework in the licensing philosophy introduced a number of radio spectrum reforms. The intention is to allow many entities to access radio spectrum. Through consideration of the introduction of "Wholesale Open Access model explained as a sharing model where a licensed entity allows other entities to offer services using its network with no locking and blocking". This will be achieved through agreed procedures, with the aim of encouraging efficient use of the radio spectrum (ICASA, 2011a, pp. 4-5).

4.3.3. International Mobile Telecommunications Roadmap

The regulator published the IMT roadmap in 2014 which identified the frequency bands to be used for deploying wireless broadband services in South Africa as shown in Table 3. The roadmap also timelines the deployment of IMT radio spectrum to support the

targets set by South Africa Connect in order to ensure universal access to broadband services by 2030 (ICASA, 2014b).

The document states that the primary objective of the regulator is to “ensure radio spectrum efficiency, universal availability of broadband services as well as a vibrant and competitive telecommunications industry while promoting investments” (ICASA, 2014b, p. 12). The IMT roadmap highlights the critical role spectrum assignment plays in effective competition of the electronic communication sector that will ensure universal access to wireless broadband services.

The IMT roadmap continues to support spectrum reforms, where it states that the award for high demand radio spectrum will be through an ITA, which will outline the process of assigning spectrum which may include market-based approaches (ICASA, 2014b).

Through IMT roadmap can be viewed as another form of regulatory certainty to promote market liberalisation through increasing access to radio spectrum.

4.3.4. Discussion document regarding the use and licensing of the frequency bands 57-66 GHz (V Band) and 71 -76 GHz paired with 81-86 GHz band.

In September 2015, ICASA published a discussion document on the licensing of V and E bands consisting of frequency ranges 57- 66 GHz (V Band) and 71-76 GHz with 81-86 GHz (E Band). These bands are useful for short links providing high data transmission rates. The regulator believes that these bands will be useful for future deployment of 4G/LTE architectures (ICASA, 2015a). In the discussion document, ICASA is considering the use of four possible approaches in regulating the use of V and E bands:

- A self-coordination approach (coordination done by the user);
- A regulator-coordinated approach;
- And a regulator-coordinated with fixed channel assignments and a license-exempt approach (ICASA, 2015a, pp. 18-19).

The consideration of these regulatory approaches by the regulator is a sign of awareness and appreciation for flexible radio spectrum management regime. This is further a move towards radio spectrum reforms.

4.3.5. Discussion Document on Framework for Dynamic and Opportunistic Spectrum Management

ICASA issued a discussion document that presents a framework for Dynamic and opportunistic radio spectrum management in October 2015. The framework gives effect to policy options as envisaged in South Africa Connect to enable dynamic radio spectrum allocation. It achieves this through the development of a regulatory framework that will enable dynamic spectrum assignment to promote efficiency in spectrum usage (ICASA, 2015b).

The discussion document promotes the principle of radio spectrum sharing, where broadband services will be allowed to share the 470 - 694 MHz radio spectrum with the incumbent broadcasting services. The proposed radio spectrum reform will make 168 MHz of radio spectrum available for provision of broadband wireless services through dynamic spectrum access in the TV White Spaces enabled by geo-location databases (ICASA, 2015b, p. 6).

The discussion paper highlights some shortcomings of exclusive allocation of radio spectrum to services. This results in the underutilisation of radio spectrum, which is currently in high demand for the realisation of South Africa Connect objectives that aim to ensure universal and affordable broadband services by 2030 ((ICASA, 2015b).

In section 5, the discussion paper further emphasizes the adoption and implementation of radio spectrum reforms ushered in by policy and legislation. It provides for the implementation of service and technology-neutral flexible licensing regime, which should foster a flexible use of resources. It concede that service and technology-neutrality is more vital considering that more radio spectrum should be made available urgently for next generation services (DoC, 2013) & (RSA, 2005) .It further states the importance of flexible radio spectrum management as a necessity to unlock industry developments and advancements. Moreover, it is necessary in facilitating the rolling out of broadband infrastructure with the sole intention of achieving broadband coverage (ICASA, 2015b).

The ICASA discussion document lists the following licensing models: License-exempt, unmanaged; license-exempt, managed; light-licensed; fully licensed and a mixture of models as potential licensing regimes for dynamic spectrum access (ICASA, 2015b, p. 29). Both the regulator and operators in the dynamic spectrum mechanism have roles to play in radio spectrum management. The dynamic spectrum regime provides users with incentives which will foster innovation in providing services. While they are presenting flexibility in radio spectrum management, they further require a well-resourced regulator with the technological means to enforce the rules (ICASA, 2015b).

The discussion document acknowledges how important it is to adopt flexible regulatory interventions to foster competition to ensure harmonisation of local regulation with global regulatory arrangements, and to promote technological innovation for sector advancement (ICASA, 2015b). Quality of services as an important component of electronic communications regulations is also not overlooked in the dynamic spectrum licensing mechanism.

4.3.6. National Radio Frequency Plan 2013 (8.3 GHz – 3000 GHz)

In 2013, ICASA published the National Radio Frequency Plan as required by the ECA. The published Plan formalises the requirement as expected in the law to provide the regulatory framework for allocation of the radio spectrum to services in the radio spectrum bands between 8.3 kHz and 3000 GHz for South Africa (ICASA, 2013b). Similar to plans of other countries that are part of the ITU, the South African National band plan incorporates the decisions of the ITU discussions (ICASA, 2013b). This implies the

decisions taken at the World Radiocommunications Conferences (WARC-92, WRC-1995, WRC-1997, WRC-2000, WRC-2003, WRC-2007, WRC-2012, WRC-15, and more to come) are taken into account for the planning of the radio spectrum. The South African Plan adopted the global harmonization regime of allocating radio spectrum for radiocommunications services. The harmonised allocation regime is covered in chapter three of the National Radio Frequency Plan. The chapter outlines all the frequency allocations for all radiocommunications services including applications as depicted in Table 3. The Plan mirrors the frequency allocation table of the ITU as contained in Article 5 of the 2012 ITU Radio Regulations as depicted in the Table 4.

Table 3: South African National Radio Spectrum Frequency Allocations

ITU Region 1 allocations and footnotes	South African allocations and footnotes	Typical Applications	Comments
790-862 MHz FIXED MOBILE except aeronautical mobile 5.316B 5.317A BROADCASTING 5.312 5.314 5.315 5.316 5.316A 5.319	**790-862 MHz** FIXED MOBILE except aeronautical mobile 5.316B 5.317A NF9 BROADCASTING 5.316A	Fixed Links (856 – 864.1 MHz) IMT800 BTX (791 – 821 MHz) Mobile Wireless Access (827.775 – 832.695 MHz) IMT800 MTX (832 – 862 MHz) Television Broadcasting (470 – 854 MHz)	The fixed links will be migrated along with the broadcasting service in line with Radio Frequency Migration Plan. Paired with 832 – 862 MHz Paired with Access (872.775 – 877.695 MHz Paired with 791 – 821 MHz Broadcasting Allotments in accordance with GE89 plan in the process of conversion to GE06. Broadcast assignments in accordance with the latest version of the Terrestrial Broadcasting Frequency

Source: ICASA, 2013b, p. 75

As shown in Table 3 the concept of sharing radio spectrum is embraced in the management and planning of the radio spectrum, bands such as 790-862 MHz are allocated to both fixed and mobile services on a primary basis by the regulator. This implies that both these radiocommunications services can use the band. Column 3 of the table further indicates the applications that are typically using the bands which are IMT, television broadcasting, fixed links and mobile wireless access. The plan encompasses command-and-control and radio spectrum sharing in that it states that

radiocommunications services allocated to a particular frequency range. An example is the 790-862 MHz band allocated to fixed, mobile except aeronautical mobile secondary basis and broadcasting services on a primary basis. However, the national radio frequency plan does support the development and evolution of technologies and services. For example the plan states that “the pattern of radio use is not static as it is continuously evolving to reflect the many changes that are taking place in the radio environment; particularly in the field of technology”. Therefore the plan is subject to continuous reviews to reflect these changes (ICASA, 2013b, p. 2). Through the allocation of 800 MHz and 700 MHz (470-790 MHz and 790-862 MHz) radio spectrum for IMT, the frequency band for many decades was planned for broadcasting services (ICASA, 2013b). It shows the move of ICASA in embracing radio spectrum reforms in a form of radio spectrum sharing. National Band Plan may be viewed as regulation in a form of radio spectrum reform that provide certainty in the market to allow for further market liberalisation.

4.3.7. Radio spectrum fees regulations

In 2010, the regulator published the radio spectrum fees regulations. The main objectives of the regulations amongst other things is to provide a pricing fee framework for radio spectrum fee that is fair, transparent, competitive and non-discriminatory. This is based on an administrative incentive pricing (a market-based approach). This does not preclude auctions, but rather encourages efficiency and effective usage of radio spectrum as well as promote competition through the simplification of spectrum fees process (ICASA, 2010e). The regulations provide a formula/guideline to be used in calculating the radio spectrum fees taking into consideration the following factors: the frequency band, congestion, coverage, geographical area of the operation amongst others. They further state the minimum fee per MHz paired is two thousand rands (ICASA, 2010e).

4.3 INTERNATIONAL REGULATIONS

In 2010, the regulator published the radio spectrum fees regulations. The main objectives of the regulations amongst other things is to provide a pricing fee framework for radio spectrum fee that is fair, transparent, competitive and non-discriminatory. This is based on an administrative incentive pricing (a market-based approach). This does not preclude auctions, but rather encourages efficiency and effective usage of radio spectrum as well as promote competition through the simplification of spectrum fees process (ICASA, 2010e). The regulations provide a formula/guideline to be used in calculating the radio spectrum fees taking into consideration the following factors: the frequency band, congestion, coverage, geographical area of the operation amongst others. They further state the minimum fee per MHz paired is two thousand rands (ICASA, 2010e).

Table 4: ITU-R -Table of Frequency Allocation for frequency range 14-15.4 GHz

Allocation to services		
Region 1	**Region 2**	**Region 3**
14.5-14.75 FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 ADD 5.A16 ADD 5.B16 ADD 5.D16 ADD 5.E16 ADD 5.F16 MOBILE Space research ADD 5.C16		
14.75-14.8 FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 MOBILE Space research ADD 5.C16		**14.75-14.8** FIXED FIXED-SATELLITE (Earth-to-space) MOD 5.510 ADD 5.A16 ADD 5.B16 ADD 5.D16 ADD 5.E16 ADD 5.F16 MOBILE Space research ADD 5.C16

Source: ITU, 2012b

4.4 INDUSTRY PERSPECTIVES

This subsection presents the stakeholder's views collected through interviews. The questions looked at getting the stakeholders' views on what policy and regulations have supported market liberalisation.

