

Spectrum management master plan PRACTICES AND REQUIREMENTS IN BRUNEI DARUSSALAM

Report



Spectrum management master plan

Practices and requirements
in Brunei Darussalam

This case study has been prepared by ITU expert Mr Pavel Mamchenkov as a part of a joint project between ITU and the Ministry of Science, ICT and Future Planning of the Republic of Korea on developing spectrum management master plans for countries in the Asia-Pacific region. The scope of the project is to assist governments and regulators in assessing, reviewing, building human capacity, competency and developing new spectrum management framework. The report has benefited from the contribution and comments of many people in particular Mr Shishir Kansal, Mr Haji Muhd Zaki Iskandar Bin Haji Mohd Suffian, and Ms Hjh Yusrina Bte Haji Mat Yussof from the Authority for Info-Communications Technology Industry of Brunei Darussalam (AITI).

ISBN:

978-92-61-21781-5 (electronic version)

978-92-61-16491-1 (paper version)



Please consider the environment before printing this report.

© ITU 2016

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Table of Contents

Introduction	1
1 Country profile	1
2 Current spectrum management framework	3
2.1 Legislative framework	3
2.2 Institutional framework	9
2.3 Current spectrum management practices	15
2.4 Current licensing scheme	19
2.5 Service provisioning licensing and spectrum usage fees	28
2.6 Spectrum trading	34
2.7 Current frequency assignment procedure	35
3 Current and future spectrum demand by sector/services	37
3.1 Spectrum management issues identified by stakeholders	37
3.2 Spectrum demand trends by sector/service	42
4 Recommendations and key issues in implementation of master plan	58
4.1 Possible alignment of the primary legislation	58
4.2 Envisaged alignment of allocation policy	59
4.3 Improvements in spectrum licensing and spectrum pricing practices	70
4.4 Spectrum management strategy	78
5 Finding and conclusions	80
5.1 Institutional aspects and strategy	80
5.2 Primary and subsidiary legislation	82
5.3 Licensing	83
5.4 Spectrum planning	84
5.5 Spectrum fees	85
5.6 Radio monitoring	86
5.7 Regulatory practices	87
Annex 1: Spectrum management master plan	89
Annex 2: Proposals on the modification of radio monitoring country-wide system for Brunei Darussalam	93
Abbreviations	96

List of tables, figures and boxes

Tables

Table 2.1: AITI terms of responsibilities	7
Table 2.2: Category and types of station licences	21
Table 2.3: Fees levied for InTi licences	28
Table 2.4: Fees levied for SeTi licences	29
Table 2.5: Dealer licensing fees	29
Table 2.6: Categories and station licences annual fees	31
Table 2.7: Application and processing fees for use of radio frequency	32
Others	33
Table 3.1: Preferred frequency bands for point-to-point systems depending on layers of mobile network	44
Table 3.2: Preferred frequency bands for point-to-multipoint systems depending on layers of mobile network	44
Table 3.3: Fixed service spectrum bands and channel plans	46
Table 3.4: Number of sites deployed up to the end 2014	54
Table 4.1: Excerpt from the ECA for 1710 – 1785 MHz sub-band	60
Table 4.2: Excerpt from the allocation and utilization plan of the radio frequency spectrum in Bosnia and Herzegovina for 1710 – 1785 MHz sub-band	60

Figures

Figure 1.1: Map of Brunei Darussalam	2
Figure 2.1: Structure of national legal framework	3
Figure 2.2: Excerpt from the Spectrum Plan of Brunei Darussalam	8
Figure 2.3: Overview of institutional structure	9
Figure 2.4: Strategic framework of AITI	12
Figure 2.5: Attribution of Broadcasting Regulatory Responsibilities to AITI	13
Figure 2.6: High level organizational chart of AITI	14
Figure 2.7: Positioning of Infrastructure and Resource Management Unit	15
Figure 2.8: Positioning of spectrum management related units in the AITI organizational chart	15
Figure 2.9: The template of station licence	23
Figure 2.10: Terms and conditions of station licence	24
Figure 2.11: Existing structure of spectrum licensing fees	30
Figure 2.12: Frequency application and assignment process	36
Figure 2.13: Frequency application processing algorithm	37
Figure 3.1: The cellular mobile band allocation in Brunei Darussalam	39
Figure 3.2: Evolution in spectrum requirements for the fixed service	43
Figure 3.3: Growth in number of point-to-point links in CEPT countries between 1997 and 2010	45
Figure 3.4: Block assignment scheme for the fixed service spectrum Band 22 GHz (case for three significant cellular operators)	47
Figure 3.5: Block assignment scenario without guard band	48
Figure 3.6: ITU global traffic estimates in 2005 and 2011	49
Figure 3.7: ITU spectrum estimates and actual spectrum supply comparison (illustrative)	50
Figure 3.8: Traffic and revenue divergence	50
Figure 3.9: Algorithm for spectrum requirements estimation	51
Figure 3.10: Spectrum efficiency by different radio technologies	53
Figure 3.11: Network growth from 2009 up to the end of 2014	54
Figure 3.12: Network growth: 10% annually. Traffic growth: 25% annually. No	

technology changes. No new spectrum.	55
Figure 3.13: Network growth: 10% annually. Traffic growth: 25% annually. GSM900 converted to UMTS900 in 2017. No new spectrum.	55
Figure 3.14: Network growth: 10% annually. Traffic growth: 25% annually. 2x30 MHz converted to LTE2100 in 2019. No new spectrum.	56
Figure 3.15: Network growth: 10% annually. Traffic growth: 25% annually. 2x10 MHz converted to LTE-A in 900 from 2022. 2x40 MHz converted to LTE-A in 2100 from 2022. No new spectrum.	56
Figure 3.16: Network growth: 10% annually. Traffic growth: 25% annually. 2x70 MHz used for LTE-A in all bands from 2024. No new spectrum.	56
Figure 3.17: Network growth: 10% annually. Traffic growth: 40% annually. No technology changes. No new spectrum	57
Figure 3.18: Network growth: 10% annually. Traffic growth: 40% annually. GSM900 converted to UMTS900 in 2017. No new spectrum.	57
Figure 3.19: Network growth: 10% annually. Traffic growth: 40% annually. 2x30 MHz converted to LTE2100 from 2019. No new spectrum.	57
Figure 3.20: Network growth: 10% annually. Traffic growth: 40% annually. 2x10 MHz converted to LTE-A in 900 from 2022. 2x40 MHz converted to LTE-A in 2100 from 2022. No new spectrum.	58
Figure 3.21: Network growth: 10% annually. Traffic growth: 40% annually. 2x70 MHz used for LTE-A in all bands from 2024. No new spectrum.	58
Figure 4.1: Evolution of licensing scheme	73
Figure 4.2: New licensing structure envisaged in the consultations, 2012	74
Figure 4.3: Proposed evolution of spectrum related prices	76

Introduction

Global evolution of the ICT sector through the variety of services and applications has dramatically changed economic and social aspects of society. It is generally accepted that an effective telecommunication infrastructure is the essential impetus that enables a country to achieve successful social and economic development. Wireless technologies are especially important for developing countries as reducing the time and expense of installing telecommunication networks. But as more and more service delivery methods rely on the limited spectrum resource, the need for efficient spectrum management is increased. Therefore, an orderly management of the national usage of the radio spectrum resource is becoming crucial in order to obtain the maximum benefits for developing countries.

In order to address these difficult challenges, especially in countries that may sometimes lack the appropriate human capacity and skills to resolve continually evolving issues related to spectrum management, ITU initiated a project on developing master plans for spectrum management for countries in Asia-Pacific region. The project is in-line with:

- WTDC-14 Objective 2 – ICT Infrastructure Development (the relevant outputs include. Master plans and best-practices; provision of technical expertise). In addition project is also covered under Priority areas of the Programme 1, i.e. spectrum management.
- Asia-Pacific Regional Initiative 5: Telecommunication/ICT policy and regulation in the Asia-Pacific region.

The project objective is to provide assistance to countries in the Asia-Pacific region in the process of establishing modern spectrum management systems. Realizing the importance of the project, the Ministry of Science, ICT and Future Planning of the Republic of Korea (MSIP) entered into partnership with ITU in January 2014 and initiated a two year project. In accordance with the project objective, ITU and MSIP formulated the scope of activities that includes assistance to the governments and regulators in assessing, reviewing, and developing new spectrum management framework and building human capacity and competency through regional events.

Following the approval of the project, an implementation methodology was finalized that required a detailed survey to assess the spectrum management situation in individual counties of the Asia Pacific region. Brunei Darussalam was evaluated to have suitable capacity and readiness in the domain of spectrum management to benefit from this project. This report provides one of the ITU steps in fulfilling its obligations to assist Brunei Darussalam in studying the existing situation with regard to spectrum management, tools and skills and estimating how well these meet the requirements of existing and future telecommunication markets.

According to the ITU project objective, the spectrum management master plan summarizes the activities to be taken in short-, medium- and long-term timeframes. The list of actions is based on detailed analysis of the current spectrum management framework in Brunei Darussalam and incorporates issues related to legal, structural, strategic and operational areas of spectrum regulation.

1 Country profile

The Sultanate of Brunei Darussalam is situated on the northwest coast of the island of Borneo. The capital, Bandar Seri Begawan, lies inland on the Brunei River. Brunei occupies 5 765 square kilometres and is divided into two parts, both of which are surrounded by the Malaysia State of Sarawak. Relatively little of the Brunei landmass is cultivated and around 60 per cent is covered by primary forest. The Brunei coastline stretches for 161 kilometres along the South China Sea. The country map is shown in Figure 1.1.

Figure 1.1: Map of Brunei Darussalam



Source: seacitymaps.com

The population of Brunei is estimated at 426 000 people. Brunei is constitutionally an absolute monarchy. The country is ruled by the Sultan and Yang Di-Pertuan of Brunei Darussalam Haji Hassanal Bolkiah Mu'izzaddin Waddaulah ibni Al-Marhum Sultan Haji Omar Ali Saifuddien Sa'adul Khairi Waddien, who is both the Head of State and the Prime Minister, and appoints and presides over four policy councils: the Council of Cabinet Ministers, the Legislative Council, the Privy Council and the Religious Council.

In 2012, oil and gas accounted for around 67 per cent of Brunei GDP. The public sector is by far the largest employer of Brunei's population, providing employment for over half the workforce.

The Brunei Government is working towards diversifying the economy away from heavy dependence on oil and gas, by promoting private non-energy sector development and attracting more non-oil and gas related investment. The Brunei Economic Development Board (BEDB) was formed in November 2001 to stimulate the growth, expansion and development of the economy by promoting Brunei as an investment destination and facilitating diversification projects.

In January 2008, the Brunei Government released its Vision 2035 (Wawasan 2035), which sets out the overarching goal of delivering economic diversification by 2035 and the broad development strategies that Brunei will pursue over this period. Five year National Development Plans then set out detailed project and budgets for delivering Vision 2035. The plan for the period 2012 to 2017 was announced in April 2012 and it continued to target an annual growth rate of 6 per cent over the life of the plan.

In line with the major objective of diversifying the economy, the Brunei Government makes early actions to ensure that the ICT market is delivering up-to-date telecommunication services to its population. The target of 100 per cent digitalisation was achieved in 1995. Telecommunications infrastructure and services throughout Brunei are of a generally high standard and the country ranks well in Asia in terms of both telecom service penetration and infrastructure facilities.

Brunei mobile penetration, which stood at an already healthy 32 per cent in 2001, has continued to expand and had reached a penetration of 115 per cent in 2014. Fixed-line penetration in Brunei, having reached a healthy 26 per cent by 2001, has been in decline, slipping to around 20 per cent by 2012 and down to 14 per cent coming into 2014. As of 2014 more than 90 per cent of Brunei Internet subscribers have high-speed broadband access, with around half of these on a mobile broadband platform. Overall growth in broadband access, having suffered a setback in 2012, had picked up

strongly in 2013 and into 2014. The government issued a National Broadband Blueprint in 2014, with a primary objective being to increase the ICT industry contribution to GDP to 6 per cent by 2015.

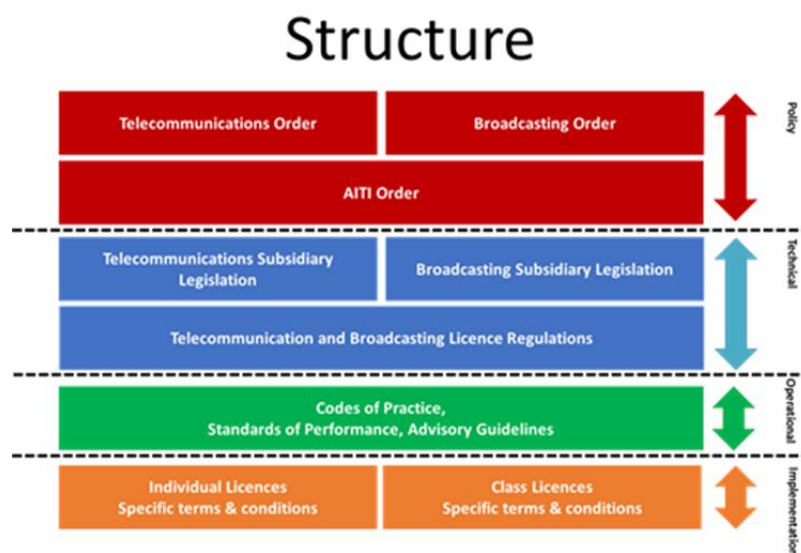
From the ICT indicators achieved to date and planned for the future it is obvious that wireless technologies are mostly valuable for the telecommunication sector development. Inherently the efficient spectrum management becomes an issue of great importance in Brunei Darussalam.

2 Current spectrum management framework

2.1 Legislative framework

Spectrum management constitutes a significant part of the Brunei Darussalam regulatory system. Provisions related to spectrum management are determined in legislative instruments belonging to different levels of legal hierarchy. Figure 2.1 shows the general telecommunication and broadcasting legislative framework.

Figure 2.1: Structure of national legal framework



Source: AITI

The primary legislation includes the Telecommunications Order 2001, the Broadcasting Act (Chapter 180), and the Authority for Info-Communications Technology Industry of Brunei Darussalam (AITI) Order 2001. Subsidiary (secondary) legislation embraces statutory instruments dealing with broad area of regulations such as telecommunication regulations, broadcasting regulations, or licensing regulations. A number of practical rules and procedures also exists, including: codes of practice, standards of performance, advisory guidelines, etc.

The following sections of the report will elucidate the issues of spectrum management in the current legal basis of Brunei Darussalam as well as their distribution between the adopted legislative instruments.

2.1.1 Primary legislation

Telecommunications Order, 2001

The Telecommunications Order, 2001 provides for the operation and provision of telecommunication systems and services in Brunei Darussalam and establishes the basis for primary legislation of the telecommunication sector of Brunei Darussalam. It also constructs the legal regime ensuring the satisfaction of the basic requirements to provide telecommunication services to the population, public and private entities from various activity sectors, and the creation of conditions conducive to the development and diversification of services. The Telecommunications Order, 2001 provides the legal background for the whole ICT sector of the country, and constitutes the basis for subsidiary legislation.

The Telecommunications Order 2001 empowers AITI with the privilege for the operation and provision of telecommunication systems and services in Brunei Darussalam (Section 3 of the Order). The privilege conferred on AITI includes the rights of establishing, installing, using, working, maintaining, developing, constructing, promoting, hiring and selling telecommunication systems and services.

In addition, AITI is vested by law to license telecommunication systems and services. A licence may (with the consent of, or in accordance with the terms of a general authority given by the Minister of Communications) be granted by AITI, either unconditionally or subject to such conditions as AITI may impose and specify in the licence and either irrevocably or subject to revocation as specified for the running of such telecommunication systems and services as specified in the licence. The Telecommunications Order, 2001 stipulates that licensees shall pay a fee on the grant of the licence or periodic fees during the duration of the licence. Consequently, this primary legal act sets out the framework for licensing fees. Furthermore, the obligations of licensees to comply with codes of practices and standards of performances applied by AITI are also included in the provisions of the Telecommunications Order, 2001.

The Order confers AITI with the competence to issue and approve and, from time to time, review codes of practices and standards of performance in connection with:

- the operation of telecommunication system and equipment;
- the provision of telecommunication services;
- the conduct of telecommunication licensees in the provision of telecommunication services.

With the third set of provisions, the Order establishes the legal framework for AITI to supervise licence conditions and to monitor quality of services provided.

The Order fixes that equipment to be used for connection to any telecommunication system or equipment belonging to a telecommunication licensee shall be approved by AITI before use. A person applying to AITI for an approval may be required to comply with such requirements as the regulator may think appropriate; and those requirements may include a requirement to satisfy some other person with respect to any matter. From there the Order establishes the legal basis for type-approval procedures in Brunei Darussalam.

The Order empowers AITI to make separate regulations for any purpose for which regulations are required. Without prejudice, AITI may introduce regulations, among the others, for the following matters:

- the classes and the conditions for the grant of licences;
- the control and regulation of dealing in and use of telecommunication equipment;
- the control and regulation of interference by radio waves or electrical or other means of telecommunications in Brunei Darussalam.

The special set of provisions presumes that AITI acquires the rights to adopt subsidiary legislation related to service provision, spectrum licensing and radio monitoring/enforcement matters.

It is fair to note that the Telecommunications Order, 2001 does not address the spectrum management issues directly in the text. Nevertheless, this primary legal act delegates the full scope of corresponding functions and duties to AITI while assuming that the overwhelming portion of this regulation should be attributed to the level of subsidiary legislation.

Broadcasting Act (Chapter 180)

The major primary legal act regulating broadcasting aspects in Brunei Darussalam is the Broadcasting Act. Revised in 2000, the Broadcasting Act includes broadcasting-related provisions on: functions, duties and powers of Minister, licensing scheme, broadcasting services, frequency planning, ownership and other miscellaneous issues. In the Broadcasting Act, the Minister means “the Minister for the time being designated by His Majesty the Sultan and Yang Di-Pertuan to be responsible for broadcasting matters”. Amongst the other responsibilities, the Minister shall exercise and perform the following ones dealing with licensing and spectrum management:

- to exercise licensing and regulatory functions in respect of broadcasting services and broadcasting apparatus;
- to assign specific frequencies in electromagnetic spectrum and satellite orbits to broadcasting licensees whose broadcasting services are to be transmitted on a frequency in such spectrum and satellite orbits.

The Minister may also issue and review the subsidiary legislation in the form of:

- codes of practice relating to standards of programmes and advertisements broadcast by licensees;
- codes of practice relating to broadcast standards required to be maintained by licensees.

Part VI of the Broadcasting Act includes the provisions related directly to frequency planning for broadcasting service. It specifies criteria of frequency planning and indicates issues that should have due regard with such planning as follows:

- social and economic characteristics within Brunei Darussalam;
- number of existing broadcasting services and the demand for new broadcasting services;
- developments in technology;
- technical restraints relating to the transmission, delivery or reception of broadcasting services;
- the demand for electromagnetic, and particularly radio frequency, spectrum for services other than broadcasting services.

The Broadcasting Act vests the Minister with the exclusive right to assign frequencies for broadcasting operators in Brunei Darussalam. The Minister may, with the approval of His Majesty the Sultan and Yang Di-Pertuan, in writing assign to any person specific frequencies in the electromagnetic spectrum and satellite orbits for the purpose of broadcasting, having regard to the international allocation plans set by the International Telecommunication Union and to national requirements.

