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The impact of policy on broadband development: 
A South African case study

A Minor Dissertation submitted in partial fulfilment of the degree

MASTER OF PHILOSOPHY

in

ENGINEERING MANAGEMENT

At the

FACULTY OF ENGINEERING AND BUILT ENVIRONMENT

of the

UNIVERSITY OF JOHANNESBURG

By

Brandon Mokwana

February 2016

SUPERVISOR: DR. AL MARNEWICK
DECLARATION

I, Brandon Mokwana, declare that *The impact of policy on broadband development: A South African case study* is my own work and that all sources that I have used have been indicated and acknowledged in the form of complete references.
ACKNOWLEDGEMENTS

I would like to acknowledge everybody who assisted me in researching this topic. In particular, I would like to thank my supervisor Dr. Annlize Marnewick for the guidance, encouragements and advices in completing this project. I would like to thank the following people; Mothibi Ramusi, Bongile Rubela, Peter Zimri, Thato Toko, Simon Musvosvo, Calvo Mawela, Kefilwe Madingoane, Silulama Doyi, Mandla Mchunu, Joe Dikgale, Eric Nkopodi and Richard Makgotlho for the useful inputs, suggestions and for helping in various ways. A special thank you goes to Mr. Pandelani Munyai for his positive criticisms and making time to review my work.

I’m deeply indebted to my family for all their outstanding support and encouragement over the past years.

God bless you all.
ABSTRACT

The economic and social benefits of broadband connectivity have become increasingly evident and can no longer be ignored. An increase in broadband penetration contributes to GDP growth as the world bank estimates that a 10% increase in penetration can yield as much as 1.4% in GDP growth. Studies and events around the globe have demonstrated that broadband internet has become a powerful force towards social change, fostering greater social inclusion, improved healthcare, improved education, public participation and political transparency amongst others. Promoting broadband access is no longer a debate amongst policymakers, the mindsets have shifted to how to provide broadband connectivity in an effective manner. The adoption of national broadband plans (NBP) by most countries advocates the importance of broadband and the intent to facilitate the rollout of broadband infrastructure for universal service and access.

The purpose of this research is to explore policy and regulatory instruments that are key to broadband development and access. The research identifies the gaps that exist within the policy and regulatory frameworks that are key to broadband development.

The research highlights the gaps that exist and identifies the remedies that are key to bridging these gaps for advancing broadband development, the rollout of broadband infrastructure and adoption.

The research will contribute to the existing body of knowledge in policy and regulatory development. The policy and regulatory instruments explored and the identified gaps offer further areas of research.
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<td>Second Generation</td>
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<td>3G</td>
<td>Third Generation</td>
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<td>3GPP</td>
<td>Third Generation Partnership Project</td>
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<td>4G</td>
<td>Fourth Generation</td>
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<tr>
<td>AIP</td>
<td>Administrative Incentive Pricing</td>
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<td>APC</td>
<td>Association of Progression Communication</td>
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<td>APT</td>
<td>Asia-Pacific Telecommunity</td>
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<td>ASO</td>
<td>Analogue Switch-Off</td>
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<td>CAPEX</td>
<td>Capital Expenditure</td>
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<td>CEPT</td>
<td>European Conference of Postal and Telecommunications</td>
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<td>CR</td>
<td>Cognitive Radio</td>
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<td>DD1</td>
<td>First Digital Dividend</td>
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<td>DD2</td>
<td>Second Digital Dividend</td>
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<td>DoC</td>
<td>Department of Communications</td>
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<td>DSL</td>
<td>Digital Subscriber Line</td>
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<td>DSO</td>
<td>Digital Switch-On</td>
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<td>DTH-S</td>
<td>Direct-To-Home Satellite</td>
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<td>DTPS</td>
<td>Department of Telecommunications and Postal Services</td>
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<td>DTT</td>
<td>Digital Terrestrial Television</td>
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<td>DVB-T</td>
<td>Digital Video Broadcasting - Terrestrial</td>
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<td>ECA</td>
<td>Electronic Communications Act</td>
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<td>ECNS</td>
<td>Electronic Communications Network Service</td>
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<td>FCC</td>
<td>Federal Communication Commission</td>
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<td>FDD</td>
<td>Frequency Division Duplex</td>
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<td>FET</td>
<td>Further Education and Training</td>
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<tr>
<td>Gbps</td>
<td>Giga bits per seconds</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GHz</td>
<td>Giga Hertz</td>
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<td>GSM</td>
<td>Global System for Mobile</td>
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<td>GSMA</td>
<td>GSM Association</td>
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<td>GSM-R</td>
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<td>HD</td>
<td>High Definition</td>
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<td>HDTV</td>
<td>High Definition Television</td>
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<td>IBA</td>
<td>Independent Broadcasting Authority</td>
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<td>ICASA</td>
<td>Independent Communication Authority of South Africa</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<td>ICT</td>
<td>Information Communication Technology</td>
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<td>International Mobile Telecommunications</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>ISDB-T</td>
<td>Integrated Services Digital Broadcasting - Terrestrial</td>
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<td>Industrial Scientific Medical</td>
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<td>ITA</td>
<td>Invitation To Apply</td>
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<td>ITU</td>
<td>International Telecommunication Union</td>
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<td>ITU-D</td>
<td>ITU Development sector</td>
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<td>ITU Standardisation sector</td>
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<td>LDC</td>
<td>Least Developed Countries</td>
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<td>LLU</td>
<td>Local Loop Unbundling</td>
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<td>LTE</td>
<td>Long Term Evolution</td>
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<td>Mbps</td>
<td>Megabits per seconds</td>
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<td>MDG</td>
<td>Millennium Development Goals</td>
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<td>MHz</td>
<td>Mega Hertz</td>
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<td>MIMO</td>
<td>Multiple Inputs Multiple Outs</td>
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<tr>
<td>MNO</td>
<td>Mobile Network Operator</td>
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<td>MTR</td>
<td>Mobile Termination Rate</td>
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<td>MVNO</td>
<td>Mobile Virtual Network Operator</td>
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<td>NBP</td>
<td>National Broadband Plan</td>
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<td>NCBN</td>
<td>National Consolidated Broadband Network</td>
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<td>NGN</td>
<td>Next Generation Network</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>OFCOM</td>
<td>Office of Communication</td>
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<td>ROI</td>
<td>Return On Investment</td>
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<td>RR</td>
<td>Radio Regulations</td>
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<td>RRC</td>
<td>Regional Radiocommunication Conference</td>
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<td>SADC</td>
<td>Southern African Development Community</td>
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<tr>
<td>SATRA</td>
<td>South African Telecommunication Regulatory Authority</td>
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<td>SD</td>
<td>Standard Definition</td>
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<td>SDR</td>
<td>Software Defined Radio</td>
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<td>SFN</td>
<td>Single Frequency Network</td>
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<td>SMME</td>
<td>Small Medium and Micro Enterprises</td>
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<td>SOE</td>
<td>State Owned Enterprise</td>
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<td>SRD</td>
<td>Short Range Device</td>
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<td>STB</td>
<td>Set Top Box</td>
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<td>Abbreviation</td>
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<tr>
<td>TV</td>
<td>Television</td>
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<td>UAS</td>
<td>Universal Access and Service</td>
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<td>UHF</td>
<td>Ultra High Frequency</td>
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<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UMTS</td>
<td>Universal Mobile Telecommunication System</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nations Education, Scientific and Cultural Organisation</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>USD</td>
<td>United States Dollar</td>
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<tr>
<td>USF</td>
<td>Universal Service Fund</td>
</tr>
<tr>
<td>UWB</td>
<td>Ultrawide Band</td>
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<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VSAT</td>
<td>Very Small Aperture Terminal</td>
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<tr>
<td>WRC</td>
<td>World Radiocommunication Conference</td>
</tr>
<tr>
<td>XPIC</td>
<td>Cross Polarisation Interference Cancellation</td>
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<td>ZAR</td>
<td>South African Rand</td>
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1. INTRODUCTION AND BACKGROUND

1.1 Introduction

The information and communications technology (ICT) industry is one of the fast growing and lucrative industries and is key to economic development of many economies globally, in both developed and developing countries. We are living in the information age, we are referred to as the information society and our economy is called the knowledge economy. The landscape of our economies has changed dramatically; the bigger proportion of our gross domestic product (GDP) is now made up by the tertiary sector also known as service sector as compared to the primary and secondary sectors [1, 2]. Application of knowledge has become the competitive advantage as compared to abundance of natural resources or labour advantage in the previous decades [2]. The information and communications technologies (ICTs) play a major role in this knowledge economy as the enabler; borders within which businesses use to operate have vanished and barriers to entry have lessened. Businesses can now operate and compete globally irrespective of their geographic locations. Technology, spectrum and infrastructure are key fundamental parameters behind the ICTs as enabler [3, 4].

The South African government like other many governments around the globe has seen and acknowledged the importance of policy development to facilitate economic growth and social upliftment of their citizens among others [5]. The communications ministry (DoC) is the government department that is mandated to oversee policy developments within the ICT industry. Two key important ICT policies that are of particular interest to this research are the national broadband policy (NBP) and spectrum policy [5, 6].

Studies have been conducted around broadband; these studies [3, 7, 8] confirm that broadband does contribute to economic growth. The studies support the claims that “increase in broadband penetration correlate with increases in GDP, new jobs, broadening of educational opportunities, enhanced public service delivery and rural development” [5].

1 | The impact of policy on broadband development: A South African case study
“South Africa has demonstrated consistent progress in moving into the electronic age despite limitations in its policy and regulatory environment. Mobile telecommunications networks have spread across the country; sophisticated ICT applications have been adopted by businesses and government; and the Internet provides a foundation for information flows and transactions in banking and financial services, universities and other scientific performing agencies, as well as in shopping and entertainment services”, this is according to Abrahams and Goldstuck [9].

1.2 Background

The demand for broadband connections has put a huge constraint on spectrum capacity. The wireless technologies are evolving in attempt to address and cope with the high demand for broadband communications, however the spectrum capacity cannot be increased [10]. The wireless traffic has more than doubled each year since 2009 [10]. The equipment vendors are faced with the challenge of developing wireless technologies that have improved and high spectral efficiency. Spectrum bands vary in their use and applications and sharing is becoming very difficult and almost impossible, particularly in the spectrum ranging from 600 MHz to 3600 MHz [11]. These spectrum bands are strictly administered by regulatory bodies and are critical to the supply of wireless broadband [11].

There are several approaches that can help improve spectrum availability and efficiency, but they are either inadequate for keeping up with the challenge of high demands of high data rates or would be obsolete in the near future [10]. These methods include:

- The reallocation of frequency bands to operators. Several models of spectrum allocations exist which include lotteries, beauty contests and auctions. Recently, the auction model has been preferred as a method of allocating spectrum, both as a transparent method of allocating scarce resource and source of revenue for regulatory bodies [12];
- The use of cognitive radio technology. This technology enables dynamic spectrum allocation and has the capability of sensing the radio environment
and based on that information identifies unused spectrum to avoid interference [13];

- Spectrum re-farming, this is an alternative for operators to introduce new wireless technologies and services in existing frequency bands without obtaining new spectrum [11]. Obtaining new spectrum may be very expensive. Successful re-farming is highly dependent on the amount of spectrum the operator possesses; and
- The use of advanced antenna techniques such as multiple inputs multiple outputs (MIMO), smart antenna and cross polarisation interference cancellation (XPIC) technology. The techniques yield high spectral efficiency; they are able to double the capacity without the need of additional spectrum [13].

These are some of the challenges that a national spectrum policy needs to address. The impact of convergence, globalisation, the use of internet, the increasing demand of broadband and mobility, competitive conditions, broader availability of wireless and the trend toward integrated national broadband policies are forces of change which drive the need for governments to rethink spectrum policy [14]. Wireless technologies are envisaged to play an essential role in broadband development, and the increasing demand for high data rates has emphasised the critical nature of the limited spectrum resource and the need to plan and accommodate future demands for spectrum. The GSR 2012 [14] highlights these as key considerations that a national spectrum policy needs to address and regard as key component in advancing national broadband policies.

1.3 Problem Statement

As it is envisaged that wireless technologies will play a key role in broadband development, the trends in the South African telecommunication market show that cellular technologies (commonly voice calls) are the most preferred medium of communication for households. This can be deduced from the statistics presented in Figure 1-1. It is envisaged that the same way cellular technologies dominate; their evolution will provide a platform for mobile broadband services to the masses, not only to South Africa but to other developing countries [8].
The major limitation with wireless technologies is that spectrum is a scarce resource and its capacity cannot be increased [16]. The connection speeds anticipated by the NBP required more spectrum bandwidth. Regulators across the globe have relied on a combination of approaches for managing spectrum, such as the administrative and market-oriented approaches [14]. Further, new approaches in the aspects of spectrum allocation and assignments have emerged, particularly in the areas of spectrum sharing, use of unlicensed spectrum and incentive pricing within some regulatory bodies [14]. A question has been raised whether the traditional approaches and principles of the spectrum policy are still relevant for the future or a reform is required [14].

Studies have confirmed that broadband has a positive contribution to GDP and that this contribution increases with penetration [17]. Wireless broadband does bridge the broadband gap that exists between developed and developing countries and this is due to adaptability of the technology for different environments and needs. However, for this goal to be realised, spectrum policy and regulation play a crucial role and all intentions should be focused on making spectrum available to support broadband.

Figure 1-1: South African households telecommunication medium 2012 [15]
development [14]. Best practices in spectrum management policy are influenced by externalities such as the national broadband plan, universal access and service, industry support, a degree of control, and social ambitions among others. The global symposium for the regulators held in 2005 (GSR05) identified a set of best practice guidelines for spectrum management that are key to promoting broadband development.

Though spectrum policy plays a crucial role in broadband development, alone it cannot be adequate, a broad approach is required to include other policy considerations to address other factors that facilitate broadband development. The research focuses on broad policy matters in broadband development, thus the problem statement is:

The South African broadband policy does not address key aspects required to facilitate universal broadband access.

1.4 Research Objectives

The research objectives are:

- Identify factors that play crucial roles in broadband development; and
- Consider policy and regulatory reforms required for facilitating broadband development.

The research results identify policy issues that need to be considered and addressed for successful broadband development. The research will contribute to the existing body of knowledge in policy development and considerations within the fields of broadband and spectrum management in South Africa and possibly offer further areas of research.

1.5 Research Questions

To explore the impact of policy on broadband development, the study seeks to answer the following questions:

- RQ 1: What role does policy play in broadband development?
RQ 2: What are key policy and regulatory considerations for smooth broadband development?
RQ 3: Why is spectrum management so important in broadband development?

If policy gaps are identified and policy reforms are implemented, broadband development can be advanced.

1.6 Research Methodology

In an attempt to answer the research questions, this study takes the case study methodology in the form of a single-case approach within the broader context of broadband and spectrum management.

Robert K. Yin [18] and Robert E. Stake [19] are some of the researchers that have written a lot about case study research and have suggested techniques for organising and successfully conducting a case study research. Their work proposes six steps that should be used in case study research, which this study will use as guidelines. These six steps can be sequentially listed as follows:

- Determine and define the research questions;
- Select the cases and determine data gathering and analysis methods;
- Prepare to collect the data;
- Collect data;
- Evaluate and analyse the data; and
- Prepare the report.

This research follows the research process as documented by Cooper and Schindler [20] in an attempt to answer the research questions. The adopted process can be summarised as follows:

**Stage 1: Clarification of the research question** - Cooper and Schindler [20] points out that it is fundamental to state the dilemma that prompts the research and develop questions around it. The aggressive drive to rollout broadband infrastructure particularly using wireless technologies has put constraints on the availability of
spectrum. This triggered the research to investigate if this is really the case and if they are alternatives to the dilemma.

**Stage 2: Research proposal** - The University requires a written proposal on the intended study, which was submitted by the researcher. The purpose of the proposal is to obtain approval from the university and presents the problem statement, objective and benefits, method of investigation, extent of analysis and delivery of results [20].

**Stage 3: Research design** - According to Cooper and Schindler [20], a research design is “a blueprint for fulfilling objectives and answering questions”. Further, Nachmias and Nachmias as cited in Yin [18] describe research design as a plan that guides the investigator in the process of collecting, analysing and interpreting observations. This study conducts a literature review to gain insight and knowledge on published literature by other researchers, and uses case study methodology to define data that is required to answer the research questions.

**Stage 4: Data collection and preparation** - The research uses case study research method, which dictates what data should be collected.

**Stage 5: Data analysis and interpretation** - Data collected is reduced into manageable and usable formats for analysis [20]. Pattern matching and applying statistical techniques are methods used to analyse the data. The findings are then interpreted in the light of the research questions.

**Stage 6: Research reporting and conclusions** - The research findings are documented based on the data collected and interpretations made. Research questions are answered and recommendations are made.

1.7 Outline of the Research

This research is divided into six chapters, which are summarised as follows:

**Chapter 2: Literature Review**, this chapter presents the literature review, comprehensive review of related literature is discussed that best fits the research area driven by the research questions and the objectives of the research.
Chapter 3: Research Methodology, this chapter presents the research methodology; the process of research methods is discussed, its relevance to the research and why it was chosen.

Chapter 4: Case Study Description, this chapter is intended to give background on the case study, how data was collected and analysed.