Stakeholders' views will be delivered through employment of themes approach in mind. The theme approach led to the construction of the following themes:

- radio spectrum governing regimes to achieve universal broadband,
- market structure and competition, effective regulatory approach for efficient radio spectrum management regulatory for rural connectivity,
- interventions for affordable roll-out broadband in rural areas.

The stakeholder's views will be presented through these themes.

4.5.1. Radio spectrum governing approach to achieve universal broadband service

It was a general feeling of the most respondents that South Africa requires a flexible not restrictive radio spectrum regulatory regime to achieve the policy goals of universal access and service for all**.**

Policy Maker (23/01/2016) stated that the main objective of SA Connect is increased broadband penetration. It stipulates that we need to have ubiquitous coverage of high-speed, high quality services, affordable services, and le devices. This requires that an appropriate suite of applications be developed and side interventions to increase awareness of ICT usage be demanded. With this background, it is important that the government accelerate the adoption of radio spectrum reform with regards to regulatory regime (Policy Maker 23/01/2016). A gradual simplification and liberalisation of the regulatory regime is important (ibid). In the case of radio spectrum, these include market-based competition for spectrum, license fee level, and structure based on opportunity cost, secondary trading rules and etc. (Policy Maker, 23/01/2016). International best practice shows that market-based approaches can be relied upon to solve the challenges of spectrum licensing (Policy Maker 23/01/2016).

Operator-A (24/04/2015) stated that the adoption of mixed radio spectrum management approaches is appropriate for achieving a universal service of broadband services as articulated in SA Connect market-based approaches for high demand spectrum, administrative approach supported by open access principles for rural connectivity and the consideration of spectrum commons and licence exemption. So the mixture of three approaches will be suitable (ibid).

Operator-C (26/05/2015) was of the view that a hybrid approach should be considered, especially when the regulator adopts market-based approaches such as auctions. This is for urban areas as competition is limited and for rural areas because there is hardly any competition. The regulator may then impose conditions such as open access. Operator-A and Expert-D are of the view that there is no clear definition of open access in policy and regulation. There is a need for clearly defined open access in policy and regulation for it to be effective (Operator-A, 24/04/2015 and Expert-D, 26/05/2015).

Expert-C (21/04/2015) suggested that the regime also needs to be supported by clear policies with objectives and regulations with technical specifications and standards such as transmission powers for technologies. The regulator should also try to include performance indicators for operators (Expert-C, 21/04/2015) and (Expert-E, 28/05/2015).

Command-and-control approach should continue with the continuous issues of interference that needs solutions. Command-and control can ensure an acceptable level of quality of service amongst other things for effective spectrum management (Researcher, 29/04/2015) and (Operator-A, 24/04/2015). However there is also a need to introduce market based approaches such as auctions to further enhance spectrum efficiency, promote competition and enable innovation for the market (Operator A, 24/04/2015).

Spectrum commons should be considered as a spectrum reform approach that is still developing, with only a few countries in the developed world having employed it (ibid). Currently ICASA's regulations allow sharing for passive infrastructure supported by sections (31) and (32) of the ECA which give effect to sharing regulation. However, these regulations can be improved through the introduction of deeper sharing such as spectrum pooling to allow more flexibility (Operator-D, 26/05/2015).

Considering the TV white space radio spectrum and dynamic access of radio spectrum, the command-and-control approach as a governing regime for radio spectrum should be reconsidered (Researcher, 29/04/2015). A flexible governing regime that covers market-based approaches and open access should be considered for the radio spectrum governing regime (Expert-B, 24/04/2015) and (Researcher, 29/04/2015).

Regulator (22/05/2015) stated that for the purposes of ensuring effective competition, a license exempt spectrum assignment approach will increase the number of electronic communication operators in the market. That will promote competition in mobile industry for provision of broadband services. The assignment of spectrum to a single provider on an exclusive basis is not an efficient way of assigning spectrum, as spectrum is scarce natural resource (ibid). In addition to the license exempt model, operators with national spectrum licences should be obliged to open their infrastructure on an open, fair and neutral wholesale access basis. Another spectrum assignment should be considered to increase the number of operators in the market and for the purposes of achieving universal access dynamic spectrum assignment should also be adopted (Regulator, 22/05/2015).

Vendor mentioned that ICASA never bothered to proactively participate in ensuring that the playing fields are level (Vendor, 18/05/2015). They still employ the first-come-first-serve approach (ibid). For example, two years ago MTN tried to get 5 MHz in the 2 GHz bands, there was no invitation to apply and no process was outlined to get that available spectrum. South Africa is a highly competitive market, implying that the spectrum cannot be licensed on a first-come-first-served (Vendor, 18/05/2015). First-come-first-served is not a competitive way of licensing spectrum; ICASA should not reconsider employing first-come-first-served but rather employ pro-competitive approaches (ibid).

Expert-F mentioned that South Africa is currently employing governing regimes which are outdated, even though ICASA is currently looking at modernising spectrum management regime (Expert-F, 28/04/2015). Command-and-control approach is still relevant to ensure quality of service and the licence exempt regime given the success of Wi-Fi is another option which can be considered to improve and expand the spectrum governing regime (Expert-F, 28/04/2015).

Expert-D is of the view that the South African market is not yet matured, therefore traditional approaches of command-and-control and reforms be introduced in a phased approach (Expert-D,26/05/2015). South Africa may have to address competition challenges before introducing advanced radio spectrum reforms (ibid). Market approaches such as spectrum trading and auctions won't be for South Africa, since the market is dominated by two operators, Vodacom and MTN, who will obviously be the beneficiary of auctions and spectrum trading (Expert-D, 26/05/2015).

Expert-E stated that on high demand spectrum the focus should be given on the objectives of the auction approach, which is not making money for treasury, but rather focuses on awarding spectrum to the bidder who will use spectrum efficiently. Contrarily, in the case of non-high demand spectrum, administrative process to award licences should be applied (Expert-E, 28/04/2015). If auctions are employed to award spectrum, there should be conditions with the license, which is that the spectrum awarded should

not cause interference (ibid). Policy objectives should not be at the cost of the spectrum but principles such as resale should be considered as they offer more incentives through secondary market (ibid).

Expert-E advocates for a mixed approach, where command-and-control is identified as appropriate for non-high demand radio spectrum, while auctions seem appropriate for high demand spectrum. Furthermore, interference conditions should be attached to this approach, where the cost of the conditions should not be higher than the money to be paid for the spectrum (Expert-E, 28/04/2015).

Researcher (29/05/2015) pointed out that ICASA might have a challenge in jumping from command-and-control, because of the successes that are associated with the approach, such as the assurance of no harmful interference and of acceptable levels of service quality. However, the approach fails in assuring radio spectrum efficiency and lacks standards that ensure that there is differentiation between a primary user and secondary user.

Even if ICASA considers adopting dynamic spectrum access, the reform can't be a standalone method of accessing spectrum. However, it can be complementary to other spectrum reforms in the spectrum management regime to ensure efficiency, to allow secondary users in the bands to address issues of spectrum scarcity (Researcher, 29/05/2015). A combination of a market-based approach and dynamic access ensures efficiency; this seems like a probable approach since dynamic access is the mechanism to access spectrum but not for assignment through promotion of secondary market (ibid).

Expert-E (28/04/2015) is of the view that elements of spectrum sharing are encapsulated in dynamic spectrum assignment. In the case of unused spectrum, this approach is not ideal for providing quality broadband services. Spectrum management through dynamic access is not justified yet; rather ICASA should focus on the bands where there is primary allocation for monitoring purposes in order to ensure quality of services. Secondary users should be subjected to the rules as stipulated in the radio regulation (ibid). Even though command-and-control is still relevant and necessary, more spectrum reforms are still required to ensure competition with the objective of achieving 2030 policy goals of universal access and affordability stated in the NDP and SA Connect (Expert-C 21/05/2015).

Regulator (22/05/2015) commented that spectrum trading as a reform is not favoured due to its unintended consequences. The players can use spectrum trading as a way of discouraging competition through hoarding to ensure that new players are not getting an opportunity to enter the market. Some operators had licensed spectrum but did not roll it out while still paying for it and their intention is to sell the spectrum when the value has increased. For example, WBS had 2.6 GHz spectrum but did not rollout the network and they are now being acquired by another company with that spectrum having added more value to what the company is worth (ibid). Spectrum, when it is licensed, must be used to rollout, but not as a commodity (Regulator, 22/05/15).

Expert-D (26/05/2015) thinks that ICASA is the one standing in the way of infrastructure sharing and radio regulations. Expert-D claims that ICASA left the enforcement of this regulation to the operators; consequently the dominant players have power to mitigate

full realization of competition. Roaming transaction between Cell C and Vodacom is a great example of competition not yielding positive results. Cell C's quality of service is poor, a clear sign that there is no willingness from operators to share infrastructure and spectrum (Expert-D, 26/04/2015) and (Expert-C, 21/04/2015). Therefore, regulations do not encouraging sharing. The introduction of AIP through spectrum license fee regulation has had an effect which resulted in massive increase of point to point usage, which has boosted universal access in rural areas providers through the encouragement of competition (Expert-F, 28/04/2015) and (Operator-D, 26/05/2015).

Operator-D (26/05/2015) mentioned that AIP has worked well as a market-based approach; it had the ability to even out the playing field for all players in the market. For example, MTN was paying more for fees than some of its rivals on 1800 MHz who were paying less. However, ICASA should find a way of making broadcasters pay spectrum fees, and security services must also be charged the same amount rather than be given an 80% discount as suggested by the current regulation. The discount for security services encourages inefficiencies for spectrum management as spectrum hoarding may still be experienced. Further to that, the regulation that unit cost will go up by CPI yearly does not help when it comes to issues of driving the communication costs down. If operators will be charged spectrum fees based on CPI, this will cost them more as it in terms of raising their operational costs (Operator-D, 26/05/2015).

4.5.2. Market structure and competition

Telecommunications market structure in South Africa is oligopolistic in mobile services, with high degree of concentration in infrastructure (BMI-T, 2013, p.77). In terms of hearings conducted by ICASA on the state of competition and the market, the regulator indicated that it is concerned about the intentions of Vodacom and MTN. Their intentions are to acquire 80% of other electronic communications network and services licensees (ICASA, 2014).