At the same time, the Broadcasting Act defines that separate licence for use of frequency by broadcasting operator is not required. Section 27 of the Order stipulates the following: “Notwithstanding anything in the Telecommunications Act or any regulations made thereunder, if a licensee is granted a broadcasting licence under this Act and the licence includes the right for the licensee to use a specific frequency in the electromagnetic spectrum or satellite orbits for the broadcasting or transmission of one or more broadcasting services, then the licensee shall not be required to obtain any other licence under this Act or the Telecommunications Act (Chapter 54) in respect of the use of such frequency or satellite

orbits for the period for which that broadcasting licence is in force and for the purposes permitted by that licence.”¹

It is important to note that from 2012 onwards AITI has been engaged in a number of activities to develop a converged telecommunication and media regulatory framework in Brunei Darussalam. The transition to the converged regulation gave rise to innovations in broadcasting regulation most notably in institutional, licensing, and frequency assignment practices (see section 2.2).

AITI Order, 2001

AITI is a legally and functionally independent institution acting under the laws of Brunei Darussalam², with duties pursuant to the objectives and regulatory principles as stipulated by the Telecommunications Order, 2001 and by other approved sector policies. In execution of its duties, AITI acts in accordance with the principles of objectivity, transparency and non-discrimination.

Analysis of the list of AITI responsibilities highlights its significant regulatory status as the official institution of Brunei Darussalam. AITI regulatory functions and duties match responsibilities of a traditional regulatory framework of independent ICT authorities as recommended by ITU, including generic regulation, licencing, management of limited resources (spectrum, numbering), type approval, monitoring and enforcement. Details of AITI responsibilities as defined in the AITI Order, 2001 is included in Table 2.1.

It should be noted that the current scope of the AITI Order, 2001 was defined prior to the transition to the converged telecommunication and broadcasting regulation in 2012. Noting the convergence trends, the AITI Order, 2001 will be amended in order to set out the updated functions and duties of AITI (see section 2.2).

2.1.2 Secondary legislation

Telecommunications (Radio-communication) Regulations, 2013

The Telecommunications (Radio-communication) Regulations, 2013 is the most important subsidiary legislation under the Telecommunications Order, 2001. It provides regulatory provisions for the management of radio frequency spectrum and the use of radio-communication systems in Brunei Darussalam, and includes the framework for spectrum related issues. It provides further steps in the attempt to move away from the traditional administrative regulations to market-based regulations, and it stipulates and establishes new spectrum licensing structure in Brunei Darussalam by implementing Spectrum Rights, Apparatus (Spectrum), Apparatus and Class Licences. It also establishes the background for AITI spectrum pricing policy.

National Frequency Allocation Table

The National Frequency Allocations Table is the legal planning instrument in the area of spectrum management. Pursuant to Regulation 3 of the Telecommunications (Radio-communication) Regulations, 2013, AITI produces the Radio Spectrum Plan that includes the National Frequency Allocations Table

¹ The Telecommunication Act referenced in the citation was replaced with the Telecommunication Order, 2001 while maintaining the same regulatory mechanism.

² The Order to establish and incorporate the Authority for Info-communications Technology Industry of Brunei Darussalam, usually cited as the Authority for Info-communications Technology Industry of Brunei Darussalam Order 2001 (AITI Order, 2001) is the basic primary legal act incorporating institutional, functional, financial and procedural provisions relevant to AITI.

Table 2.1: AITI terms of responsibilities

Generic regulation	Licensing	Resources management	Type approval	Monitoring and enforcement
To act internationally as the national administration of information and communication sectors.	To grant telecommunication licences, supervise and enforce compliance with licence conditions	To regulate spectrum allocations and usage of satellite orbit in Brunei Darussalam.	The establishment of standards and codes relating to equipment attached to telecommunication systems and monitoring of and access to such equipment and software	To control and regulate interference to telecommunication systems.
To issue standards of performance and codes of practices in ICT.	To levy charges and fees for granting licences.	To grant station (apparatus) licences including assigned frequencies or spectrum rights.	To control and regulate import of telecommunication equipment.	To establish and maintain standards and codes for the monitoring and regulation of the ICT aspects, data privacy and protection.
To regulate rates, fees and charges levied by telecommunication operators	To promote and maintain efficient competition at ICT market.	Administration of spectrum assignments and registered radio stations data bases.	Equipment compliance and approval.	
To regulate interconnect and access to telecommunication systems.		To control and regulate numbering plan.		
To regulate infrastructure sharing.		To authorize or regulate the registration, administration and management of domain names		
To advise government on ICT development matters.				

(NFAT) and other information related to spectrum management in Brunei Darussalam. The content of NFAT, as well as decisions on making use of the radiofrequency spectrum, are legally binding on AITI.

The Spectrum Plan divides radiofrequency spectrum of Brunei Darussalam into a number of frequency bands and specifies the general purposes for which the bands may be used. This process is referred to as the allocation of frequency bands to Radiocommunication Services.

Brunei Darussalam is a signatory to the Constitution and Convention of the International Telecommunication Union (ITU). ITU world radiocommunication conferences (WRCs) revise Radio Regulations normally every four years. The basis for the structure of the Spectrum Plan of the country is the Table of Frequency Allocations contained in Article 5 of the ITU Radio Regulations. The ITU Radio Regulations Table of Frequency Allocations lists frequency bands allocated to Radio Services according to three geographic Regions. Brunei Darussalam is located in Region 3 and its NFAT is aligned to Radio Regulations allocations for Region 3.

NFAT of Brunei Darussalam is reproduced in traditional manner as it is done in the vast majority of national telecommunication administrations. The ITU Radio Regulations Table of Frequency Allocations is included in first three columns while the Brunei Darussalam allocations are included in the last column of the table. The table indicates the associated footnotes for the three regions. The footnote numbers are those listed in Article 5 of the ITU Radio Regulations. The allocation column of Brunei Darussalam contains national footnotes (designated as 'BD'). The texts of those footnotes are represented in Chapter 6 of the Spectrum Plan. The excerpt from the Spectrum Plan is given in Figure 2.2.

Figure 2.2: Excerpt from the Spectrum Plan of Brunei Darussalam

2 700-4 800 MHz			
Allocation to services			Allocations in Brunei Darussalam
Region 1	Region 2	Region 3	
2 700-2 900 AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation 5.423 5.424			2 700-2 900 AERONAUTICAL RADIONAVIGATION 5.337 Radiolocation 5.423 5.424
2 900-3 100 RADIOLOCATION 5.424A RADIONAVIGATION 5.426 5.425 5.427			2 900-3 100 RADIOLOCATION 5.424A RADIONAVIGATION 5.426 5.425 5.427
3 100-3 300 RADIOLOCATION Earth exploration-satellite (active) Space research (active) 5.149 5.428			3 100-3 300 RADIOLOCATION Earth exploration-satellite (active) Space research (active) 5.149 5.428
3 300-3 400 RADIOLOCATION 5.149 5.429 5.430	3 300-3 400 RADIOLOCATION Amateur Fixed Mobile 5.149	3 300-3 400 RADIOLOCATION Amateur 5.149 5.429	3 300-3 400 RADIOLOCATION Amateur 5.149 5.429 BD429

Source: AITI

Allocations in Brunei Darussalam are broadly harmonized with the ITU Radio Regulations requirements for Region 3. The existing 15 footnotes associated with Brunei Darussalam are those related primarily to large regional groups of countries. AITI notes such variations as being the subject to the condition that the associated radio stations do not cause harmful interference to the radio services or communications of other ITU Member States operating in accordance with the provisions of the ITU Radio Regulations, and that the possibility of harmful interference from such services and communications is accepted.

The Spectrum Plan is the higher level technical document showing the allocation of bands to various types of services in Brunei Darussalam. It is the primary planning document that should be followed

with regard to spectrum arrangements. AITI published the NFAT of Brunei Darussalam in January 2015. There are other technical elements contributing to spectrum management in Brunei Darussalam:

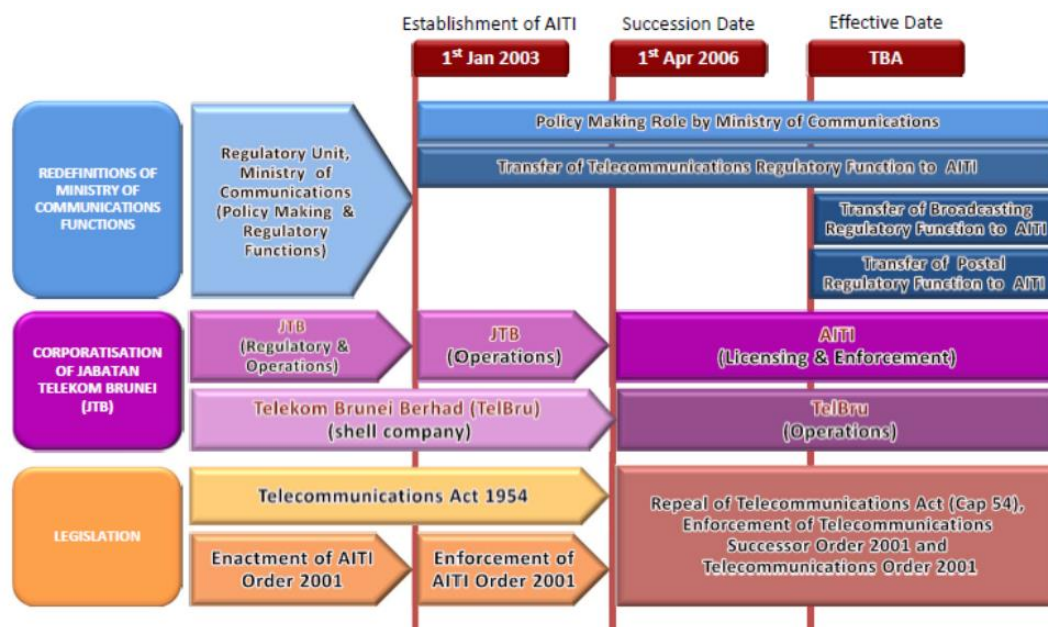
- frequency band plans and frequency channel plans;
- frequency assignment requirements included in legislative instruments and administrative policy documents;
- the technical conditions applied to spectrum rights, apparatus licences and class licences, including any requirements for compliance with standards;
- the technical conditions of frequencies utilization arising from administrative agreements on cross-border coordination.

Recognizing the multi-layered structure of spectrum planning section 2.3.1 below provides detailed information on different levels of the process in Brunei Darussalam. Explicit suggestions on potential options to further improvement of the informational capacity and procedural aspects associated with the maintenances of the spectrum plan are presented in section 4.2.1.

2.2 Institutional framework

On 1 April, 2006, the Telecommunications Successor Company Order 2001 and the Telecommunications Order 2001 were brought into force. This had the effect of corporatizing the Telecommunications Department of Ministry of Communications to become Telekom Brunei Berhad (TelBru) and transferring the regulatory authority of the Director of Telecommunications initially resided at the Telecommunications Department of the Ministry of Communications to AITI. Prior to this rearrangement, the Telecommunications Department of the Ministry performed the dual functions of regulator and service provider. An overview of national regulatory structure is shown in the Figure 2.3.

Figure 2.3: Overview of institutional structure



Source: AITI

The following subsections provide information on institutional elements of the existing structure of ICT regulation in Brunei Darussalam.

2.2.1 Ministry of Communications

The Ministry of Communications was established in 1984, soon after Brunei Darussalam gained its independence. The departments accountable for under the Ministry of Communications are the Department of Telecommunications, the Postal Services Department, the Department of Civil Aviation, the Land Transport Department, the Ports Department and the Marine Department. Since 1 April, 2006, the Department of Telecommunications was corporatized and became known as Telekom Brunei Berhad (TelBru).

Ministry mission:

- To create a conducive and dynamic environment for sophisticated society.
- To establish and sustain hubbing activities in communications.
- To provide safe, efficient, accessible and secure communications so as to enhance national competitiveness and quality of life in the knowledge-based economy.

2.2.2 Authority for Info-Communications Technology Industry (AITI)

The Authority for Info-Communications Technology Industry (AITI) is the statutory body responsible for regulation in the areas listed below:

- telecommunications and radiocommunications regulation;
- radiofrequency spectrum planning and management;
- ICT industry development.

AITI was established on 1 January, 2003 by the primary legal act, AITI Order 2001, to function as the telecommunication regulator, national radio-frequency spectrum manager, and developer of the Brunei Darussalam ICT industry. According to Section 6 of the Authority for Info-Communications Technology Industry Order, 2001, AITI has functions and duties as follows³:

a.	To promote the efficiency and international competitiveness of the information and communications industry in Brunei Darussalam;
b.	To ensure that telecommunication services are reasonably accessible to all people in Brunei Darussalam, and are supplied as efficiently and economically as practicable and at performance standards that reasonably meet the social, industrial and commercial needs of Brunei Darussalam;
c.	To promote and maintain fair and efficient market conduct and effective competition between persons engaged in commercial activities connected with telecommunication technology in Brunei Darussalam;
d.	To promote the effective participation of all sectors of the Brunei Darussalam information and communications industry in markets (whether in Brunei Darussalam or elsewhere);
e.	To act internationally as the national body representative of Brunei Darussalam in respect of ICT matters;
f.	To advise the Government on national needs and policies in respect of all ICT matters and on matters appertaining to the Authority generally;
g.	To further the advancement of technology and research and development relating to ICT;
h.	To exercise licensing and regulatory functions in respect of telecommunication systems and services in Brunei Darussalam, including the establishment of standards and codes relating to equipment attached to telecommunication and radio-communication systems, and any equipment or software used as an adjunct to or in conjunction with such systems and the monitoring of and access to such equipment and software;

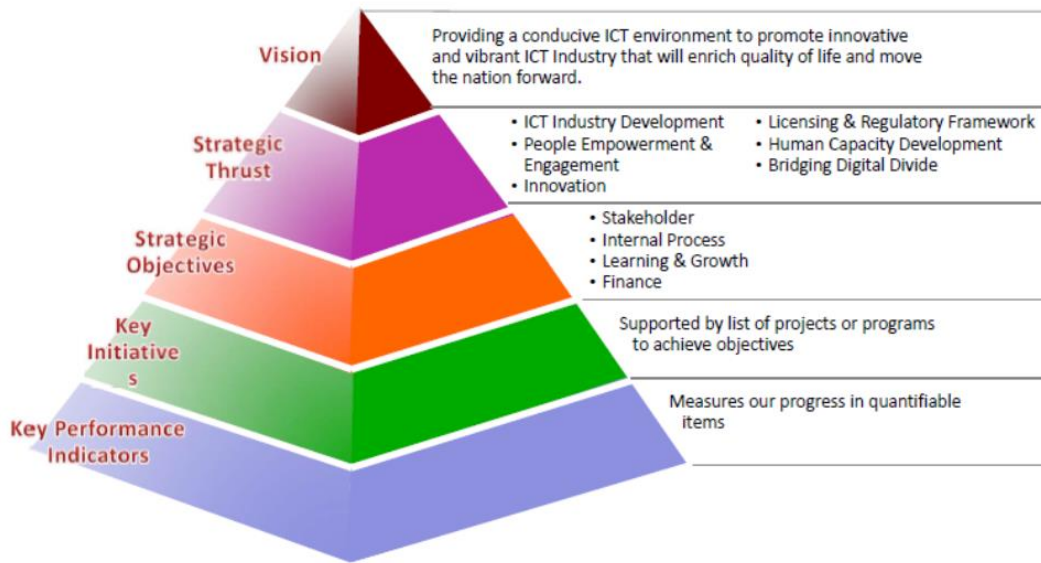
³ www.aiti.gov.bn/AboutUs/Pages/function-duties.aspx

i.	To exercise licensing and regulatory functions in respect of the allocation and use of satellite orbits and the radio frequency spectrum in Brunei Darussalam for all purposes, including the establishment of standards and codes relating to any matter in connection therewith;
j.	To encourage, facilitate and promote the greatest practicable use of industry self-regulation by the information and communications industry in Brunei Darussalam;
k.	To exercise licensing and regulatory functions in respect of the installation, use and provision of undersea cables, cable frontier stations and satellite stations, receivers and transmitters in Brunei Darussalam and all equipment used in connection therewith;
l.	To exercise regulatory functions in respect of the determination and approval of prices, tariffs, charges and the provision of telecommunication and such other related services;
m.	To encourage, promote, facilitate, invest in and otherwise assist in the establishment, development and expansion of the information and communications industry in Brunei Darussalam, including ICT manpower resources in Brunei Darussalam;
n.	To provide facilities for the training of and do anything for the purpose of advancing the skills and knowledge of persons for any purpose connected with the information and communications industry in Brunei Darussalam;
o.	To advise on the development and implementation of ICT systems and services for Government ministries, departments and agencies;
p.	To advise on education and training in the ICT in Brunei Darussalam;
q.	To establish and maintain, to the extent permitted by any law, standards and codes for the monitoring and regulation of such aspects of the ICT data privacy and protection as AITI thinks fit;
r.	To promote the use of the Internet and electronic commerce and to establish regulatory frameworks for the purpose;
s.	To promote consultancy and advisory services relating to ICT;
t.	To promote the acceptance and use the ICT in Brunei Darussalam;
u.	To exercise any other functions and duties conferred on AITI by or under the Telecommunications Order 2001 or any other written law.

It should be emphasised, that AITI has the power to introduce subsidiary legislation and has approved one of great significance for the ICT sector; the Telecommunications (Radio-communication) Regulations, 2013. AITI also regulates competition in radiocommunication and telecommunications, including promoting industry self-regulation and managing the radiofrequency spectrum. AITI is also empowered to ensure consumer protection.

Access to the radiofrequency spectrum is facilitated by AITI through planning, licensing, managing interference and ensuring industry compliance with mandatory standards and conditions. Spectrum auctions are legally envisaged as an option of allocating spectrum fairly and efficiently. AITI also advises on the use of telecommunication and the radiofrequency spectrum and investigates interference complaints. AITI monitors compliance with technical standards for communications equipment and cabling, and for electromagnetic compatibility of electrical and electronic equipment. It also sets out standards protecting the integrity of communications networks and the interoperability of the standard telephone service. AITI represents Brunei Darussalam communication interests internationally through ITU, the Asia-Pacific Telecommunity (APT), and other international bodies. Figure 2.4 illustrates the AITI strategic framework from the basic level of KPIs towards the top level of its strategic vision.