Chapter 5: Research Finding and Discussions, this chapter presents the analysis of the data collected and the findings.

Chapter 6: Conclusions, conclusions are made from the analysis and results from the previous chapter.

1.8 Conclusion

This chapter gave an overview in terms of an introduction and background to the research’s aims and presented the problem statement. It also presented the current developments that are being explored in attempt to address the problem statement. The research process that the research adopts has also been discussed.

It cannot be ignored that the broadband infrastructure is seen as crucial to social, economic and scientific goals and a requirement for both knowledge economy and information society for many countries. Studies have confirmed that broadband has the ability to improve the lives of citizens by providing ICT skills for employment and improving access to online education. In the developing countries, it is envisaged that wireless infrastructure will be key to providing broadband services which puts constraints on spectrum availability.

Chapter 2 reviews the relevant published literature in broadband and spectrum management, in line with the research questions and study objectives.
2. LITERATURE REVIEW: BROADBAND AND SPECTRUM MANAGEMENT

2.1 Introduction

Literature review is the power source of the framework of any research [21]. A comprehensive review is of fundamental importance and provides foundation for the research. Gary [21] emphasises the essentiality of a comprehensive literature review and its benefits. Gary further accentuates that comprehensive review provides an up to date understanding of the subject, significance and structure; it is informed by the views and research of experts in the field; and it provides the basis on which the research findings can be compared [21].

In this chapter, the literature being reviewed has been previously published and is on broadband and spectrum management. The literature is relevant to the research questions as it provides background and the basis from comparing the research findings. The literature reviews the key aspects for facilitating broadband development.

The broadband literature review focuses on broadband development and all other important aspects that surrounds broadband, the aspects include national broadband plan, policy and regulatory approaches and considerations that are key to broadband development.

2.2 Broadband

Various definitions of broadband exist and vary on what speeds constitute broadband. The standardisation (ITU-T) and development (ITU-D) sectors within the ITU have different definitions of broadband; this is in line with their functions. The ITU-T defines broadband as speeds of 1.5 Mbps to 2 Mbps while the ITU-D defines broadband as speeds of 256 Kbps and above. The South African Broadband policy has adopted the broadband definition by the ITU-D which is interpreted as “an always available, multimedia capable connection with a download speed of at least 256 Kbps” [5].

Kelly and Rossotto [22] further describe broadband as not just about improving the speeds at which the users are able to download a file, play video games or engage in
social networking. It is acknowledged that speeds are the key drivers of demand and provide benefits to users; however broadband is seen as an enabling platform that allows developers and individual users to enhance existing services and develop tools that improve business and society [22]. According to Kelly and Rossootto [22], the benefits of broadband expand beyond the ICT sector itself, with a ripple effect across the economy and serving as an essential input and enabler for all other sectors.

The Organisation for Economic Co-operation and Development (OECD) acknowledges the critical role that broadband plays in the workings of the economy [8]. The OECD further alludes to the fact that broadband connects different participants (consumer, business and government) in the economy and facilitates social interactions. Broadband is believed to be the infrastructure of knowledge economy [7]. The OECD has been instrumental in fostering broadband development and many countries have followed recommendations and implemented policy suggestions by the organisation in their ICT policy developments. In line with developments around the globe, South African government approved the building of information society in 2007 [5]. The purpose of broadband policy is to advance and improve the country in ensuring the realisation of all-inclusive information society in all areas (urban and rural) that can enjoy the economic benefits that come with broadband [5].

Studies have shown that broadband internet improves the lives of people and facilitates access to economic opportunities and social welfare particularly in developing countries where it was previously inaccessible [7]. The research further confirms that the use of mobile broadband has facilitated financial inclusion through mobile banking applications in Africa and has capabilities to support new ways of delivering other social and health services. Innovation; new products and services development; and productivity improvement are some of benefits of broadband access that businesses enjoy [7].

2.2.1 Broadband Infrastructure, Markets and Developments

The OECD and most of its member countries have been monitoring the broadband markets on regular basis since 2001. This has been triggered by the growing economic and social importance of broadband [8]. The OECD uses five criteria for evaluating
broadband markets, which are: penetration; coverage; prices; services and speeds; and choice and competition. These are important indicators that allow countries to measure their own performances. The OECD further urges that though social and economic factors are not included as part of the criteria, they should not be ignored as they play a big role in affordability [8].

2.2.1.1 Penetration

Broadband has become a political issue in many countries. Penetration statistics are commonly used in debates and policy discussions. It is fundamental to note the difference between broadband subscriptions and broadband usage; often the two are confused especially when discussing penetration statistics [8]. Broadband subscription is the subscriber data that represent the physical and active connections to broadband service providers. The subscriber data is timely and accurate; and represents the total number of broadband lines in a particular country [8]. On the other hand, broadband usage is data collected through surveys or questionnaires and given to a sample subset of the population; such statistics can be sourced from national statistic agencies, such as Stats SA.

Penetration levels are directly impacted by prices, coverage and competition levels in a broadband market; all these factors are determinants in subscriber take-up. South Africa has seen a tremendous growth in broadband usage and subscriptions in recent years. A report by World Wide Worx [23] indicates a 128% growth in broadband usage from 3.6 million users in 2010 to 8.2 million users in 2012. World Wide Worx also reports that South Africa has a 15.8% broadband penetration of the population measured in subscriptions. The growth is linked to the falling cost of data and proliferation of promotional offers and the landing of several submarine cables for global connectivity [23].

The broadband commission [24] ranked South Africa number 111 globally with regard to fixed broadband penetration per 100 inhabitants, and number 62 for mobile broadband penetration in 2012.
2.2.1.2 Coverage

Geographic conditions such as the terrain and dispersion of the population can increase the cost of providing broadband access coverage. Providing universal access becomes very difficult particularly in large countries with dispersed populations. Despite these challenges, most of the OECD countries have managed to provide extensive broadband access. In 2006 Canada, the largest country in the OECD had virtually all its households in urban areas and 78% of households in the remote and rural areas within the broadband footprint [8].

The dominating networks in the OECD countries that have the most extensive broadband coverage are digital subscriber line (DSL) and cable networks, both are fixed-line broadband networks [8]. On the contrary, in developing countries the growth in fixed-line broadband networks is very slow and is mainly focused in metropolitan areas. This can be attributed to the high capital investment required for building these networks. Hence wireless broadband, particularly mobile is expected to be the technology to fill the void and support economic growth [7].

South Africa has a number of players in the broadband market, ranging from regional to national providers. The dominating wireless broadband players are the mobile operators with national coverage. The rollout of broadband infrastructure (3G and LTE) is mainly focused in the urban and major areas where high ROI is guaranteed with the remote and rural areas totally neglected, this is supported and confirmed by the coverage maps provided by Vodacom, MTN and CellC on their websites [25, 26, 27]. On the same note, the dominating fixed-line operator Telkom has infrastructure to provide DSL services in the metro areas and with no infrastructure in the rural areas. Neotel which was licensed as the second fixed-line operator has really made little impact in bringing competition and being an alternative provider in the fixed-line space, particularly in the consumer segment. Its broadband offerings are limited to the five major areas in South Africa, namely Johannesburg, Pretoria, Cape Town, Durban and Port Elizabeth [28]. Its coverage has not expanded since 2011. This has negative impacts on universal access and widens the digital divide between urban and rural areas.
The OECD has noted these uneven growths between urban and rural areas and has recommended that governments need to intervene and encourage broadband coverage to the rural and remote areas [8]. In line with the recommendation, the DoC was tasked with the rollout of a National Consolidated Broadband Network (NCBN) as a remedy to address broadband coverage in rural and underserviced areas, thus increasing both internet and broadband penetration. Sentech, the state-owned enterprise and signal distributor was to be used as the enabler of the NCBN to provide access and connectivity to school, health centres, further education and training (FET) institutions and other spheres of government in these areas [29]. In 2013, Sentech announced the return of its 2.6 GHz and 3.5 GHz spectrum allocations to the regulator citing the high cost of spectrum fees that had grown tenfold from 4 million ZAR to 40 million ZAR [30]. In the same year, Treasury asked Sentech to return 584 million ZAR that it had allocated as budget for the rollout of the NCBN citing the lack of policy direction from the DoC with regard to broadband rollout. Sentech could not afford to keep the unused spectrum. The returned spectrum is fundamental to the rollout of broadband services, 2.6 GHz spectrum for mobile broadband due to its propagation capabilities and 3.5 GHz for fixed broadband.

2.2.1.3 Prices

Prices are strong determinants of services and products take-up, and are commonly lower in markets with high levels of competition. In the OECD countries, broadband services are reported to be affordable [8]. In economic terms, the definition of affordability includes the elements of: the ability to pay the service or good without suffering hardship; and the degree of need for what is purchased. Thus to increase broadband penetration, the prices have to be affordable. Developing policies to bring prices down may be helpful, introducing different tariffs and paying schemes like prepaid and post-paid [7].
The South African market has seen more affordable broadband offerings since the landing of several submarine cables that brought global connectivity, shown in Figure 2-5. The rivalry between the service providers has resulted in reduced data costs and a price war. However, South Africa is still ranked amongst the highest in terms of broadband access prices. The global average price is 6.95 USD per Mbps and South Africa is multiple higher at 30.72 USD per Mbps [30].

2.2.1.4 Services and Speeds

It is acknowledged that competition is the key driver of lowering prices in any market but has significant impact on the quality of services and speeds that can be made available to consumers particularly in the broadband space [8]. Most broadband offerings are characterised by contentions, average speeds and usage limitations (data caps). The high volumes mean the contention ratios become high which has a direct impact on the connection speeds. Of course this is dependent on broadband access technologies been used by the service providers. Wireline technologies tend
to offer less contented, controlled and high speeds broadband services as compared to the wireless technologies especially the mobile.

![Figure 2-2: Benchmark of Broadband speeds in Africa, adapted from [32]](image)

According to the Ookla Netindex [32], South Africa’s broadband has an average download speeds of 5.2 Mbps way below the global speeds of 18.5 Mbps. Comparing the 5.2 Mbps to the 2.95 Mbps that was reported in 2012, there has been a significant growth and speeds have almost doubled. Benchmarked against other peer African countries, South African has moved one level up to fifth position after Rwanda, Kenya, Ghana and Libya in the rank of the best African broadband speeds country [32]. One country that is doing very well is Rwanda as shown in Figure 2-2; the country jumped from fifth position to the top. Rwanda has benefited from the 24 million USD funding from the World Bank, which was used to develop national capacity to provide broadband connectivity and as well as increasing availability of international bandwidth through submarine cables on east coast of Africa [33].

### 2.2.1.5 Choice and Competition

The OECD highlights that having access to broadband and having access to a variety of competitive broadband service providers should not be confused. It argues that
through satellite, almost all subscribers in its countries are within the footprint for broadband-type speeds but satellite services are characterised by high prices [8]. Broadband service providers compete mainly on prices and offerings, however the bigger rivalry is on infrastructure [8]. Network expansions and upgrades using enhanced and faster broadband technologies; and enticing prices are fundamental to increasing market share.

Time to market is critical in infrastructure competition, the re-farming of the 1800 MHz spectrum has compromised the quality of services in the 2G networks but had to be done to meet the demands of high data rates. LTE promises high data rates and there is no spectrum made available to rollout LTE services. The South African consumer market is hungry for high speed broadband [34].

This section has introduced and discussed what broadband is, why it is important and its benefits. Further, key indicators were also discussed that are very important in terms of monitoring and evaluating performance in broadband markets, infrastructure deployments and service offerings.

The next section focuses on detail discussions on the impact of broadband, with emphasis on the economic development.

2.2.2 Broadband Impact on the Economy

There are several studies conducted by a number of researchers to analyse the social and economic impact of broadband. The GSR 2010 [35] in its study reviewed the literature regarding theories of broadband impact on the economy and presented and summarised the evidence generated from these theories. Similarly, Katz [36] conducted a study that focused on assessing the demand for broadband technology and its potential economic impact. Both studies conclude that broadband does have an impact on the economy as discussed below.

2.2.2.1 Contribution to Economic Growth

The GSR 2010 [35] acknowledges that research aimed at producing evidence regarding the impact of broadband on economy is fairly new. The evidence generated
to this far, falls into three categories: contribution to GDP growth, productivity gains and other specific effects on economic growth [35].

Research has confirmed the positive impact of broadband on GDP growth [35]. Though the studies were primarily in the OECD countries and states in the US due to constraints in data availability, data is readily becoming available for other countries. A study by the World Bank has shown the impact of broadband on GDP growth [37]. The impact is seen due to the ability to provide easier access to information that increases efficiencies and productivity in the economy. The study further found that low and middle income countries experienced about 1.38% increase in GDP for every 10% increase in broadband penetration between 2000 and 2006. The study also highlights that the development impact of broadband is greater in emerging economies than in high-income countries.

Table 2-1: Research results of broadband impact on GDP growth [35]

<table>
<thead>
<tr>
<th>Country</th>
<th>Researcher (Institution)</th>
<th>Data</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Crandall et al. (Brookings Institution) and Thompson and Garbacz (Ohio University)</td>
<td>48 states for the period 2003 - 2005 and 46 states for the period 2001 - 2005</td>
<td>No statistically significant results 10% increase in penetration yields 3.6% increase in efficiency</td>
</tr>
<tr>
<td>OECD</td>
<td>Czernich et al. (University of Munich) and Koutroumpis (European Investment Bank)</td>
<td>25 OECD countries for the period 1996 - 2007 and 22 OECD countries for the period 2002 - 2007</td>
<td>10% increase in penetration yields 0.9 – 1.5% GDP growth per capita 10% increase in penetration yields 0.25% increase in GDP growth</td>
</tr>
<tr>
<td>High income economies</td>
<td>Qiang et al. (World Bank)</td>
<td>66 countries for the period 1980 - 2002</td>
<td>10% increase in penetration yields 1.21% increase in GDP growth</td>
</tr>
<tr>
<td>Low &amp; middle income economies</td>
<td>Qiang et al. (World Bank)</td>
<td>120 countries for the period 1980 - 2002</td>
<td>10% increase in penetration yields 1.38% increase in GDP growth</td>
</tr>
</tbody>
</table>
The data presented in Table 2-1, shows the research results of broadband impact on GDP growth collected by various researchers. The conclusion by most of these studies is that broadband penetration has an impact on GDP growth [35].

Rwanda has become one of the powerhouse countries in Africa when it comes to broadband development. Statistics for Rwanda show that the increase in usage and penetration does indeed impact positively on the GDP of the country as shown in Figures 2-2 and 2-3. The GDP per capita for 2015 will be only known end of 2015.

![Figure 2-3: Rwanda Population and Internet Users [38]](image1)

![Figure 2-4: Rwanda Penetration and GDP per capita [38]](image2)
South Africa has also seen an aggressive growth in terms of penetration figures however there are no statistics to show and support the impact on GDP. It is envisaged that once the broadband policy is in its implementation, data will emerge that will support impact of broadband on the GDP. The NBP accentuates that if broadband targets as proposed are met, an assessment of the impact of ZAR 65 billion broadband investment over 10 years will create over 400 000 jobs and will contribute about ZAR 130 billion to GDP [5].

2.2.2.2 Productivity

According to GSR 2010 productivity of information workers depends directly on the investment in ICT capital, which includes the adoption of broadband [35]. Further, the GSR 2010 points out that research has identified positive effects of broadband impact on productivity. Waverman as cited in the GSR 2010, estimated that for every one percent increase in broadband penetration, productivity grows by 0.13% in high and medium income countries [35]. Studies by Atrostic and Nguyen; Rincon-Aznar et al; and Fornefeld et al. in manufacturing, services and information sectors yielded productivity improvements induced by broadband of 5%, 10% and 20% respectively [35].

2.2.2.3 Job Creation and Employment

Katz [36] acknowledges that there is enough evidence that supports broadband contribution towards employment creation, however there are difficulties in measuring the precise causality. Further, according to Katz evidence collected on the impact of broadband on job creation yields two types of employment: jobs created as a result of network infrastructure deployment and jobs that are generated as a result of network externalities [36].

According to Katz and GSR 2010, national studies have estimated the impact of network construction on job creation. These studies relied on the input-output matrices and assumed a certain amount of capital investment [35, 36]. The studies further calculated multipliers, which are a measure of total employment change in relation to
the deployment of broadband networks [36]. Though the studies are for specific countries, it is acknowledged that they cannot be directly applied to other countries but could be used as a base for estimating potential employment gains [22]. Beyond employment created as a result of network construction, researchers have also studied the impact of network externalities on job creation and employment. These studies have found that network deployment has the potential of creating indirect and induced jobs [36]. Table 2-2 below shows the employment effects as a result of capital investment in broadband deployment.

Table 2-2: Employment impact of broadband network construction [36]

<table>
<thead>
<tr>
<th>Country</th>
<th>Capital Investment (USD mil)</th>
<th>Employment Creation</th>
<th>Employment Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>Induced</td>
</tr>
<tr>
<td>US</td>
<td>6 390</td>
<td>37 300</td>
<td>31 000</td>
</tr>
<tr>
<td>Switzerland</td>
<td>10 000</td>
<td>80 000</td>
<td>30 000</td>
</tr>
<tr>
<td>Germany</td>
<td>47 600</td>
<td>281 000</td>
<td>126 000</td>
</tr>
<tr>
<td>UK</td>
<td>7 463</td>
<td>76 452</td>
<td>134 541</td>
</tr>
</tbody>
</table>

Unemployment is one huge factor that impacts negatively on the economy, and South Africa has seen its unemployment rate worsen in recent years. The unemployment rate was estimated to be at 24.7% in 2013 and has increased to 25% in 2015 [38]. Government’s main challenge is to create more jobs and take the unemployment rate down. Any means to create jobs will be very much welcome.