Operator-D states that the number of operators does not determine competitiveness in the market (Operator-D, 26/05/2015). What determines market competitiveness is the ability of operators to compete amongst each other. The cost to communicate has been driven down in South Africa for the data market. The market can't sustain more operators since Cell C and Telkom mobile are already struggling to compete with MTN and Vodacom (Operator-D, 26/05/2015).

Operator-B (14/05/2015) is of the view that spectrum regulation certainty is required in relation to mergers and acquisitions. Currently there is a lack of clear rules and principles with the Electronic Communications Act making reference to concepts such as cede, transfer of radio spectrum licence with non-existence of the criteria, guidelines and clear rules from ICASA (ibid). It is important for ICASA to provide a framework on the conditions of approving these transactions (Operator-B, 14/05/2015).

Operator-D states that the number of operators does not determine competitiveness in the market (Operator-D, 26/05/2015). What determines market competitiveness is the ability of operators to compete amongst each other. The cost to communicate has been driven down in South Africa for the data market. The market cannot sustain more

operators since Cell C and Telkom mobile are already struggling to compete with MTN and Vodacom (Operator-D, 26/05/2015).

Operator-A (24/04/2015), Operator-B (14/04/2015) and Policy Maker (23/01/2016) stated that the South African market structure is characterised by four market players; i.e. Vodacom, MTN, Telkom and Cell-C. Two of these operators, MTN and Vodacom, are dominant. The regulator should find ways of strengthening the small players - Cell C and Telkom - by fostering regulations that will ensure these operators are effectively competitive (Operator-A, 24/04/2015). It is also important that government focuses on levelling the playing field to foster meaningful and sustainable competition amongst other objectives such as affordability, universal service, access, and etc. (Policy Maker, 23/01/2016).

Operator-D (26/05/2015) is of the view that number portability and big corporates are giving business to Telkom. Telkom has a de facto monopoly on corporates numbers including toll free numbers. Telkom is the only operator with the 3.5 GHz, which was initially assigned for fixed links to deliver point to point services. However, Telkom is currently using it for mobile services, which put it in a better competitive position. Change to use this particular spectrum did not even follow necessary process, which requires approval from the regulator. Therefore the delay in releasing the 2.6 GHz is a continuously stifling competition (Operator-D, 26/05/2015).

Policy Maker (23/10/2016) claims that a decision on spectrum award does depend critically on whether the policymaker and regulator believe that one or more new wireless entrants are required in the market (which could be either mobile or fixed-wireless access operators). A change to fixed market structure has little relevance to the award of spectrum (ibid). Most mobile markets are best served with three to four players and if the enabling environment has been set correctly, all players would have a sustainable business (Policy Maker 23/01/2016).

Regulator (22/05/2015) is of the view that the current approach does not encourage competition in the four main players (Telkom, MTN, Cell-C and Vodacom). Telkom does not have spectrum below 1 GHz (900 MHz). On the other hand, all the other three do have assignments below 1 GHz; this makes it difficult for Telkom to roll-out in areas where they need to make bigger cells. The spectrum holding by these players is not balanced (ibid).

Market-based approach AIP does not encourage competition but rather, encourages spectrum efficiency (Expert-D, 26/05/2016), (Operator-A, 24/04/2015), (Expert-F, 28/04/2015) and (Regulator, 22/05/2015). MTN and Vodacom are currently dominating the market share despite the AIP (Expert D, 26/05/2015). To address competition challenges, the regulator should license a new operator and give them the entire spectrum and allow it to compete with the existing operators and impose open access (ibid).

It is important for the regulator to assess the objective of providing the market with multiple operators, whether it's in the best interests of providing universal access and broadband services (Expert-A, 12/05/2015). Operator-A (24/04/2015) pointed that there is a problem with competition because lots of operators ranging from mobile operators, Internet

Services Providers (ISPs) including municipalities are competing for a slice of the market. In the case of the urban areas, there is no need for open access while the urban areas are still lagging behind when it comes to infrastructure (ibid).

Vendor (18/05/2015) stated that the current approach of first-come-first-served employed by ICASA does not encourage competition. Expert-B (12/05/2015) stated that proposed transactions of buying each other in the market by the operators may result in stifling competition by limiting the number of the operators in the market. This action has a disadvantage of derailing the 2030 policy objectives for SA Connect Policy. Expert-A (12/05/2015) further mentioned that these proposed transactions may also result in the quickest way of accessing the spectrum, which is in high demand and may result in creating monopolies in the market (Expert-A, 12/05/2015).

South Africa always gets it wrong when it comes to the introduction of competition in the telecommunications sector for both fixed and mobile. The timing of introducing competition is not conducive for South Africa at the network level; there should rather be consideration to introduce competition at the service level. This can be achieved by the introduction of Mobile Virtual Networks (MVNOs), which is another form of ensuring the realization of universal and broadband services (Expert-E, 28/04/2015). The introduction of more competition in rural areas is possibly viable as there is enough competition in urban areas (Expert-E, 28/04/15).

Expert-C (21/04/2015) is of the view that the licensing of high demand in South Africa can possibly lessen the market consolidation pushed by the operators with proper market definition. ICASA's current regulatory approach is capable of ensuring efficient competition as long as there is no interference from policy maker (government). ICASA has tried to published a number of ITAs on how to release radio spectrum, however this has not yielded any success as a result of interference from the government (Expert-B, 24/04/2015).

Efficiency of the licensing of spectrum in terms of the lead time between submission of the application and the actual licensing of spectrum requires an intervention as the current approach by the regulator is disadvantaging the new entrants (Expert-A, 12/04/2015). One reason is that it takes a relatively long period of time to process a license application by the regulator, which to a certain, extent gives the incumbent sufficient time to entrench / close the market. This leaves nothing for the potential competitors (Expert-A, 12/04/2015).

Looking at the previous ITAs published by ICASA it is a clear indication that the regulator is intending to release the spectrum and introduce more players in the market. However, there is a tendency from operators to frustrate the process of releasing spectrum in an attempt to delay competition (Regulator, 22/05/2015).

Expert-F (28/04/2015) pointed out that for access networks there is no competition, implying that the licensing of the high demand spectrum can assist in introducing competition. The TV white space discussion document for licensing of operators will encourage competition. However, there is a need to foster a regulatory approach to encourage competition for point-to-point links and as a result; this delays the release of access spectrum by ICASA (ibid).

All three operators have 900 MHz spectrum except for Telkom. There is a need for Telkom to be assigned the sub 1 GHz spectrum (Operator-A, 24/04/2015). The other problem is that the 800 MHz spectrum will only be available in 2018. This delay will further entrench the dominance of the big players, which can access the 2.6 GHz spectrum (ibid) currently available. Spectrum availability can be used to facilitate competition, with sub 1 GHz radio spectrum having been made available to Telkom (Operator-A, 24/04/2015).

Policy Maker (23/01/2016) stated that as much as spectrum is not the only lever that can be used to correct the imbalance, it is important that we do not repeat the mistakes of the past. African countries, with the exception of a few, have been reluctant to do a paradigm shift from traditional to market-based mechanisms in spectrum licensing (ibid). For instance, auctions have proven to be the best methodology to license spectrum, and they can address government objectives if designed correctly. They can also cater for new entrants with set-asides and reasonable reserve prices for spectrum lots or blocks (Policy Maker, 23/01/2016).

Expert-A (12/04/2015) claimed that ICASA's regulatory framework is unclear, limited, and with no proper road map articulated. This move by ICASA further entrenches the dominance of the incumbents.

ICASA’s current regulatory approach for high demand spectrum and non-high demand spectrum as proposed in 2011 is capable of ensuring that there is sufficient competition for as long as there is no interference from government (Expert-B 24/04/2015). ICASA has tried to publish a number of ITAs on high demand spectrum that has the potential of facilitating competition (ibid). The conditions put on the 2.6 GHz band for BEEE in 2011 prohibited true competition for MTN and Vodacom, however competition is not about number of players but more about the effectiveness of players in the market (Expert-D, 26/05/2015). It is this view that ICASA regulations must talk to policy but not go against itICASA’s current regulatory approach for high demand spectrum and non-high demand spectrum as proposed in 2011 is capable of ensuring that there is sufficient competition for as long as there is no interference from government (Expert-B 24/04/2015). ICASA has tried to publish a number of ITAs on high demand spectrum that has the potential of facilitating competition (ibid). The conditions put on the 2.6 GHz band for BEEE in 2011 prohibited true competition for MTN and Vodacom, however competition is not about number of players but more about the effectiveness of players in the market (Expert-D, 26/05/2015). It is this view that ICASA regulations must talk to policy but not go against it.

Proper market review governance and first mover advantage by Vodacom and MTN makes it difficult for Cell C to compete effectively in the market. This requires the Competition Commission and ICASA to constantly perform market reviews and develop informed regulatory intervention to address competition challenges in the market (Expert-C, 21/04/2015) and (Expert-A, 12/05/2015). Cell C does not have enough spectrum in the high demand band (1800 MHz) currently having high volume of dropped calls, which is a negative factor for an operator to compete effectively in the market (ibid). Therefore, Cell C will need more radio spectrum to meet the targets set out in SA Connect (Expert C 21/04/2015).

Expert-E (28/04/2015) thinks that under normal conditions the market's maturity and price wars between operators will lead to mergers and acquisitions. This calls for South Africa to look at developments of markets worldwide. It will assist the South African market if ICASA focuses on the pro-competitive conditions to give effect to mergers and acquisitions. For example, ICASA should be looking at the wholesale market with the focus of developing pro-competitive conditions for that market. For example, South Africa's MVNOs have actually suffered as a result of nonexistence of a wholesale market (ibid).

Access to spectrum has nothing to do with end-user affordability. Rather, facilitation of competition through radio spectrum licensing is the solution to address issues of affordability (Expert-D, 26/05/2015). Matured market has mastered the art of fostering competition where their level of substitutability is very high. In the case of South Africa, the level of substitutability is low and the possibility of substitutability is what is required for SA market to attain efficient competition (ibid).

Re-farming and consolidations are currently the only alternative to the 900 MHz and 1800 MHz spectrum for LTE, a strategy which might not even be sustainable in the long run. The majority of South African subscribers are still using 2G services, where more than 70% of MTN's traffic still caters to 2G services. This will eventually cause 2G customers to suffer in the end, hence the urgency to release high demand spectrum.