Figure 2.4: Strategic framework of AITI



Source: AITI

2.2.3 Transition to the converged regulatory regime

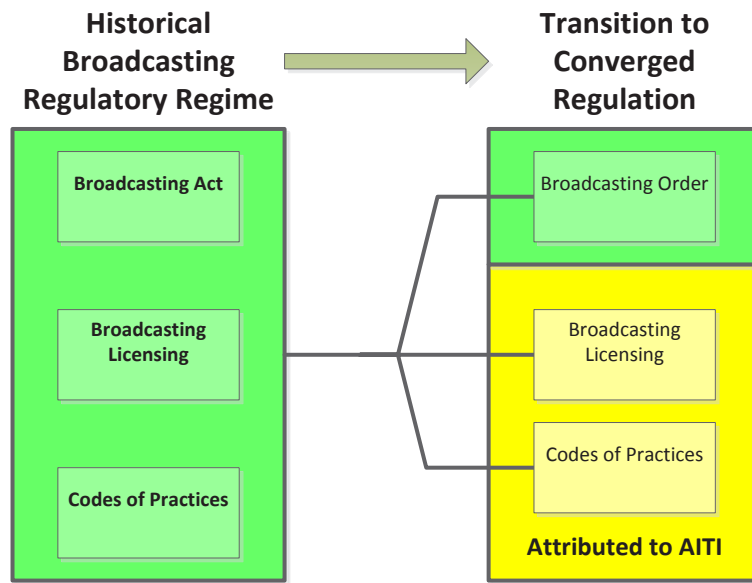
Formerly the regulation of telecommunication and broadcasting sectors of Brunei Darussalam was performed by different governmental entities separately, each sector with distinct legislation. With this traditional scheme, the regulation was broadly based on delivery platforms and executed by means of different legislation and regulators. In 2010 to 2011, the old scheme had become vulnerable as platforms capable of delivering all electronic communications had become increasingly common.

In line with the objective of ensuring efficient and co-ordinated regulation of a converging communications sector, in 2012, AITI decided on migration of its current licensing framework to a more streamlined licensing structure, as the consequence of a merger of the current licensing and regulatory regimes in the telecommunication and broadcasting sectors. To comply with this intension, AITI undertook the consultation exercise to gather feedback on its proposed approach towards a converged regulatory framework. This was the first stage of public consultations dealing with the subject of implementing a unified licensing system.

Pursuing the objective of a new regulatory convergence approach, the Government of Brunei Darussalam contemplated bringing the existing telecommunication and broadcasting regimes under a single regulator –AITI. This required broadening the scope of the current duties, functions and responsibilities of AITI in order to regulate effectively the broadcasting sector in addition to the telecommunication sector. However, the first stage of transition did not intend to bring about a radical overhaul of existing legislation. The regulator decided to leave legislation covering the telecommunication and broadcasting sectors separate and in their current form as there were no plans to implement an umbrella ICT legislation in Brunei.

Although AITI regulates the telecommunication and broadcasting sectors, legislative amendments were limited mostly to essential areas ensuring efficient and effective regulation of the converged communications sector, including provisions to accommodate the roles, functions, duties and powers of a converged regulator. AITI has attributed two out of the three regulatory areas that previously had been the integral elements of broadcasting regulatory regime. Broadcasting licensing and creating of codes of practice became functions of AITI under the new converged regime as shown in the Figure 2.5.

Figure 2.5: Attribution of Broadcasting Regulatory Responsibilities to AITI



Source: ITU

Amendments to the existing three primary legal acts (the Telecommunication Order, the Broadcasting Order and the AITI Order) have been agreed and submitted to the final stage of their approval by the government. Along with that the major subsidiary legislation instruments affected by transition process to the new layout of converged regulation such as codes of practice related to dealer licences, technical standards and content regulation have been revised and are awaiting final approval simultaneously.

Similar to independent regulators in other countries, AITI seeks to incorporate both telecommunication and broadcasting technical administrative practices in the converged entity. On other hand even though administratively AITI has embedded telecommunication and broadcasting regulatory issues, its legal basis has not yet been formalised. This process should be strongly promoted, as it will become the prerequisite for successful introduction of the new approaches in spectrum management, and will facilitate effective implementation of innovative converged radio technologies and services in the country.

AITI recognises that convergence is not just about technology. It is about services and about new ways of doing business and of interacting with society. The emergence of innovative services and the development of existing services are expected to expand the ICT sector. It is important that the development of new services should not be hindered by the existence of barriers, including regulatory barriers. In order to promote a common regulatory approach towards the converged communications sector and eliminate regulatory barriers to the efficient development of such sector, AITI proposes to streamline the existing licensing categories by implementing a unified licensing framework. The final draft of the Competition Code is part of the package. It is in line with the generic competition policy and law guidelines at the ASEAN level. Further, a competition order for the entire economy has also been drafted. AITI intends to undertake additional consultations on legislative amendments to accommodate the converged regulatory framework as well as pricing of licences.

2.2.4 Spectrum management positioning in the structure of ICT regulation

In accordance with Section 6 of the Authority for Info-communications Technology Industry of Brunei Darussalam Order, 2001, AITI is responsible for the management of the radio frequency spectrum, and ensures effective and efficient use of the radio frequency spectrum in Brunei Darussalam by planning, regulating, monitoring and administering as well as internationally coordinating the use of the radio frequency in accordance with the ITU Radio Regulations.

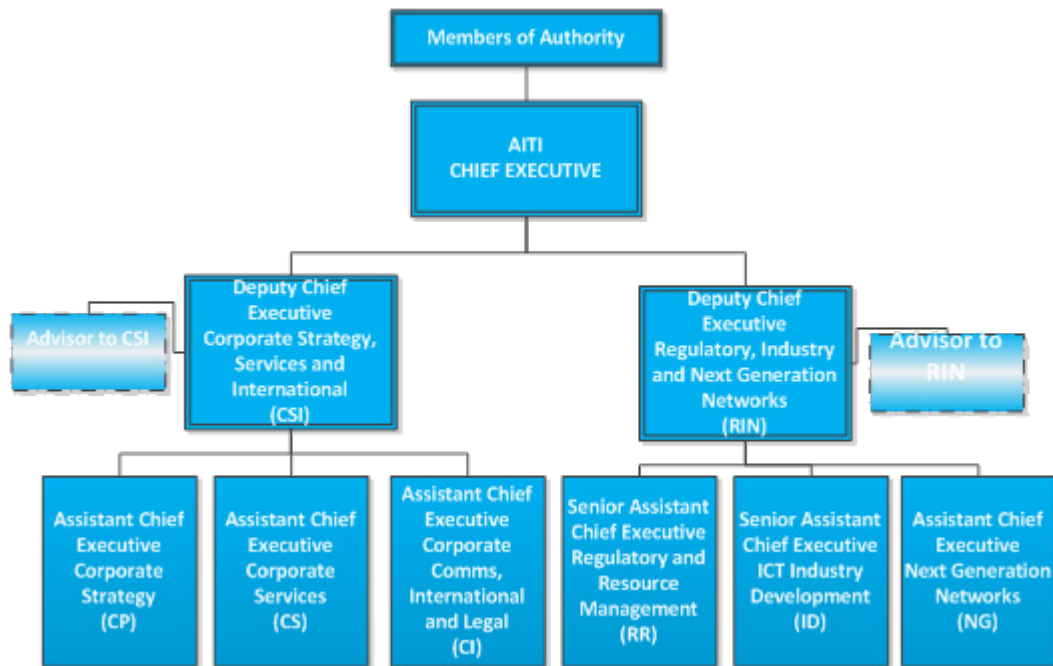
Brunei Darussalam is a member of Asia Pacific Telecommunity (APT), an intergovernmental organization for information and communication technology in Asia-Pacific region. AITI represents Brunei Darussalam in attending several conferences, meetings and seminars organized by APT, including the APT Preparatory Group (APG) for the World Radiocommunication Conference (WRC). The objective of APG is to harmonize views and develop common proposals from the Asia-Pacific region for the WRC.

AITI is a member of the Frequency Assignment and Coordination, Singapore, Malaysia and Brunei Darussalam (FACSMAB), which is a platform for regional frequency coordination, cross-border radio frequency interference resolution as well as discussions on developments of ICTs.

2.2.5 AITI organizational chart: Spectrum management positioning in the structure

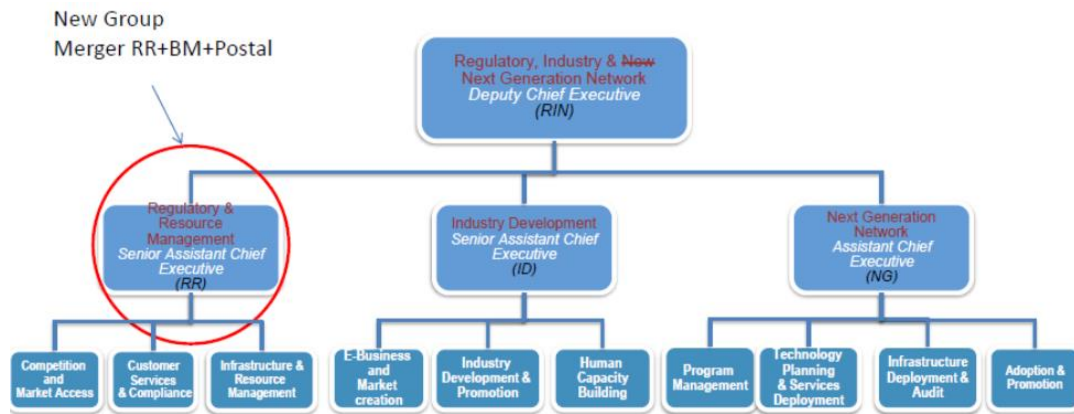
According to the AITI Order, 2001, AITI consists of a Chairman, a Chief-executive, and such other members, not being less than two and more than six, as the Minister may from time to time determine. The Chairman and other members of AITI are appointed by the Minister. The high level current organizational chart of AITI is shown in Figure 2.6.

Figure 2.6: High level organizational chart of AITI



Source: AITI

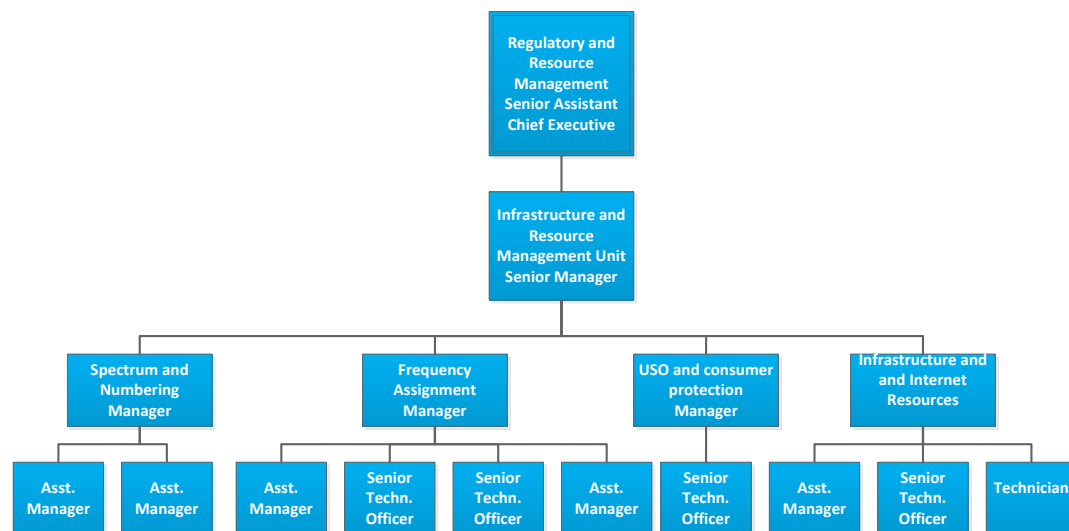
Figure 2.7: Positioning of Infrastructure and Resource Management Unit



Source: AITI

The Deputy Chief Executive is in charge of Regulatory and Resource Management department incorporating the Infrastructure and Resource Management Unit, including the spectrum management functions. The next underlying level of organizational hierarchy is depicted in Figure 2.7. The Spectrum Planning and Frequency Assignment functions are located under the Senior Assistant Chief Executive of Infrastructure and Resource Management Unit. The positioning of those spectrum management related elements of the structure of Infrastructure and Resource Management Unit is illustrated in Figure 2.8. It contains two separate functions, namely the spectrum planning and frequency assignment. The spectrum planning unit within AITI is responsible for the issues dealing with the National Frequency Allocation Table, creating spectrum band plans and other strategic planning of spectrum as the limited natural resource of the country. The frequency assignment unit takes care of the overall frequency application processing, stations licensing, border coordination, electromagnetic compatibility expertise and maintenance of the national data base of the frequency assignments.

Figure 2.8: Positioning of spectrum management related units in the AITI organizational chart



Source: AITI

2.3 Current spectrum management practices

According to the subsidiary legislation, the objectives of spectrum management in Brunei Darussalam are:

- To maximize the overall benefit to the public by ensuring the efficient and effective use of spectrum.

- To facilitate current and future introduction of advanced and innovative communication services and to develop competition in communications services.
- To safeguard government and community services by ensuring that necessary spectrum is reserved for services to be provided by or on behalf of the government.
- To fulfil Brunei Darussalam international obligations relating to the use of spectrum.

Before 2010, the executive practices of AITI by means of which spectrum was planned, allocated and licensed, represented the so-called administrative model of spectrum management. The major feature of this model resides in the fact that the governmental regulator takes the full scope of responsibilities for spectrum planning and authorises users with the station licences (apparatus licences). In the traditional context, an apparatus licence is a station licence authorizing a user to operate a particular radio station at a particular geographical location having the fixed list of technical parameters and operational characteristics.

In the meantime, the administrative model internationally gained a reputation of hardly suitable to satisfy the comprehensive demands of the up-to-date ICT environment from both technology development and resources management points of view. The fast changing telecommunication services and corresponding turnover of wireless technologies created a powerful momentum to the transition to hybrid administrative/market models. Pertaining to spectrum management in Brunei Darussalam the new Telecommunications (Radio-communications) Regulations came into effect in 2013. This subsidiary legislative instrument took note of and introduced three innovative categories of spectrum licensing, namely 'spectrum rights', 'class licence' and 'apparatus (spectrum) licence'.

Conceptually the new scheme of spectrum licensing should represent the partial delegation of power in spectrum management from the administrative level to market level. In particular, spectrum rights are assuming to provide the licensee with quasi-proprietary and tradable flexibility with the allocated spectrum band or sub-band. Licences in the form of spectrum rights are easier to encompass such inherent elements of modern regulation as technology neutrality and service neutrality, thus giving a licensee freedom to operate the allocated frequency resources in the most efficient way.

The next important innovation introduced with the adoption of Telecommunications (Radio-communications) Regulation, 2013 is the price-based method of spectrum allocation under which spectrum rights licences are issued. The Telecommunications (Radio-communications) Regulations, 2013 incorporated auctions as a type of spectrum licensing process aimed on optimizing efficiency of spectrum utilization by allocating usage rights to those who values the resource most. With these regulatory innovations, it becomes clear that AITI task in the short and medium term would be to ensure smooth transition from the inherited administrative station licence based regulatory approach to the practice of issuing licences primarily based on spectrum rights.

With the new regulatory approach in 2013, AITI recognized that secondary market or spectrum trading can increase the capacity and efficiency of spectrum use. The provisions related to spectrum trading with spectrum rights were introduced in the national legislation regulating spectrum usage. Actually, spectrum trading can make unused or under-used spectrum held by existing licensees available to other users and uses without regulatory intervention, alleviating excess demand, and providing a transition path to new technologies. A secondary market can provide an incentive to licensees to be more spectrum efficient by increasing the value of any spectrum that can be released for sale or lease. It can also encourage existing licensees to move towards technologies that are more efficient in order to increase the amount of spectrum they can sell or lease.

In practice, AITI had implemented frequency fees practices ahead of the official adoption of Telecommunications (Radio-communications) Regulations. The corresponding obligations, conditions and formulas to calculate those fees are included as the separate Schedule of this legislation instrument.

2.3.1 Spectrum planning

The Telecommunications (Radio-communications) Regulations, 2013 contains the legal background and related procedural aspect of spectrum planning process in Brunei Darussalam. The key elements of national spectrum planning as defined by the Telecommunications (Radio-communications) Regulations, 2013 are the radio spectrum plan, radio frequency band plan, spectrum marketing plan, and spectrum conversion plan.

According to the Telecommunications (Radio-communications) Regulations, 2013, the radio spectrum plan contains the National Frequency Allocations Table (NFAT) and other information related to spectrum management in Brunei Darussalam. The contents are legally binding on AITI in making decisions on use of the radiofrequency spectrum. Radio Frequency Band Plan designates more detailed information on particular bands specifying the purpose for which the particular radio frequency band may be used, including the reservation for future use and for the prevention or control of interference to radio-communications.

In order to designate parts of spectrum for use, AITI has the right to prepare spectrum marketing plans and spectrum conversion plans. The Telecommunications (Radio-communications) Regulations, 2013 stipulate the following constituent parts with respect to the spectrum marketing plan:

- the methods and procedures for determining the allocation of a spectrum right;
- the timetable for granting a spectrum right;
- the apportionment of the designated frequency bands in the radio spectrum plan for use or grant of a spectrum right;
- the amount of spectrum to be reserved for public or community services;
- the conditions of granting of a spectrum right.

The spectrum conversion plan should describe and provide guidance for the transition from the current spectrum usage (primarily authorized with station licences) to spectrum rights as specified by the spectrum marketing plan for the designated frequency band. Without limiting the matters that may be included, the conversion plan may consist of:

- the procedures and timetable for determining the allocation of a spectrum right to replace the spectrum use allocated for licensees;
- such other matters as AITI considers necessary.

2.3.2 Radio spectrum plan

Spectrum planning is one of the most significant parts of spectrum management framework in Brunei Darussalam. It consists of several elements attributed to different levels.

At the upper international level the AITI spectrum planning activity associates with the allocation of spectrum bands to radio services. This level assumes participation of the telecommunication administration of the country in the work of ITU and World Radio Conferences in particular. The resulting spectrum harmonization gives a consistent basis for the development of communications products from economy of scale and prevents severe problems related to cross border interference.

AITI acknowledges the benefits from international spectrum harmonization. Brunei Darussalam imports radio technologies and equipment at less cost than is likely to be the case if it adopted markedly different spectrum arrangements to the rest of the world. Furthermore, the internationally harmonized spectrum planning also ensures harmonized frequency arrangements for public safety purposes such as public protection and disaster relief (PPDR) applications, Global Maritime Distress and Safety System (GMDSS), etc.

AITI produces the radio spectrum plan, which provides a clear picture on how the radio frequency spectrum is currently utilised in Brunei Darussalam and how AITI plans to develop it further in the future. With this plan, AITI ensures optimal utilisation of spectrum as the finite natural resource whilst accommodating the continuously changing technology as well as catering for the demands of general public. The Brunei Darussalam spectrum plan coincides with the allocation table for Region 3, guaranteeing predictability and transparency to spectrum users (see section 2.1).

2.3.3 Radio frequency band plans

AITI produces the detailed frequency band plans for specific bands. The frequency band plans are consistent with the radio spectrum plan, and further divide allocations made in the radio spectrum plan into specific utilization types accompanied with channelling arrangements. The adopted radio frequency band plans are included into the Brunei Darussalam Radio Spectrum Plan. The list of radio frequency band plans taken from this document is the following:

- 1 Public Mobile Telecommunications Services
- 2 Fixed Services
- 3 Land Mobile/Trunked Radio Systems
- 4 Broadcasting Services
- 5 Short Range Devices
- 6 ISM Band
- 7 Amateur Bands
- 8 HF for Maritime Mobile Service
- 9 VHF for Maritime Mobile Service
- 10 Frequency Allotment Plan for Aeronautical Mobile (OR) Service.