The national development plan (NDP) through the broadband policy [5] acknowledges and identifies the knowledge economy as one of the major job creation drivers. In its definition, it refers to the knowledge economy as “an economy that is underpinned by universally available and accessible high speed broadband providing access to the creation and consumption of a wide range of converged services required for effective economic and social participation”.

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2.2.2.4 General-Purpose Technology

A general purpose technology (GPT) has to do with the role of technology in economic growth and it usually has to do with the changes that transform both consumer life and the ways in which businesses operate [39]. Further, GPTs are seen as technologies that enable new and different opportunities across the entire economy and cut across all sectors of the economy rather than addressing issues of one particular sector or industry [22]. Stream, electricity, and information technology are some of the technologies classified as general purpose technologies as they affect the whole economy [39].

The importance of broadband may be fully realised as it becomes a GPT, broadband as a platform has the potential to satisfy three criteria to be a GPT as in Table 2-3.

Table 2-3: General Purpose Technology Criteria vs. Broadband Potential [39]

<table>
<thead>
<tr>
<th>General Technology Criteria</th>
<th>Broadband Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pervasiveness</td>
<td>Broadband can be used as key input in nearly all sectors.</td>
</tr>
<tr>
<td>Improvement</td>
<td>Broadband has the potential for technological dynamism through the development of new technologies as well as improvements in the capacity and speed of broadband systems.</td>
</tr>
<tr>
<td>Innovation spawning</td>
<td>Broadband has the potential to enable and engender new organisational methods that result in more general increases in productivity.</td>
</tr>
</tbody>
</table>

It is envisaged that as the potential to become a GPT is realised, broadband will become an enabler of technology-based innovation and growth throughout the entire economy by both individuals and businesses including government, academia and other institutions [22]. The symptoms are already showing, today broadband technologies and services are used by businesses and individuals to create new applications and services in areas such as e-commerce, social networking and financial services amongst others.
There is enough evidence that broadband indeed can enable economic growth in the ICT sector and beyond, for both developed and developing countries. The following are some of the specific examples of the impact of broadband as a GPT [22]:

- Research and Development;
- Cloud Computing;
- Improving Customer Relations;
- Improving Supply Chain;
- Building Human Capital through Education;
- Improving Health and Medical Outcomes; and
- E-Government Applications

Certainly, broadband has benefits that facilitate economic development of countries as pointed out in this section. Governments around the globe are pursing public policies to advance broadband development in their countries.

The next section focusses on discussions relating to the role of policy in fostering broadband development and policy options and considerations.

### 2.2.3 Policy and its importance

A policy is defined as "a deliberate plan of action to guide decisions and achieve rational outcomes, the term may apply to government, private sector organisations and groups, and individual" by the Association of Progressive Communication (APC) [40]. One key reason governments develop policies around ICTs is to create an all-inclusive information society, thus addressing the issues of universal access and digital divide. According to the APC, ICT policy should cover information and communication technologies, networks, services, markets and the relationships between the different stakeholders [40].

The broadband commission for digital development was set up by the ITU and United Nations Educational, Scientific and Cultural Organisation (UNESCO) in response to the United Nations (UN) Secretary-General to step up the efforts of the UN to meet the Millennium Development Goals (MDGs) [4]. The commission just like the OECD is in the forefront of fostering policy development with regard to broadband access. It
advocates the importance of broadband on international policy agenda and believes the expansion of broadband access is fundamental for every country in facilitating progress towards achieving the goals set for 2015. The commission further emphasises the importance of national policy leadership, and that it should provide clear vision in identifying opportunities, constraints and actions around the supply and demand of broadband. The commission has established five targets for tracking universal access to broadband as well as digital inclusion for all, and these targets are [24]:

- **Target 1:** Making broadband policy universal by 2015, all countries should have a national broadband plan (NBP), strategy or include broadband in their universal access and service (UAS) definition;
- **Target 2:** Making broadband affordable by 2015, entry-level broadband services should be made affordable in developing countries;
- **Target 3:** Connecting homes to broadband by 2015, 40% of households in developing countries should have Internet access;
- **Target 4:** Getting people online by 2015, Internet user penetration should reach 60% worldwide, 50% in developing countries and 15% in least developed countries (LDCs); and
- **Target 5:** Achieving gender equality in access to broadband by 2020.

Between 2009 and 2010 there has been an explosion in the number of countries that introduced and adopted broadband plans, as depicted in Figure 2-5.
By the middle of 2013 about 69% of all countries had adopted some form of a national plan, strategy or policy in place to promote broadband; this is in line with broadband commission’s targets. Figure 2-6 shows the countries that have some form of NBP and those who don’t.

Figure 2-5: Growth in National Broadband Plans, 2005 - 2013 [24]

Figure 2-6: World Map, according to the status of NBP [24]
To maximise the impact of broadband, the commission makes the following policy recommendations [24]:

- Promote market liberalisation;
- Review and update regulatory service obligations;
- Consider open access approaches to infrastructure;
- Introduce and develop a NBP;
- Update and utilise Universal Service Funds (USFs);
- Review licensing schemes;
- Review and reduce taxation;
- Review policy frameworks for spectrum;
- Spur demand and introduce measures to stimulate the creation of local content;
- Support accurate and timely statistical monitoring; and
- Public consultations on policy.

Many countries including South Africa have relied on the private sector for the deployment of broadband services. It is critical for governments to take a lead role in ensuring a stable legal and regulatory environment to foster investments by creating a landscape that is conducive to competition amongst the different players, as well as establishing adequate spectrum policy and fair spectrum allocation [24].

### 2.2.3.1 South Africa connect

In July 2010, South Africa developed its national broadband policy, revised in 2013 and titled “South Africa Connect: Creating Opportunities, Ensuring inclusion”. The main policy objectives included building an information society; and increasing affordability, the uptake and usage of broadband services [5]. The policy further acknowledges the benefits of broadband as:

- Economic development and growth - which include stimulating growth of SMMEs and cooperatives; increasing employment; improving marketability and encouraging investments; and reduced cost of communication.
- Social services improvements - improved quality of education, health and government services; and reduced carbon emissions.
The ultimate goal of the policy is to achieve universal download speeds of 100 Mbps by 2030 for users. The policy sets progressive milestones towards accomplishing its goal. In February 2014, the DoC in a presentation to the portfolio committee on communications set the policy’s targets as tabulated in the Table 2-4 below, these targets are to be reviewed periodically [41].

Table 2-4: Broadband Policy Targets [41]

<table>
<thead>
<tr>
<th>Penetration measure</th>
<th>Baseline 2013</th>
<th>Target 2016</th>
<th>Target 2020</th>
<th>Target 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>% of population</td>
<td>33.7%</td>
<td>50% at 5 Mbps</td>
<td>90% at 5 Mbps 50% at 10 Mbps</td>
</tr>
<tr>
<td>Schools</td>
<td>% of schools</td>
<td>25%</td>
<td>50% at 10 Mbps</td>
<td>100% at 10 Mbps 80% at 100 Mbps</td>
</tr>
<tr>
<td>Health Facilities</td>
<td>% of health facilities</td>
<td>13%</td>
<td>50% at 10 Mbps</td>
<td>100% at 10 Mbps 80% at 100 Mbps</td>
</tr>
<tr>
<td>Public Sector Facilities</td>
<td>% of government offices</td>
<td>50% at 5 Mbps</td>
<td>100% at 10 Mbps</td>
<td>100% at 100 Mbps</td>
</tr>
</tbody>
</table>

The policy has three key priority areas which are critical and in line with the targets as set by the broadband commission, and these areas are: access, affordability and usage. The policy also clarifies the roles of the three spheres of government (national, provincial and local), state-owned enterprises (SOEs) and the private sector in its implementation [5]. A steering committee and five task teams have been appointed, which consist of different stakeholders that seek to facilitate the completion of the implementation plan. The implementation plan is structured around the digital strategy in the policy, which has four pillars: digital readiness, digital development, digital future and digital opportunity [41].
Monitoring and evaluation are important management tools that help track progress and facilitate decision making, and are key in managing a project, program or policy for that matter. Countries that seek to implement their NBPs must have capabilities to be able to track and monitor progress on the implementation of their plans. The next section discusses key indicators that are used to evaluate and monitor performance in relation to NBP with regard to broadband markets, infrastructure and developments.

### 2.2.4 Policy approaches to promoting broadband development

The adoption of a NBP is the right direction, but the task of developing strategies and policies to promote broadband is not an easy one, policy makers are now becoming aware of the difficulty in promoting broadband as compared to other types of services such as mobile and fixed telephony [22]. According to Kelly and Rossotto [22], the usefulness of a mobile or home phone is obvious to the consumer irrespective of their income or education level. The use of broadband requires access to a computer or smartphone and a connection to a network through some form of subscription either post-paid or prepaid.

Policy makers and analysts have to consider how to best promote broadband. Kelly and Rossotto [22] suggest that broadband should be viewed as an ecosystem with supply and demand dimensions. The building of networks to carry broadband services becomes a priority on the supply side, however having built the networks, does not automatically guarantee that the services will be taken [22]. Demand should be driven by government policy together with private sector investment through an awareness campaign by educating users about the benefits of broadband and the skills needed to use the services [22]. According to Kelly and Rossotto [22], the countries that have succeeded in broadband development have focused on holistic policy developments that supported and balanced both sides of the supply and demand equation.

The role of governments becomes critical in policy development. Williams [37] emphasises that successful policy should include these two complementary elements, namely:
The creation of an enabling environment for infrastructure competition through full liberalisation of markets to encourage infrastructure competition and allow aggregation of traffic onto backbone networks; and

- Simulate rollout in underserved areas, especially in remote and rural areas.

Williams further highlights how a number of policies and strategies could be adopted within these elements. The summary of these policy options with their strategies are shown in Table 2-5.

According to William [37], the lack of incentives for private investment in many countries in the sub-Saharan Africa has been seen to be discouraging competition. Governments by effectively promoting private investment will likely achieve policy objectives and at the same time reduce the financial burden on the public sector by ensuring and facilitating universal and affordable broadband access [37]. In the OECD countries, the policy of promoting infrastructure competition is very consistent and a report by the OECD as cited in William [37] has indicated that the implementation of such policy has resulted in highly competitive markets, and that the very same competitive forces have driven the cost of telecommunication down.

**Table 2-5: Summary of Policy Options [37]**

<table>
<thead>
<tr>
<th>Policy Option 1</th>
<th>Policy Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create an enabling environment for infrastructure competition</strong></td>
<td><strong>Stimulate rollout in underserved areas</strong></td>
</tr>
<tr>
<td><strong>Remove regulatory obstacles to investment and competition</strong></td>
<td><strong>Implement incentive-based private sector models</strong></td>
</tr>
<tr>
<td>- Remove limits on the number of network licenses</td>
<td>- Provide operators with incentives to cooperate in the development of broadband/backbone infrastructure in underserved areas where infrastructure competition is not commercially viable</td>
</tr>
<tr>
<td>- Encourage entry of alternative infrastructure providers</td>
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<td>- Remove constraints on the broadband/backbone services market</td>
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<td>- Improve the regulation of broadband/backbone networks</td>
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<tr>
<td><strong>Reduce the cost of investment</strong></td>
<td><strong>Establish competitive subsidy models</strong></td>
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<tr>
<td>- Facilitate access to passive infrastructure</td>
<td>- Provide operators with incentives to build networks in currently underserved areas through reductions in taxation or</td>
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<tr>
<td>- Promote infrastructure sharing</td>
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universal service fund (USF) contributions

<table>
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<tr>
<th>Reduce political and commercial risks</th>
<th>Create shared infrastructure/ consortium models</th>
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<tr>
<td>• Provide risk guarantees and political risk insurance</td>
<td>• Provide operator(s) with a subsidy to build and operate a network in currently underserved areas of the country; provide services in these areas on a non-discriminatory basis</td>
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<td>• Aggregate demand</td>
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<th>Promote competition in the downstream market</th>
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<td>• Implement regulation that will effectively promote such competition</td>
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The liberalisation of network markets have shown that even if all regulatory obstacles are removed, the investment and competition will only emerge in areas that are commercially attractive [37]. Thus the large proportion of the population will still not benefit from the competition, particularly the developing countries as the majority of the population resides in rural and remote areas. Critically, the policy for stimulating rollout in the unserved areas becomes very important. The implementation of such policy requires public subsidy to facilitate rollout in those areas.

These two policy options are relevant to the South African environment and can be used on a complementary basis as they address two crucial areas, competition and universal access. In commercially attractive areas, the infrastructure competition policy becomes relevant and appropriate for stimulating competitiveness. The implementation of the NBP will adopt the second policy option as its key objective is that of bringing universal access and service.

The next section discusses other policy considerations that are crucial to successful broadband development. The GSR 2011 has identified and endorsed best practice guidelines on regulatory approaches to advance the deployment of broadband, these guidelines are some of the policy considerations that are key to broadband development.

Approaches to infrastructure deployment for broadband development are key. Government should take the lead in fostering broadband. The following are key
lessons that have been learnt from other countries, with regards to the roles of government in broadband development [22]:

- Government should focus on maximizing competition, including removing entry barriers and improving the incentives and climate for private investment.
- Government should provide for specific, limited, and well-justified public funding interventions only in exceptional circumstances. For example, where governments are trying to promote growth of underdeveloped markets.
- Government funding or policy should not compete with or displace private sector investment.
- Government should maintain a level playing field for competition by avoiding favouring one company over another.
- Subsidised networks should be open access.
- Government may need to regulate dominant providers to avoid market concentration or other adverse impacts on overall market competition.
- Government should eliminate barriers to content creation and refrain from blocking access to content, including social networking sites, or restricting local content creation.

2.2.4.1 The broadband supply chain

Broadband service may be seen as the last-mile connection to the end-user. However, the end-to-end connection has several components connected in a chain. Kelly and Rossotto [22] categorise these components into four hierarchical levels, which when combined constitute the supply chain for broadband services. This is vital for policy makers to note and recognise these components when considering plans and strategies for developing broadband networks [22].

Government’s role is to develop enabling policies that eliminates bottlenecks in the broadband supply chain. Competition should be ensured in all the different levels of the supply chain, this is to ensure that bottlenecks do not arise which severely reduces the benefits of broadband diffusion [22]. Figure 2-7 summaries the policies and what they seek to achieve on all levels of the supply chain.
Kelly and Rossotto [22] list the four hierarchical infrastructure components of broadband supply chain as:

- **International connectivity** - this layer provides connectivity beyond the country's borders of local broadband networks to other countries, either via satellite and/or optic fibre;
- **National backbone network** - provides pathways across the country, typically via microwaves, optic fibre and satellite links;
- **Metropolitan/backhaul network** - provides the connections between local areas and the national backbone network, usually via optic fibre and microwave links; and
- **Local access networks** - provide the infrastructure (wired and wireless) that the users utilise to connect the broadband network.

### 2.2.4.2 Open access

The OECD [16] describes open access as wholesale access to network infrastructure or services that are provided on fair and reasonable terms, where some degree of transparency and non-discriminatory is exercised. OECD further highlights the leading role open access plays in the development of competition, such as local loop...
unbundling (LLU) and mobile virtual network operator (MVNO). The studies undertaken by OECD [16] have revealed that LLU has developed significant competition among the players in numerous countries. Open access policies in the form mandated regulated access, brought about liberalisation in markets in most OECD countries [16]. It is envisaged that open access arrangements will also play a leading role in shaping competition in the next generation access networks (NGA), particularly where infrastructure competition is not economical for operators especially in areas outside dense and urban areas [16]. Open access can also be used through public-private partnerships for investing in facilities where private initiative is found to be not in line with public policy objectives [16]. Further, the OECD [16] highlights that in the case of market failures, open access policies are often used to address such issues usually in the form of mandated open access.

Bogataj [42] defines open access as;

“access model that provides broadband-access with fair access to services, provided by different and usually competing service providers. All service providers share the same network resources and the equipment of a single network provider”.

Open access models are normally implemented as a result of regulatory intervention aimed at promoting certain policy objectives, such as universal access and service; greater choice for consumers; or addressing infrastructure bottlenecks [16]. According to Bogataj [42], there are several approaches to open broadband access and technically the model can be implemented in several ways beyond the traditional wholesale model, with different roles and obligations for parties involved. Bogataj [42] further lists the different technical flavours as:

- Two-tier open access model - individual service providers provide to the customers only the services they specialised in. They all maintain their separate service networks and provide their own getaways as the connection points for the services they offer over the network provider’s network;
- Three-tier open access model - the model is similar to the two-tier open access model, except for the introduction of the third and intermediate party, the service integrator. The service integrator providers its own gateway as a connection
point for services the individual service providers offer to their customers over the network provider’s network; and

- Integrated open access model - the model eliminates the need for the service integrator in the three-tier open access model. The network provider provides everything including the gateway as connection point to the individual service providers.