4.5.3. Regulatory Interventions for rural connectivity

To try and address issues relating to rural connectivity, South Africa may consider multiband auctions or spectrum awards with any licensing methodology with coverage obligations (Policy Maker, Operator-A, Operator-B, Vendor, Expert-B, Expert-D, Expert-A and Operator-C). In May 2010, Germany concluded a spectrum auction across four bands: 800 MHz, 1800 MHz, 2100 MHz and 2.5 GHz. A total of 360 MHz was on offer at this auction (ibid). To ensure rural coverage, BNetzA, the regulator imposed a coverage obligation on each of the three offered 800 MHz licences (Policy Maker, Operator-A, Operator-B, Vendor, Expert-B, and Expert-D).

However, Expert-B (24/04/2015) is of the view that the regulator should not insist that everyone go to the rural areas before rolling out in urban areas. The requirement should not be to start in the rural areas so that there is no force for everyone to roll-out in the same rural areas. The operators can decide among themselves who will roll-out the infrastructure to each of the least served areas and provide open access before they may roll out in urban areas (Expert-B, 24/04/2015).

However, Expert-B (24/04/2015) is of the view that the regulator should not insist that everyone go to the rural areas before rolling out in urban areas. The requirement should not be to start in the rural areas so that there is no force for everyone to roll-out in the same rural areas. The operators can decide among themselves who will roll-out the infrastructure to each of the least served areas and provide open access before they may roll out in urban areas (Expert-B, 24/04/2015).

There is no one size fit all solution for South Africa. All metropolitan areas of South Africa have sufficient competition and there is high demand of services. This results in high spectrum density, which implies the need for additional spectrum in order to address the problem. While in rural areas there is no infrastructure and the demand for services is also low. Therefore, the problem in rural areas is not spectrum but the viability of models in the rural areas to ensure access to services. The proposed solution is for the state to subsidize the roll-out of infrastructure in rural areas (Expert-D, 26/05/2015).

Alternatively, proper definition in policy and regulations for open access can assist in increasing universal access and service in rural areas, through the creation of NBN which is funded by universal service fund (USAF) and government (Expert-D, 26/05/2015). Rural connectivity can be realized through the usage of policy levers where government can impose open access principles. Furthermore, the government can put conditions for high demand spectrum and use the universal access service fund to subsidise the infrastructure to be rolled-out in the rural areas (Expert-E, 28/04/2015), (Expert-B, 24/04/2015), (Operator-B, 14/05/2015), (Operator-D, 26/05/2015) and (Operator-C, 26/05/2015).

A clear incentive framework has to be developed by both ICASA and policy makers in order to provide applicants with an opportunity to roll-out infrastructure in rural areas (Expert-B, 24/04/2015). The framework should not have too many restrictions and should at least include those environmental issues which will be negotiated by the regulator. These are alternative ways of accelerating rural deployment of broadband (ibid).

The Policy Maker suggested that other regulatory interventions such as Radio Access Network (RAN) sharing and national roaming be enforced as conditions of auctions like it happened in countries such as Colombia and Czech Republic (Policy Marker, 23/01/2016). Operator-E (28/04/2015) and Operator-A (24/04/2015) are also of the view that there should also be consideration of Public Private Partnerships where both the government and private sector can be innovative co-builders of the infrastructure in rural areas.

Expert-E (28/04/2015) suggested that the mixture of approaches can benefit the country with operators using their money to roll out infrastructure. Operators should use their own resources to roll-out in the rural areas and be innovative with new techniques that allow spectrum sharing through wholesale approach and open access model (ibid). Policy Maker (21/01/2016) is of the view that for the government to meet SA Connect targets, there is a need for ICASA to address rapid deployment guidelines and speed up the licensing of IMT frequency bands that have a better ecosystem. The example is the case of 1800 MHz, now the remaining bands are the 700 MHz and 800 MHz that are essential for the coverage of the marginalised areas and in-building penetration.

For rural connectivity spectrum, sharing through embracing the Wi-Fi approach has the potential of alleviating challenges facing rural connectivity, the same applies to new techniques through the usage of TV white spaces (Expert-B,24/04/2015). Researcher (29/04/15) is of the view that dynamic spectrum access can be used as a solution for broadband access in rural areas as opposed to urban areas. This is because there is

more demand of broadband services in urban than in rural areas, therefore there is a need for capacity needed to increase in urban areas through assignment of spectrum to operators to ensure quality of services.

Operator-D (26/05/2015) is of the view that MVNOs represents open access on a non-discriminatory basis. Therefore, there is no need for South Africa to reinvent the wheel through the development of policy for open access. South Africa should consider adopting the French model of open access through non-discriminatory access to the incumbent networks.

There was overwhelming view from the respondents that lack of spectrum is stifling competition. Operators are unable to switch off the legacy technologies since the majority of South Africans are still using 2G services. Therefore, operators are held back from introducing new technologies such as LTE as a result of lack of spectrum. Operator-D (26/05/2015) suggests light touch regulation to enable competition and the sector to growth.

4.5.4. Interventions for effective regulation

Capable technical personnel with proper remuneration to attract relevant people who will be able to perform technical work will be an intervention that might be able to help ICASA to develop effective regulation. This is because at the moment the regulator do not have proper personnel (Expert-B, 14/05/2015).

Policy Maker was of the view that ICASA regulates broadcasting, electronic communications and postal services (Policy Maker, 23/01/2016).ICASA has a constitutional mandate in broadcasting but its role in electronic communications and broadband in particular is governed by legislation. Specifically, it has a mandate to provide further direction on universal service and services for schools, and promote competition (ibid).

In a liberalised market, ICASA needs to exercise its mandate especially in relation to spectrum licensing (Policy Maker, 23/01/2016). This must be done within the context of a modern spectrum policy framework (ibid). The question is ‘what is that modern spectrum policy framework?’ In most markets, this framework is government's intention to direct the regulator to rely on market forces to the extent feasible under the ECA. Also, to regulate radio spectrum in a manner that allows market forces to the minimum extent necessary (Policy Maker, 23/01/2016).

Minimum interventions through government policy imply that ICASA will not have a burden to regulate everything given that technology is changing rapidly (Policy Maker 23/01/2016 and Expert-B, 24/04/2015). But government still has the responsibility to ensure that as South Africa strives for an effective spectrum policy and management, that shift should continue to serve the social and economic interests of all (Expert-D, 26/05/2015).

Policy Maker stated that the effective regulation of markets in Europe, America, Canada and Asia has shifted the focus to addressing the following issues: the application of

economic incentives and market forces in spectrum management, facilitating the use of spectrum, roll-out license conditions, advances in technology, facilitating electronic communications in rural and remote areas and public safety (Policy Maker, 23/01/2016).

To ensure effective regulation for radio spectrum, property rights should not be allowed in ICASA's regulation because that will be incompatible with efficient spectrum use. Rather, it encourages spectrum hoarding because a spectrum licensee can refuse other spectrum users from using their spectrum as they will evoke the right to property doctrine to their licensed spectrum (Expert D, 26/05/2015 and Expert B, 24/04/2015). Policy Maker is of the view that the introduction of market-based mechanisms in ICASA's regulations has the potential of complementing market liberalisation (Policy Maker, 23/01/2016).

The Electronic Communication Act is an open access legislation yet to be implemented through the development of regulations (Expert-F 28/04/2015). The regulations need to have principles of non-discrimination, quality of service and transparency clearly articulated to encourage infrastructure sharing (Expert-F, 28/04/2015) and (Researcher, 29/04/2015). Mobile networks will have a problem with open access if the regulations go deeper the networks (ibid). Wholesale networks can enable service competition in their networks, on a non-discriminatory, quality of service and transparent manner as offered by the network operators with the pricing as the same as that of the network operators service providers (Expert F, 28/04/2015).

For effective regulation of spectrum, intervention such as spectrum audits conducted by the regulator become necessary (Expert-B, 12/05/2015), (Operator-A, 24/04/2015), (Expert-E, 28/04/2015) and (Expert-F, 28/04/2015). This will assist the regulator to determine how efficiently the licensed spectrum is being used by the operators. In addition, the regulator should be in a position to make operators account for the spectrum usage and for the quality of service they offer. Lastly, the regulator must ensure universal access of services (Expert-A, 12/05/2015).

Operator-B (14/05/2015) is of the view that ICASA should strive to keep accurate spectrum records as that will result in effective regulation of spectrum. Example, currently ICASA does not have the C-band spectrum records that will indicate who is in those bands between broadcasters and mobile operators. Operator-B further provided an example where in one meeting ICASA indicated that mobile operators are buying satellite capacity while mobile operators are actually using their own spectrum for the backhaul links (Operator-B, 14/05/2015).

In terms of access to information, ICASA always relies on the industry, hence competition in the market is a challenge (Expert-D, 26/05/2015). Operators have a wider knowledge base than the regulatory. Regulator is not empowered to perform their regulatory responsibilities; they always have to fight their mandate on court bases (ibid). ICASA needs to be functional and financially independent because the regulator must not rely on industry to access information in order for it to be an effective regulator (Expert-D, 26/05/2015).

4.5 SUMMARY AND CONCLUSION

The researcher identified the following problems relating to radio spectrum reforms as a contributing measure to continued market liberalisation:

- Ineffective regulation for dominant players
- Inefficiencies of employing conventional command-and-control approach for assigning radio spectrum
- Vertically integrated market structure which resulted in structural constrains for the market
- Delay in assigning radio spectrum
- Introduction of open access and infrastructure sharing for rural areas
- Introduction of competition at service level as opposed to infrastructure for urban areas

These issues identified will be discussed in chapter 5.

CHAPTER FIVE: ANALYSIS OF RADIO SPECTRUM REFORMS AND THEIR EFFECT ON MARKET LIBERALISATION

This chapter declares the results of qualitative analysis of the documentation and survey responses as presented in Chapter 4. The results are delivered in the form of strides made in radio spectrum reforms and the associated extent of market liberalisation to achieve universal broadband for all using the conceptual framework depicted in figure 6. This emulate copies a phased approach proposal in addressing radio spectrum reform in a country as proposed by World Bank paper (Wellenius & Neto, 2008). It will outline reform strategies discovered in the analysis of documents and interviews conducted.