2.3.4 Spectrum marketing and conversion plans

According to the Telecommunications (Radio-communications) Regulations, 2013, AITI may prepare the marketing and conversion plans for the specified spectrum bands.

Conversion plans

Upon approval of decision designating a specified part of the spectrum to be allocated by issuing spectrum rights, a conversion plan can be prepared in the form of a legislative instrument. The conversion plan should set out the procedures and timetable for issuing spectrum rights to replace existing station licences that authorise operation of radiocommunications devices at frequencies within that part of the spectrum and within the specified geographical area. The conversion plan may contain such other additional matters as AITI thinks fit.

Marketing plans

AITI may also, by a legislative instrument, prepare a marketing plan for issuing spectrum rights that authorise the operation of radiocommunications devices at frequencies, within that part of the spectrum that will be used under spectrum rights issued in accordance with the conversion plan and within the specified area. Without limiting the matters that the marketing plan may contain, it may indicate:

- the procedures to be followed for issuing spectrum rights in accordance with the plan;
- the timetable for issuing spectrum licences in accordance with the plan;

- how the spectrum dealt with under the plan is to be apportioned amongst the spectrum licences to be issued;
- how much of the spectrum dealt with under the plan is to be reserved for public or community services;
- the conditions, or types of conditions, that may be included in spectrum licences to be issued.

In indicating the procedures to be followed for issuing spectrum rights, the marketing plan may indicate whether the licences are to be allocated by auction, by tender, for a pre-determined price, or for a negotiated price.

The marketing plan must not be inconsistent with:

- the radio spectrum plan;
- the frequency band plan that relates, wholly or partly, to the part of the spectrum to which the marketing plan relates.

2.4 Current licensing scheme

2.4.1 Licensing scheme for service provisioning

Under section 3 of the Telecommunications Order, 2001, AITI has “exclusive privilege for the operation and provision of telecommunication systems and services in Brunei Darussalam”, and may, under section 5, grant licences to operate telecommunication systems and services, subject to conditions imposed by AITI.

Several types of licence are issued by AITI to authorize service provision in Brunei Darussalam, namely Infrastructure Provider for Telecommunication Industry (InTi) Licence, Service Provider for the Telecommunication Industry (SeTi) Licence, Dealer Licence and Station Licence. With the adoption of the Telecommunications (Radio-communication) Regulations, 2013, these service provision licences were supplemented with the innovative categories of spectrum licences, namely spectrum rights, apparatus licence, apparatus (spectrum) licence, and class licence.

Infrastructure provider for telecommunication industry licence

The first category is InTi licence. InTi Licence is required by an operator to own and provide infrastructure, systems, networks, facilities and other equipment (except for customer premises equipment) for the purpose of enabling telecommunication services.

Classes of InTi licences:

- Mobile Telecommunication Infrastructure
- Non-Fixed Telecommunication Infrastructure
- Fixed-Wired Telecommunication Infrastructure
- Fixed-Wireless Telecommunication Infrastructure
- Public Broadcasting Infrastructure
- Special Purpose Infrastructure

There are two possible options of InTi licences. The first option is relevant to licences with the allocated frequency spectrum to be used in conjunction with the infrastructure operated. The second option relates to licences that have not been granted any spectrum.

InTi licences assume the associated list of fees. There is an application fee of BND 10 000 per licensable activity. It is stipulated in the legislation that an additional BND 10 000 application fee is charged if

frequency spectrum is needed. Nevertheless, currently it is not the practice and it will not be supported in the future converged regulatory framework. Recurrent licence fee is 1.5 per cent of periodic gross turnover of the licensee subject to a minimum of BND 100 000 per year payable annually.

For the time being the InTi licence is partly technology neutral. AITI allows InTi licensees to change to an advanced technology with prior notification and subject to AITI confirmation. On the other hand the bulk of details related to the infrastructure are included into the special schedule to InTi licences. If a licensee intends to change or modify the infrastructure from that, which is described in this schedule, an InTi holder must obtain prior written approval from AITI and an updated licence from AITI before new infrastructure can be deployed. The intention of AITI is to liberalize the existing regime with the implementation of the spectrum rights licensing scheme. Nevertheless, there are still a number of unsolved issues primarily related to correlations and linkage of spectrum rights to InTi and station licences. It assumes certain constraints on the flexibility of operators to update their approaches to spectrum utilizations. AITI is preparing proposals to modify the existing primary and subsidiary legislation in order to facilitate further flexible regulation in the converged licensing regime (see also sections 2.2 and 4.3).

Service provider for the telecommunication industry licence

The second category is SeTi licence. A SeTi licence is required by a person who leases telecommunication facilities from an InTi licensee to provide its own telecommunication services, or to resell the services of an InTi licensee to third parties such as consumers and corporate customers. A SeTi holder does not own its own infrastructure such as telecommunication system, network, facilities and equipment (except for customer premises equipment) outside of its own premises. However, a SeTi licensee may own infrastructure within its own premises and provide telecommunication services to third parties within its premises.

Classes of SeTi licences:

- Public Mobile Telecommunication Service
- Public Non-Fixed Telecommunication Service
- Public Fixed Telecommunication Service
- Resale of Telecommunication Service
- Internet Access Service
- Bandwidth Exchange Service
- Private Network Service
- Public Payphone Service
- Prepaid Telecommunication Service
- Value-Added Service

The following fees are attributed to SeTi fees. Application fee is BND 5 000 per licensable activity. The periodic license fee is 1.5 per cent of the periodic gross turnover of the licensee subject to a minimum of BND 5 000 per year.

Dealer licence

Dealer licences are required for the importation and supply/sale of telecommunication and radiocommunications equipment. The type of dealer licence required depends on the class of equipment to be imported. AITI processes three types of dealer licence. Two telecommunication and radiocommunications equipment (DTQ and DRQ) dealer licences are issued and authorized by AITI, whereas one (DSQ) is processed by AITI and authorized by the Broadcasting Unit of the Ministry of Communications (previously the Broadcasting Department of the Prime Minister's Office). Dealer

licences are valid for one year as from the date of issue. Reminder slips for renewal of the licence are usually sent to dealers at least two months before the expiry date of licence.

Station licence

The fourth category of licences is the station licence. Station licences are needed to own and operate radiocommunications equipment in Brunei Darussalam. It contains the following list of data:

- the type and the number of radiocommunication equipment;
- the call sign (for aeronautical and maritime licences);
- the MMSI (for maritime licences);
- the operating radio frequencies and the bandwidth;
- the level of radio emission;
- the site names and locations at which the radiocommunication equipment are installed;
- the validity period of the licence.

At the practical level AITI authorizes spectrum users with station licences. Station licences are required to own and operate radiocommunications equipment in Brunei Darussalam. All station licensees must operate their radiocommunications equipment according to the details stated in their licences. Licensees must notify AITI of any changes in its details specified in their licence. Any changes to the licence details are subject to approval by AITI. Categories and station licence types are shown in the Table 2.2 below.

Table 2.2: Category and types of station licences

	Category	Types
1	AEF	Aeronautical Station – Aeronautical Fixed Station
2	AEM	Aeronautical Station – Aircraft Station
3	AMA	Amateur Radio – General
4	AMS	Amateur Radio – Restricted
5	AMC	Aero Model Control – RBAF Flying Club
6	BCA	Broadcasting Station – AM
7	BCF	Broadcasting Station – FM
8	BCT	Broadcasting Station – TV
9	FSS	Earth Station – Satellite Earth Station
10	FST	Earth Station – TVRO & ASTRO (Free-to-Air)
11	FSR	Earth Station – Café & Restaurant
12	FSC	Earth Station – Apartment & Hotel
13	FSV	Earth Station – VSAT (Very Small Aperture Terminal)
14	MAF	Maritime Radio – Coast Station
15	MAM	Maritime Radio – Ships Station

	Category	Types
16	RSF	Radio Station – Microwave Fixed Station
17	RSM	Radio Station – LMES (Land Mobile Earth Station)
18	RSR	Radio Station – Radio Determination
19	RST	Radio Station – Land Mobile
20	RSP	Radio Station – Repeater Station
21	RSB	Radio Station – Based Station
22	RDR	Radar Station
23	FSW	RadarEarth Station – Weather Satellite

Station licences are valid for one year. Renewals must be processed within two months of its expiry date. Applicants must complete AITI application forms and provide any necessary documentation. AITI processes complete application forms, payment of fees, and required documents. Approval of applications depends on the frequency to be used as it may require coordination with other countries and possibly additional information submitted to AITI. Applicants requiring specific frequencies for the station, must also fill in the frequency application form and submit it together with the network diagram of the system to be operated and antenna radiation pattern where applicable. Figure 2.9 presents the AITI template for the station licence. Figure 2.10 provides information on station licence terms and conditions.

Figure 2.9: The template of station licence

\Foreach(BLG_PAYMENT)\

LESEN STESEN RADIO
Dikeluarkan dibawah Perintah Telekomunikasi
2001 dan Peraturan-Peraturan dibawahnya

RADIO STATION LICENCE
*Issued in accordance with the Telecommunication Order
2001 and Regulations made thereunder*

Nombor Lesen (<i>License Number</i>) :	Tarikh Mula Lesen (<i>License Start Date</i>) :	Tarikh Akhir Lesen (<i>License End Date</i>) :
{:Invoice.Licence.STANDARD}- {:Invoice.Licence.Type.NAME}- {:Invoice.Licence.Owner.CODE}- {:Invoice.Licence.FIRST_DATE}- {:Invoice.Licence.ID}	{:Invoice.Licence.START_DATE}	{:Invoice.Licence.STOP_DATE}
Kelas (<i>Class</i>) :	Isyarat Panggilan (<i>Callsign</i>) :	Jumlah Alat (<i>Eqpt Quantity</i>) :
	{:Invoice.Licence.CUST_TXT20}	{:Invoice.Licence.NBE_TXRX}

Lesen ini diberikan kepada (*This license is issued to*) :

{:Invoice.Licence.Owner.NAME}

Alamat Persuratan (*Correspondence Address*) :

{:Invoice.Licence.Owner.ADDRESS}

Alamat Pemasangan (*Installation Address*) :

{:Invoice.Licence.CUST_TXT6}

Frekuensi Menghantar <i>Transmit Frequency</i> (MHz)	Frekuensi Menerima <i>Receive Frequency</i> (MHz)	Bandwidth/Emissi <i>Designation of emission</i>	Kuasa Pancaran <i>Power output</i> (dBW)	Lokasi <i>Location</i>	Kodinat <i>Coordinates</i> Lat/Long
\Begrecord(j)\ \Join(Invoice)\ \Join(Licence)\ \Foreach(r1,MICROWA.Licence= Invoice.Licence)\ \Begrecord(r1)\					
{r1:StationA.TX_FREQ}	{r1:StationB.TX_FREQ}	{r1:DESIG_EM}	{r1:StationA.EIRP}	{r1:StationA.Position.NAME}	{r1:StationA.Position.LONGITUDE}/{r1:StationA.Position.LATITUDE}
\Endrecord(r1)\ \Endforeach(r1)\ \Endjoin(Licence)\ \Endjoin(Invoice)\					

Bayaran (<i>Payment</i>) :	Bil. Resit (<i>Receipt Number</i>) :	Tarikh Bayaran (<i>Payment Date</i>) :
{:Invoice.Licence.FEE}	{:ID}	{:PAY_DATE}

Lesen ini tidak boleh dipindah milik
This license is non-transferable

STAMP AITI
LESEN INI TIDAK SAH TANPA BUKTI PEMBAYARAN PADA MUKASURAT INI
THIS LICENCE IS INVALID WITHOUT PROOF OF PAYMENT ON THIS PAGE

Source: AITI

Figure 2.10: Terms and conditions of station licence

TERMS & CONDITIONS OF STATION LICENCE

1. This Licence comes into force on the date of issue and is valid for the duration specified on the Licence unless suspended or cancelled by AITI.
2. This Licence is only valid for:
 - a) The named Licensee; and
 - b) For the ownership and operation of radiocommunications stations for the category described on the Licence.
3. This Licence is subject to the terms and conditions contained herein, the Telecommunications Order 2001 and any other relevant Laws of Brunei.
4. This Licence may be further renewed for such period as AITI thinks fit and subject to such terms and conditions as may be specified by AITI under Section 5 of the Telecommunications Order.
5. AITI may vary, amend, modify or revise any of the terms and the contents of this Licence pursuant to Section 7 of the Telecommunications Order 2001.
6. Where the licensee breaches any licence condition, AITI may impose a financial penalty on the licensee, suspend, cancel or terminate this licence in whole or in part, in accordance with Section 8 or any other relevant section of the Telecommunications Order 2001.
7. AITI reserves the right to publish at any time, information concerning any enforcement actions taken against and/or penalties imposed on the licensee for breach.
8. In the event that the Licensee desires to terminate this Licence, the Licensee must give written notice to AITI prior to the expiry of this Licence. The notice of termination must detail the status of the equipment and the equipment must be officially written off, sealed, disabled or dismantled in the presence of an AITI authorised officer.
9. Any termination notice submitted to AITI by Licensee after the expiry of this Licence, the Licensee must settle outstanding licence fees between expiry and termination.
10. Any termination, suspension or cancellation of the Licence shall be without prejudice to the rights and remedies which may accrue to the Licensee or AITI under this Licence or any written law in force in Brunei Darussalam as at the date of termination except that the Licensee shall not have the right to seek a refund of the licence fee or any other fee paid in advance, whether in whole or in part.
11. The Licensee shall comply with any directions which AITI may issue under Section 27 of the Telecommunications Order 2001, this Licence or any other applicable written law in force in Brunei Darussalam.
12. The Licensee shall comply with the requirements of Section 18 of the AITI Order 2001 and Section 62 of the Telecommunications Order 2001. This includes provision of information and provision of lawful entry to authorised AITI officers for the purposes of investigation.
13. The Licensee shall comply with all applicable codes of practice and Advisory Guidelines which AITI may issue under Sections 26 and 28 of the Telecommunications Order 2001.
14. The Licensee shall not assign, transfer, sublet or otherwise deal with or dispose of its rights, duties, liabilities, obligations and privileges under this Licence to any person or entity except with the prior written approval of AITI. Any such approval shall be given subject to terms and conditions which AITI in its sole discretion may impose.
15. The Licensee and all the persons operating the equipment which the Licensee is authorised by this Licence to establish, install and operate, shall observe and comply with the all relevant laws, in particular, the Telecommunications Order 2001 and any subsidiary legislation and the conditions of this Licence.
16. This Licensee shall not permit or cause any unauthorised person to operate the equipment or have access to the equipment contained therein. The Licensee shall ensure that persons authorised to operate the equipment observe the conditions of this Licence at all times.
17. The equipment shall be used only with the technical parameters specified in this Licence which includes the frequency(s), location, bandwidth and transmit power.
18. The Licensee shall maintain up-to-date records of the list of the equipment, including the installation location of the equipment, name or equipment manufacturer, model, serial number of the equipment, number of equipment, frequency(s), output power, date of purchase and date of disposal of the equipment. This list shall be made available for inspection by AITIs and when requested. The Licensee shall also be required to submit the updated list in the manner specified by AITI at least three month prior to the expiry of this Licence. This Licence shall only be renewed upon submission of the aforesaid list to AITI.
19. The Licensee shall notify AITI of any intended change of address of the Licensee or any proposed change in any of the equipment comprised in the Stations of any proposed change in the operating radio frequency(s), the mode of transmission or usage, the location at which the equipment are installed, and before such change is effected, the Licensee shall obtain the prior written approval of AITI.
20. The Licensee shall ensure that the equipment are installed properly are not tampered with or modified in any manner unless AITI's written approval has been obtained.
21. Prior to operation under this Licence, the Licensee shall, in accordance with Section 9 of the Telecommunications Order 2001, submit for AITI's written approval, all radiocommunications equipment to be used. All radiocommunications equipment used by the Licensee shall be type approved to conform to the relevant equipment and emission standards and technical specifications or requirements specified by AITI, from time to time, in relation thereto.
22. The Licensee shall not undertake or participate in the business of production or provision of all telecommunications / radiocommunications equipment unless the Licensee is in the possession of relevant Licences.
23. The Licensee shall notify AITI in writing within 5 working days, of any changes to the information provided in its application for this Licence.
24. The Licensee shall provide AITI with any documents or information within its knowledge, custody or control that AITI may by notice or direction require for the exercise of its functions and duties under the Telecommunications Order 2001.
25. The Licensee shall keep in strict confidence any documents or information so required by AITI as well as the fact that AITI has requested such documents and/or information.
26. AITI may use and disclose any such document or information provided to AITI as AITI deems fit. Where AITI proposes to disclose information obtained and considers that the disclosure would result in the release of information concerning the business or commercial or financial affairs of the Licensee which disclosure would or could reasonably be expected to adversely affect the Licensee's lawful business or commercial or financial affairs, AITI will give the Licensee a reasonable opportunity to make representations on the proposed disclosure before AITI makes a final decision whether or not to disclose the information.
27. The Licensee shall observe and comply with the Telecommunications Order 2001, the AITI Order 2001 and any other treaty or convention to which Brunei Darussalam is a party, and all applicable Laws of Brunei.
28. Nothing in this Licence shall be taken as discharging the Licensee from its obligations to obtain any other licences, permits or approvals that may be required under any written law in force in Brunei Darussalam.
29. This Licence shall be governed by and construed according to the laws of Brunei Darussalam.
30. All notices under this Licence shall be in writing and shall be deemed to have been given if sent by hand or pre-paid post or by facsimile to the Licensee's correspondence address as contained in the Licence application.
31. Every Clause and part thereof shall be construed as a separate and severable provision so that if any Clause and part thereof is held invalid, unenforceable or illegal for any reason, the remainder of the Licence shall remain in full force in every respect.
32. In this Licence, unless the context otherwise requires:
 - a) Words importing the singular or plural shall be deemed to include the plural or singular respectively, and words importing one gender include the other gender and vice versa;
 - b) The headings to the provisions of this Licence are for convenience of reference only and are not part of this Licence and shall not in any way affect the interpretation thereof;
 - c) Unless the context otherwise requires, any word or expression used in this Licence shall have the same meaning as it has in the Order;
 - d) Any reference in this Licence to the Telecommunications Order 2001 or the AITI Order 2001 shall include any re-enactment and amendment thereof and any regulations made thereunder;
 - e) Any reference in this Licence to any regulations made under the Telecommunications Order 2001 or the AITI Order 2001 shall include any regulations made under the same and their predecessors until such regulations are revoked or repealed by subsidiary legislation;
 - f) Any reference in this Licence to a person shall be deemed to include natural and legal persons;
 - g) Any reference to monetary amounts in this Licence shall be deemed to be denominated in Brunei Dollars; and
 - h) Any reference to any codes of practice, directive, advisory guidelines, framework or any other rule, document or written instrument promulgated by AITI shall include any amendment thereof.

Source: AITI

2.4.2 Types of spectrum licences

The Telecommunications (Radio-communication) Regulations, 2013 introduced the innovative regime of spectrum licensing in Brunei Darussalam from which there are four types of spectrum licence: spectrum rights, apparatus (spectrum) licence, apparatus licence, and class licence.