Kajee’s [43] study on open access network model for South Africa has revealed that the price of broadband access is very high for both fixed and mobile markets. Affordability is one key barrier to broadband adoption [24]. The open access model may help in bringing competitive pricing thus increasing penetration. Kajee [43] further lists the following factors as key drivers for open access network model:

- Small commercial players - wanting to gain access to infrastructure and markets at fair and equitable terms.
- Government - wanting to improve access to ICT for poor communities in order to stimulate economic growth as well as improving utilisation of state resources.
- End users - wanting cheaper access to faster high quality bandwidth.
- Non-Commercial and Non-Profit Organisations - wanting to improve the social welfare of people in need through ICT.
- Civil Society - lobbying for spectrum to be allocated, licensed and managed in a manner that creates maximum benefits for everyone is the country.

Forzati et al. as cited in Kajee [43], highlight that the state has strong political interest in fibre access networks and this is motivated by the argument that high broadband penetration results in social, environmental and economic benefits. Kajee’s analysis of the South African telecommunication market indicates that high levels of anti-competitiveness due to larger incumbents monopolising network infrastructure and access to give themselves unfair advantage over smaller players who are unable to compete [43]. The open access model is seen to be the solution to address such uncompetitive conditions [43].

The NBP [5] lists the adoption of open access principles as one of its key policy objectives. It further emphasises its intentions as part of its strategy of meeting the
national broadband requirements to reserve spectrum for the creation of a national open access wireless network. Further, according to the NBP [5] the creation of the national broadband network (NBN) will stimulate the building of the broadband network infrastructure by reducing the investment risks for the incumbents by avoiding duplication. However, the areas and aspects of the rollout that require a smart kick-start approach will be prioritised and funded by public sector investment.

The national integrated ICT policy green paper [44] highlights the policy objectives of promoting open access as creating a clear access regime that is enforceable as well as a uniform access regime that considers all technologies and services. The submissions to the green paper revealed the lack of effective regulation on open access as the primary reason for failure in achieving policy objectives [45]. The discussion paper also highlights that most of the submissions are in favour of the open access. However there is a strong argument that a balance must be struck allowing providers to recoup investment in broadband infrastructure thus encouraging further investment, and preventing excessive profits [45]. Further the ECA does not provide sufficient details with regard to open access which makes the work of the regulator very difficult in determining the perimeters [45].

2.2.4.3 Infrastructure sharing

According to the APC [46], infrastructure sharing is an effective strategy for accelerating the extension of telecommunication networks and reducing costs. Sharing takes place between different network providers and may take many forms, ranging from passive infrastructure to active elements such as network roaming and the core [47]. A study [46] commissioned by the APC and undertaken by Deloitte shows that infrastructure sharing has many benefits hence it should be considered as one of the key components of any national policy effort, aimed at unleashing the economic and social benefits of affordable broadband. The benefits include better connectivity, cost savings, revenue generation and competition [46].

However, the market and regulatory environments dictate the infrastructure sharing opportunities to a large extent and thus the national policies in place may either foster
or inhibit the adoption of infrastructure sharing [46]. Key constraints beside the market environment that hinder infrastructure sharing have been identified as [46]:

- Lack of coordination across different sectors regulation;
- Lack of broader strategic telecoms plans;
- Lack of stability in licensing environment;
- Lack of funding; and
- Lack of spectrum or high spectrum fees.

For broadband development to flourish, policy and regulation have a role to play particularly in encouraging and promoting infrastructure sharing. The findings of APC study has identify a number of general strategies that governments and regulators can consider in order to for encourage and promote infrastructure sharing for broadband.

From policy development perspective, the following strategies were identified to promote sharing for both the ICT industry players and other passive infrastructure operators in other sectors:

- Include obligations that ensure provision for sharing in the planning approval procedures for infrastructure development;
- Provide financial support to encourage sharing where public works are undertaken by the state;
- Subside the extension of private networks, and impose sharing obligations on the subsided infrastructure; and
- Facilitate use of rights of ways.

The strategies that regulators may consider include [46]:

- The creation of sharing framework that forms part of the licensing mechanism and associated regulations;
- Make the publishing of infrastructure sharing information a requirement for operators;
- A rapid and effective dispute resolution mechanism to avoid arbitrary sharing request denials from operators; and
- Financial incentives to facilitate investment in infrastructure.
The green paper [44] is of the view that infrastructure sharing promotes the objective of the NDP in ensuring affordable access to an array of ICT services. Further, the paper highlights that policy must seek and provide for maximisation of the use of facilities through the use of infrastructure sharing [44]. The ECA [48] makes provisions for facilities leasing and that it should promote an environment of open, fair and non-discriminatory access to broadcasting services, electronic communication networks and to electronic communications services.

According to Gillwald et al. [49], regulatory and way-leave approval bottlenecks have hindered effective rollout of services in South Africa. No progress has been made despite the identification of the need for an integrated national rights of way for fibre rollout, and the operators find themselves having request way-leave permissions on an individual basis from the municipalities and other agencies [49]. There is no coordination at all in the permission process and it is evident by constant digging and pulling of streets and pavements by operators after one another [49]. While the legislation allows new entrants to interconnect and lease facilities from the incumbent operators already in the market, Gillwald et al. [49] have found that the costs charged to the new entrants for leasing such facilities are exorbitant. Due to these high costs, the new entrants resort to building their own networks instead of relying on third party infrastructure which require capital investment thus duplicating the infrastructure unnecessarily and they are unable to compete effectively with the incumbent [45, 49].

2.2.4.4 Funding and universal broadband access

Network infrastructure deployment requires significant amounts of capital investment. The ITU [17] has identified a number of models and their combinations thereof, which countries could adopt for broadband development funding. The models are listed as:

- Direct government investment;
- Targeted government investment;
- Public-private partnership; and
- Private partnership.

It is acknowledged that the private sector will play a central role in broadband development in most countries and thus supportive policy and good governance
become essential for successful broadband deployment and take-up [50]. In cases where it is not commercially viable and attractive for private investment, government could mobilise public funds through public-private partnerships to invest in broadband infrastructure in those areas, thus leveraging on such partnerships [50]. Further, where such partnerships are not possible, public funds could be utilised for broadband infrastructure development and implement open access policies for accessing the infrastructure facilities to maximise the economic benefits for both the suppliers and consumers. The GSR 2011 [50] emphasises that regulatory framework plays a crucial role in this regard, and that a framework that eliminates barriers of entry for new players combined with market-based schemes are the most effective way of promoting broadband development.

The broadband commission [24] lists updating and utilising the universal service and access funds (USAF) as one of the policy recommendations for maximising the impact of broadband. Similarly, the GSR 2011 [50] also recommends that regulators and policy makers should modernise universal service programmes and funds. The existing universal service programmes should be transformed into programmes for digital inclusion that support universal broadband services for all citizens, this could be achieved through incorporating a framework that ensures blanket access to broadband services [50]. The broadband commission highlights that USFs and similar subsidies may be used to fund programmes intended to improve availability and affordability of broadband services for the underserved areas. Besides infrastructure investment, the USFs could be used for promoting broadband adoption through subsidising content, devices, services and digital training [24].

The NBP’s implementation plan is structured around its digital strategy which has four pillars, namely: digital readiness; digital development; digital future; and digital opportunity [5]. The four pillars will be funded as follow:

- The digital readiness and digital development pillars will be funded through reprioritisation and rationalisation of existing budget allocations [5]. Further, the DoC will engage other government departments for exploring other funding options, such as the public works and rural development. Sector specific
agencies and funds such as USAF and skill development fund will be explored as well.

- The digital future strategy's intention is to create an open access broadband network for universal access, which it acknowledges that its implementation requires significant funding. Funding is expected to be channelled through public-private collaboration and raising funding from institutions such as the Development Bank of South Africa (DBSA) and the Industrial Development Corporation (IDC) to finance network extension to rural and unserved areas [5]. Further funding is expected to come from the fiscal in consultation with national treasury [5].

On the contrary, it is advised that market-based funding solutions for the broadband deployment and uptake should be rather preferred to government investment in order to avoid straining public finances [22]. Further, it is advised that governments should ensure that the use of public funds for broadband are supported by sound economic analysis and that benefits are weighted against investing in other areas such as education, health and energy [22].

### 2.2.4.5 Market Liberalisation

The GSR 2011 believes that governments should have a policy in place that clarifies their commitment to foster broadband development across all sectors through liberalising the broadband market and empower the regulator to enforce [50]. Similarly, the broadband commission emphasises that the governments’ role is to ensure that market liberalisation encompasses all key elements of broadband service delivery [24]. A study conducted by ITU/Cisco as cited in the broadband commission suggests that competition plays a strong role in boosting broadband penetration and has been a key driver of private investment in communication infrastructure in many countries [24]. Thus, it is suggested that existing legal and regulatory frameworks need to be reviewed to lessen the barriers that hinder the broadband development [50].

The telecommunication regulatory environment (TRE) assessment is “a diagnostic instrument for assessing the performance of policy and laws affecting the telecommunications and the various government entities responsible for their
implementation” [49]. According to Gillwald et al. [49], South Africa has a poor TRE position and ranked position 10 out of 11 countries assessed in 2012. The stakeholder perception with regard to market entry was negative. South Africa’s policy on market liberalisation is that of a managed approach and was entrenched in the 1996 Telecommunications Act and has been like that since [49]. Gillwald et al. [49] highlight that this managed liberalisation approach has made it difficult for new entrants to compete effectively. Though the Electronic Communications Act of 2005 (ECA) does liberalise the market, but according to Gillwald et al. the lack of effective regulation in wholesale market has made it impossible for new entrants to compete, hence the costs of communication are still high [49].

2.2.4.6 Licensing Regime Reform

The broadband commission is of the view that modern approaches to regulation need to be considered for broadband development to flourish [24]. The GSR 2011 also concurs and stresses that in order to lessen the barriers of entry which increase competition, the licensing regulation should take a simplified and unified licensing framework approach [50]. This approach involves one unified license given to the incumbents for provision of any telecommunication service [24].

The service licensing framework in South Africa under the ECA [48] is technology-neutral and has been separated into two categories, namely:

- **Electronic Communications Network Service (ECNS) licence**: this license authorises the holder to construct and operate a network infrastructure. No restrictions are imposed in terms of technology of choice; the licensee can construct a network using either wireline or wireless technologies; or a combination of both. Furthermore, the holders of this license have the right to enter into commercial agreements with other providers, who do not possess this license, to allow them to use their networks to provide services to the market.

- **Electronic Communications Service (ECS) licence**: this license grants the holders the right to provide services to the market. Either by using own networks
for holders with ECNS or leasing capacity from ECNS licensees’ networks based on commercial arrangements.

Under this licensing framework, incumbents require both service licenses for network infrastructure deployment and service provisioning.

2.2.4.7 Promoting Demand

The “if you build it, they will come” approach was very successful for 2G voice networks, however the very same approach cannot be applied to broadband [51]. Broadband use and take up is dependent on a number of factors, which include digital literacy, level of education, costs and relevance [51]. Kelly and Rossotto [22] emphasise that in order to stimulate demand and uptake of broadband, governments should create an enabling environment through policy by addressing awareness, affordability and attractiveness of broadband services.

The ITU [7] acknowledges that there are differences in culture, landscape and technological development, however there are several key factors that are common in economies that have been successful in promoting broadband. The ITU summarises the factors as:

- Informing the public about broadband;
- Making effective use of broadband through applications and content;
- An environment that fosters broadband innovation; and
- A competitive market structure that keeps prices low.

The ‘digital opportunity’ is one the four implementation strategies of the NBP, its intentions are to ensure that people realise the benefits of broadband by creating awareness and having the skills, relevant content and applications that are aimed at enticing and stimulating demand and uptake [5]. The NBP further identifies high prices charged for communication services in South Africa as one of the factors that hinder competitiveness and acknowledges that the high prices create barriers to broadband adoption, uptake and usage [5]. The NBP suggests that considerations be made around using the universal service and access fund to subsidise low income consumers.
2.2.4.8 Spectrum

The distribution of spectrum for broadband wireless services has become the cornerstone of the future growth of the digital economy. As the demands for more powerful, ubiquitous and seamless broadband services grow, it is envisaged that wireless broadband, in particular mobile will play a crucial role in addressing the market demands [50]. The GSR 2011 advices that policy makers and regulators need to address a host of policy issues around spectrum management in fostering broadband development.

This section discussed key policy issues that are fundamental to broadband access and development. Broadband offers countries an enabling platform and new tools to foster growth, extend public services, enhance businesses, and benefit their people. Thus making broadband a priority in a country’s development agenda becomes a necessity and should be driven through government policy.

The next section discusses spectrum in detail as one key element for fostering broadband development.

2.3 Spectrum Management

The ITU describes radio spectrum as “a subset of the electromagnetic waves lying between the frequencies from 9 kHz to 300 GHz” [11]. Spectrum is a natural resource that has both economic and technical dimensions. Economically, spectrum can be used as an input in a multitude of services such as communications or other uses. Technically, radio frequency spectrum is the part of the electromagnetic spectrum that carries radio waves [11]. The entire electromagnetic spectrum and some of its uses are shown in Figure 2-8.

Radio spectrum has a variety of different uses and applications. The most common are: broadcasting, satellite and mobile communications services [52]. Broadcast uses include radio stations, television stations, and satellites used for direct broadcasting. Mobile communications can provide a variety of services to both public and the private sectors. In the public sector, the uses range from military, police, air traffic control,
emergency and rescue services; while commercial uses include cellular radio, paging systems, trunked radio systems, aeronautical radio navigation and communications, and the mobile satellite communications and tracking systems [52].

Radio frequency spectrum is a limited resource just like land and water, it has the properties of being conserved if used properly and wasted if not. Its uses need to be coordinated to avoid harmful interference between the different users hence the need for it to be managed. Spectrum management is an extremely important part of telecoms policy and regulation. The ITU defines spectrum management as “a combination of administrative, scientific and technical procedures to ensure the efficient operation of radio communication equipment and services without causing interference” [54]. In simpler terms, spectrum management is the overall process of regulating and administering radio frequency spectrum. The key elements in spectrum management are frequency management, licensing and enforcement [54].

The spectrum is allocated for particular uses, and specific technical and service rules govern those allocations. There are four main areas of work in spectrum management namely planning, engineering, authorisation and monitoring [11].
Spectrum planning involves the allocation of portions of frequency spectrum to specified uses in accordance with regulation, e.g. Table of frequency allocations.

Spectrum authorisation involves granting of access under specified conditions by various types of radio communication equipment and certification of radio operators, e.g. Type Approval certificates.

Spectrum engineering involves development of electromagnetic compatibility standards for equipment that emits or is susceptible to radio frequencies.

Spectrum monitoring and compliance involve the monitoring of the use of radio spectrum and the implementation of measures to control unauthorised use.

The ITU further stresses that the goal of spectrum management is to maximise efficiency and minimise interference. According to the ITU [11] and Cave [55], spectrum management has three competing objectives, namely:

- Economic efficiency, this objective is about deriving high value from the spectrum by allocating it to the market that has high demand for it. Responsiveness and flexibility are fundamental to changes in markets and technologies thus accommodating new services that are technically and commercially feasible;
- Technical efficiency implies the fullest possible use of spectrum with adherence to technical limits; and
- Policy, this objective is about consistence in government policy towards different stakeholders, fostering an environment that is conducive to fair competition and safeguarding essential services such as defence, emergency and other public services.

The next section focuses on the institutions and their arrangements with respect to their roles and responsibilities in performing spectrum management functions.

### 2.3.1 Spectrum Management Institutional Arrangements

The ITU sits at the highest level of management, as a specialised agency of the UN [12]. It regulates the use of radio spectrum globally. It organises world radio
conferences (WRC) every three to four years. At these conferences, the member states debate, review and revise by consensus the radio regulations (RR). The RRs are the international treaty that governs the use of radio frequency spectrum and satellite orbits on the basis of technical and regulatory studies and expert advice [24]. The treaty represents the international agreement for allocation and harmonisation of spectrum to ensure smooth operation of wireless devices free from interference. All member state governments and regulators are expected to commit and adhere to the treaty that the spectrum will be used as documented in the RR. The wing of ITU that deals with spectrum management is called the ITU-R. In the nutshell, the role of ITU-R is to provide an enabling environment for the development of radio communications through [11]:

- Worldwide spectrum regulations and harmonisation;
- Coordination and recording of frequency assignment;
- Worldwide standards and best practices on spectrum usage; and
- Informing, advising and assisting membership.

Beyond the ITU, spectrum management responsibilities are relegated and divided amongst the government, regulator and the private sector organisations. The country's constitutional circumstance, political and legal systems determine how the power to regulate spectrum should be exercised [11]. In some countries, the regulator is an independent agency and in others it is part of the government ministry.

The South African regulatory landscape is that of an independent agency. ICASA was established in 2000 as a merger between Independent Broadcasting Agency (IBA) and South African Telecommunication Regulatory Authority (SATRA). This was one of the structural changes in regulatory framework. The merger was to ensure effective and seamless regulation of the telecommunications and the broadcasting sectors in the mind of accommodating the convergence of technologies. The ICASA’s mandates are stipulated in the ICASA Act of 2000 and subsequently in the Electronic Communications Act (ECA) of 2005. The ECA introduced a number of positive changes to the roles of the regulator, ICASA and the DoC. The ECA gives clear distinctions in terms of roles which the two entities are responsible for, amongst others including [48]:

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ICASA no longer has to act in accordance with ministerial policy directions, but must consider these policy directions;

ICASA is free to make regulations and requires no approval from the minister, but must inform the ministry prior to making such regulations; and

ICASA has the control of the licensing process except that it may not issue an invitation to apply (ITA) for an individual electronic communications network service (ECNS) license unless this is done in accordance with a ministerial policy direction.