5.1 STRIDE 1: ESTABLISHMENT OF AN INDEPENDENT REGULATOR OF THE INDUSTRY AND RADIO SPECTRUM

In 1996, an independent regulator was established which led to the introduction of other operators to access radio spectrum to provide services. Vodacom and MTN were licensed in both the 900 MHz and 1800 MHz bands, a regulatory intervention that brought about a level of competition and liberalisation of the market. Few years after 1996, Cell C was introduced and awarded similar radio spectrum. It also created a monopolistic market with one fixed operator dominating the market until 2005 when Neotel was licensed as a second fixed operator. This stride introduced a certain level of competition for mobile and fixed services. Further to that, there was access to radio spectrum by players in the market.

During the survey, the respondents confirmed that a level of competition was experienced as a result of the licensing of radio spectrum to the above-mentioned mobile operators. However, it was also clear from the survey that the competition introduced was not highly effective. On the contrary, there was a rapid uptake of 2G phone services using GSM. As shown in figure 6 on the conceptual framework, the radio spectrum regulatory intervention was focused on market liberalisation and placed less focus on market based approaches, such as auctions.

The regulator through regulatory intervention it created an exclusive assignment of radio spectrum to licensees. This exclusive assignment stifled innovation. Backhaul for radio spectrum was reserved for Telkom and this limited operators to innovate and self-provide through the roll-out of their own infrastructure. This policy position, in actual fact, stifled competition and hampered market liberalisation. However, this stride created availability of competing platforms such as end-to-end operators, satellite and the Asymmetric Digital Subscriber Line (ASDL). As Cave, Minervini & Mfuh (2008) postulates, command-and-control introduced competition on an infrastructure level where operators vigorously rolled out infrastructure in order to sharpen commercial rivalries and to promote service differentiation.

The regulator, through its regulatory intervention it created an exlusive assignment of radio spectrum to licensees which stifled innovation. Radio spectrum for backhaul was reserved for Telkom limiting operators to innovate and self-provide through rolling out

their own infrastructure. This policy position in actual fact stifled competition and hampered market liberalisation This stride however, created availability of competiting platfrms such as end-to end operators, satellite and Asymmetric digital subscriber line (ASDL). As Cave, Minervini & Mfuh (2008) postulates command-and-control introduced competition on infrstrature level where operators vigorously rolled-out infrastrature in order to sahpen commercial rivalries and promotion of service differentiation.

While the independence of radio spectrum management was realised through the introduction of an independent body, command-and-control was still practised as a primary approach. For example, radio spectrum was awarded to the operators administratively with prescribed conditions akin to command-and-control as a method of managing it. The radio spectrum licences precisely described the radio spectrum and the type of technology to be used and services to be provided using the assigned radio spectrum. This made it possible to create a trajectory of wireless technology for harmonisation of radio spectrum, which consequently presented an advantage of interoperability and economies of scale (Cave, Minervini, & Mfuh, 2008).

Through this intervention, the management of the radio spectrum was still centralised and the government remained the custodian of the radio spectrum. The challenges associated with radio spectrum property rights were never clearly defined. This was another defect to market liberalisation. It further introduced a hierarchy of users, i.e. primary and secondary, who enjoyed varying levels of protection in terms of usage of radio spectrum (Cave, Minervini, & Mfuh, 2008).

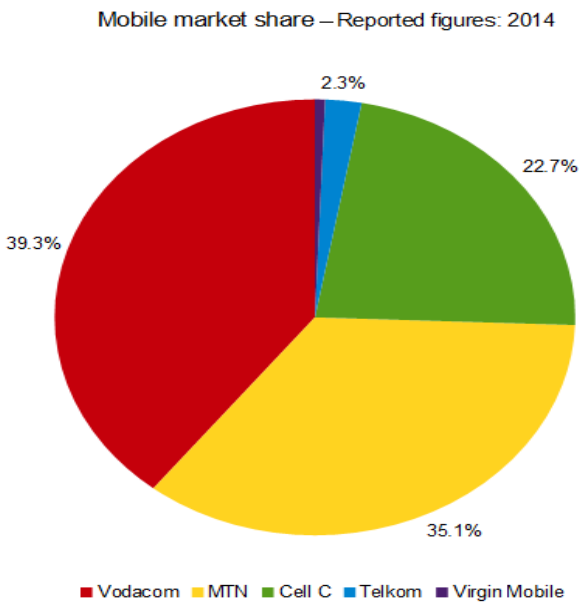
Given the above analysis, there is a call for radio spectrum reformation to increase market liberalisation. Radio spectrum management remained a limiting factor for flourishing market liberalisation. The command-and-control approach adopted brought about an oligopolistic market structure partly due to inefficient radio spectrum management approaches. Some of the responses during interviews argued that the fragmentation of radio spectrum assigned to one of the operators affects the performance of the network, hence the lack of effective competition in the telecommunications sector. While this might not explain the technical issues, it points to a lack of flexibility for players to manage aspects of the licensed radio spectrum efficiently. For the operators to efficiently make use of the radio spectrum awarded to them, it would require a by-in of the regulator which has to provide an approval for any change which might arise as a result of ensuring efficiency in radio spectrum usage. This is a very tedious and time consuming process.

Further example of inefficiencies due to command-and-control is the fact that radio spectrum pooling has never been practiced in the market by operators. This encouraged radio spectrum hoarding by a few, an action which can be attributed to manifestation of tragedy of anti-commons. As shown by the interviews, incumbents still argue that additional radio spectrum should not be given to new entrants but be consolidated with them. It further made any assignment and allocation to displace the rights to the incumbents and generates opposition to change. This made the issue of radio spectrum assignment and allocation to be an inherently political process with many competing interests. It has been evident over years that incumbents have done everything possible to ensure that additional radio spectrum is not released in case it falls in the hands of new

entrants. This was actually supported by a response provided during interview where it was stated, with all ITAs issued by the regulator it is a clear indication that the regulator intends to release radio spectrum and introduce more players in the market. However there is a strategy by existing players to frustrate the process of releasing radio spectrum, in an attempt to delay introduction of competition in the market. Similar challenge has further been displayed in the digital migration process which will see the release of the digital dividend radio spectrum for the broadband services. For South Africa, the process has taken too long and not even a little progress has been done, while other countries have concluded the process with services already been deployed a couple of years ago already.

The first stride made had a huge contribution in ensuring some level of market liberalisation; however it was still based on the same traditional command-and-control approach, an inefficient radio spectrum management approach. Figure 7 show that the first stride has created oligopolistic market structure.

Figure 7: South African mobile market share by players

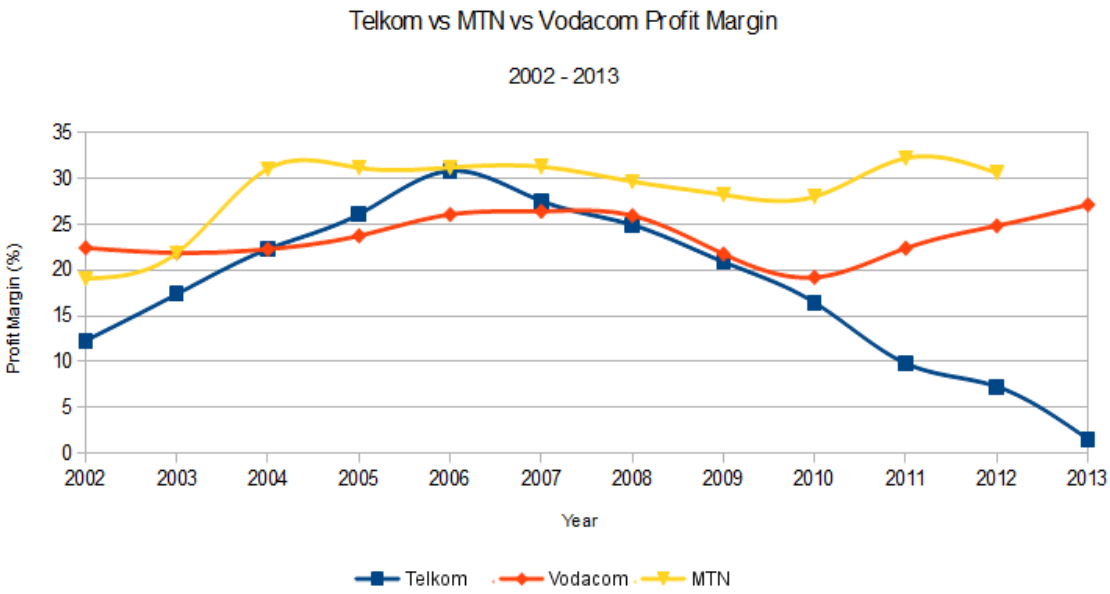


Source: BusinessTech, 2015

As a result, Vodacom has 38% market share, MTN has 33.2 %, Cell C has 25% compared to Telkom's 2.6 % market shares, and the remaining 0.7 % market share sitting with other (Business Tech, 2015). Over the years, radio spectrum reforms initiated by the independent regulator have seen considerable amounts of progress made in terms of profits by players in the market over the years. Figure 8 indicates a steady increase in terms of profits margins made by the players from the year 2003 to 2013 with tremendous

drop of profit margins by Telkom over the years compared to its competitors. This can be attributed to market share percentages depicted in figure 7.

Figure 8: Operators profit margins



Source: BusinessTech, 2013

5.2 STRIDE 2: INCREASED ACCESS TO RADIO SPECTRUM

Up until 5th February 2000 the utilisation of most of the radio spectrum was predominantly limited to Telkom. At this point, the eleven incumbent operators became able to self-provide their own backhaul. The promulgation of the ECA made it possible for every ECNS and ECS licensee to apply for use of any types of radio spectrum they deem necessary. Using the conceptual framework in chapter 2 there was further controlled liberalisation of the market in that players could:

- to self-provide through building their own infrastructure;
- provide access and services through microwave radio spectrum; and
- use license exempt radio spectrum.

However, this was not fully realised until the 2008 Altech decision took effect, providing some 451 VANS licensees with licences equivalent to Telkom and the other ten previously advantaged licensees on the 19th January 2009. With the new dispensation, new entrants could be able to use access radio spectrum that is not in high demand. This allowed better innovation, possible reduction of the cost of doing business and better competition. It further provided an opportunity for flexibility in radio spectrum management where users of radio spectrum are allowed to access whenever they need to.

However, respondents felt competition was still not adequate as a result of ineffective radio spectrum management by the regulator. Further, respondents felt that the lead time for radio spectrum applications were too long and not properly planned for from the side of the regulator and the policy maker. For example, there is no mechanism to release "high-demand" access radio spectrum as both the policy maker and the regulator have taken too long to give effect to the draft documents such as the 2011 draft policy directions and the three ITAs. This is a process that will help to release the radio spectrum for the provision of broadband services. Applications for radio spectrum not in high demand can take up to six months to a year and even more, and the requirements are unnecessary stringent. This aspect becomes another limiting factor for market liberalisation.