Spectrum rights

Spectrum rights generally refers to a licence category that authorizes licensees to utilize a specified band of radio spectrum in a defined geographical area for the purposes they see fit subject to compliance with the limitations in technical framework approved by the regulator for this band. The spectrum right is the flexible multi-dimensional approach specifying generic frameworks for different areas, namely basic requirements for the band ensuring interference-free operations in the adjacent bands, local geographical constraints on the acceptable emissions levels or time-restricted slots of operation. Within these frameworks usually spectrum rights licensees are allowed to utilize any radiocommunications equipment or devices for any purposes assuming that these utilization does not exceeds predefined technical conditions and does not contradict with the generic requirements for service provision. With the spectrum right the licensee is free to change the type of radiocommunication equipment, to deploy new radio technologies to deliver services to customers. Ideally the spectrum rights holder (licensee) is free to trade the whole right or the whole band or part of the rights/bands to third parties. Thus, the spectrum right is the obvious precondition for technology and service provision neutrality, as well as for spectrum trading.

As an innovative spectrum licensing regime has only recently been implemented in Brunei Darussalam with the adoption of Telecommunications (Radio-communication) Regulations, 2013, AITI has not yet had sufficient time to apply spectrum rights broadly. AITI considers that in the future spectrum rights will become the primary category of the spectrum licensing regime. The existing spectrum rights format is founded on the corresponding provisions from the Telecommunications (Radio-communications) Regulations, 2013. Among other requirements, it includes:

- period of validity, geographical area, and spectrum fees;
- the need to be granted with further licences;
- directions, enforcement and obligations of the licensee;
- spectrum trading and spectrum sharing issues;
- termination, suspension, cancellation, variation and resumption.

Emerging AITI spectrum rights regulatory practices are relevant to technology neutrality aspects of spectrum rights. Section 14 of the Telecommunications (Radio-communications) Regulations, 2013, stipulates that AITI may grant a spectrum right subject to conditions specifying the type of station or network, and type of radio-communication equipment comprising the station or network, which the person granted the spectrum right is authorised to operate. As a consequence, the spectrum rights licence in the current form is directly linked to the InTi licences having references to technical specifications of network infrastructure. In turn, InTi licences have the rigid connection to station licences thus partly restricting flexibility of a licensee to change the type of radio equipment. This situation is at odds with the concept of spectrum rights being by nature technology neutral (see section 4.3).

The next significant amendment in spectrum licensing regime arising from the introduction of Telecommunications (Radio-communications) Regulations, 2013 is the market-based method of allocation of spectrum licences. AITI requires that spectrum rights be issued using a price-based method. The price-based allocation practice includes auction, tender, predetermined or pre-negotiated price.

There is one pending issue concerning the market-based method mentioned above. It is obvious that AITI should allocate spectrum at auction where sufficient demand exceeds supply of frequency resources. The traditional trade-off between supply and demand requires a mechanism of demonstration of this demand by expressing the corresponding interest. Unfortunately, AITI has no established mechanism, telecommunication authorities applying allocations of limited spectrum resources through market-based methods usually include provisions in the primary or subsidiary legislation related to the estimation of spectrum limitations and rules to assess demand for the

limited spectrum resources. The primary and subsidiary legislation of Brunei Darussalam in force do not incorporate any provisions of that nature. The corresponding amendments would become vital questions in the short term.

Apparatus and apparatus (spectrum) licences

Apparatus licensing is the traditional method of authorizing radiocommunications equipment. The distinctive feature of apparatus licence lies in the fact that it authorises a person to operate a particular transmitting or receiving device at a fixed geographical location and subject to compliance with the technical parameters included in the licence conditions. Although apparatus licences can be changed to include innovative technologies, it should be noted that with rigid operational requirements, apparatus licences differ from spectrum rights flexibility when choosing/changing technical conditions of spectrum utilization.

With the approval of the Telecommunications (Radio-communications) Regulations, 2013, AITI applies two types of apparatus licence – apparatus (spectrum) licence and apparatus licence. AITI has not changed its practice from station to apparatus based licensing yet. Nevertheless the vision of both future apparatus (spectrum) and apparatus licences is clearly established by the provisions of in the Telecommunications (Radio-communications) Regulations, 2013.

The apparatus (spectrum) licence is defined as:

“An apparatus (spectrum) licence may be granted by the Authority under Section 5 if the Authority is satisfied that the radio-communication equipment is to be operated using a spectrum right granted by the Authority and the radio-communications equipment

- a) Meets with and conforms to applicable –*
 - i) Radio emission standards; and*
 - ii) Technical requirements, specifications and standards,*

As the Authority may impose; and

- b) Is of the kind or class that is approved by the Authority for use under a spectrum right.”*

The apparatus licence is specified as:

“The following classes of apparatus licences may be granted under section 5 –

- a) Fixed apparatus licence;*
- b) Mobile apparatus licence;*
- c) Radio-determination Apparatus licence;*
- d) Space Apparatus licence;*
- e) Broadcasting Apparatus licence;*
- f) Amateur Apparatus licence;*
- g) Ship Apparatus licence;*
- h) Aircraft Apparatus licence;*
- i) Localized radio-communication Apparatus licence;*
- j) Experimental Apparatus licence;*
- k) Special Purpose Apparatus licence.”*

Future apparatus licences will be similar to the current station licence if it determines the fixed list of technical and operational parameters, including installation points, operating frequencies and bands, type of equipment and number of devices, the levels of radio emissions etc. The radio-communications

equipment under apparatus licences should not be changed or modified in respect of any particulars mentioned in the licence, except with the prior approval of AITI.

Under certain circumstances, apparatus licences are the only option to deal with interference. For example, propagation characteristics within certain spectrum bands can exhibit intolerable levels of interference over wide areas and require accurate coordination activities with adjacent spectrum bands or territories. This is true for the telecommunication administration of Brunei Darussalam with the need to proceed with coordination issues on a permanent basis.

Apparatus licences are most likely to constitute the bulk of the AITI frequency licensing activity, in the future, despite today's technological and regulatory frameworks dictating the need to implement other flexible licensing schemes. In this respect, instead of apparatus licensing, AITI should endeavour to give preference to spectrum rights. In circumstances where apparatus licensing is inevitable, AITI should follow a licensing approach by issuing apparatus (spectrum) licences (see also section 4.3).

Class licences

The notion of a class licence was introduced into regulatory practices to determine the conditions under which all interested parties are allowed to operate a selected category of radio-communication equipment. The concept is based on the fact that class licence is not issued to an individual user. Locations of devices are not recorded in databases and it does not apply any licence conditions to individuals. Class licences authorise users of designated segments of spectrum to operate on a shared basis.

Typically, the class licensing is the regime to authorise access to spectrum for services, which are able to use common frequency resources on a non-coordinated basis as the result of low potential risk of interference. It means that class licences are suitable only for particular equipment types and uses. Class licensed applications generally do not require regulatory and technical protection from interference caused by other radiocommunications systems.

Usually class licences deal with low-power mass consumer items such as remote-control domestic devices with little risk of harmful interference. The next outstanding example of class licensing is the deployment and successful operation of WiFi networks based on IEEE 802.11x standards.

Conditions in class licences aim to avoid possible harmful interference and facilitate usage of the specific spectrum band by the designated category of radiocommunications equipment. For example, there are class licences for mobile terminals in the spectrum bands of cellular networks. Those class licences restrict unauthorized implementation of other types of terminal equipment in the cellular mobile bands. On the other hand, they define the framework of technical parameters for a category of equipment-resulting in simpler type approval formalities by avoiding unnecessary appeals to the regulator.

The Telecommunications (Radio-communications) Regulations, 2013, specifies class licences similar to those described above. The corresponding provisions establish the reliable basis for introduction of this licensing regime in Brunei Darussalam. It is recommended that in order to introduce class licensing regime in its daily practice, AITI should examine further opportunities for issuing class licences where administrative efficiency will be ensured and where the risks of interference are low or acceptable.

2.5 Service provisioning licensing and spectrum usage fees

2.5.1 Fees for licensing of service provisioning

According to the primary telecommunication legislation of Brunei Darussalam, AITI is empowered to levy charges from service providers for their licences being issued and under operation. The structure of the fees imposed concerning different categories of licences is set out below.

- a) Application fee: This is the fixed fee associated with the cost of application processing. The application fee is the prerequisite for submission of application documents for issuing a licence. This fee is also payable upon renewal of a licence.
- b) Granting or bid fee: In the case of a competitive tender, this fee is defined as the accepted bid price. In all other cases, this fee will be a fixed or variable amount based on the perceived or forecasted value of the licence or spectrum that is granted. This fee may also be payable upon renewal of a licence.
- c) Periodic licence fee: This is the fee payable by all InTi and SeTi licensees for their service provisioning on the annual basis. The periodic fees imposed on InTi licensees are presented in Table 2.3 and those applied for SeTi licences are presented in Table 2.4.
- d) Mobile terminal licence fee: This fee is charged on subscription of mobile phone services (per SIM card) and is collected by the licensee on behalf of AITI. Afterwards this fee is transferred by mobile operators to AITI.
- e) Dealers/type approval fees: These are the administrative fees collected by AITI to process type-approval and dealer permit applications. The fees related to Dealer Licensing Process are described in Table 2.5.
- f) Import permit fees: This is the administrative fee collected by AITI to process import permit applications.

Table 2.3: Fees levied for InTi licences

Infrastructure Provider for the Telecommunication Industry (InTi) Licence	
Application Fee	B\$10,000 to be submitted with the application for each class of infrastructure.
Granting Fee	Nil, unless otherwise stipulated. If a fee is stipulated, or a successful applicant is subject to bid/auction price, then that fee or price shall be payable in B\$ within two (2) weeks of being notified by AiTi of the successful outcome of the application, or otherwise in accordance with such payment terms and schedule as may be stipulated by AiTi. Failure to pay the granting fee within the stipulated time may be grounds for the licence to be cancelled.
Periodic Licence Fee*	Minimum of B\$100,000 per year or 1.5% of PGTO (Periodic Gross Turnover) to be charged on each 6-month period in advance based on the prior 6 months' Gross Turnover. <i>Illustration: The Fee payable on 31 January 2004, for the period of February 2004 through to July 2004 = 1.5% of the PGTO for the period June 2003 to November 2003, while the Fee payable on 31 July 2004, for the period of August 2004 to January 2005 = 1.5% of the PGTO for the period of December 2003 to May 2004.</i>
Payment Terms for Licence Fee	Payable within 1 month of granting or anniversary thereof. In the event of late payment, interest will be charged based on the prime interest rate as published by the Brunei Association of Banks from the date the payment is due until the date the full payment is received by AiTi. If not paid in full 3 months after the due date, notice will be given that the licence will be suspended. If not paid in full 6 months after the due date, the licence will be cancelled.
License Duration	20 years

Table 2.4: Fees levied for SeTi licences

Service Provider for the Telecommunication Industry (SeTi) Licence	
Application Fee	B\$5,000 to be submitted with the application for each class of service.
Granting Fee	Nil, unless otherwise stipulated. If a fee is stipulated, or a successful applicant is subject to bid/auction price, then that fee or price shall be payable in BS within two (2) weeks of being notified by AiTi of the successful outcome of the application, or otherwise in accordance with such payment terms and schedule as may be stipulated by AiTi. Failure to pay the granting fee within the stipulated time may be grounds for the licence to be cancelled.
Periodic Licence Fee*	Minimum of B\$5,000 per year or 1.5% of PGTO (Periodic Gross Turnover) to be charged on each 6-month period in advance based on the prior 6 months' Gross Turnover. <i>Illustration: The Fee payable on 31 January 2004, for the period of February 2004 through to July 2004 = 1.5% of the PGTO for the period June 2003 to November 2003, while the Fee payable on 31 July 2004, for the period of August 2004 to January 2005 = 1.5% of the PGTO for the period of December 2003 to May 2004.</i>
Payment Terms for Licence Fee	Payable within 1 month of granting or anniversary thereof. In the event of late payment, interest will be charged based on the prime interest rate as published by the Brunei Association of Banks from the date the payment is due until the date the full payment is received by AiTi. If not paid in full 3 months after the due date, notice will be given that the licence will be suspended. If not paid in full 6 months after the due date, the licence will be cancelled.
Licence Duration	7 years

Table 2.5: Dealer licensing fees

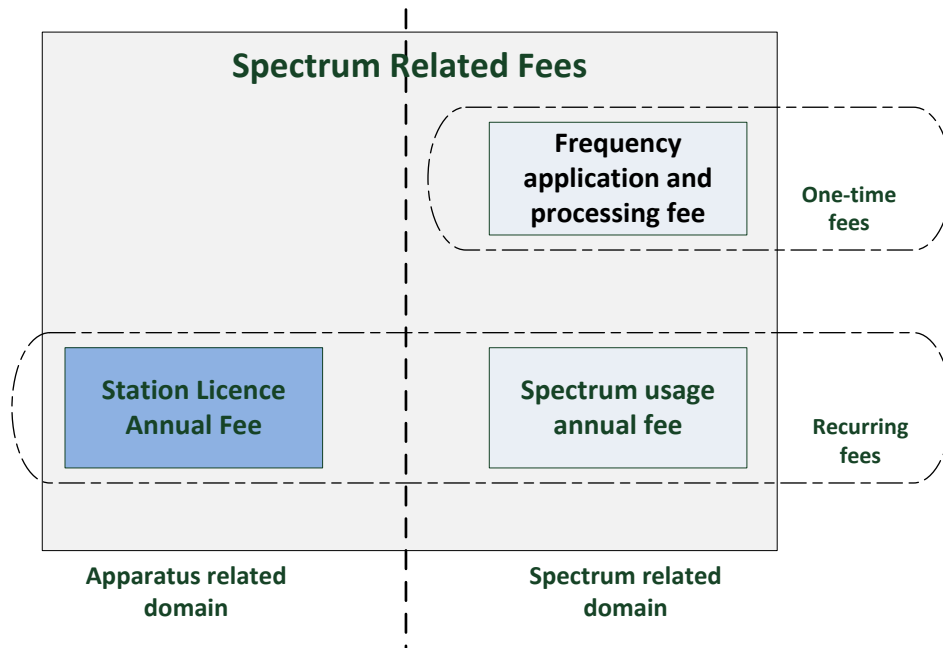
Licence Type	Description	Application Fee	Renewal Fee	Validity	Processed by	Authorised by
Dealer Tele-communication Equipment(DTQ)	Dealers can import and sell/supply telecommunication equipment such as telephone, ADSL modem, Fax and PABX	BND 100.00	BND 100.00	1 year	AITI	
Dealer Radio-communication Equipment(DRQ)	Dealers can sell/supply radiocommunication equipment such as mobile phones, cordless phones and pagers	BND 100.00	BND 100.00	1 year	AITI	
Dealer Satellite Equipment (DSQ)	Dealers can sell/supply satellite equipment such as satellite receivers and Kristal Astro sets.	BND 100.00	BND 100.00	1 year	AITI	Broadcasting Unit, MOC

2.5.2 Spectrum licensing related fees

There are three types of fees directly related to spectrum usage. These are annual fees for station licence, frequency application and processing fees, annual fees for spectrum usage. More precisely frequency application and processing fees and annual fees for spectrum usage have the direct connection to spectrum. While annual fee for station licence to a large extent deals with apparatus authorization and operation. Frequency application and processing fees are paid once only. Annual fees for station licence and for spectrum usage are recurring. The existing structure of spectrum licensing related fees is illustrated in Figure 2.11. The following subsections provide detailed information on

structure and tariffs associated with these fees. Section 4.3.4 presents proposals on possible alignment of spectrum pricing scheme in Brunei Darussalam.

Figure 2.11: Existing structure of spectrum licensing fees



Source: ITU

Station licence annual fees

The station licences are issued upon the payment of the station licence annual fee. The station licence annual fees for different categories of radio stations are summarized in Table 2.6.

Table 2.6: Categories and station licences annual fees

	Category	Types	Fees (BND)
1	AEF	Aeronautical Station – Aeronautical Fixed Station	25.00
2	AEM	Aeronautical Station – Aircraft Station	25.00
3	AMA	Amateur Radio – General	25.00
4	AMS	Amateur Radio – Restricted	25.00
5	AMC	Aero Model Control – RBAF Flying Club	25.00
6	BCA	Broadcasting Station – AM	25.00
7	BCF	Broadcasting Station – FM	25.00
8	BCT	Broadcasting Station – TV	25.00
9	FSS	Earth Station – Satellite Earth Station	2400.00
10	FST	Earth Station – TVRO & ASTRO (Free-to-Air)	240.00
11	FSR	Earth Station – Café & Restaurant	500.00
12	FSC	Earth Station – Apartment & Hotel	1200.00
13	FSV	Earth Station – VSAT (Very Small Aperture Terminal)	2400.00
14	MAF	Maritime Radio – Coast Station	25.00
15	MAM	Maritime Radio – Ships Station	25.00
16	RSF	Radio Station – Microwave Fixed Station	25.00
17	RSM	Radio Station – LMES (Land Mobile Earth Station)	25.00
18	RSR	Radio Station – Radio Determination	25.00
19	RST	Radio Station – Land Mobile	25.00
20	RSP	Radio Station – Repeater Station	100.00
21	RSB	Radio Station – Based Station	100.00
22	RDR	Radar Station	2400.00
23	FSW	RadarEarth Station – Weather Satellite	2400.00

Applications and processing fees for use of radio frequency

The application and processing fees for use of any radio frequency in the course of operating or using a radio-communication equipment under station (in future apparatus (spectrum) licence or apparatus licence) are charged as the form of payment for frequency application processing. Fees are separated for terrestrial and earth stations, varying with the frequency channel bandwidth.

Table 2.7: Application and processing fees for use of radio frequency

No.	Bandwidth	Fee payable per frequency BND)
1.	Temporary use	100
2.	All other frequencies –	
	(a) bandwidth of 25 kHz or less	290
	(b) bandwidth of more than 25 kHz but less than 500 kHz	450
	(c) bandwidth of 500 kHz or more but less than 1 MHz	700
	(d) bandwidth of 1 MHz or more but less than 20 MHz	900
	(e) bandwidth of 20 MHz or more	1 200
3.	Satellite frequencies	
	Uplink	500
	Downlink	500

Annual fees for use of radio frequencies

AITI charges licensees for their annual spectrum usage. AITI has divided frequency applications in three categories, all of them having different formulas for calculating the fee, namely medium-term spectrum usage, long-term spectrum usage, and temporary usage.

Long-term: *Broadcasting, cellular, land mobile or trunked radio wireless broadband access*

The annual fee is calculated using the formula

Annual RF usage fee = Unit price (B) (K1)

where,

Unit Price = BND 1 000

B=Bup + Bdown (assigned bandwidth in MHz or spectrum size in MHz)

K1 – Band factor

1.0 for TV band

6.0 for Radio Band

8.0 for 2.3/2.5 GHz band WBA

10.0 for 1.7 to 2.1 GHz band (Cellular and WBA and land mobile or trunked radio (non-localized use)

12.0 for 700 MHz to 900 MHz band (Cellular and WBA)

Duplex/Simplex – For simplex channel, unit price will be half of equivalent duplex channel.