This was a huge step taken by the act towards making ICASA independent from ministerial interference in its day-to-day operations. However the ECA diminishes the regulator's powers in respect of radio frequency spectrum, by requiring approval from the ministry for development of national frequency plan. This somehow duplicates the function as both the ministry and the regulator have to employ personnel with this expertise.

The institutions within the field of spectrum management and their relations have unpacked in terms of their responsibilities and powers. Next section looks at different approaches in which spectrum management functions could be performed, particularly managing and allocating spectrum licenses to prospective users.

### 2.3.2 Spectrum Management Approaches

Several approaches to spectrum management exist. These approaches offer unique advantages and disadvantages, and none is superior to the others. Three common methods in spectrum management are: administrative, market-based and commons approaches. The ITU argues that the regulators should strike the right balance between these methods in managing the spectrum [11]. There is a general trend globally where spectrum regulators are moving away from the administrative approach towards the market-based approaches and this is due to the growing demands of spectrum and technology evolutions.
2.3.2.1 The Command and Control Approach

The administrative method also known as the “command and control” is the most dominating approach and has been there for over hundred years. The method specifies the rules and constraints in terms of how the spectrum should be used and who has access, it prescribes the application and technology for every block of spectrum. It assigns property rights to the user. The biggest positive of this method is minimisation of interference thus protecting the users. According to Freyens [56], the command and control approach does not allow license trading, thus providing no incentive to license holders to maximise the value of their spectrum allocations. This leads to inefficiencies, spectrum hoarding, idle bandwidth and restrictions to adapt to new market conditions [56]. The ITU [11] and Bauer [57] concur and further list the flaws of this method as rigidity, long delays, and patterns of over and under allocation of spectrum to users. Song et al. [58] blame this approach for spectrum scarcity and further stress that it is the one that is preventing users from benefiting from the abundance of the resource. Cave et al. [12] point out that the most popular administrative method of assigning licenses is the use of comparative hearings also known as “beauty contests”. The “beauty contests” are believed to be lacking objectivity and transparency and thus are prone to favouritism and corruption [12].

2.3.2.2 Market-based Approach

Market-based methods are employed when new licenses are issued and when change of use for a particular spectrum is required. According to Freyens [56], this model keeps the idea of licensing the spectrum to users in terms of giving property rights but differ from the “command and control” in many ways. Auctions and trading are the most common models used in the market-based approaches and are viewed as superior ways of achieving economic efficiency [11].

Auctions are mainly considered in cases where: the supply of available spectrum is scarce; there are many spectrum license applications; the service to be provided with the spectrum can be precisely defined; and the monetary value of spectrum license is high [11]. According to the ITU, the license goes to the highest bidder. One critical thing for auctions to work properly is that the rules must be clear and understood by
all participants. Cramton [59] points out that though there have been positive experiences with auctions, several auction design issues have surfaced that are conducive to tacit collusions. He emphasises that the goal of an auction should be efficiency rather than revenue maximisation. Cramton further stresses that revenue maximisation is a short-sighted strategy and that it creates monopolies [59]. Cave et al. [12] outline and summarise the objectives of auctions as follows:

- Efficiency - the assignment of licences leads to licences being awarded to those who value them the most;
- Revenue - tax revenue raise for the government;
- Competition - spectrum rights are issued in a way that helps promote effective competition; and
- Transparency - to ensure that the process of selection is without corruption.

Several auctions have taken place around the globe; in particular the Federal Communication Commission (FCC) which is the regulator of the commercial spectrum within the borders of United States of America (USA) has run a series of successful auctions since 1994. Between 2000 and 2001, a sequence of auctions took place in Europe for 3G licences which began in the United Kingdom (UK) driven by Office of communications (OFCOM), the independent regulator and competition authority, which saw operators’ bids in the excess of $35 billion for five 3G licences [11]. In 2002, Nigeria successfully auctioned three national GSM licenses.

Spectrum trading is defined by the ITU [60] as a “mechanism whereby rights and any associated obligations to use spectrum can be transferred from one party to another by way of a market-based exchange”. Cave et al. [12] insist that spectrum trading is a powerful way of allowing market forces to manage the assignment of spectrum rights and associated obligations. Trading promotes efficient use of the spectrum and takes place if the spectrum has more worth to the new user that the current holder. The transaction costs should kept at minimal but have to make business sense and be beneficial to both parties. Some of the benefits of trading include: enabling the licensees to expand quicker; and making it easier for new entrants to acquire spectrum. The ITU lists the forms of spectrum trading as [60]:

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• Sale - usage right ownership is transferred to another party;
• Buy-back - usage right is sold to another party with an agreement that the seller will buy back the usage right in the future;
• Leasing - the right to exploit the usage right is transferred to another party for a defined period of time but ownership and the obligations remains with the original rights holder; and
• Mortgage - the usage right is used as collateral for a loan.

Bilateral negotiations, auctions, brokerage and exchange are some of the mechanisms used in trading and are likely to be combined in effecting the trade [60]. Australia, El Salvador, Guatemala, New Zealand, UK and the USA are some of the few countries that have already implemented spectrum trading.

2.3.2.3 Commons Approach

The “commons” also known as license-exempt or unlicensed spectrum is the part of the spectrum where a license is not required to transmit [11, 12, 60]. According to the ITU [11], the unlicensed bands were designated as industrial, scientific and medical (ISM) for non-communications use, such as heating. These bands are widely regarded as “garbage bands” and many industry observers concluded that the designated uses of these bands particularly the 2.4 GHz band have crowded the band sufficiently that no reliable service could be offered [61]. There have been lots of interests in these bands recently and new developments have since surfaced. These developments include: the successful commercial deployments of wireless local areas networks (WLANs) in the 2.4 GHz band, which proved to be innovative; the development of ultra-wide band (UWB) and software defined radio (SDR); and continuous development of low power devices and new applications such as Bluetooth and radio frequency identifications (RFID) [11, 12].

The commons model suggests that frequency bands be shared by unlicensed users adhering to codes of conduct and technical standards [56]. The model is based on technological arguments for efficient spectrum management. According to Lehr and Crowcroft [62], the commons approach offers many attractive benefits when implemented in conjunction with the market-based approach. It is believed that
openness promotes innovation in the use of spectrum, and this is advocated by the successful development and deployment of systems for spread spectrum technologies into cordless phones, WLANs and wireless home networks. Faulhaber and Farber [63] argue that if innovation has been so forthcoming in this unlicensed environments, why not extend the commons environment to the entire spectrum. The benefits of the common approach provides users with greater economies of scale by reducing equipment costs, removes the direct costs that are associated with accessing spectrum and reduces the barrier of entry providing wireless services [64]. Further, the model could be used for jumpstarting broadband wireless access deployment particularly in the rural and underdeveloped areas.

On the contrary, regulators should take precautions when implementing this approach. The ITU [64] warns and advises that considerations should be made with regards to the long-term inherent risks that are associated with the approach. In the long-term, this approach might result in overcrowding as a result of increasing numbers of competing and interfering radios thus creating an unstable environment [64]. These risks could be mitigated by imposing new set of technical rules which would effectively be converting the common approach into the “command and control” approach thereby defeating very purpose for establishing the common approach [64].

No particular approach is superior to the others and a balance should be struck between these approaches when developing spectrum policies. Most spectrum policies are still based on the traditional approach, which lacks flexibility and discourages innovation.

According to Ellipsis [41], ICASA has followed the first-come-first-serve approach in assigning spectrum to this far and it is envisaged that the regulations that are about to be finalised will set out the mechanisms to be employed in assigning spectrum where demand exceeds supply. The subsequent draft policy directions issued by the DoC in 2011 for assigning high demand spectrum was intended to facilitate different licensing methods in high demand spectrum bands [65]. ICASA was mandated to determine an appropriate licensing methodology to achieve the following policy objectives: universal access and broadband for all; introduction of new entrants and economic empowerment [65]. Further, the policy less favoured auctions, and insisted that the
auctions should be considered as the last resort in cases where there are competing applications who have met all stated policy objectives [65].

The next section looks at changes that spectrum policies should introduce to allow flexibility and encourage innovation.

2.3.3 Spectrum Policy and Framework Reforms

The need for spectrum policy reforms cannot be ignored and has become imperative for governments and regulators to relook at their policies to cope with the current demands and challenges of the future. The different approaches to spectrum management have been discussed; the ITU and other commentators argue that a right balance between the approaches should be struck. Rafique et al. [66] insist that the current spectrum management regulatory framework need serious consideration for policy reforms. They argue that these reforms are fundamental to meeting the future challenges that will be imposed by bandwidth hungry applications and converged ubiquitous communication services on regulatory models. They further point out that the conventional model has resulted in spectrum hoarding thus depriving the economy of the opportunity cost of this scarce resource. The main factors that can be attributed to the need for spectrum reforms are [11, 66]:

- The obsolete “command and control” system - the system was developed over 100 years ago and was based on limited and primitive knowledge about radio frequency waves and conventional interference management techniques. The system has been proved to have a lot of inefficiencies, lacks flexibility and cannot adapt to changing market conditions and demands.

- Next Generation Wireless Networks - the demand for broadband connections has driven the technology vendors to develop and advance the current technologies to cope and adapt with high demands. These emerging technologies require spectrum in the already allocated bands thus requiring some form of reform in regulatory framework in spectrum management.

- Technology innovation - the development of technologies such ultra-wide band (UWB), software defined radios (SDR) and cognitive radios (CR), which have intelligent ways of using spectrum, are the driving forces towards open access.
- Market pressures - new business models, trading, market liberalisation and innovative technologies such as UWB and CR are the key drivers.

The ITU [11] points out that the main principles that underpin spectrum management reform agenda are: liberalisation and flexibility; technology and service neutrality; and trading and open access.

The GSR 2012 [14] highlights that the main forces that drive governments to rethink spectrum policy include the following: convergence, globalisation, use of the internet, increasing demand for broadband and mobility, competitive conditions, much broader availability of wireless and the trend toward integrated national broadband policies. A well-designed spectrum policy is essential in a digital world and this is due to the advances in broadband which have put strain on spectrum capacity [14].

2.3.3.1 The Regulatory Model

The regulatory model for spectrum regulation has to evolve with times to address all the issues raised. The change has to be in accordance with policy priorities of the time. The shifts in approach has been influenced by advances in technology, opportunities that come with convergence and socio-economic needs [14]. The GSR 2012 lists and distinguishes the three generations of regulations. Each generation has distinct policy priorities, regulatory focus and spectrum management approach as shown in Table 2-5.

Table 2-6: Generational changes in regulation [14]

<table>
<thead>
<tr>
<th>Regulatory Phase</th>
<th>Policy Priorities</th>
<th>Regulation Focus</th>
<th>Spectrum Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Generation</td>
<td>Regulation of monopoly</td>
<td>Independent regulation, correcting monopolistic behaviour, price regulation</td>
<td>Separate administrative methods of spectrum allocation and assignment</td>
</tr>
<tr>
<td>2nd Generation</td>
<td>Infrastructure competition</td>
<td>Resale, pricing, access, unbundling, bit stream access, cross-subsided universal access</td>
<td>Increasing use of market methods for allocation of spectrum. Some merging of regulatory bodies</td>
</tr>
</tbody>
</table>
The transition between the generations was as result of the quick growing demands and the realisation of spectrum scarcity [14]. The administrative methods are being replaced with market-based approaches that seek to maximise that economic value of the use of the spectrum where appropriate. The transition towards the 3rd generation regulatory model is led by convergence, spectrum scarcity and the persuasiveness of broadband communications across all economies [14]. Due to the pressure on spectrum and its availability, the regulator’s focus has shifted towards evaluating alternative uses of spectrum, re-use, liberalisation and improving efficiency of current uses. The “digital dividend” is the result of reconsidering how the TV broadcasting spectrum is being used and introducing efficient way of using the spectrum [14].

2.3.3.2 Strategic Planning and Forecasting

Rafique et al. [66] suggest that ITU in conjunction with regulatory institutions should proactively make provision for careful planning for spectrum usage thus accommodating continuous developments in technology; and forecast future traffic volumes based on the current volumes, offerings and emerging new services. By so doing, Rafique et al. [66] guarantee that the spectrum would be used in an optimum way thus transferring the real benefits of the resource to the society. These provisions will eliminate the underutilisation of the spectrum as confirmed by spectrum usage and band occupancy studies that indicate that the usage is below 50% [67, 68, 66].

The ITU-R Report SM.2015 on Long-Range Planning describes four phases of planning which are:

- Determining spectrum requirements;
- Determining spectrum availability;
- Considering spectrum planning options; and
- Spectrum planning implementation.
2.3.3.3 Spectrum liberalisation

The “command and control” approach is known for its rigidity and offers lots of inefficiencies as discussed. A move towards flexible approaches becomes critical, and the concept of dynamic allocation can be exploited and possibility of secondary markets through trading and other sharing mechanisms. Rafique et al. [66] insist that the only ways to facilitate and achieve this approach are:

- Technology neutrality;
- Spectrum trading; and
- Dynamic spectrum access.

South Africa is among countries that have been hesitant despite the persuasive rationale of spectrum trading; this is due to concerns that still remain in spectrum trading and liberalisation which include [11]:

- Insufficient use of spectrum;
- High transactions costs;
- Risk of interference;
- Anti-competitive conduct;
- Impact on investment and innovation;
- Disruptive effect on consumers; and
- Ability to achieve public interest objectives.

Dynamic spectrum access is another technique for spectrum liberalisation and is seen as the evolution of the regulatory regime for future wireless services that is linked with the technical evolution of the infrastructure capabilities that supports them, such as cognitive radio and software-defined radio technologies [11]. New business and technical models will arise as a result of these capabilities. It is urged that though auctions are the preferred and common techniques that spectrum agencies use to assign spectrum to new users, the spectrum requirements for the future wireless services will better be served by dynamic spectrum access which creates a secondary market that allows economical-driven re-assignments.
The draft policy directions [65] published in 2011 to address the allocation of high demand spectrum directed ICASA to facilitate and determine an appropriate licensing approach that is aimed at achieving universal access and broadband for all; introduce new players and economic development. On the contrary, the policy does not advocate the use of auctions as a methodology for assigning high demand spectrum and it further states that in cases where no other alternative approaches are not possible, auctions should be used as the last resort [65].

2.3.3.4 Spectrum Pricing

Spectrum pricing has to do with spectrum management activities that include administrative fees, spectrum usage and spectrum prices determined through government policy and market influences. The APT [69] suggests that when spectrum pricing strategies are developed, the alignment of revenue goals and objectives of both the government and the regulators become imperative in setting targets and discussion with key stakeholders such as the operators. The radio spectrum is a scarce natural resource and is an essential element of communications infrastructure and of course it has an economic value. Just like any other resource, the primary economic objective should be to maximise the net benefits to society. The APT points out that economic method can help improve the spectrum management system over and above the technical, regulatory and legislative procedures and thus it is necessary to simulate the market value of the spectrum which requires financial analysis, estimations of demand or market studies to achieve a valuation, and considerable expertise [69]. The ITU and APT further list the goals and objectives of spectrum pricing as [11, 69]:

- The spectrum should be utilised efficiently, economically, rationally and optimally;
- Transparency in the process of allocating spectrum fostering technology and service neutrality and fair competition;
- Promote innovation;
- Maximise the economic benefits to the country from use of the spectrum;
- Ensure users benefit from the use of the spectrum;
- Balance the spectrum demand-supply equilibrium;
- Encourage spectrum sharing and upgrading of legacy systems toward new technologies;
- Generate revenue for the government or regulator; and
- Promote social and cultural activities.

The APT states the critical requirements in spectrum pricing as: spectrum pricing policy; spectrum pricing rules and regulation; and spectrum pricing factors. The policy is deemed necessary to determine the principles of spectrum pricing based on rational parameters such as the country’s GDP, priority, demand, supply and willingness to pay amongst others [69]. Rules and regulations are necessary to enforce the policy directives and the pricing factors such as occupied bandwidth, coverage area, location and service priority are used as inputs in the calculation of the prices.

Several pricing techniques exist; countries make use of any one or more of these techniques for setting of pricing as per need. These techniques include [11, 69]:

- Recovery of administrative cost model for pricing - the model is based on the recovery of the annual running costs of the agency that manages the spectrum. The biggest drawback of this model is that it does not stimulate spectrum efficiency, this is due to the fact that the administrative costs have no relations with the economic value of the spectrum;
- System performance based pricing - the model sets prices based on the performance of the radio system using various technical parameters such as spectral efficiency, transmitter power, modulation and so on;
- Re-farming pricing - the model sets prices based on the costs of re-farming, these are costs required to migrate existing users in that particular frequency band;
- Administrative incentive pricing (AIP) - the model sets prices by attempting to approximate the prices that emerge in the market; it is often based on flat rate structure. The prices reflect the opportunity cost of the spectrum while encouraging efficient use; and
- Market-based pricing - the prices emerge due to a market transaction such as auctions or trading.
In 2010 ICASA published regulations on spectrum fees in Government Gazette No. 33495 and lists the objectives of the regulations as [70]:

- Standardising the spectrum fees and pricing to promote efficient use and conforming with international standards;
- Establishing transparent, fair, competitive and non-discriminatory ways of spectrum pricing using the AIP;
- Encouraging efficient and effective utilisation of spectrum based on incentives;
- Ensuring that the costs of managing and monitoring the resource is covered by the fee income;
- Promoting competition by simplifying and harmonising the pricing process; and
- Achieving government policy objectives of even ICT infrastructure development across the country.