Even more so South Africa has also experienced unnecessary delays with regard to the release of high demand radio spectrum especially 2.6 GHz which does not have any dependencies compared to the digital dividend radio spectrum. The digital radio spectrum 800 MHz and 700 MHz is depended on the digital migration process for it to be used for broadband services. The release of 2.6 GHz radio spectrum has a great potential to increase access to radio spectrum by players, thus introduce further competitiveness in the market and contribute to market liberalisation.

Due to these challenges some respondents held a mistaken view that the regulator does not have records of radio spectrum use and some thought that access to radio spectrum could be increased through spectrum audits. The reality is that previous radio spectrum audits have not provided any new information and the issues of lead time and inability to assign radio spectrum by the regulator has nothing to do with lack of information and hence lack radio spectrum audits. The results of previous audits have not influenced any regulations by the regulator to increase access to radio spectrum.

The other inefficient radio spectrum regulatory intervention which demonstrates an element of not helping in ensuring that there is an increased access to radio frequency spectrum is the licensing of radio spectrum on an exclusive basis. The fact that radio spectrum was awarded to operators on a national and exclusive basis, not only stifled competition but also exacerbated the dominance of some of players in the market. The regulations do not present incentives to radio spectrum holders to innovatively come with up ways that will enable an increased access to radio spectrum by other players in the market. For example section 31 of the ECA states that no person may transmit any signal or radio apparatus to receive any signal by radio except under and in accordance with a radio spectrum license, in addition to a license to provide services there is requirement that one has to have a radio spectrum license (RSA, 2005). This is another inhibitor of progress to further market liberalisation.

Unlicensed radio spectrum was another reform which greatly benefited some level of competition in the broadband wireless and efficient use of radio spectrum, an innovation in technology that relies on short-distance radio communication (Public Knowldge , n.d). The responses during interviews confirmed the level of competition brought by the success of Wi-Fi in the wireless broadband for South Africa. This experienced a lot of Internet service providers starting to give more competition through access to 5 GHz radio spectrum. Interviewees spoke of an appeal made to the regulator to find ways to expand

the availability of unlicensed radio spectrum for the future in order to increase level competition for wireless broadband services. National Broadband Policy states that there is a need to make available sufficient radio spectrum for extensive Wi-Fi and other public access technologies and services (DoC, 2013).

The second stride made an appreciable progression for radio spectrum reforms. The potential for more effective competition was somewhat increased. However, this was only limited to a few players already in the market due to some requirements stated in policy and regulations.Therefore, progression for market liberalisation was not extensive compared to the reforms. It was at this stride where elemnts of market libeerlisation rising quiker than radio spectrum as shown in figure 6 were starting to be evident.

5.3 STRIDE 3: SERVICE AND TECHNOLOGY NEUTRALITY ON RADIO SPECTRUM

Service and technology neutrality introduce some level of flexibility into radio spectrum usage which leads to loss of control for the regulator in radio spectrum management. It is also an incentive for innovation, has the potential to reduce barriers to entry and support competition. However, as it may liberalise a market, it increases the risk of harmful interference as a result of a combination of technologies using similar radio spectrum (London Economics, 2008).Therefore , creation of a strategy to address these challenges becomes an integral part to realise the effectiveness of service and technology neutrality for the market (London Economics, 2008).

For South Africa, the doctrine of service and technology neutrality has been advocated in a number of documents, namely, the ECA, National Spectrum Policy, and ICASA's radio spectrum regulations, SA Connect, National Broadband Policy and the NDP. Explicitly, the NDP states that the policy should promote the notion of technology neutrality for the licensing of radio spectrum to allow for flexible use as well as competition where incumbents will not be prohibited from gaining access to the digital dividend radio spectrum (NDP, 2012).

This stride further emulated a regulatory tool which alluded to one of the strategies postulated by Wellenius and Neto in 2008 for market liberalisation, even though it has not been used to the full extent in practice. This element of radio spectrum reforms ensures that radio spectrum is not only assigned to those who value it the most, but it is also used for services that are most likely to derive value, thus result in radio spectrum efficiency. Clearly defined radio spectrum property rights as a reform plays a vital role in this stride as it gives users of radio spectrum full rights to implement technology and service neutrality. It was indicated that a lack of releasing the high demand radio spectrum by both the policy maker and regulator has made it difficult for players to realise the benefits presented by service and technology neutrality. This is worsened by a lack of properly defined property rights for radio spectrum. Because most South African consumers are still using 2G services, refarming 900 MHz and 1800 MHz to provide LTE services will not be idealThis view is supported by some of the respondents who believed that a decision to provide dynamic radio spectrum access a chance to be practised in South Africa has

a great potential to give effect to this radio spectrum reform. It should however be mentioned that there was also some concerns raised by other respondents suggesting that caution should be exercised when it comes to employment of dynamic spectrum access. They indicated it will be a premature action for the regulator to even think about employing dynamic spectrum access as it is has to address the issue of releasing high demand radio spectrum.

The use of service and technology neutrality has manifested by the refarming of 2G and 3G radio spectrum to 4G radio spectrum. The operators who were previously licenced for voice can today provide data in the same networks. As explained by other respondents during interviews that Telkom was initially assigned spectrum in 2.3 GHz radio spectrum for backhaul, which they now use for provision of mobile services. There was also some concerns raised regarding the refarming of radio spectrum to give effect to service and technology neutrality as most South Africans, especially in rural areas, are still using 2G services. Therefore, continuous refarming of radio spectrum for LTE networks in the long run might come at the expense of the consumers.

Service technology neutrality has blurred the line between data and voice, and between landline and mobile, which further stimulates market liberalisation and competition. Operators are free to provide various services at all levels using radio spectrum and technologies.

This third stride stimulated further progress on both radio spectrum reforms and market liberalisation as reflected in figure 6. The economic efficiency of radio spectrum use was evident, with more value service offered in the radio spectrum and newer business models. Greater technical efficiency brought about by newer technologies and refarming of the radio spectrum could be realised. It has further made possible for players to employ strategies such as radio spectrum refarming to enable the roll-out of new technologies, such as LTE, to meet end-user demands.

5.4 STRIDE 4: ESSENTIAL FACILITIES TO ENABLE SHARING

The ECA gave way to regulations on essential facilities and facilities leasing or sharing in terms of section 43 (8). An essential facility in terms of the ECA is defined as an electronic communication facility that is predominantly provided by a single or limited number of licensees and cannot feasibly be substituted or duplicated in order to provide services, and examples given are local loop, sub loops and associated electronic facilities for accessing subscribers and provisioning services (RSA, 2005). Radio spectrum as a scarce resource enables players in the market to have essential facilities such as their infrastructure networks. The definition of essential facilities as expressed in the ECA should give a way for radio spectrum sharing and leasing. This would further liberate the market and allow more players gain access to radio spectrum as an essential facility in the process of providing services through having access to infrastructure owned by their competitors.

The definition in the ECA suggests that radio spectrum is indeed an essential facility. However, the regulations for essential facilities have still not been concluded since 2007. The draft regulations did not list radio spectrum as an essential facility, even though the definition in the ECA suggests that it is. This has left uncertainty in the industry around radio spectrum leasing and sharing, and has further limited market liberalisation and allowed anti-competitive behaviour by the dominant players.

The respondents suggested that essential facilities, and facilities leasing and sharing concepts give effect to open access as contained in the ECA. Therefore, this gives the assertion that open access is a separate and greater stride of radio spectrum reforms. It can be shown that open access is an important radio spectrum reform that can ensure greater market liberalisation supported by flexibility. The ICT Integrated Policy Review report noted that access to critical and essential infrastructure is of vital importance for the achievement of South Africa Connect policy objectives of universal and access broadband services for all by 2030. It further indicated access to essential infrastructure is one of the bottlenecks that exist in the electronic communications sector that affects effective competition (DTPS, 2015).

To show the importance of access to essential infrastructure, the ICT Integrated Review report recommend sharing of active electronic elements of the network or national roaming based on market competition analysis. It also supports sharing of Radio Access Network (RAN) to ensure effective usage of radio spectrum. These recommendations were also supported by some of the respondents during interviews.

Essential facilities and facilities leasing and sharing applied to radio spectrum bring about huge opportunities for effective competition, flexibility and market liberalisation. Newer players may be able to make use of radio spectrum without actually having a radio spectrum licence. They may be able to use infrastructure of the incumbents to provide services and thus compete at a service level. This stride becomes a springboard for wireless open access, radio spectrum trading and service based competition. However, it must be said that there has not been huge enthusiasm in the market for facilities leasing and infrastructure sharing. Even though this has potential to deliver a broad range of services through access to radio spectrum, there are no incentives for players to use it. Instead, this is used by players to curtail competition by denying their competitors access to radio spectrum and thus resulting in ineffective competition: the “tragedy of anti-commons”. This regulatory intervention represents the saturation point depicted in figure 6.

5.5 STRIDE 5: MARKET-BASED APPROACHES RADIO SPECTRUM PRICING AIP

Market-based approaches predominantly take into account the economics of radio spectrum, with an attempt to solve the demand and supply problem. The total supply of radio spectrum is finite, but the extent to which it can be used depends on innovation. Both supply and demand of radio spectrum is affected by innovation. Market based approaches incentivise innovation, which in turn affects radio spectrum usage efficiency.

It can be shown that demand for radio spectrum increases with falling prices, whereas the supply remains invariant (Marks, et al., 2006).

Market based mechanisms include AIP, radio spectrum auctions and radio spectrum trading in secondary markets. The mechanisms typically co-exist with each other. The ECA does not directly mandate market based approaches in management of radio spectrum as an alternative approach to command-and-control. However, it does refer to efficient radio spectrum management and to competitive bidding processes for radio spectrum acquisition, especially where demand for available radio spectrum exceeds supply (RSA, 2005). Further, the National spectrum policy prefers the employment of market based approaches where demand exceeds supply to be considered by the regulator to assign radio spectrum (DoC, 2010). Similarly, ICASA regulations and published ITAs make reference to market based approaches to ensure efficiency and flexibility in radio spectrum management. On the other hand, the NDP states that market based approaches such as auctioning or reverse bidding of the radio spectrum as a form of licensing as well as radio spectrum trading should be considered by the regulator (NDP, 2012).