Medium-term: *Microwave, satellite uplink and downlink and radar*

The annual fee is calculated using the following formula

Annual fee per hop = (Unit price) (F1) (F2) (N)

where,

Unit Price= BND 500

F1 – Band factor

- 1.2 for 1 – 4 GHz band
- 1.0 for 5 – 8 GHz band
- 0.8 for 9 – 14 GHz band
- 0.7 for 15 – 18 GHz band
- 0.5 for 19 and above

F2 – Bandwidth factor

- 2 for $x \leq 7$ MHz
- 4 for $7 \text{ MHz} < x \leq 14$ MHz
- 6 for $14 \text{ MHz} < x \leq 28$ MHz
- 8 for $x > 28$ MHz

N – total number of RF channels

Land Mobile, trunked radio, telemetry, fixed point-to-point, aeronautical and maritime (localised use)

Annual fee per channel = BND 75 per 12.5 kHz of occupied bandwidth

Fixed fee: high frequency (3 MHz – 30 MHz)

Annual fee per channel = BND 50

Temporary Usage

Public telecommunication infrastructure and service

Fee = BND 1 000 per 1 MHz of occupied bandwidth

Others

Bandwidth, x	Fee payable per frequency for 0 – 90 days
$x \leq 25$ kHz	BND 100
$25 \text{ kHz} < x < 500$ kHz	BND 150
$500 \text{ kHz} < x \leq 1$ MHz	BND 200
$1 \text{ MHz} \leq x < 20$ MHz	BND 400
$x \geq 20$ MHz	BND 700

The methodology of spectrum fees in Brunei Darussalam reflects existing best practice. The calculation formulas take into account the coefficients required to substantiate final prices as corresponding to Brunei Darussalam's ICT development. The methodology clearly distinguishes between charges imposed on different types of radio technologies – those with higher social loading are charged less compared to commercial technologies dominating at the mass telecom market (e.g. broadcasting versus cellular mobile). Formulas use variable coefficients depending on the size of spectrum band allocated to licensees. The methodology encourages the usage of higher spectrum ranges and wider bandwidths of the channels.

Usually telecommunication administrations try to apply favourable regimes to implement the most up-to-date radio technologies. From this perspective, spectrum prices are also diverged among the old radio technologies (e.g. GSM900) and new technologies (e.g. LTE).

Band factors can differ for spectrum ranges, for example, the band factor chosen for spectrum in 700 MHz and 900 MHz is 12, and the 700 MHz band should be less than 12 to facilitate the fastest deployment of LTE in this band. Several proposals to improve spectrum pricing are included in section 4.3.

2.6 Spectrum trading

The subsidiary legislation (the Telecommunications (Radio-communications) Regulations, 2013) contains two provisions dealing with the issue of spectrum trading in the format of licence transfer. Section 18 determines conditions of spectrum trading relevant to spectrum rights:

“Subject to such conditions as the Authority may generally or specifically impose, a person granted a spectrum right may assign, or otherwise deal with, the whole or any part of the rights and privileges under the spectrum right.

No assignment of, or dealing with the whole or part of the rights and privileges granted under, a spectrum right shall take effect until the Authority gives its approval in writing.”

Section 66 of the Telecommunications (Radio-communications) Regulations, 2013 foresees the possibility of transfer for apparatus (spectrum) licences:

“Except with the approval in writing of the Authority, a licensee shall not

- *Assign, transfer, sublet or otherwise dispose of the benefit of any apparatus (spectrum) licence or apparatus licence;*
- *Permit other person to participate in any of the benefits, powers or authority granted under such licence.”*

As it appears from those provisions AITI is empowered to agree on possible licence transfer between undertakings. There are no clarifications on the principles and procedures of spectrum trading in the existing legislation and no practical cases of trading of spectrum rights of use in Brunei Darussalam. To some extent, it may cause certain challenges when spectrum trading becomes a commonly applied regulatory tool for the constantly increasing number of telecommunication administrations.

For instance, EU regulation provides a mature framework for spectrum trading. The Radio Spectrum Policy Group (RSPG) of the European Commission actively studied the issue of secondary trading of rights to use radio spectrum and explained the advantages that could be expected from trading of rights of use:

“Potential benefits of trading include facilitating market entry and exit, permitting more rapid redeployment and faster spectrum access for innovators and new players and allowing new technologies to gain access to spectrum more quickly. For existing operators, benefits could include the opportunity to sell unused or underused spectrum and make more flexible use of spectrum. Secondary trading may also provide incentives to transfer underused spectrum to those who can utilise it better and a mechanism to address excessive spectrum fragmentation through the amalgamation of spectrum holdings.”

The RSPG opinion also notes that spectrum trading can be expected to promote competition. However, the introduction of spectrum trading does raise concerns about the potential for competition to be distorted. The RSPG considers that the question of whether existing general competition regulations are sufficient to prevent this is complex, particularly as it may be necessary to consider competition in the market for communications services as well as within the spectrum market itself.

AITI should recognise that there are a number of issues which need to be considered with practical implementation of spectrum trading, which include regulator obligations to provide:

- certainty in relation to the rights and obligations associated with secondary trading likely to be required by potential traders;
- special considerations should apply to the decision on whether conditions attached to individual rights of use shall continue to apply after a transfer or lease of the licence;
- sufficient safeguards to protect the public interest, such as the need to ensure transparency and regulatory supervision of potential spectrum trades;
- appropriate protections against spectrum hoarding and other potentially harmful outcomes.

While dealing with secondary spectrum trading issues in Brunei Darussalam, it is recommended that AITI gives due consideration to the specific features of local ICT market development and demand for spectrum resources. It is obvious that trading of rights to use spectrum occurs in the cases when spectrum demands exceeds the available spectrum supply, in other words, when spectrum is proved to be a scarce resource. Currently there is not a scarcity of spectrum in the majority of bands in Brunei Darussalam with the exception of cellular mobile bands, and it is difficult to see how there could be a viable secondary market for spectrum trading in those bands where there is not a scarcity of spectrum. Thus the possible spectrum trading regime could be applied exclusively for those highly demanded cellular bands leaving other bands in the traditional regulatory environment.

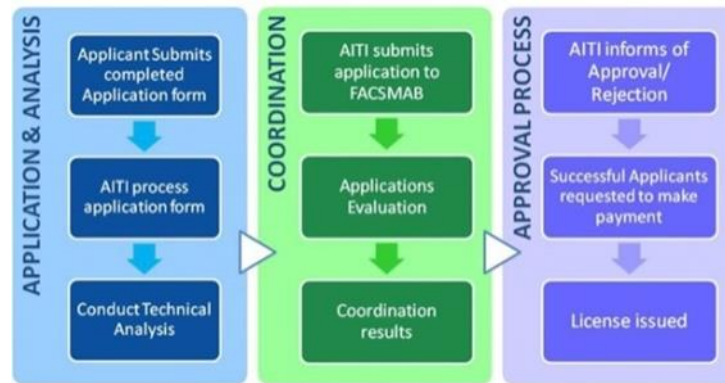
AITI should establish its regulatory and working methods in order to accept spectrum trading. The proposed regulatory framework may be based on the inclusion of provisions in the primary and secondary legislation:

- 1 AITI may, after hearing the parties concerned, release frequency bands for trading and define the framework conditions and the procedure for trading when there is interest in trading usage rights for the spectrum concerned.
- 2 The procedure shall include termination of the frequency assignment and the issue of a new assignment.
- 3 The framework conditions and procedure for trading shall ensure, inter alia, that:
 - spectrum efficiency is increased or maintained;
 - no distortion of competition in the relevant product and geographic market is to be feared;
 - other legal framework conditions, in particular the conditions of use and international agreements on spectrum use, are complied with; and the current regulatory aims.
- 4 Decisions on the framework conditions of and the procedure for spectrum trading should be published.

2.7 Current frequency assignment procedure

The existing workflow for station/frequency application processing is shown in Figure 2.12.

Figure 2.12: Frequency application and assignment process



Source: AITI

To apply for frequencies and station licences, applicants are required to fill in and submit the completed AITI frequency application form and station licence application form together with the following documents:

- cover letter;
- equipment technical specifications;
- network diagram;
- antenna radiation pattern.

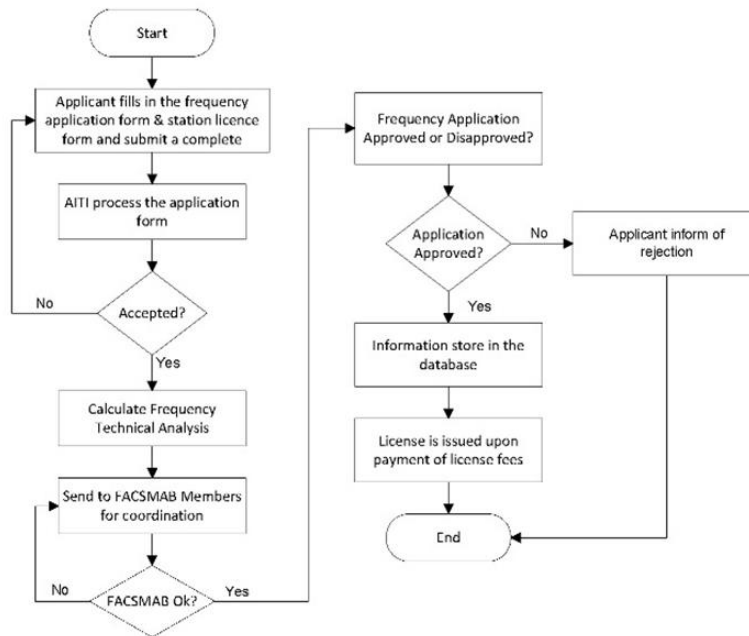
AITI only processes complete application forms with signature together with payment of the requisite fees and submission of required documents. Once all forms and documents are received, EMC analysis is performed to ensure that no interference occurs to the existing radiocommunication equipment. To ensure management of interference on a regional level, AITI coordinates future frequency assignments with Malaysia and Singapore in the monthly FACSMAB meeting and the application is subject to approval from FACSMAB Members. The applicant is then informed in writing if the application is approved. To facilitate the coordination process, it is advised that the applicant submits the full application before the FACSMAB meeting. The algorithm of frequency application and station licence application process as well as the station licence fee are summarized in Figure 2.13.

Figure 2.13: Frequency application processing algorithm

FREQUENCY APPLICATION CHARTS



AUTHORITY FOR INFO-COMMUNICATIONS TECHNOLOGY INDUSTRY OF BRUNEI DARUSSALAM (AITI)



Source: AITI

The AITI frequency assignment unit (composed of four staff members) is actively involved in planning and handling the intensive application flow. The list of responsibilities and examinations imposed on its staff provides evidence of the urgent need to increase the number of expert staff attributed to particular radio technologies to avoid scattering of competences. AITI may distribute responsibilities between the personnel based on Radio Services. AITI could also increase staff capacity of frequency assignment planning units while differentiating staff with respect to radio services.

According to existing practice, all anticipated frequency assignments should come through the border coordination process (FACSMB). Probably this process is slightly redundant for particular applications. Even taking into account the relatively small territory, there is still a possibility to define those applications with the coordination contour entirely inside Brunei Darussalam territory. Having filtered the technologies and applications, AITI could try to agree with neighbouring telecommunication administrations on exclusion from the standard coordination process. It will drastically decrease time of application processing as well as reduce pressure on AITI human resources.

3 Current and future spectrum demand by sector/services

3.1 Spectrum management issues identified by stakeholders

With the active assistance of AITI staff, meetings with several stakeholders involved in spectrum related issues were arranged. Representatives of the major groups of spectrum users were interviewed about the current spectrum management environment in order to identify the most crucial points in spectrum management that require improvement and inclusion in the future roadmap of the Authority.

3.1.1 Sound broadcasting providers

The representatives of sound broadcasting community noted that the frequency channels of the company had been assigned to their organisations around 20 years ago. The Telecommunications Administration of Brunei Darussalam accrues benefits from the successful legacy in frequency coordination with neighbouring countries from 1948, and channels assigned to the companies have no interference to/from the broadcasting providers of neighbouring countries.

Separately, AITI summarizes results of cross-border coordination in a document containing the agreed band plans for different spectrum ranges and technologies. The frequency allotment plans for sound and TV broadcasting services are included. The described approach significantly facilitates the process of frequency channel assignment and successive utilization by both TV and sound broadcasters.

To date the sound broadcasters of Brunei Darussalam are using analogue technology within their networks. Nevertheless, the possible transition to digital technologies will be considered subject to market demand. The confidence of national sound broadcasters in available financial resources to cover the estimated costs associated with the process of transition is the second essential precondition. The transition to digital audio broadcasting technologies is hardly the subject of frequency management in Brunei Darussalam for the time being as the number of existing and foreseen providers is relatively low and spectrum is unlikely to be congested.

The local sound broadcasting companies appreciate the current regulatory regime of AITI related to spectrum management including the frequency fees scheme, which were reported to be adequate for the current conditions of sound broadcasting market in the country. By no means does the existing spectrum charging practice affect the business of the interviewed companies.⁴

3.1.2 TV broadcasting provider

The TV broadcasting provider operates analogue and digital transmitters. Channel 28 is assigned for DVB-T and Channel 30 is for DVB-T2 Single Frequency Network. DVB-T2 network is under trial. Station/frequency application forms are submitted to AITI for two additional frequency DVB-T channels.

It should be noted that Brunei Darussalam is in the transition period for the digital TV. The estimated date of analogue switch-off is 2017. Nevertheless, AITI is not administratively insistent on this particular matter as the situation with spectrum availability is not crucial. It is more the issue of readiness of customers to express the demand for digital TV through and their willingness to get new TV receivers. From the radio planning point of view and in order to facilitate the process of introduction of digital TV, AITI tries to make frequency assignments for analogue TV in VHF spectrum band and for digital TV primarily in UHF band V. The TV bands upper 694 MHz are not used thus establishing the required preconditions for future implementation of LTE in Digital Dividend II spectrum band (former TV bands in 694 – 790 MHz).

The TV provider appreciates the transition of AITI to converged regulation by absorbing part of the broadcasting regulation as long as this transition simplifies practical aspects, such as broadcast licensing.

3.1.3 Mobile cellular and broadband providers

There are two players in the cellular mobile market: Data Stream Technology Sdn Bhd (DST) and Progresif Cellular Sdn Bhd (PCSB). The frequency bands allocated and reserved for future allocations in the most traditional frequency bands are illustrated in Figure 3.1.

⁴ Broadcasters noted the current tendency of merging the telecommunication and broadcasting regulations within a single authority, and the anticipated merge would not hamper existing business, but considerably simplify the historically settled practice of broadcasting licensing in Brunei Darussalam.

Figure 3.1: The cellular mobile band allocation in Brunei Darussalam



Source: AITI

Figure 3.1 shows that Datastream Technology Sdn Bhd (DST) has 2x10 MHz in 900 MHz band for GSM applications, 2x20 MHz in 2100 MHz band for UMTS applications and 2x20 MHz in 1800 MHz band for LTE applications. DST is a diverse group providing mobile services, broadband, broadcasting and content. DST flagship subsidiary, DST Communications Sdn Bhd (DSTComm) provides mobile services for 2G, 2.5G and 3.5G and mobile broadband on HSPA broadband network capable of supporting download speeds of up to 14.4 Mbit/s and provides 4G LTE services.

Progresif Cellular Sdn Bhd (PCSB) is a new entrant in the Brunei Darussalam mobile telecommunication sector, taking over operations of the second mobile operator (B-Mobile Communications Sdn Bhd) in 2014. PCSB has the spectrum allocations solely in 2100 MHz bands; thus 3G is utilized for voice and data services. Both companies raised issues concerning the regulatory framework of their operations, and the following is a summary of their comments:

- The mobile operators are in favour of the trend to accomplish finalized technology neutral regulatory regime. One of the operators is actively considering the usage of UMTS900 and LTE900. DST has already completed the trials of UMTS900. Five sites has been deployed and used to assess the resulting coverage. The results of the trial network gave impetus to DST to apply to AITI for the additional 2*5 MHz allocation to their current spectrum.
- Operators noted AITI activity concerning technology neutrality and the corresponding changes in legislation. DST pointed out that the period of authorizing them with all required permission in case of LTE1800 took less than one year from the beginning of discussions with the regulator.
- PCSB informed of their plans to utilize WiFi based equipment for the last mile and backhaul decisions in the network, and hopes it can be accomplished having no changes in the existing regulatory environment. However, there are doubts on spectrum management aspects of this proposal primarily with the issues of output powers of the transmitters, possible seeking of PCSB for protection from other unlicensed users of the band, as well as possible challenges with spectrum pricing of this decision.
- Operators are the members of the joint working groups with neighbouring operators including the joint team on radio measurements. They are actively involved in AITI border coordination proceedings. The existing AITI procedures dealing with coordination are suitable for operators.
- Mobile operators outlined a multi-layer regulatory scheme imposed on them by AITI in the process of networks development. The first layer is coordination of operator development plans with the regulator, which are submitted to AITI for consideration. Compliance of the practical development to the plan becomes the second layer of regulation. The third layer deals with AITI

monitoring of operator quality of service. The Code of Practice is approved exclusively to this regulatory task.

Practical issues were also raised:

1. Congestion of lower frequency bands of fixed radio service for utilization by microwave links is an issue. Traditionally the mostly popular microwave frequency in Brunei Darussalam is the 7 GHz spectrum range. Today there is an acknowledged congestion of this band for fixed applications. AITI could consider higher spectrum bands above 13 GHz for microwave links.
2. The efficiency of the current scheme of regulation tied to station licences being applied to cellular networks was raised. All base stations should be authorized by awarding station licences accompanied with the corresponding application fees and spectrum usage fees. It is clear that cellular networks are evolving by means of implementation of additional base stations on a regular basis. This is the prerequisite for maintaining its market position as well as the required QoS, which is monitored and administrated by AITI. In parallel, the extension of network infrastructure is a way of increasing efficiency of spectrum utilization – a process that should be stimulated by the regulator.

Taking this into account it is apparent that a spectrum pricing regime based on station licences contradicts the inclination of mobile operators to provide services of the required quality to the highest number of customers. However, spectrum pricing regimes for a cellular operator should establish incentives to use frequency resources with the highest possible efficiency.

On the other hand, it is clear that the base stations of cellular networks could not be excluded from the authorization regime due to the need to make an expertise of frequency assignments in the process of cross-border coordination and due to other administrative reasons seen by AITI. The possible compromise may apply based on a new regulatory regime focused on charging mobile providers for the spectrum band allocated to the operator instead of doing so for each base station. The fees levied for station/frequency application and processing should be maintained.

3. Operators also raised the issue of mobile terminal fees. Today the mobile terminals in Brunei Darussalam are charged on a per subscription basis. This charge is imposed on the subscribers of mobile phone services and is collected by the operators on behalf of AITI. By its nature, the mentioned fee does not relate to operators directly, but to make the transaction to AITI. Certainly, the terminal fee is passed on to customers. However, part of operator resources are attracted to this process thus having an indirect additional load on staff etc.
4. The difficulties associated with the site acquisition process was also raised as an issue for both operators.