The model used in the regulations uses formulae to determine the annual license fees for coverage systems, point-to-point systems and satellite (ground stations and VSAT). The formulae use factors such as frequency, bandwidth, congestion, geographic location, sharing, area coverage, minimum hop length and unidirectional, which are then given weights to determine the fees based on one unit (1 MHz) of spectrum [70].

2.3.3.5 Digital Migration

Analogue terrestrial TV broadcasting uses significant parts of the spectrum, particularly in Ultra High Frequency (UHF) and Very High Frequency (VHF) bands. The biggest portion of spectrum is in the UHF band (470 – 862 MHz) which amounts to about 392 MHz. The channel bandwidths of these bands range between 6 to 8 MHz in size depending on the ITU regions; and an analogue TV transmitter occupies one channel to offer just one TV service or program [71]. Given the amount of spectrum available, the analogue distribution method has limitations in terms of the number of analogue programs that could be offered.

The transition from analogue to digital terrestrial TV broadcasting offers great benefits; it brings to the market a higher number of programmes thus creating opportunities for content providers, better quality and new services such as high definition (HD) TV. In
comparison to an analogue transmission, a digital transmission can carry a multiplex of 2 to 12 equivalent programmes occupying the same channel bandwidth [71]. Furthermore, most digital TV standards have capabilities of implementing single frequency networks (SFN) which allow the reuse of the same spectrum over much larger areas and thus increasing the spectral efficiency even further [71, 72]. Consequently, with such great spectral efficiency some spectrum will be freed. The concept of ‘digital dividend’ has emerged, and it is defined as “the amount of spectrum made available by the transition of analogue terrestrial television broadcasting to digital” [71]. The available spectrum may be used to provide other services, mobile broadband in particular.

The ITU set the deadline of 2015 for the transition to be completed [73]. The resolution on this deadline was adopted and agreed by 101 nations in Europe, Africa and the Middle East in 2006 at regional radiocommunications conference (RRC-06). The consequences of not meeting the deadline are that the ITU will no longer intervene to protect any country’s TV broadcast signals in any instances where these are being interfered by neighbouring countries, unless those signals have been switched to digital [74].

According to Pamias and Torras [73], the need for global harmonisation is critical for facilitating cross-border services, interference mitigation and allowing equipment vendors and operators to benefit from economies of scale. The digital dividend is divided into two parts: lower digital dividend and upper digital dividend. In ITU Region 1 (Europe, Africa, Middle East and parts of Asia) of the ITU, the lower digital dividend is reserved for TV broadcasting and the upper dividend (790 to 862 MHz) is allocated to mobile broadband. However, band occupancy studies undertaken in Europe to quantify the potential of white space in the 470 – 790 MHz band indicate that approximately 56% of TV channels are unused [68]. Thus the unused spectrum can potentially be made available for other uses. In the other ITU regions, the lower digital dividend has been allocated to mobile broadband because the band 698-790 MHz had already been allocated to the mobile services. This creates a misalignment between the three ITU regions. The world radiocommunications conference (WRC-15) held in 2015 aimed at correcting this misalignment by allocating the entire band (694 – 790 MHz) to mobile services across all regions [72]. Thus both the 700 MHz and 800 MHz
spectrum would become available for mobile broadband. Figure 2-9 shows the upper digital dividend allocations in different ITU regions.

![Figure 2-9: Upper Digital Dividend Allocation by ITU Regions [73]](image)

From a technical perspective and capital expenditure (CAPEX) point of view, the “digital dividend” spectrum is very attractive. The spectrum offers phenomenal balance between transmission capacity and distance coverage. It has good signal propagation characteristics thus less infrastructure is required for providing larger coverage areas and thus reducing CAPEX drastically [75]. The reduced costs of the building infrastructure has direct influence on service provisioning costs, which means service offerings prices can be lowered thus making broadband affordable.

The progress made by different countries around the globe on the transition has been briefly discussed in Chapter 1. This research has particular interest in the status quo and progress made by South Africa. South Africa started on a good footing and intentions towards digital migration; as a consequence she set ambitious targets for digital switch-on (DSO). In 2007, cabinet approved the dates for DSO and analogue switch-off (ASO) of 1st of November 2008 and 2011 respectively [76]. As a consequence, the digital migration policy was developed in August 2008. However, the switch-off date was not met and the date was then postponed to December 2013.
The DoC in its strategic plan for 2011-2014 states that the government will assist poor households through subsidising the set-top-boxes (STBs) as part of the migration process [77]. The STBs is one critical issue that could be blame for the delays with regard to the control systems. Most broadcasters are against the compulsory STB control systems that the government is imposing; there is court case after court case [78]. The other issue that caused turmoil in 2010 was the government’s decision to review the digital video broadcasting - terrestrial (DVB-T) technical standard that South Africa at adopted at the RRC-06, after serious lobbying in favour of adoption of the competing standard, the integrated services digital broadcasting - terrestrial (ISDB-T) [76]. This has since been resolved and a change of technical standard would have had fatal consequences. Should South Africa have opted for the ISDB-T standard that would have meant that the investment and progress made in terms DVB-T infrastructure and network rollout would have gone to waste. The other issue would have been that of harmonisation in terms of band plans, the ISDB-T system uses only 6 MHz channels while the DVB-T has the flexibility to offer 6, 7 and 8 MHz receivers. The UHF bands (IV and V) that South Africa uses are dictated by the ITU for region 1 and use 8 MHz channel plans.

Sentech has made significant progress in terms of deploying digital terrestrial television (DTT) network infrastructure and reported 80.43% coverage to the South African population in April 2013 [29]. However, there is doubt from the industry commentators that South Africa will not meet the June 2015 deadline for DSO, not from network infrastructure rollout but rather from the STBs rollout. The rollout of the STBs is critical and until it is complete, the analogue signal cannot be switched-off thus further delaying the much anticipated “digital dividend” and the implementation of the national broadband policy. The cost of not making the “digital dividend” spectrum available is very high as all advocated by the policy [5].

2.3.4 Best practices guidelines for spectrum management to promote broadband access

The Global Symposium for Regulators (GSR) held in 2005 sets the precedence of what the best practices should be for spectrum management to promote broadband.
The GSR acknowledges the importance of broadband as an essential component of ICTs and its contributions to the creation of information society and economic development [64]. Further, the GSR notes that wireless broadband technologies will play an important role in bridging the broadband divide that exists between the developing and the developed countries [64]. Since these technologies require more spectrum, the emphasis is on the need to manage the spectrum effectively and efficiently to maximise both the economic and social benefits. This requires versatile approaches to managing the spectrum to adapt and cope in making spectrum available for broadband and other new services [64].

The new broadband landscape presents challenges to spectrum regulators outside the political context of regulatory policy-making, thus the regulators should strive to achieve and advance three separate but interrelated goals at once [64]. These goals are [64]:

- The regulators should provide proper incentives for spectrum licensees to invest in broadband services as a primary goal;
- The regulators should expand consumer choices and welfare by enabling sustainable competition for broadband alternative services irrespective of the underlying transport technologies; and
- The regulators should implement policies that discourage wasteful use of the spectrum and anti-competitive behaviours.

As a result the GSR 2005 identified a set of best practice guidelines for spectrum management to promote broadband access. These best practices are intended to foster widespread adoption and deployments of broadband services [64]. The ten best practices identified as the regulators participating in the GSR 2005 are as follows [64]:

- **Facilitate deployment of innovation broadband technologies.** The emphasis is on adopting policies that promote innovative services and technologies. The policies should manage spectrum in the public interest, reduce unnecessary restrictions on spectrum use, adopt harmonised spectrum plans, embrace the principle of minimum necessary regulation and ensure effective and timely release of spectrum to broadband operators. Though there
are attempts in adopting such policies such technology neutrality, dynamic spectrum access and adopting harmonised plans; South Africa is failing this guideline dismally.

- **Promote transparency.** The emphasis is on adopting policies that are transparent and non-discriminatory; ensure adequate availability of spectrum; provide and promote regulatory certainty and investment.

- **Embrace technology neutrality.** The emphasis is on a landscape that offers freedom and flexibility in terms of choice of technologies. The re-farming is an exercise that is permitted by technology neutrality

- **Adopt flexible use measures.** The emphasis on flexible measures that minimise barriers to entry and providing incentives to small broadband players to begin operations on small scales without imposing enormous conditions; adopting lighter regulatory approaches in remote and rural areas; and recognising the need for cost-effective backhaul infrastructure for semi-rural, rural and remote areas.

- **Ensure affordability.** The emphasis on spectrum fees, the pricing model adopted should foster the provisioning of broadband services at affordable prices, particularly in rural and under-served areas.

- **Optimise spectrum availability on a timely basis.** The emphasis is on making the available spectrum for offer, of course this should be done in line with the national ICT master plans, to avoid cases where prices are pushed up due to restrictive supply and amount of spectrum available.

- **Manage spectrum effectively.** This is a scarce resource thus effective and efficient management is required. Spectrum planning is central to achieving such management be it for long-term or short-term purposes. New spectrum management approaches have to be explored and adopted for allocating spectrum in an economical and efficient manner.

- **Ensure a level playing field.** The introduction of spectrum caps is one mechanism that used to limit the amount of spectrum one operator is able to obtain.

- **Harmonise international and regional practices and standards.** One key benefit that harmonisation offers is the economies of scale in the production and manufacture of network and equipment infrastructure.
- **Adopt a broad approach to promote broadband access.** Though spectrum management plays a crucial role in promoting broadband, alone it cannot be adequate hence the requirement for a broad approach. A broad approach includes other regulatory instruments such as open access to infrastructure, the promotion of broadband supply and demand, universal access and service obligations, incentives, and development of backbone and backhaul networks.

2.3.5 Technologies enabling Spectral Efficiency and Sharing

In technical terms, the efficient use of spectrum implies the full use of the available spectrum using two efficiency measures: occupancy and data rates. The new innovative technologies have employed new techniques that create new opportunities for sharing and “new” capacity is the existing spectrum. These techniques include access methods on the physical layer; and intelligent ways of using the spectrum [77, 66].

2.3.5.1 Ultra-Wide Band

The ultra-wideband (UWB) technology has been developed to have capabilities of transferring large amount of data for short-range and indoor applications. It can be used as an underlay technology; meaning it can coexist as a secondary user due to its extremely low emission levels. According to Rafique et al. [66], this technology has one key advantage over the other existing alternative wireless technologies; that is its capabilities to offer data rates up to 1 Gbps by using the spectrum in a stealthy way in the existence of other users. It has since become a potential alternative to wireless technologies such as Bluetooth, WiFi and WLAN.

2.3.5.2 Software Defined Radio

The ITU [60] describes software defined radio (SDR) as a radio system that is implemented on general purpose hardware where specific operational characteristics are implemented on software. Key radio parameters such as operating frequency, modulation and protocol are controlled and defined by software instead of the hardware as with traditional radios, thus increasing its flexibility. The main functions of
SDR include: multi-band operation, multi-standard support, multi-service support and multi-channel support [13]. These functionalities facilitate spectrum sharing as well as cost-saving for operators.

**2.3.5.3 Cognitive Radio**

Cognitive radio (CR) is an intelligent wireless communication system that is aware of its environment. Hossain et al. [13] point out that the technology is based on software defined radio and provides mechanisms for spectrum sensing, spectrum management and spectrum access to cognitive radio users. They further list the main functionalities as: spectrum sensing, spectrum analysis, spectrum access and spectrum mobility. According to Bourdena et al [79], the technology was introduced in response to wireless networks needs for increased spectrum availability and improved radio-resource utilisation. The technology enables dynamic use of the spectrum in an opportunistic manner and its main objective is to obtain the best available spectrum through cognitive capability and configurability without interfering with the transmissions of primary users [13].

**2.3.5.4 MIMO Technology**

This technology is used to enhance the performance of a wireless transmission through the use of multiple antennas. The technology achieves higher data rates to almost double depending on the configuration without the need of additional spectrum thus improving the spectral efficiency of the radio system. This is achieved through the use of advanced signal processing techniques and the capabilities of reconstructing the original data by combining the multipath signals [13]. The technology can also be used as a technique for diversity maximisation thus increasing the radio system’s availability and reliability.

In today’s broadband environment, access to spectrum is of paramount importance driven by the anticipation that many countries in particular the developing countries will use wireless technologies as the primary vehicle for broadband development. In the regard, policy and regulatory reforms become necessary to facilitate and promote broadband access and infrastructure development.
2.4 Conclusion

The literature reviewed in this chapter covered two related topics of broadband and spectrum management. The importance and benefits of broadband have been highlighted, the adoption of NBP as well as constraints in deploying broadband. Digital migration which is fundamental to the successful implementation of broadband infrastructure was discussed as well as the status of South Africa with regard to set deadline. Critical aspects within spectrum management were also covered in line with broadband requirement issues and adapting to current and future demands.

Economic development and social benefits that come with broadband should be an agenda for all countries seeking to advance their citizens. The adoptions of NBPs and digital migration plans have become imperative to successful implementation of broadband infrastructure for information society and digital inclusion. Spectrum management techniques have to evolve and adapt with times to cope with current and future demands for spectrum, offer flexibility, foster and encourage innovation.

The literature reviewed has armed the researcher will knowledge and serve as base for comparing the research findings. The reader is able to deduce relations between broadband and spectrum management and the role of policy in facilitating broadband development; and have a clear understanding of their importance and their relevance to the research questions.
3. RESEARCH METHODOLOGY

3.1 Introduction

Kothari [80] describes research methodology as a way to systematically solve a research problem. According to Quinlan [81], the chosen methodology should have the capabilities to support, enable and facilitate the completion of the research project. This study uses the case study method attempt to answer the research questions. The method was particularly chosen for the following reasons:

The method is suitable because generally it is used to answer questions that begin with “how” or “why”. The questions are usually targeted at a small number of events to study how the relationships are formed and why [82]. According to Dooley [83], “a researcher that embarks on a case study research is usually interested in a specific phenomenon and wishes to understand it completely”. Yin [18] further points out that a case study is a research method that has been used in many situations as a knowledge contributor to individuals, groups, organisations and related phenomena. He further emphasises that its distinctive need is that of fulfilling a desire to understand complex social phenomenon. The researcher has huge interest in the subject and wants to develop expertise and pursue a career in broadband and spectrum management.

3.2 Case Study Approach

According to Yin [84], a case study may either consist of a single case or multiple cases, which can be labelled as single-case and multiple-case study respectively. He further states that irrespective of the number of cases it may have, the case study can either be holistic or have embedded subcases within the holistic case. This creates a two by two matrix that yields four types of case studies, as depicted in Figure 3-1 and these types of case studies can be summarised as [84]:

- Single-case holistic: this design focuses on a single unit of analysis;
- Single-case embedded: this design still focuses on a single holistic case but has multiple units of analysis as subcases;
- Multiple-case holistic: this design has multiple units of analysis, thus focuses on more than one case; and
- Multiple-case embedded: this design has multiple cases and within each case there are subcases as well.

![Figure 3-1: Basic types of designs case studies][84]

This research takes the single-case approach, the unit of analysis is a case of the impact of policy on broadband development in South Africa.

### 3.3 Research Design

Nachmias and Nachmias as cited in Yin [18], describe a research design as a plan that guides the investigator in the process of collecting, analysing and interpreting observations. Similarly, Cooper and Schindler [20] describe the research design as the blueprint for fulfilling objectives and answering questions of a research project. They further highlight that there are many definitions of a research design and no single definition outlines the full range of important aspects. Though all of these definitions differ in detail, they together give the essentials of the research design which are [20]:

[84]
A plan that is based on activities and time;
A plan that is always based on the research question;
A plan that guides what sources and types of information should be selected;
A framework that specifies the relationships among the variables in the study; and
A procedure that outlines all research activities.

It is a common belief amongst researchers that designing a study helps researchers to plan and implement the strategy that will help them achieve the intended results thus increasing the possibilities of obtaining the relevant information that is associated with the real situation. Yin [18] concurs and further adds that the design is the logical sequence that connects the empirical data to the study’s initial research questions to its conclusions. He further points out the five important research design components in a case study research as:

- Study questions;
- Study propositions;
- Unit of analysis;
- Linking data to the proposition; and
- Criteria for interpreting a case study’s findings.

In summary, a case study research design should include these five components, the first three components’ purpose is to define the study’s questions, propositions and unit of analysis which lead the design into identifying the data that needs to be collected. The last two components define the logic that links the data to the proposition and the criteria for interpreting the findings which leads the design into anticipating the study analysis, suggesting what needs to be done after data collection [18].