AIP as a regulatory tool further represents a plateau where the market liberalisation is saturated in figure 6. This is a pricing strategy introduced by the regulator in South Africa through radio spectrum fee regulations. The application of AIP has been instrumental in improving efficient use of radio spectrum in South Africa. Since the implementation of AIP regulations, some operators, such as Sentech and Telkom, offered to give back some of the radio spectrum they held. This presented new players with the opportunity to obtain radio spectrum, although the impact would be negligible in terms of the number of new entrants. It further represented a stride for efficient radio spectrum management. The respondents to the interviews further indicated that AIP managed to level the playing field in terms of ensuring players in the market pay equal radio spectrum fees.

Auctions were pronounced as the preferred method to award the digital dividend radio spectrum. This has been stated in the draft ITAs published by ICASA for releasing the high demand radio spectrum. The NDP also states that auctioning or reverse bidding of the radio frequency spectrum should be a method to license radio spectrum as well as radio spectrum trading.

However, the regulator has failed to get buy-in for radio spectrum auctions and to date, any attempts to introduce radio spectrum auctions have failed. Radio spectrum trading is alluded to in the form of radio spectrum leasing, but the full extent of radio spectrum trading remains unclear in terms of the ECA.

There were two opposing views put across during interviews on radio spectrum auctions. The one group felt that even though auctions have the potential to introduce flexibility to command-and-control, they also present some elements to act as a barrier of entry for new entrants, and by doing so, entrench the dominance of the incumbents. The other group strongly suggested that auctions should complement command-and- control to create a hybrid model for awarding radio spectrum licenses to ensure flexibility.

The integrated ICT review report suggests that there is not an obvious benefit for radio spectrum trading and auctions. It must be said that while market based approaches might have to some extent enabled efficient utilisation of radio spectrum, in the long term it entrenches the exclusivity in utilisation of radio spectrum.This inadvertently stifles competition and has a negative contribution towards market liberalisation “the tragedy of anti-commons”.

5.6 STRIDE 6: SERVICE BASED COMPETITION VERSUS INFRASTRUCTURE BASED COMPETITION

Infrastructure based competition is characterised by horizontal market structure, with market forces determining what will be sustainable for business models and market structure. It further provides the market forces the legitimacy to decide on what is effective competition for the market (Broadband Prime, 2008). While service based competition according to information gathered during interviews is about open access to networks through one established infrastructure operator in a form of National broadband network that will allow access to its network by its competitors for provision of services. This has potential for open access incentives which not only lowers the financial barriers new market players, but also increases access to radio spectrum while ensuring non-profitable areas are served (Broadband Prime, 2008).

Both the NDP and National Broadband Policy have stated the importance of South Africa to rather focus on service based competition than infrastructure based competition. The NDP indicated the importance to review the market structure and analysis of benefits and costs of duplicating or sharing infrastructure , given that the radio spectrum on which mobile broadband depends is limited (NDP, 2012, p. 191).

While National Broadband Policy states that there should be a feasibility study to establish whether there should be multiple national broadband networks or a single network to provide broadband services to all by 2030. The national broadband network envisaged is to provide wholesale wireless open access services to other players. This would allow other players who do not have access to radio spectrum to provide wireless and mobile services. This radio spectrum reform ensures that access to radio spectrum is no longer a barrier to entry to the market, hence improving competition and making huge leap towards market liberalisation.

In South Africa services based competition concept as a phenomenon enabled strategies such as national roaming to allow Mobile Virtual Networks (MVNOs) to access radio spectrum and provide services and incentivises players to be more innovative, thus improving competition.

Respondents during interviews suggested in urban areas there is sufficient competition with regard to infrastructure and networks. Therefore what is required is the regulator to release radio spectrum to enhance competition through better networks. This will ensure that the demands of consumers in metropolitan areas are met and service based competition is enabled. While for rural areas there is not sufficient infrastructure hence

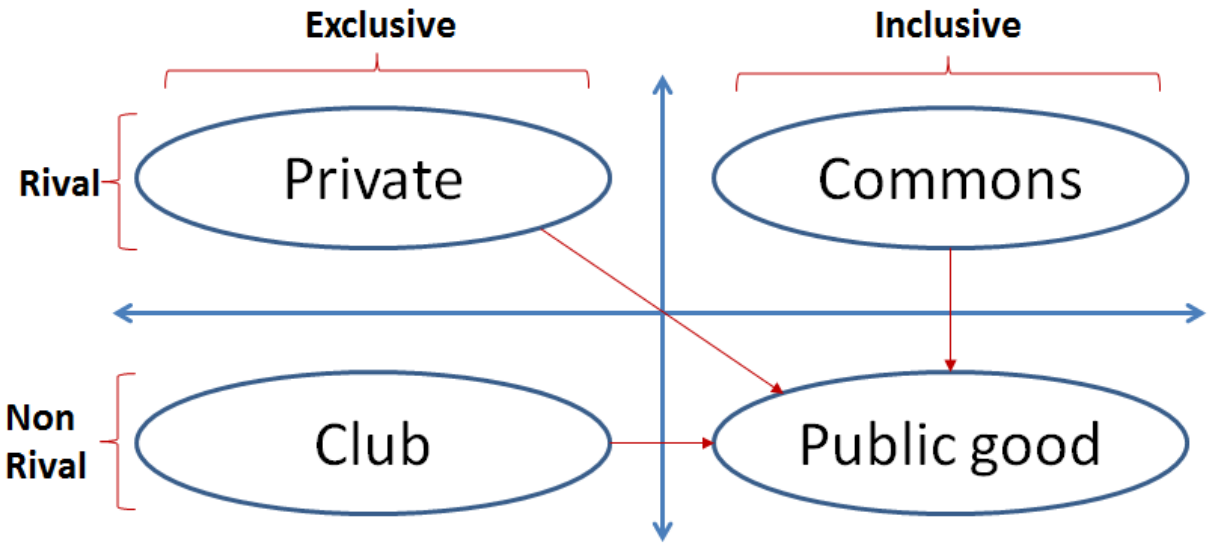
the need to create more infrastructures to meet National broadband policy imperatives for universal access for all.

This sixth stride made improved progression on market liberalisation and created some level of competition for metropolitan areas and minimal infrastructure sharing elements presented through roaming, with lack of infrastructure in rural areas. It ideal to move from continuous infrastructure competition but service based competition to further bring market liberalisation. Similarly, this regulatory intervention represents a plateau in market liberalisation as shown in figure 9.

5.7 STRIDE 7: NON-RIVAL NON-EXCLUSIVE UTILISATION OF RADIO SPECTRUM

The third stride made improved progression on both radio spectrum reforms and market liberalisation. The economic efficiency for the usage of radio spectrum was evident, with more value-added services offered in the radio spectrum and newer business models as depicted in figure 7 below. This regulatory intervention represents market liberalisation driven by radio spectrum reforms as shown in figure 6. In this stride the priority is given to radio spectrum with market liberalisation marginalised.

Figure 9: Economical perspective of radio spectrum management



Source: Researche's own

Market-based approaches, like command-and-control, continue to entrench exclusive allocation and assignment of radio spectrum and cause the tragedy of anti-commons. With this dominant players ensure that other players do not have means to compete, such as having no access to radio spectrum.

On the other hand the stride on service based competition, serving as a springboard for wholesale open access, does well in encouraging new entrants and somehow level the playing field. However, dominant players tend to rely on the integrated market structure for themselves and compete unfairly with new entrants or those who do not have access to radio spectrum.

New technologies including cognitive radio and dynamic radio spectrum access make the phenomenon of self-regulation and dynamic coordination a reality. This means that, at least in theory and with a little coordination, it is possible for adjacent radio stations to use the same radio spectrum without causing harmful interference. In economics terms this is referred to as non-rival. If many players can make use of the radio spectrum in this manner, then the radio spectrum can be considered almost non-exclusive. Therefore non-rival and non-exclusive utilisation of radio spectrum could be considered the ultimate goal to deal with both economic and technical issues in radio spectrum management. This will result to universal access to broadband services through a liberalised market.

ICASA's discussion document on Dynamic radio spectrum access states that the dynamic spectrum regime provides the users with incentives to ensure innovation providing services. The National Broadband Policy and National Radio Spectrum Policy support radio spectrum sharing between licensees and across services to enable efficient use of radio spectrum. The National Broadband Policy also supports the enabling of dynamic radio spectrum access.

The respondents suggested that essential facility leasing and sharing concepts give effect to open access and that there is no need for open access policy or regulation. In the end this will lead to realising radio spectrum as a public good that can be accessed and used by all to deliver services. While the National Broadband Policy states that open access will enable sharing of infrastructure platforms by service providers. This will allow competition at service and technology level, while facilitating service neutrality to allow flexibility in usage of resources (DoC, 2013). Open access will further facilitate the flexibility in usage of common principles and standards to enable interoperability and universal access to broadband services, while focusing on providing services in underserved areas and communities (DoC, 2013).

The ICT Integrated Policy Review report recommends the open access regime that is supported by regulatory framework to satisfy effective access to the infrastructure, transparent services and access in a non-discriminatory manner.

5.8 SUMMARY AND CONCLUSION

This chapter analysed the data from interviews, providing better understanding of radio spectrum reforms and market liberalisation. This was done with data collected and reviewed from documents. New themes emerged and were presented in a form of strides representing regulatory steps taken informed by data from previous chapter.

The analysis confirms the strategies alluded to by Wellienus and Neto on radio spectrum reforms for developing countries. It further reveals that there is a relationship between radio spectrum, even though there can be the adoption of radio spectrum reforms without market liberalisation. Recommendations for consideration by policy maker and regulator will be made in the next chapter.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

Radio spectrum management in the main is about access to and usage this rare natural resource by different radiocommunication services without causing any harmful interference thus ensuring quality of service to the end-users. Numbers of regulatory reforms have been used by regulators for market liberalisation. In this report, the relationship between market liberalisation and radio spectrum reforms has been presented. The effect of radio spectrum reforms on innovation, flexibility and efficiency to management of radio spectrum management is also demonstrated.

As stated in chapter 1, prior to 1996, there was radio spectrum reform introduced which saw radio spectrum hosted under Telkom a state owned monopoly. During that period there was no market liberalisation as Telkom was the only player in the market providing services to the end-users. It provided basic telecommunications services, hence radio spectrum management was not focused on encouraging players to be innovative when providing services. Similarly, radio spectrum was in abundance with limited radio communications services requiring radio spectrum. The main objective of radio spectrum management was to ensure there is no harmful interference hence command-and-control as an approach was effective. However, radio spectrum reforms had fewer contributions on market liberalisation.