3.1.4 Satellite telecommunication service providers

The issues related to spectrum management, alongside wider issues of authorization, were discussed with the licensed satellite communications service provider in Brunei Darussalam. The interviewed company provides resilient, secure and cost-effective network connectivity solutions to its customers using innovative satellite solutions. It supports the growing needs of the satellite communications market in Brunei, such as enterprise data transmission, military and emergency response and broadband Internet. The services provided are last-mile and back-up connectivity needs through various solutions, ranging from small quick-deploy VSAT installations on top of buildings and 2.4 m Gyro-Stabilized Vehicular Antennas to Inmarsat IsatPhone Pro and broadband mobility terminals such as the Inmarsat Broadband Global Area Network (BGAN). It also offers Land Mobile Earth Stations, Maritime Mobile Earth Stations and operates VSAT satellite equipment as well as the set of Satellite Earth Stations. The satellite equipment utilizes spectrum in L-band (1 – 2 GHz), C-band (3.4 – 7 GHz), Ku-band (10.7 – 14.5 GHz) and Ka-band (17.7 – 30 GHz). L-band and C-band are used more intensively compared to the recently introduced Ku and Ka bands.

In order to operate telecommunication systems and to provide its services, the satellite operator needs to be granted with the following set of licences:

- infrastructure provider for the telecommunication industry (InTi) licence;
- service provider for telecommunication industry (SeTi) licence;
- dealer licence;
- station licences;
- type-approval certificate.

The satellite operator was concerned about the structure of AITI fees in the regulatory framework as referred to Earth stations. In particular, the annual station licence price for VSAT is BND 2 400. This is an impressive amount considering the limited size of the national market of satellite telecommunications. The second key issue for the satellite provider is the need to authorize the usage of multiple frequency channels of earth stations. It is obvious that satellite systems operate the network with the dynamic selection of frequency channels, which may vary significantly in the allocated bandwidth based on the traffic conditions.

The authorization process, in addition to the expertise of a particular frequency channel, becomes a significant constraint for the satellite provider. From this perspective, there are two options for possible improvement. The concept is to distinguish regulatory regimes between VSAT stations and central Earth satellite stations or hubs.

If the number of earth stations in the satellite network is small (Hubs), then the most efficient way to authorise their operation is via station or apparatus licences. Annual fees should be payable for awarding and renewal of these apparatus licences. This regulatory regime results that the hub stations should be individually coordinated with other terrestrial users of the same frequency bands and thereby the potential for interference can be minimized.

If the number of earth stations in the satellite network is large (VSATs), the most efficient way to authorise their operation is the usage of apparatus (spectrum) or in some cases class licensing mechanisms. The class licence may specify broad frequency bands within which the space stations can operate and only authorises VSATs operating within these bands. In this regime, there will be no need to apply to AITI to authorize operation of each VSAT station and frequency fees will not be payable.

3.1.5 ISP, fixed broadband and PSTN service provider

Telekom Brunei Berhad (TelBru) was incorporated on 30 May, 2002, under the Company Act Cap 39 as a Public Limited Company. TelBru has been fully operational since April 2006 when Jabatan Telekom Brunei (JTB) was corporatized on 1 April, 2006.

TelBru is the premier telecommunication company in Brunei Darussalam, a leading provider for fixed line services, Internet, and broadband services, along with providing leased lines and data services. TelBru plays an integral part in the ICT eco-system of Brunei Darussalam by providing a comprehensive range of products and services in the quadruple-play space.

TelBru cannot be considered as the essential spectrum user stakeholder. However, it operates radiocommunication equipment as the part of their PSTN and Internet access network. In particular, TelBru utilizes microwave links in several bands and fixed point-to-point links in 2500 – 2690 MHz band. With the latter TelBru come to the arena of spectrum management as number one stakeholder.

From the perspective of spectrum conversion, TelBru is considered to be the incumbent operator with the existing applications in one of the most popular LTE bands 2500 – 2690 MHz. AITI has already initiated the discussions with TelBru on spectrum release matters. This issue is still under

consideration. The key point for TelBru is finding the alternative spectrum bands to resettle the existing applications. For AITI, this task is likely to become the first practical activity on spectrum redeployment.

3.1.6 Trunked radio provider

The trunked radio operator has much experience in spectrum management issues. The first Motorola SmartZone network was delivered in 1999, and from 1999 to 2011, the network used this analogue infrastructure in 800 MHz. From 2011, the infrastructure was swapped to ZTE GoTa CDMA-based equipment, in the same 800 MHz spectrum band.

Noting the issues of spectrum harmonization in conjunction with the effect of economy of scale for equipment, the provider has requested AITI to consider possible redeployment to 400 MHz band. AITI appreciated the intention, conducted studies of possible redeployment and suggested a few options in response. Since there are some existing users who occupy the frequencies in the same band, it was deemed that releasing additional spectrum in future may not be guaranteed. This issue has not been finalized (mainly due to incumbent users of 400 MHz band), and spectrum rights have been granted in 800 MHz band.

Reallocation, in this case to the 400 MHz band, is a significant part on the spectrum management agenda for AITI. Perhaps this can be resolved by means of spectrum strategic planning using the mechanisms of spectrum conversion and spectrum marketing plans.

3.2 Spectrum demand trends by sector/service

3.2.1 Spectrum demands and proposals for regulation of fixed service

Spectrum trends for the fixed service

In general, fixed service is used to provide connection links for various applications across a wide range of frequency bands, typically ranging from 400 MHz up to 86 GHz and typically used for long-haul trunk/backbone networks, infrastructure support networks, and fixed wireless access networks.

- Long-haul trunk networks are historically used for transmission of long-distance telephone traffic between regional switching centres within national PSTN networks, and form part of international connections. To a large extent, backbone networks are being replaced by larger capacity fibre connections unless geographical remoteness justifies their service. Mobile operators are simultaneously introducing networks in scarcely populated areas thus requiring the spectrum resources of previous long-haul trunked networks for their usage in distant connections between big exchange centres.
- Infrastructure support networks of fixed service are usually used to provide connectivity between switching centres (one or several) and various nodes at different layers of telecommunication networks identified as public mobile telephony networks or fixed wireless access networks. The growth of internal infrastructures of cellular mobile networks was required to support the permanent growth of subscriber bases, and as this still continues today, the infrastructure networks are also likely to grow further. This growth will continue and with the continuous expansion of mobile broadband networks (HSPA, HSPA+, LTE), further demand for infrastructure support solutions can be expected.
- Fixed wireless access networks are designed to provide a direct connection between the customer premises equipment and an operator core network (PSTN network, data communication network). Fixed wireless access normally uses point-to-multipoint radio technology to serve a large number of customer premises equipment within the coverage area of a central station. Fixed wireless access is also aiming at providing access solutions capable of provisioning broadband (multimedia) services to end-customers.

Very high capacity links are able to provide a viable alternative to deploying fibre optic cable especially in rural areas but equally in high density urban areas where there would be severe disruption caused by digging up roads etc. to lay down fibre. That is the reason for significant increases of fixed service assignments over the last two decades coming in particular from the area of infrastructure support for public mobile networks. In Europe, for example, the number of point-to-point links increased by more than 24.5 per cent per year in average between 1997 and 2010.

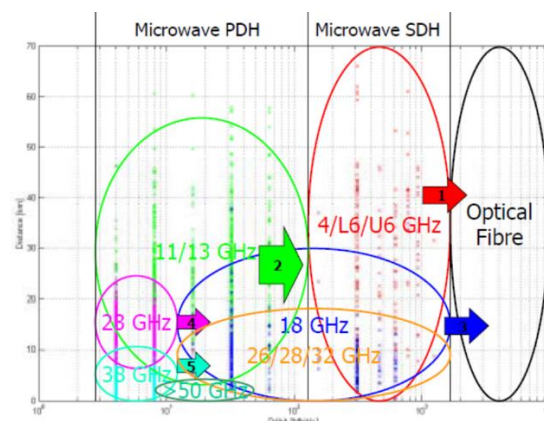
This demand is expected to increase further with the expected growth worldwide in capacity and number of connected nodes (base stations) with the introduction of UMTS/HSPA/HSPA+/LTE/LTE-Advanced. Provisioning of infrastructure support through various point-to-multipoint technologies is also being considered, or already implemented in some countries as a viable alternative with high density of served base stations. The growth in number of fixed service links is likely to continue for the foreseeable future.

In that respect it is interesting to note the results of a study conducted in 2002 in CEPT on spectrum requirements arising from deployment of 3G networks in Europe (ECC Report 19). For the purposes of estimations in that study the mobile traffic included high-quality speech, high-speed packet and medium/high multimedia signal transport. It was assumed that required capacity to an individual base station will increase about four times compared to that for the second generation system.

The major conclusion of the study was that the capacity demands for a combined 2G/3G network would increase significantly. To support the services of 3G it was anticipated that the data traffic capacity would increase to the extent that it can no longer be carried by the 2G infrastructure, particularly in the urban areas of the network. It may be that in traditional frequency bands where the actual assignments exist, the frequency spectrum is congested.

This implied the need of new fixed service spectrum for combined 2G/3G networks. In the medium-to-long term, upgrades of the old assignments towards the required higher capacity demands are possible in the old bands. Depending on the national situation a complete shift of the assignments to new bands at least in the dense areas would then be favourable for upgrading 2G to a combined 2G/3G network. The spectrum released in these 'old' bands might be available for the use of various high capacity applications (both mobile and fixed network related). Among the other results, the noted study illustrated the trend in fixed service spectrum band evolution owing to transition from 2G to 3G with the consequent dramatic traffic growth. The tendency is shown in Figure 3.2.

Figure 3.2: Evolution in spectrum requirements for the fixed service



Source: ECC Report 19

Figure 3.2 clearly represents the shift to the right direction, in particular to the higher spectrum ranges and higher data rates. The identified inclination remains valid with the contemporary transition from 3G to 4G networks.

Having in mind that spectrum demand for the fixed service is primarily justified by the development of the mobile broadband networks, it is easy to identify the most valuable fixed service spectrum bands based on topology of network infrastructure. The ECC Report 19 for the purposes of estimation included the network elements of 3G networks, namely Node B, traffic concentration point (TCP), Node A, RNC and MNC/SGSN. In principle, this approach will not contradict similar considerations related to 4G networks.

Tables 3.1 and 3.2 from the ECC Report 19 provide a list of appropriate frequency bands for accommodating wireless links, employed at different network layers of UMTS/IMT-2000 infrastructure network.

Table 3.1: Preferred frequency bands for point-to-point systems depending on layers of mobile network

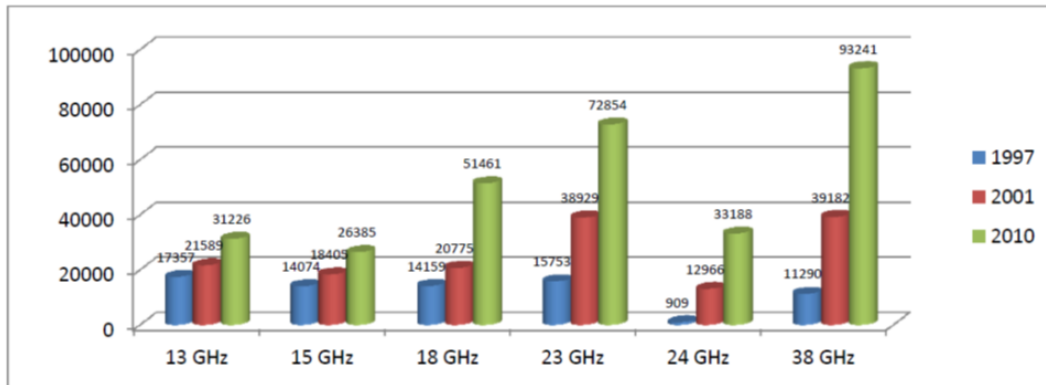
Network Layer	Frequency bands	Preferred frequency bands for shorter haul (urban)	Preferred frequency bands for longer haul (rural)
Single Node B	13-58 GHz	32-38-52-55-58 GHz	13-15-18-23-26-28-32 GHz
Node B--> TCP	11-55 GHz	26-28-32-38-52-55 GHz	11-13-15-18-23-26-28-32 GHz
TCP--> Node A	11-38 GHz	26-28-32-38 GHz	11-13-18-23-26-28-32 GHz
Node A--> RNC	4-32 GHz	13-18-23-26-28-32 GHz	4-L6-U6-7.5-11-13-18 GHz
RNC--> MSC/SGSN	Up to 18 GHz	13-18 GHz	Up to 18 GHz

Table 3.2: Preferred frequency bands for point-to-multipoint systems depending on layers of mobile network

Network Layer	Possible frequency bands
Single Node B	26-28-32 GHz
Node B--> TCP	26-28-32 GHz
TCP--> Node A	N/A
Node A--> RNC	N/A
RNC--> MSC/SGSN	N/A

The validity of the conclusions made in 2002 has been proven by the practical development of the fixed service application. The results of the growth analysis of point-to-point links in Europe conducted by CEPT in 2012 show that the bands 18 GHz, 23 GHz and 38 GHz were the most attractive spectrum assets aimed at satisfying the increased traffic requirements of mobile networks (Figure 3.3).

Figure 3.3: Growth in number of point-to-point links in CEPT countries between 1997 and 2010



Source: ECC Report 173

Based on the conclusions presented above, it is recommended that AITI concentrate its attention on the 18 GHz, 23 GHz, and 38 GHz bands in order to comply with the requirements of future development of fixed service applications in mobile networks. It is highly advisable to establish the short and medium-term position of AITI on expected utilization of these bands including refarming issues if necessary. A separate issue for consideration by AITI concerns utilization of point-to-multipoint spectrum (26 GHz, 28 GHz, and 32 GHz bands) to provide the transport network access to base stations of mobile operators.

Options for future regulation of the fixed service

The fixed service regulatory framework is summarised in the following four categories based on frequency assignments schemes:

- 1 **Individual licensing:** the conventional link-by-link coordination, where the regulator keeps full control of the national and cross-border interference.
- 2 **Light licensing:** refers to a combination of licence-exempt use and protection of spectrum users. This model has a first-come first-served feature where the user notifies the regulator with the position and characteristics of the stations. The database of installed stations containing appropriate technical parameters (location, frequency, power, antenna etc.) is publicly available and should thus be consulted before installing new stations. If the transmitter can be installed without affecting stations already registered (i.e. not exceeding a pre-defined interference criteria), the new station can be recorded in the database. A mechanism remains necessary to enable a new entrant to challenge whether a station already recorded is really used or not. New entrants should be able to find an agreement with existing users in case interference criteria are exceeded. From the spectrum usage point of view, this method is, in principle, equivalent to individual licensing; only the potential risks of 'errors' or 'misuse' in the coordination process might be higher due to the number of actors involved and technical issues.
- 3 **Block assignment:** the assignment might be made through licensing (renewable, but not permanent) or through public auction (permanent). This is the scheme allowing the user's freedom to use the spectrum block to deploy a network; in some cases, there might not even be a limit to wireless communication methods used in the block (e.g. point-to-point and/or point-to-multipoint, terrestrial and/or satellite or any other innovative technology or architecture).
- 4 **License exempt:** this method offers the most flexible and cheap usage, but does not guarantee any interference protection. It is most popular in specific bands (e.g. 2.4 and 5 GHz) where SRD are allocated, but fixed service applications may also be accommodated; in addition, it is often used in less attractive bands, between 57 GHz and 64 GHz, due to unfavourable propagation attenuation.

Currently, AITI is assigning fixed links (point-to-point links) with individual frequencies and fixed stations are licensed on a link-by-link basis (Scheme 1 – individual licensing). However, many telecommunication administrations simplify procedural approaches related to frequency assignments for radio stations in the fixed service. Regulatory practices applied nowadays provide users of point-to-point links with sufficient flexibility in choosing operational characteristics of their stations while offering savings in human/time resources of the governmental bodies and ensuring electromagnetic compatibility.

As the most inhabited spectrum bands for point-to-point lines in Brunei Darussalam are those below 13 GHz, the higher ranges are still waiting for active utilization, there is a natural capability for AITI to implement advanced regulation (Scheme 3) for fixed service.

This subsection of the report presents the proposed regulatory method based on point-to-point block assignment license (Scheme 3 – block assignment). The method of point-to-point frequency block licence assumes that spectrum blocks are assigned on geographical or national basis and are to be self-managed by the licensee. Blocks would be assigned in the bands approved by the regulator for such purposes aimed at preferably larger channel bandwidths (e.g. 28 MHz, 56 MHz or 112 MHz), according to the internationally harmonized channel plans. From the technical point of view, frequency block licences are only valid for the deployment of digital point-to-point links in the frequency bands and associated channels designated by the regulator. The possible list of bands and corresponding frequency arrangements are detailed in Table 3.3. Band-assigned licence holders are encouraged to take into account and conform to the relevant stated channel plans. Furthermore, sites and frequencies used for the fixed link stations shall comply with the requirements specified in ITU Radio Regulations Articles 21.2 – 21.6. Among the other operational requirements the following are of great importance:

- Operators are encouraged to use higher performance antenna options wherever possible to minimise interference potential especially on any congested sites.
- Operators are encouraged to use more spectrally efficient modulation (e.g. 16, 32 and 64 QAM) especially for higher capacity systems to minimise the required bandwidth.

Table 3.3: Fixed service spectrum bands and channel plans

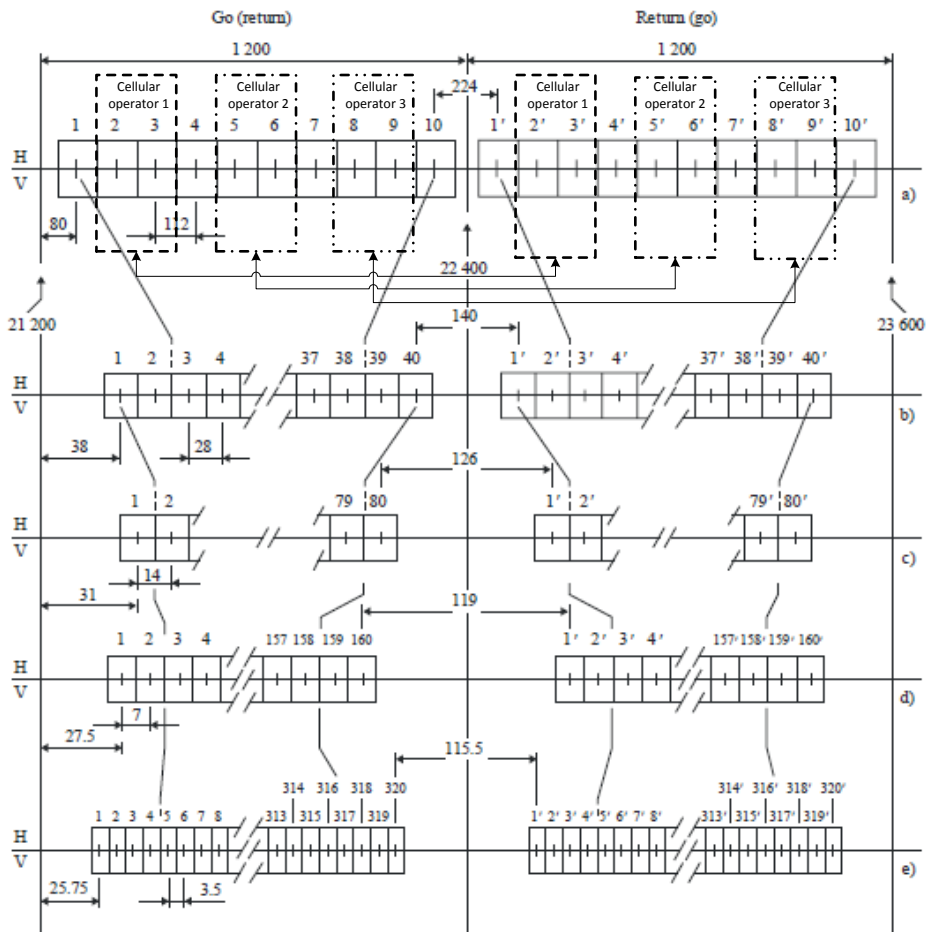
No	Spectrum Band	Channel Plan	Channel Bandwidth for Block Assignments
1.	11GHz (10700 – 11700 MHz)	ITU-R Rec. F.387	28 MHz
2.	13 GHz (12750 – 13250 MHz)	ITU-R Rec. F.497	28 and 56 MHz
3.	15 GHz (14400 – 15350 MHz)	ITU-R Rec. F.636	28 and 56 MHz
4.	18 GHz (17700 – 19700 MHz)	ITU-R Rec. F.595	27.5 and 55 MHz
5.	22 GHz (21200 – 23600 MHz)	ITU-R Rec. F.637	28, 56 and 112 MHz
6.	28 GHz (27500 – 29500 MHz)	ITU-R Rec. F. 748	28, 56 and 112 MHz
7.	38 GHz (37000 – 39500 MHz)	ITU-R Rec. F.749	28, 56 and 140 MHz

The intention is to award adjacent blocks of spectrum, wherever possible, to the same licensee to avoid the need for either guard bands, that are spectrally inefficient, or co-ordination of assignments with those undertaken by a regulator in adjacent bands. The number of blocks awarded will be determined in discussions with a regulator, and the operator will be required to provide the necessary technical information to substantiate their requests.