### 3.4 Research Design Quality

Yin [18] emphasises that a research design should represent a logical set of statements and therefore its quality could be judged based on logical tests. These tests include trustworthiness, credibility, conformability and data dependability.
According to Yin [18], four particular tests are used to establish the quality of any empirical social research and these are very relevant to case study research as well. Yin [18] further identifies several tactics that should be employed when dealing with the four tests and at what phase the tactic should occur. The tests, tactics and phases are summarised in Table 3-1.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Case Study Tactic</th>
<th>Phase of Research</th>
</tr>
</thead>
</table>
| **Construct validity** | • Use multiple sources of evidence  
• Establish chain of evidence  
• Have key informants review draft case study | Data collection  
Data collection  
Composition |
| **Internal validity** | • Do pattern matching  
• Do explanation building  
• Address rival explanations  
• Use logic models | Data analysis  
Data analysis  
Data analysis  
Data analysis |
| **External validity** | • Use theory in single-case studies  
• Use replication logic in multiple-case studies | Research design  
Research design |
| **Reliability** | • Use case study protocol  
• Develop case study database | Data collection  
Data collection |

**Construct Validity**

According to Rowley [85], this is about establishing correct operational measures for the concepts being studied. She further emphasises that the concern is that of exposing and reducing subjectivity by linking data collection questions and measures to research questions and propositions. This study will use multiple sources of evidence to construct validity as discussed in the data collection section.

**Internal Validity**

Rowley [85] points out that this has to do with establishing causal relationships, providing evidence that certain conditions lead to other conditions separated from
spurious relationships. This is only applicable to explanatory and causal studies and does not include descriptive and exploratory studies. This study is exploratory.

**External Validity**

This is about establishing that a domain to the study’s finding can be generalised [85]. The generalisation method used in case studies is not statistical but rather analytical. Analytical generalisation uses previously developed theories as the basis for comparing empirical findings of the case study. This study will generalise the findings to the theory covered in the literature review.

**Reliability**

This has to do with the procedure which the study follows. The findings and the conclusions of the study should not differ should another researcher undertake the same study all over again. This is accomplished through documenting the procedures and appropriate record keeping [85]. The ultimate goal of reliability is to minimise or eliminate errors and biases in a study [18].

### 3.5 Data Collection

Data is defined as “information obtained during the course of an investigation or study”. Data collection methods refer to the means that are used by researchers to gather the required data for the research project [81]. Several methods exist for data collection which includes questionnaires, interviews, focus groups, scales, documents, records, diaries and visual methods amongst others. Quinlan [81] stresses that it is fundamental for the researcher to know what kind of data is required and where to find it before deciding on the collection method. In deciding which data collection method is appropriate, Quinlan suggests that the researcher should make the following considerations [81]:

- Can the data be gathered by interviewing people?
- Will questionnaires produce the required data?
- Will focus groups be useful?
- Will diaries give the required data?
• Will documents, records and archives contain the required data?
• Will observations be best for gathering the relevant data?

Rowley [85] further stresses particularly to case study research, that data collection should be guided by case study protocol. She points out that the protocol should include the following sections:

• An overview of the case study project;
• Fields procedures - use of multiple sources of information and access arrangements to the sources; and
• Case study questions - the researcher should keep these questions in mind when collecting data and these questions may be used to guide the formulation of interview questions.

According to Rowley [85], case studies draw on multiple sources of evidence. These include documents; archival records; interviews; direct observations; participant-observation; and physical artifacts [18, 85]. Yin [18] further emphasises that no single source has advantage over the others, since each source has its strengths and weaknesses. They complement each other. Rowley [85] further stresses that a different approach of interrogation is required for each source. Yin [84] points out that case study evidence can include both qualitative and quantitative data irrespective of the source. This study will be of qualitative nature, no numeric data will be presented but rather categorical information that is systematically collected and presented in a narrative form. This study will use documents, interviews and observations as sources of evidence.

3.5.1 Documentation

According to Yin [18], documentary information is likely to be relevant to every case study topic and should be the object of explicit data collection plan. Though this source does present some weaknesses; it has strengths such as stability (can be reviewed repeatedly), unobtrusive (not created as a result of the case study), it is specific and broad [18].
This study makes use of a variety of written materials that are available for public consumption as one of the sources of evidence. Largely, the documentation used in this study was obtained from the internet as publications by the government, ICASA and other organisations that have interest in the industry. The documentation includes policy documents, legislation, regulations, research reports and audit documents. The following are some of the documents that have been reviewed in this study:

- National Broadband Policy 2013 - South Africa Connect: Creating Opportunities, Ensuring Inclusion [5];
- National Radio Frequency Spectrum Policy [6];
- National Integrated ICT Policy green paper [44];
- National Integrated ICT Policy discussion paper [45];
- Electronic Communications Act 36 of 2005 [48];
- Understanding what is happening in ICT in South Africa Policy Paper [49];
- Draft Policy Directions on high demand spectrum [65];
- National Radio Frequency Spectrum Regulations 2011 [70];
- Draft IMT Roadmap for Consultation [86];
- Spectrum Usage and Availability Report Q1 2014 [87];
- Second Digital Dividend Final Report and Implementation Plan ; and
- South African Radio Frequency Audit Phase 1 and 2 Reports.

3.5.2 Interviews

Yin [18] rates an interview as one of the most important sources of case study evidence. In an interview, the interviewer has an opportunity to establish a rapport with the respondent [81]. The research will conduct interviews with industry experts from the policymaker, regulator, and industry players.

The researcher has been in the industry for over fifteen years and is currently under the employment of one of the operators. The researcher has networked with individuals in the industry and the network has fair amount of representation in terms of stakeholders ranging from policy making, regulation and operations. The respondents were invited to participate in the interviews through telephone calls and an official letter was sent through an email to all of them. Appendix A shows the
invitation letter. The participants were selected based on their roles in their respective organisations and their knowledge in the field of broadband and spectrum management.

The researcher used structured interviews with set questions in the form of a questionnaire, which was sent to all participants. Due to tight schedules, most of the respondents opted to respond to the questionnaire in a written format. Four of the nine respondents preferred to do one-to-one interviews. Though the interview questions were based on the questions in the questionnaire, they were follow-up questions based on their responses. The follow-up questions proved to be very in-depth and armed the researcher with even more insight information. The questions that were asked are shown in Appendix B, as well as the parts of the research the questions intended to address. The questions were drafted in such a manner that they source point of view answers from the participants in line with the research questions and the literature reviewed in this study. Though some of the questions were technical, researcher's intentions were to gain more insight on technical issues related to the research. The interviews were used to source information that the literature review did not address adequately.

A fair representation of nine participants across all three stakeholders (policy, regulation and operations) was obtained. Though the researcher would have liked to have representation from MTN, Vodacom and Telkom, responses were not forthcoming even after persistence from the researcher. The profiles of the respondents from the different stakeholders are listed below:

**Policy Development**

- Chief Director: Broadband – mandated with the responsibility to deliver the implementation plans of the NBP and address other policy issues that are related to broadband.

- Director: Radio Spectrum Policy and Planning – responsible for policy matters on radio spectrum and international frequency management issues.
- CTO: SITA – with responsibilities to provide strategic direction and leadership for technology deployment for internal IT as well as persuading stakeholders of technology in practice.

**Regulation**

- Senior Manager: Spectrum Management – responsible for drafting and issuing regulations with regard to the licensing and use of radio spectrum.

**Operations**

- Technical Regulatory Departments – these departments are responsible for the technical regulatory strategy of individual incumbents. They prepare and make submissions to policy and regulatory bodies, provide technical regulatory guidance to internal stakeholders, drive technical regulatory compliance and provide regulatory support to the incumbent strategy and risk mitigation initiatives. Participants in this regard came from CellC, Neotel, Multichoice, Sentech and WBS.

### 3.5.3 Direct observation

A case study takes place in a real-world setting and that creates an opportunity for direct observation [18]. According to Quinlan [81], the researcher engages in an observation to gather data on the phenomenon under investigation. In conducting an observation, the researcher should observe what is happening and record the observations.

The researcher attended public hearings conveyed by the regulator on issues relevant to the research where the public is required to participate and give comments as required by legislation and makes observations. Further observations made through media reports and speeches by key individuals in the sector on issues relevant to the research. All these observations were recorded and then used in the data analysis.

In November 2014, the researcher attended the public hearings on the draft IMT roadmap where stakeholders made presentations and recorded observations. The researcher also watched the parliamentary services TV channel and followed the
portfolio committee on communication’s (PCC) presentations by portfolio organisations on their strategic plans and progress reports; and made observations on issues relevant to the research.

In February 2015, the researcher attended the 2015 sub-Sahara spectrum management conference held in Sandton. The conference brought together high-level stakeholders and decision makers from SSA and beyond to discuss issues relating to management and coordination of spectrum policy across the region. The conference was sub-divided into sessions with particular emphasis on topics affecting the region. Keynote speakers made presentations on these topics followed by panel discussions. The researcher made observations on issues discussed relevant to this study. The topics that were discussed amongst others included:

- WRC-15 – key priorities, positions and agenda items;
- Meeting the deadline for ASO;
- The challenges of valuing and designing digital dividend spectrum in Africa;
- Dynamic spectrum access;
- Enablers for realising digital inclusion in Africa;
- Spectrum requirements across the SSA region; and
- Best practices in spectrum awards for an open and competitive market.

### 3.6 Data Analysis

The research has identified and adopted a five step process for data analysis in case studies as documented by Yin [84]. The process is as follows:

- Organising and preparing data collected from the documents, interviews and observations;
- Categorising data;
- Interpreting single instances of textual data using a coding approach to establish themes and categories for analysis to identify patterns;
- Identifying patterns; and
- Synthesising and generalisation of the data.
A deductive approach was used to analyse the data based on the research questions, the data was then categorised as follows:

- Policy and regulatory factors that facilitate broadband development, and
- The importance of spectrum in broadband development.

Patterns are identified and gaps revealed.

### 3.7 The Study Process

The research, in an attempt to answer the research questions, adopts the single case holistic approach as documented by Yin [18].

**Study propositions**: This is an exploratory case study research and thus does not have propositions. Rather the research develops a descriptive framework for organising the case study. The framework has sections reflecting themes in the case study and evidence is collected within the themes, analysed and compared in these categories.

**Unit of Analysis**: The unit of analysis is an individual case of ‘the impact of broadband policy on broadband development’ in South Africa. The analysis is done using multiple sources of evidence, which includes interviews of experts, published documents (legislation, policy, regulations and unpublished reports) and observations.

**Link data to hypothesis**: Pattern-matching will be used to link the research problem and the evidence.

**Criteria for interpreting study’s finding**: Triangulation will be used to verify the accuracy of the findings to draw unbiased conclusions.

### 3.8 Conclusion

In this chapter, the researcher described the research design that the research adopts and why it is relevant to the research. The case study research method is unpacked in detail and how validity is ensured. The data collection methods to be used by the
research are also highlighted and discussed. The researcher’s goal is to design a good case study and collect, analyse and present data fairly.
4. CASE STUDY DESCRIPTION

4.1 Introduction

This chapter is intended to give background and the regulatory environment within which the research is conducted as well as the description relating to how the evidence would be collected and analysed using the methods discussed in the previous chapter.

“Telecommunications regulation is a vastly complex area of expertise and is most properly left to those who have adopted it as a speciality. Nevertheless a working knowledge of regulatory issues is critical for managers in telecommunications companies and customers of such companies”, this is according to Cull [88].

4.2 Research objectives

The case study is about the impact of the broadband policy on broadband development in South Africa, all the evidence collected and discussed in the research will be about South Africa as a country irrespective of whether the sources are within its borders or from international institutions and organisations.

The objective of the research project is to understand the impact of policy on broadband development in the South African context. Specifically, the study sought to answer the following questions:

- RQ 1: What role does policy play in broadband development?
- RQ 2: What are key policy and regulatory considerations for smooth broadband development?
- RQ 3: Why is spectrum management so important in broadband development?

4.3 Research setting

The research is conducted in the ICT sector within the borders of the Republic of South Africa. The sector and its role players are governed by legislative framework. The ECA is the primary act of parliament for regulating the ICT industry in South Africa, which
is characterised as pro-competitive legislation. The legislation covers a wide range of aspects from licensing; access; infrastructure rights; frequency management and assignment; markets and competition to universal service among others. The functions of the role players in the industry are separated into policy, regulation and operations as illustrated in Figure 4-1 below.

![Figure 4-1: ICT Structure – Policy, Regulation and Operations [89]](image)

4.3.1 Government

The DoC is a government department mandated with the policy development, oversight of radio frequency spectrum and represents the country in international forums. The ECA entitles the minister of communications to issue both policy and policy directions; subsequently the minister is required to consult with ICASA and to follow public policy process [48].

4.3.2 Regulator

ICASA is the independent communications regulator established and governed by the ICASA act [87]. ICASA draws its powers and functions from the ICASA act which
includes making recommendations to the minister on policy matters; monitoring the sector to ensure compliance to legislation and license obligations; managing the radio frequency spectrum; making regulations; granting, renewing, amending, transferring and revoking licenses; and investigating and adjudicating complaints among others.

4.3.3 Operators

These are the industry players that interact with market directly by offering products and services. The incumbents operate under the licensing framework as stipulated in the ECA. It is ICASA’s responsibility to register and grant electronic communication licenses to these service providers. The framework has two main categories of service licenses, namely [48]:

- **Electronic Communications Network Service (ECNS) licence**: this license authorises the holder to construct and operate a network infrastructure. No restrictions are imposed in terms of technology of choice; the licensee can construct a network using either wireline or wireless technologies; or a combination of both. Furthermore, the holders of this license have the right to enter into commercial agreements with other providers, who do not possess this license, to allow them to use their networks to provide services to the market.

- **Electronic Communications Service (ECS) licence**: this license grants the holders the right to provide services to the market. Either by using own networks for holders with ECNS or leasing capacity from ECNS licensees’ networks based on commercial arrangements.

These service licenses are further subdivided into individual and class categories. With regard to ECNS, an individual license (I-ECNS) allows network rollout nationwide while class license (C-ECNS) limits to network rollout to a district or local municipality. In terms of ECS, individual license (I-ECS) allows the holder to provide services such as internet access; email; hosting; VPN and MPLS among others including voice services that make use of numbers taken from the nation numbering plan. A class license (C-ECS) allows for the exactly the same services as the individual license expect for voice services that require numbers from nation numbering plan [41].
The service licensing is distinct from radio frequency spectrum licensing; an ECNS license is a prerequisite and entitles the holder to apply for radio frequency spectrum license. The incumbents that play in the broadband space and that have been assigned parts of the sub-3 GHz spectrum include Cell C, MTN, Neotel, Telkom, Vodacom, and WBS. This study looks at these incumbents’ usage of the spectrum.

South Africa falls within ITU Region 1 and thus most of the band plans it adopts are harmonised and agreed to under the ITU’s auspices; with great influence from European countries.

4.3.4 Policy advisory unit

Also known as the portfolio committee, it is a committee that is appointed by national assembly to shadow the work of the national department, in this case the department of communications. Its roles among other include considering bills and making recommendations about any aspect of the department, including its structure, functioning and policy.

4.3.5 Board of directors

This is a group of individuals that are elected to act as representatives of the shareholders to establish corporate management related policies and to make decisions on major company issues. An operator is accountable to its board, to satisfy its specified economic and social objectives [89].

4.3.6 Market

These are the consumers of the products and services offered by the operators. The role of policy and regulation is to ensure that there are not market failures, and protect consumers from unfair business practices and poor quality services.
4.4 Broadband development in South Africa

The broadband commission, the ITU as well as the GSR have identified and recommended critical policy and regulatory considerations that are key to broadband development. A broad approach is fundamental as advised by the GSR as it encompasses all other policy and regulatory instruments that are fundamental to promoting broadband access [64]. This case presents the status quo of the South African landscape against these recommended policy and regulatory considerations and identifies the gaps.

This research have identified policy and regulatory best practices and considerations that are fundamental to broadband development through the literature. The South African implementations with respect to these key policy and regulatory considerations are presented in the research findings chapter.

In line with the targets established by the broadband commission for tracking universal access to broadband as well as digital inclusion for all, it has a link to the millennium development goals. South Africa has accomplished target 1 of the broadband commission by developing its national broadband policy “SA connect”. However, though the policy does touch on these factors that are fundamental to facilitating broadband development, there are policy and regulatory gaps that exist and need to be addressed to facilitate the implementation of the policy. Gillwald et al. [49] and discussion paper [45] have highlighted these bottlenecks and the remedies are summarised as:

- Create an open access network;
- Reduce costs and prevent unnecessary duplication through incentivising infrastructure-sharing;
- Ensure access to facilities at cost but ensure reasonable ROR;
- Coordinate and schedule rights-of-way access;
- Remove special taxes and duties on ICT equipment and services, in order to bring down prices, grow services, and grow the general tax base;
- Free up and release critical spectrum for wireless broadband use, through competitive evaluation and allocation of spectrum, and coordinate spectrum re-farming and migration; and
- Use existing unused USAF levies to build out network into underserved areas through reverse-bidding to service areas and in support of demand stimulation strategies including e-skills development.

### 4.5 Conclusion

The case study was chosen to investigate and gain an in-depth understanding of the South African landscape with regard to policy and regulatory practices with regard to broadband development. The research followed the case study protocol in identifying methods of evidence collection, collecting the evidence and finally, analysing the data collected. The researcher has acquired a wealth of knowledge and has now a good understanding of policy and regulatory landscape, particularly in the field of broadband and spectrum management, this is attributed to the use of case study as a research method.