6.1 STRIDE 1

In 1996 the management of radio spectrum was moved to an independent body SATRA later ICASA, resulting in some form of market liberalisation. This saw the introduction of competition with radio spectrum awarded to two operators and later the third player was licensed to provide services. However, this move while introducing a level of competition did not bring much change in radio spectrum management as command-and-control was still prevalent. Rigidity and inflexibility for radio spectrum management remained. The radio spectrum licenses were prescriptive in terms of the type of services and the technology to be used to provide services. Even though a slight move towards market liberation was realised, radio spectrum remained a limiting factor for increasing competition. The introduction of an independent regulator in itself it is tool for reform; however in this study we consider the second stride as the initial step towards radio spectrum reform.

6.2 STRIDE 2

The second stride which was introduced in the ECA with increased access to radio spectrum is a step towards radio spectrum reform. Increased access to radio spectrum means any service provider was eligible to obtain any type of radio spectrum provided that radio spectrum is available. It meant that the options became many, allowing meaningful competition and innovation among the players. Regulatory tools such as licence-exempt and commons radio spectrum became a catalyst for internet service providers and value-added network systems (VANS) to be participants in the market

through provisioning of services to the end-users without necessarily own networks but using the infrastructure owned by others.

6.3 STRIDE 3

The ECA also brought about service and technology neutrality in radio spectrum management, as third stride to spectrum reforms. This move allowed broad range of radio communications services and it is at this point where innovation by services providers was further experienced which is benefiting the end-users. It enabled operators to use re-farmed radio spectrum for new and advanced technologies as a temporary solution for lack of access to radio spectrum due to the delay of release of high demand radio spectrum by ICASA. This did not only ensured flexibility and efficiency in radio spectrum management; it also aided the market players in meeting the demands and needs of the consumers. It further allowed licensees to continue with the provision of basic mobile services such as 2G in nonprofitable areas of the country where more advanced services such as LTE are not yet a need for consumers.

6.4 STRIDE 4

The ECA further brought about essential facilities leasing and sharing. These regulatory tools, while improved radio spectrum efficiency, they did not necessarily move market liberalisation further. Part of the problem why market liberalisation was not further realised is a tragedy of anti-commons. In that radio spectrum as resource has the potential to allow multiple rights holders. However the licensing regime adopted in South Africa is still promoting exclusivity right to radio spectrum with majority of players are prevented from using it, frustrating further market liberalisation.

6.5 STRIDE 5

ICASA was successful in implementing a radio spectrum pricing strategy which is AIP. This is the first regulatory intervention based on market based approach adopted by the regulator. Efficiency on radio spectrum usage was realised with some operators offered to return excess radio spectrum to ICASA. It further played a role in levelling the playing field because the pricing formula for radio spectrum used by ICASA ensured that all players pay for radio spectrum equally.

6.6 STRIDE 6

A huge stride around service based competition as opposed to infrastructure based competition will serve as springboard for advanced radio spectrum utilisation models and thus lead to further market liberalisation. This is backed by advancement in technology with innovation and new business models. It allows wholesale open access. However, if this regulatory tool is still based on command-and-control which is static and in the main favours dominant players, it will suffer the tragedy of anti-commons problem. Where a number of players prevent others from using radio spectrum, frustrating what would be a socially desirable outcome for universal access to broadband services.

6.7 STRIDE 7

Therefore, a more advanced model recommended should be based on non-rival and non-exclusive usage of radio spectrum. This will allow market liberalisation, competition, flexibility and innovation and in the end they will be free markets.

Market based approaches are important for radio spectrum management but do not remove the rivalry and exclusive nature of spectrum and suffer from the tragedy of anti-commons. Like command-and-control, they entrenches exclusivity and rivalry.

Given the challenges of integrated market and anticompetitive behaviour by players, it is recommended that any regulatory intervention has to look at open access as a signboard. This help with unlocking the issue of accessing radio spectrum for the purpose of ensuring universal access to broadband services. The second thing that the regulation is to create incentives to ensure facility leasing and sharing is enforceable. Even though market based approaches has potential to bring some market liberalisation it also has negative effect of encouraging rivalry and exclusivity.

CONCLUSION

Future challenges such as universal access to broadband services by all and industrial Revolution 4.0 will be shaped by a fresh wave of innovation in areas such as driverless cars, smart robotics, materials that are lighter and tougher, and a manufacturing process built around 3D printing. This era will see convergence of multiple sectors of technology and industry (artificial intelligence, nanotechnology, autonomous vehicles, to name a scant few) as evidence that humans are entering a new era of profound, exponentially increasing possibility and risk. Similarly ITO where technology will disrupt people's lives through intelligent sensors improving efficiency while collapsing existing architecture into one and create systems that are more economic and effective and reduce operational costs. This will bring changes the type of workers, skills, and it will also bring additional value to end users. These challenges recognise the need for us to prepare for the industrial revolution. Hence the shift on the assignment and allocation of radio spectrum not giving one entity radio spectrum, so we are able to respond to these changes and radio spectrum is at the centre of this revolution.

It is therefore recommended that consideration should be given to radio spectrum reforms which will enable non-rival and non-exclusive utilisation of radio spectrum to ensure efficiency in radio spectrum usage and management. If the status quo of radio spectrum management remains it will further limit efficient use of radio spectrum.

A regime with elements of self-regulatory models could also be considered as an incentive to ensure that players embrace non-rivalry and non-exclusivity. This regime will address the challenge of the tragedy of anti-commons in that rightful licensees of radio spectrum would not be in a position to prevent other radio spectrum users to use it. It further do not encourage tragedy of commons in that shared-resource system where individual users acting independently would not prevent use of radio spectrum as a shared resource to their own self-interest to a point where the value of radio spectrum is depleted. The ultimate goal should be a market where radio spectrum is accessed as public good to enable efficiencies through innovation. In the end this has the potential of delivering the policy objectives of South Africa Connect of universal and affordable broadband services for all.

APPENDIX A: RESEARCH QUESTIONNAIRE

Dear Sir/Madam

My name is Cynthia Lesufi, currently working towards completion of the degree, Master Arts in ICT Policy and Regulation, at the University of Witwatersrand (WITS). The curriculum consists of coursework and research, which involves compilation of a Research Report. The research seeks to explore required spectrum reforms, in the “high demand broadband spectrum”, that could enable South Africa to fulfil national objectives as expended in the National Development Plan (NDP) and in the National Broadband Policy, “South Africa Connect”). Broadly, there is a requirement for high-speed, high quality broadband networks for everyone by 2030, facilitated by open access networks and highly competitive market structure. Efficient allocation and assignment of “high demand broadband spectrum” is seen as one of the main ingredients in creating an enabling environment to achieve the objectives.

South Africa has always had an intention to liberalise the telecommunications market and increasing competition. On the other hand, there is the issue of spectrum scarcity which is required for market growth. It appears that issues around spectrum assignment and allocation may impact market liberalisation and competition. Therefore, these questions are aimed at establishing your perception about spectrum assignment and allocation, the way it has affected your business, as well as competition and liberalisation of the market in general.

The main objectives of these questions are to:

- To ascertain if current methods of assigning spectrum managed to bring effective competition in the market.
- Trying to understand the core relation between liberalised of market and spectrum reforms

All your responses will be held in strict confidence; findings will be summarized and no statements used in the report will be attributed directly to you. The interview will take approximately 60 minutes and with your permission, the proceedings will be recorded.

Thanking you,

C Lesufi

TOPIC: RADIO SPECTRUM REFORMS AND ASSOCIATED EFFECTS ON MARKET LIBERALISATION

As part of the research methodology the following are questions used for data collection.

Which current radio spectrum reforms are most likely to achieve market liberalisation for universal access to broadband services?

❖ ***Sub-questions***

Q.1. To what extent can addressing radio spectrum management efficiencies in the South African context assist achieving universal access to broadband services? For instance, South Africa Connect, broadband policy calls for 100% broadband access and this policy objective expands what the National Development Plan is calling for, which is:

- Timeous allocation and assignment of radio spectrum to roll-out broadband infrastructure and provide broadband services
- Proper development and implementation of monitoring strategies for efficient and effective usage of radio spectrum to eliminate radio spectrum shortage
- Adoption of proper radio spectrum fees strategies (commercial vs. government radio spectrum)
- Spectrum refarming

Q.2. To what extent can the current radio spectrum regulatory approach of licensing radio spectrum adopted by ICASA encourage competition and ensure infrastructure sharing?

- Prohibition of radio spectrum trading in secondary markets
- Prohibition of radio spectrum sharing
- Administrative Incentive Pricing model
- Command-and-control approach

Q.3. To what extent can adoption of the alternative radio spectrum regulatory approach of licensing radio spectrum encourage competition in the following areas?

- Market-based approaches (auctions and radio spectrum trading)
- Radio spectrum pooling, commons and parks
- Innovation
- Probability of substitutability

- Redefinition of the market structure
- Market consolidation
- Increased accessibility and affordability of broadband services and infrastructure

Q.4. Can an alternative radio spectrum regulatory approach of licensing radio spectrum possibly assist to address the cost associated with the usage and access of broadband services?

Q.5. What regulatory interventions can ICASA possibly adopt to limit the possibility of consolidation of markets to distort competition and universal access?

Q.6. To what extent can the employment of dynamic radio spectrum access improve efficiency in radio spectrum usage?

APPENDIX B: Participation Information Sheet

Dear Sir/Madam

My name is Cynthia Lesufi, currently working towards completion of the degree, Master Arts in ICT Policy and Regulation, at the University of Witwatersrand (WITS). The curriculum consists of coursework and research, which involves compilation of a Research Report. I kindly request that, you be a participant in my research.

The main objectives are to:

- To ascertain if current methods of assigning spectrum managed to bring effective competition in the market.
- To try and understand the core relation between liberalisation of market and spectrum reforms

Your participation will be through an interview conducted with you.

As a participant to the interview, you have the right to leave out some questions and you can refrain from answering any questions during the interview. If you also feel that some of the answers provided should not be mentioned in the research, you have the right to indicate or mention that during or after the interview.

Topic: Alternative spectrum reform approaches to enable National Broadband Policy "South Africa Connect"

SECTION A - DETAILS OF THE PARTICIPANTS

1. Organisation: _____

2. Occupation: _____

3. Date of interview: _____

4. Length of time at institution/organisation: _____

5. Email and contact numbers:

_____

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