Chapter 5 presents the findings of the case study.
5. RESEARCH FINDINGS

5.1 Introduction

This chapter presents the findings, which are synthesised from the analysis of the data collected from the different sources. The sources of these findings are a combination of the documentations; observations made by the researcher and questionnaire data as discussed in sections 3.5.1, 3.5.2 and 3.5.3.

Two main themes were identified from the findings and discussed.

5.2 The role of policy in broadband development

The deduction from the literature is that government policy plays an important role in ensuring that broadband becomes a priority in a country’s developmental agenda and sets an environment that is conducive for broadband to flourish. Policy becomes the foundation and puts the legislative and regulatory instruments in place to ensure successful implementation of its objectives. Studies undertaken by several researchers have also revealed substantial evidence on positive impact broadband has on economies. GDP growth, productivity, employment and job creation are economic effects that broadband has been proved to have.

No particular question with regard to the role that policy plays in broadband development was asked in the questionnaire. However, observations made are that broadband policy has become one priority on many countries’ development agenda. Countries with coherent national strategies on broadband have tended to be more successful in fostering broadband diffusion.

Question 1 in the questionnaire was asked to all the respondents to capture the importance of broadband. Eight of the nine respondents concur with the literature with regard to the importance of broadband. Though the literature review only focused on the economic impact of broadband, the interviews revealed the social impact as well. One of the respondents, a representative from the industry players sees broadband from societal view as facilitator for interaction and enabler for communication thus
minimising time, improving efficiency and save money. And from a business view, businesses will see growth. Another respondent from policy development is of the view that if broadband is implemented correctly it has the ability to ignite other developmental pillars such as education, health, small business development, research and development and so on.

The ninth respondent, a representative from industry conditionally agreed with the statement made in question 1, he made the following statement

“I conditionally agree. The availability of broadband does not necessarily lead to acceptable economic development and social inclusion. The impact of broadband should be looked at in respect of infrastructure development, household penetration & accessibility and SMME penetration & accessibility, increase in total factor of productivity, creation and/or increase of consumer surplus. The importance of penetration & accessibility to cost-effective services can never be overemphasised with regards to the creation of positive externalities. Broadband strategies that are not in line with the countries needs will affect the impact of positive externalities.”

The deduction made from this statement is that promoting demand is fundamental and creating awareness of benefits of broadband.

5.3 Policy and regulatory factors that facilitate broadband development

Policy plays a vital role in broadband development as the government takes the lead role in this regard. By virtue of adopting some form of a plan for broadband development is the first step into the right direction. Broadband should not be viewed as the last mile connection but rather as an ecosystem. This view is critical and useful for policy makers and other stakeholders, as it encourages development of holistic, coherent and integrated policies that maximise the full benefits of broadband. The approach to policies that are intended to promote broadband development should address and balance both the supply and demand sides, hence the emphasis of viewing broadband as an ecosystem. The stakeholders, particularly the policy maker and the regulator should recognise the full scope of the challenges to be addressed for stimulating and promoting broadband development. By so doing they will be better
armed and be able to develop strategies for stimulating supply and encouraging demand and uptake for broadband services.

In the literature review, key policy and regulatory approaches and considerations that are key to promoting broadband development were identified and discussed. Table 5-1 lists and summarises these policy and regulatory considerations against the South African implementation. The deductions are made from published policy and discussion documents as well as published research findings by other researchers.

Table 5-1: Key policy and regulatory considerations for broadband development

<table>
<thead>
<tr>
<th>Policy and Regulatory required to facilitate broadband development</th>
<th>South African Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incentive Regulation</strong> (This a broad term for market liberalisation and license regime reform)</td>
<td>The incentives could be provided through adopting enabling policies, simplifying licensing regimes, making available more spectrum, reducing regulatory obligations, and offering tax incentives [43]. The South African licensing framework has been simplified and unified, under the ECA the incumbents have been given unified licenses that give them the right to provision any telecommunication service [48]. However, the South African regulatory environment in this regard has been perceived as ineffectual [44]. This is based on TRE ranking that assesses the effectiveness of sector regulation using seven regulatory dimensions: market entry, QoS, anti-competitiveness practices, universal service obligations, access to scarce resources, interconnection and traffic regulation.</td>
</tr>
<tr>
<td><strong>Infrastructure sharing and open access</strong></td>
<td>It is acknowledged that the principle of infrastructure sharing seeks to promote effective competition, avoid duplication of investment in infrastructure, reduce cost of services and realise universal access objectives [45]. The identified need for an integrated national rights-of-way plan between key stakeholders: the regulator, metros and road agencies has shown no progress to date and this creates regulatory and way-leave approval bottlenecks that hinders the efficient rollout of broadband services [49]. The lack of facilities regulation, particularly in mobile operators also hinders the competitiveness of new entrants in the markets, the cost of leasing the facilities such as roaming are exorbitant [49].</td>
</tr>
<tr>
<td><strong>Spectrum</strong></td>
<td>Spectrum limitations remain a critical regulatory bottleneck [49]. The deadline for digital migration has been missed and the licensing of the 2.6 GHz still awaits policy decisions [65]. Though some form of liberalisation has been achieved through technology neutrality, the South African spectrum policy does</td>
</tr>
</tbody>
</table>
5.3.1 Incentive regulation

The deduction made here is that government policy should create incentives for the private sector to take a lead in this. Tax concessions and government subsidies should be used to entice service providers to rollout required infrastructure. Observations made are that the dominant players are reluctant to invest in network infrastructure in areas where it is not commercially viable for them.

Question 4 in the questionnaire was intended to capture the views of respondents on how broadband development would be achieved. A respondent from Neotel was of the view that the regulatory environment was the only avenue that needed to take responsibility for universal access. This should be done such that it must make business sense for operators to invest in universal broadband access. Current incentives to operators are not relevant.

5.3.2 Open access and infrastructure sharing

A respondent from policy development made this statement with regard to how to achieve universal broadband access

"Through better coordination of all stakeholders involved in the supply side and demand side of the value chain. On the supply side the market structure needs to be
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realign to accommodate open access principles. Administration bottlenecks need to be removed through the amendment of various institutions, policies, legislations and regulations, which need to be adapted to the current environment. Government must lead the uptake and usage of broadband services and create a conducive environment for the creation of localised and relevant digital opportunities”.

Questions 3 and 5 were intended to capture aspects of infrastructure development. The deduction in this respect is that the current infrastructure is not adequate to support universal access, more investment is required. Changes in legislation are also required, that enable an environment that naturally separates infrastructure services from access services. This will breed an environment that is conducive for open access models as well as encouraging infrastructure sharing, which avoids duplications of infrastructure. Further, it is believed that management principles for the country’s infrastructure are going to play a decisive role especially with talks about open access models, a principle still to be defined.

One of the respondents also highlighted that the country has a multiplicity of infrastructure providers who are over investing in privileged areas. There is a lot of duplicity and efforts to connect rural areas do not make economic sense to private operators with a focus on making huge profits. Though ICASA has published facilities leasing regulations, one respondents pointed that the regulator had no capacity to enforce them.

5.3.3 Funding

The deduction is that the broadband development needs to be a project that is led by government and not an industry lead project. Most of the respondents were of the view that government policy needed to create incentives for the private sector to further invest in infrastructure. Tax concession, subsidies are some of the incentives mentioned that could be used to entice service providers to rollout required infrastructure.
5.4 The importance of spectrum in broadband development

Spectrum is seen as a big role player in broadband development particularly in the developing countries as it is anticipated that wireless technologies will bridge the gap and will account for the majority of broadband connections. A number of questions that relate to spectrum have been asked in the questionnaire, the intention was to capture the views of the respondents on key aspects of spectrum management in relations to broadband development.

The general consensus amongst the respondents is that the spectrum management approaches need to change in terms of allocation of spectrum. A combination of beauty contents and auctions is preferred, in this way terms should be put in place to ensure that policy objectives are achieved whilst at the same time the spectrum will go to those with resources to make a meaningful investment in infrastructure. Attempts must be made to share spectrum amongst serious players in the industry. Further, the licensing should carry obligations that would ensure that marginalised communities are prioritised.

The deduction is that the current spectrum policy does not engender competition if one operator is given more spectrum than others. It also highlighted that allocation of spectrum on exclusivity basis has its downfalls and leads to hoarding. The view is that the spectrum policy should be reviewed and hopefully that it would embrace the principles of open access to ensure that universal broadband is achieved.

5.5 Conclusion

There is enough evidence that support the importance of broadband, both in economic growth and information society building. The research has explored the South African landscape with regard to broadband development and factors that impact on broadband. Patterns have been identified and presented. Though there are still areas where South Africa lacks, with time, it is envisaged that urgent policy matters will be given the right attention and thus fast-track broadband development.

Chapter 6 concludes the research.
6. CONCLUSIONS

6.1 Introduction

This chapter highlights the findings and conclusions of the research, which are based on the literature review, observations and stakeholder interviews aligned with the research questions and objectives as detailed in chapter 1. The limitations of the research are also outlined and the chapter concludes by making recommendations.

6.2 Findings

This research has identified the importance of broadband and key factors that require considerations for broadband development through the literature. Studies conducted by various researchers have found that broadband offers countries an enabling platform and new tools to foster economic growth, extend public services, enhance businesses, and benefit their citizens. GDP growth and employment are key benefits which have been identified to come with broadband development. Thus making broadband a priority within a country’s development agenda is vital and will ensure that digital divide that exist between developed and developing countries is bridged and does not extend further.

The demand for broadband services has changed the dynamics of policy and regulations approaches. Key policy and regulatory considerations for broadband development have to follow a broad approach. The analysis of the interviews, observations made and the policy documents reviewed shows that there are patterns with policy and regulatory considerations and recommendations reviewed in the literature. However, the analysis also reveals that there are some gaps in the policy and regulatory implementations in the South African landscape with regards to facilitating broadband development.
6.3 Gaps revealed

The two policy options discussed under section 2.2.4 are very relevant to the South African landscape for facilitating broadband development. A hybrid approach is fundamental in driving infrastructure development in underserved areas while still maintaining an environment that enables and encourages competition.

Table 5-1 under section 5.3 lists the key factors that policy should address in facilitating broadband development and summarises the South African implementations. This study identifies gaps in the following.

6.3.1 Incentives

Incentives are key to attracting investment in broadband infrastructure development. The capital required for such investments is enormous and government alone cannot provide. Thus, there is a requirement for government to create an environment that is conducive to attracting such investments, by providing overall direction through national policy, making sound commitments and a predictable regulatory environment. This includes rationalising licensing regimes which consider reduction of the requirements for market entry. Reducing the burdens that come with regulation and employing regulatory intervention as the last resort will stimulate infrastructure rollout.

These incentives are not visible in the South African environment, and therefore are identified as gaps which require policy attention or regulatory intervention.

6.3.2 Infrastructure sharing and open access

The regulatory framework is governed by the ECA and ICASA is mandated with the responsibility of the implementation of the act. This has been a challenge for the regulator for creating an environment that enables sharing. To date, the LLU has not materialised and is a concept that is farfetched for most players. The November 2011 deadline has not been met for the implementation of the LLU. The regulatory and wayleave approval challenges are also hampering the rollout of infrastructure.
ECA broadly speaks about open access. Clear policy that defines what open access is and how it should be implemented is not in place, this becomes a requirement to a confusion with managed services.

### 6.3.3 Spectrum

The spectrum policy was published in 2010, no reviews have been done since. A lot has changed since then in the wireless and the policy needs to adapt to the new changes and ensure future adaptations.

The NBP has all the good intentions and its objectives are in line with targets of the Broadband Commission for Digital Development. However, the delays in policy directives that will support and facilitate its implementation are creating barriers and holding back the country’s broadband development.

Gillwald et al. [49] have also made a deduction that there are policy and regulatory shortcomings, and these shortcomings are compounded by leadership and competency crises in the DoC. Further, there is a need for institutional arrangement review that will ensure that the ICASA has necessary independence, competencies and resources to enable effective regulation and provide regulatory certainty that attracts investments required for development of ICT networks, services, applications and content [49].

In conclusion, the research makes the following statements with regard to the research questions:

- **Policy plays an imperative role in setting up an environment for broadband development and other matters of national interest.**
- **Open access, infrastructure sharing, funding, licensing regime, spectrum and promoting demand are key policy and regulatory considerations for smooth broadband development.**
- **Spectrum is of paramount importance driven by the anticipation that many countries in particular the developing countries will use wireless technologies as the primary vehicle for broadband development.**
6.4 Recommendations

The vital importance of national policy leadership is understood by ICT stakeholders around the globe. Policy leadership should provide clear vision to identify opportunities, constraints and actions required for broadband development [24]. The NBP has identified the opportunities, highlighted the constraints and has also identified the actions that are required for implementation of its ‘digital’ strategy.

Effective policy and regulatory frameworks play a vital role in facilitating broadband development [24]. All stakeholders have a role to play and should be involved in all matters relating to broadband development. South Africa is experiencing delays in policy and regulatory frameworks that will support and facilitate broadband development through the NBP. This study’s recommendations are in line with those recommended by Broadband Commission relating to policy matters to facilitate broadband development and maximise the impact of broadband. The recommendations are as follow:

- Prioritise critical policy matters on time;
- Consider open access approaches to infrastructure;
- Review and update regulatory service obligations;
- Review licensing schemes; and
- Review policy frameworks for spectrum.

6.5 Study contributions

The research contributes to the existing body of knowledge in policy and regulatory development in broadband and spectrum management in South Africa.

The research has identified key policy roles that are fundamental to broadband development as well the importance of spectrum in the same regard, that a broad approach is key as it addresses broadband development holistically. The broad approach includes key policy and regulatory instruments that are fundamental to broadband development. These individual instruments offer new areas of in-depth research areas.
6.6 Limitations of the Study

The unavailability and reluctance of respondents particularly from the incumbents was one of the limitations, had the research secured interviews with these key stakeholders, it is possible that the research could have arrived at somewhat different findings. The other limitation was the classified information of the incumbents that the researcher could not use as doing so could have had an impact on their competitiveness.
7. **BIBLIOGRAPHY**


The impact of policy on broadband development: A South African case study


APPENDIX A: INVITATION LETTER

Dear Sir/Madam

I am currently conducting a research in technology evolution and spectrum management as part of the requirement for completing my Master’s degree in Engineering Management at the University of Johannesburg.

Part of my research data collection method requires me to conduct interviews with experts in the industry ranging from policy making, regulatory and operations. I hereby humbly request that you avail yourself and make time within your tight schedule for about 30 minutes to respond to questions I have attached.

Your responses to the questions will be solely be used for completing the research report and the information will treated confidentially.

Thanking in advance.

Regards

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Faculty of Engineering and Build Environment
Student No. 201326237
<table>
<thead>
<tr>
<th>#</th>
<th>Questions</th>
<th>Research area addressed</th>
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<tbody>
<tr>
<td>1</td>
<td>The broadband plays an important role in information society building and facilitates economic development and social inclusion. Do you agree with this statement and why?</td>
<td>Factors that make broadband important</td>
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<td>2</td>
<td>The broadband policy’s ultimate goal is to achieve universal download speeds of 100 Mbps for users by 2030. Do you think that these speeds are realistic and achievable considering the shared environment?</td>
<td>Spectrum</td>
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<td>3</td>
<td>Do you agree that South Africa has adequate backbone capacity and infrastructure to support universal broadband access?</td>
<td>Infrastructure</td>
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<td>4</td>
<td>In your view, how will universal broadband access be achieved?</td>
<td>Funding, and all other key factors</td>
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<td>5</td>
<td>Millimetre wave technology will play a role in broadband provisioning both as last mile and backhaul media in the absence of fibre infrastructure. Do you agree with this statement and why?</td>
<td>Technical + infrastructure</td>
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<td>6</td>
<td>How should spectrum in the millimetre wave bands be allocated and licensed?</td>
<td>Spectrum</td>
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<td>7</td>
<td>Do you think that South Africa will meet that deadline of June 2015 for digital switch-over?</td>
<td>Policy + regulation</td>
</tr>
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<td>8</td>
<td>What are the implications of not making the deadline?</td>
<td>Policy</td>
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<td>9</td>
<td>How should the digital dividend 1 (800 MHz) be licensed in your view, not considering the draft published by the regulator?</td>
<td>Spectrum</td>
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<td>10</td>
<td>Do you foresee any issues that South Africa may face with regard to making digital dividend 2 (700 MHz) available?</td>
<td>Technical + spectrum</td>
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<td>11</td>
<td>Do you support the current institutional arrangement between the policymaker and the regulator?</td>
<td>Policy</td>
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<td>Question</td>
<td>Category</td>
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<td>12</td>
<td>Does it foster independence?</td>
<td>Institutional functionality</td>
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<tr>
<td>13</td>
<td>Is it effective and efficient for performing spectrum management functions?</td>
<td>Policy</td>
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<tr>
<td>14</td>
<td>In your view what is an ideal arrangement?</td>
<td>Policy</td>
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<tr>
<td>15</td>
<td>Do you think South Africa has an effective spectrum policy that encourages competition, attracts investments and allocates spectrum fairly?</td>
<td>Policy</td>
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