Figure 3.4 represents the possible option for the arrangement of fixed service spectrum 22 GHz band for three significant cellular operators in a country. Each of the operators is awarded with nonadjacent

blocks of 2x112 MHz (4x56 MHz, 8x28 MHz etc.) frequency channels. At the Figure 3.4 operator 1 is assigned with channel blocks 2, 3 and 2', 3'; operator 2 is assigned with channel blocks 5, 6 and 5', 6'; operator 3 – with the blocks 8, 9 and 8', 9'. Meanwhile the remaining channel blocks 1 and 1', 4 and 4', 7 and 7', 10 and 10' might be utilized by other users with the channel bandwidths less than 112 MHz thus providing additional guard bands with the channels assigned to significant mobile operators.

Figure 3.4: Block assignment scheme for the fixed service spectrum Band 22 GHz (case for three significant cellular operators)



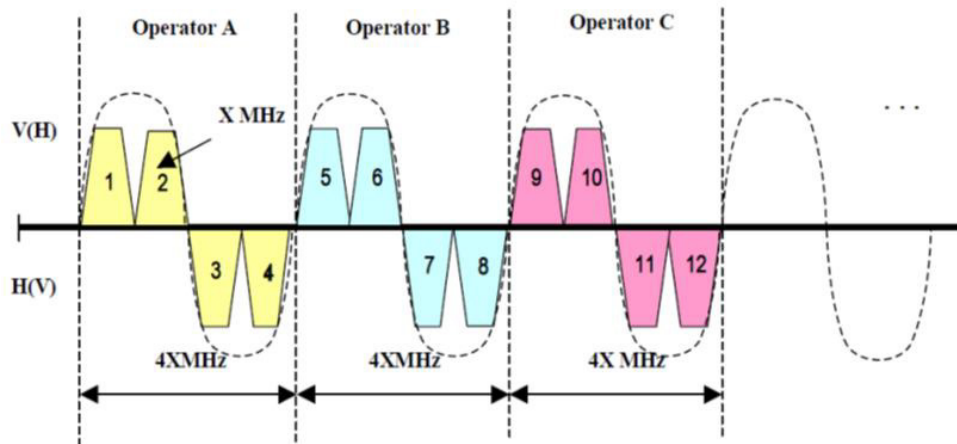
Source: ITU

There are several further technical options to avoid spectrum losses due to guard bands. The most efficient option assuming assignment scenario without guard bands arises from usage of different polarizations.

As an example this assignment scenario is attained by the following (see Figure 3.5).

- 4 RF channels are accommodated within 4xX MHz bandwidth assigned to one operator;
- adjacent RF channels between two operators (e.g. channels #4 and #5) are arranged in different polarizations, and this will contribute to reduction of the inter-operator interference;
- one operator could use channels from the lower frequency (e.g. channels #1 and #2) utilizing a single polarization antenna, then increase the link capacity by employing either the opposite polarization feeder or separate antenna with the opposite polarization.

Figure 3.5: Block assignment scenario without guard band



Source: ECC Report 19

The important practical aspect of the scheme lies in the fact that usually these block licences are only available to major users of fixed links that require a greater number of links in a frequency band over a large geographic area (e.g. mobile network operators, oil and gas companies). Applications for block assigned licence should be considered by the regulator on a case by case basis. Any organization which is a major user of fixed links (e.g. mobile operator or oil and gas companies etc.) wishing to be assigned with a frequency block should contact the regulator to discuss their potential requirements in advance of submitting any licence application. The applicant is then required on an annual basis to:

- demonstrate a current or potential demand for fixed link spectrum assignments;
- justify the need for geographical/nationwide block allocations;
- provide plans to deploy links and indicate the estimated capacity requirements;
- prove sufficient competence to manage the assigned blocks/bands for fixed links with due attention to efficient use of spectrum, the avoidance of interference, and the management of any cases of interference which may arise.

The regulator must follow the status of frequency block usage and when spectrum is not being used efficiently, the revocation procedure may be invoked.

The licensee is responsible for managing the spectrum and determining which frequencies to use within the licensed block and to ensure there is no potential for interference for other users operating in adjacent frequencies. If there is a need for coordination with spectrum licensees in other countries, the licensee should contact the regulator, which will undertake the coordination with neighbouring countries.

3.2.2 Spectrum demands and proposals for regulation of land mobile service

Spectrum requirements for IMT systems

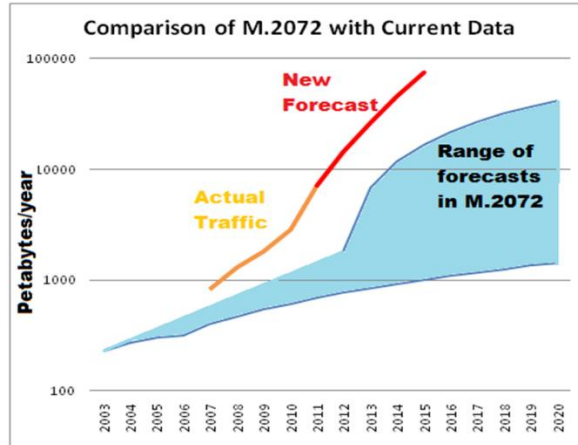
There are two major ITU studies referring to spectrum requirements for IMT systems:

- spectrum estimation, including traffic assessment, in the Report ITU-R M.2078 based on the Reports ITU-R M.2072 and ITU-R M.2074 contents (finalized in 2005-2006);
- traffic growth assessment in the Report ITU-R M.2243 (finalized in 2011).

When discussing future spectrum requirements for IMT the data from Report ITU-R M.2243 should be mentioned, which provide comparison of earlier global traffic assumptions in 2005 with factual

data and forecasts available for 2011. This comparison is shown in Figure 3.6, where the actual data on global traffic growth in cellular networks is several times higher than initially anticipated values.

Figure 3.6: ITU global traffic estimates in 2005 and 2011



Source: ITU

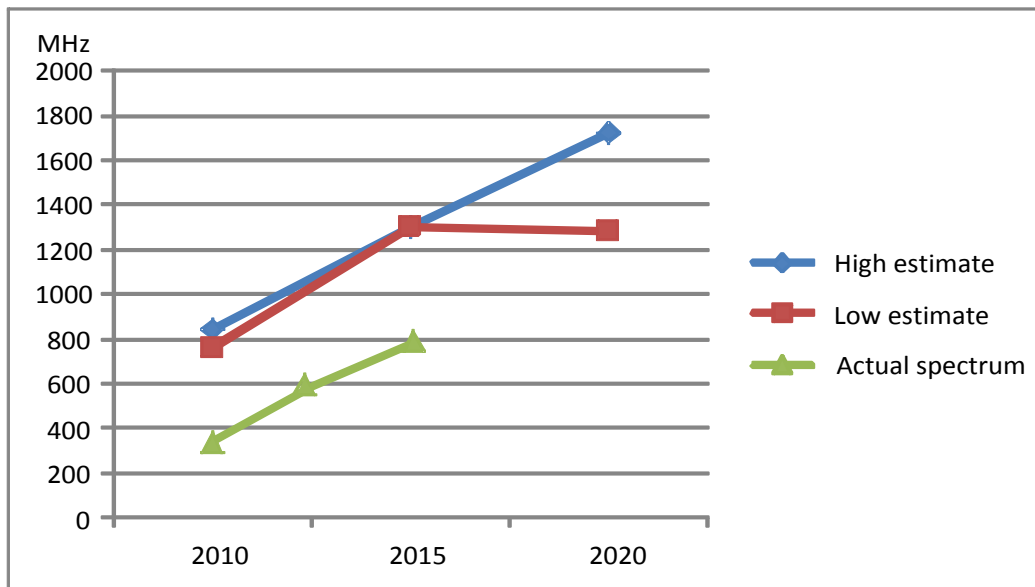
However, this is not the only significant mismatch between previous estimates and the current situation. It is important to note that besides consuming much more traffic than was predicted, it is done with much less spectrum than was estimated. To illustrate this Figure 3.7 shows the range of spectrum estimates within the Report ITU-R M.2078 in comparison with the amount of spectrum licensed or to be licensed in some countries.

The described situation for lower levels of spectrum supply is depicted as the sum of spectrum from 900 MHz, 1800 MHz and 2100 MHz IMT bands. Later the spectrum for IMT deployment was extended with 800 MHz and 2600 MHz bands, which correspond to the middle level in the Figure 3.7. The spectrum from 3.5 GHz band is added to derive the upper level in the curve of spectrum supply. Although the timing and bands could differ, this illustration is somewhat optimistic in terms of IMT spectrum utilization in many cases.

On the other hand recent development of mobile broadband networks witnesses the phenomenon of divergence between traffic being processed within mobile broadband networks and revenues gained by mobile operators (see Figure 3.8).

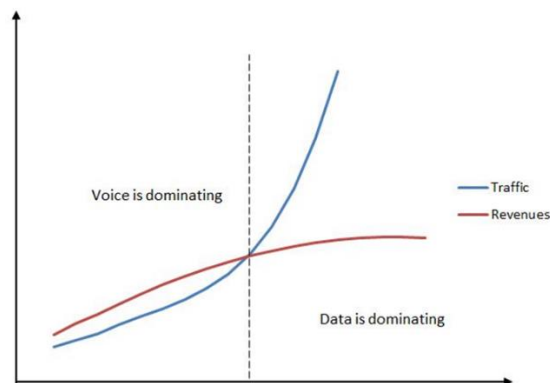
From this perspective, it is clear that regulators should allocate sufficient spectrum resources for mobile network operators (MNOs) to maintain economically effective networks with the required QoS.

Figure 3.7: ITU spectrum estimates and actual spectrum supply comparison (illustrative)



Source: ITU

Figure 3.8: Traffic and revenue divergence

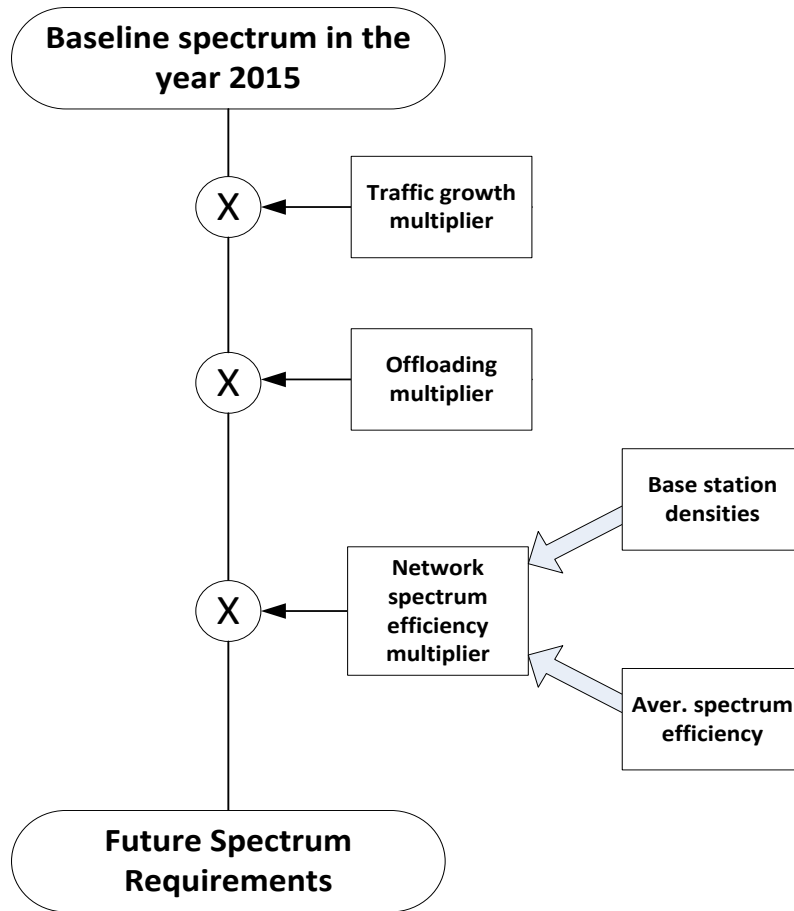


Source: ITU

Overview of the methodology to estimate future spectrum requirements

To exclude detailed traffic calculations and their translation into specific radio environments currently available spectrum from 2015 is used to extrapolate a future situation assuming that available spectrum in 2015 satisfies existing traffic demand. The methodology is schematically described in Figure 3.9. Most of the steps are straightforward including the assessment of future network spectrum efficiency, which takes into account sites deployment growth and increase in average spectrum efficiency. The assumptions and justifications to select the value for each multiplier are described below.

Figure 3.9: Algorithm for spectrum requirements estimation



Source: ITU

Based on the discussed multipliers overall spectrum required to fulfil traffic expectations is found by the following formula:

$$S = S_{2015} \cdot N_{traffic} \cdot N_{offloading} \cdot N_{NSE} \text{ MHz},$$

where

S_{2015} – total spectrum bandwidth allocated to MNOs in 2015 or baseline spectrum supply, MHz;

$N_{traffic}$ – traffic growth multiplier;

N_{NSE} – network spectrum efficiency multiplier.

$$N_{NSE} = \frac{NC_{2010}}{NC_{current\ year}},$$

where

NC – network capacity that can be defined as

$$NC = S_{GSM} \cdot SE_{GSM} \cdot N_{GSM} + S_{UMTS} \cdot SE_{UMTS} \cdot N_{UMTS} + S_{LTE} \cdot SE_{LTE} \cdot N_{LTE} + S_{LTE-A} \cdot SE_{LTE-A} \cdot N_{LTE-A}$$

where

S_{GSM} – is the spectrum available for GSM networks;

SE_{GSM} – is the average spectrum efficiency in GSM cell;

N_{GSM} – is the number of GSM cells;

S_{UMTS} – is the spectrum available for UMTS networks;

SE_{UMTS} – is the average spectrum efficiency in UMTS cell;

N_{UMTS} – is the number of UMTS cells;

S_{LTE} – is the spectrum available for LTE networks.

SE_{LTE} – is the average spectrum efficiency in LTE cell;

N_{LTE} – is the number of LTE cells;

S_{LTE-A} – is the spectrum available for LTE-A networks.

SE_{LTE-A} – is the average spectrum efficiency in LTE-A cell;

N_{LTE-A} – is the number of LTE-A cells;

Assumptions for baseline year spectrum supply (S_{2015})

In 2015, 900 MHz (2x10 MHz for GSM900), 1800 MHz (2x20 MHz for LTE1800) and 2100 MHz (2x40 MHz for UMTS2100) spectrum bands are in use in Brunei Darussalam for mobile broadband networks. The total utilized bandwidth is 2x70 MHz for different technologies – total utilized bandwidth S_{2015} = 140 MHz.

Traffic growth assumptions ($N_{traffic}$)

Different sources for traffic growth assumptions are available. One of the contributions for the Report ITU-R M.2243 (specifically UMTS Forum traffic forecast for the period between 2010 and 2020⁵) is estimating the traffic to be increased 33 times or something around 40 per cent growth annually. This forecast corresponds well with the traffic growth observed in recent years. Nevertheless some APT countries demonstrate much higher annual traffic growth (e.g. according to the Report ITU-R M.2243 Japan showed the increase ratio of 64 per cent in 2010).

For the purpose of this study the annual values of traffic growth $N_{traffic}$ per cent and 40 per cent for two scenarios are used.

⁵ UMTS Forum Report 44 “Mobile traffic forecasts 2010-2020 report”, January 2011.

Offloading factor assumption ($N_{\text{offloading}}$)

Another recent trend is intensive usage of IEEE 802.11 standards wireless technology for traffic offload. There are different forecasted values for the percentage of traffic that will be offloaded from IMT spectrum into unlicensed spectrum. The Report ITU-R M.2243 mentions 20 per cent of traffic offloading, which is also used in this analysis. Accordingly the offloading multiplier is set from 0.9 to 0.8 depending on the year.

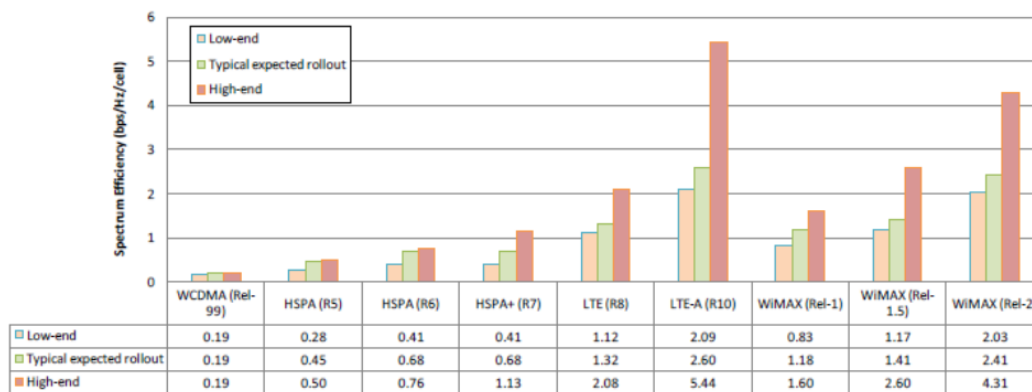
Network spectrum efficiency (N_{NSE})

This term is introduced as an integral measure of the network capacity increase, which incorporates base stations density growth and average spectrum efficiency increase in the future. This multiplier also takes into account the current situation of spectrum usage by different technologies.

For the GSM spectrum efficiency (SE_{GSM}) the value of 0.3 bps/Hz/cell⁶ is used which corresponds to GSM networks using dynamic channel allocation resulting in frequency reuse factor reduction. Spectrum efficiencies for UMTS (SE_{UMTS}) has the value 0.68 bps/Hz/cell, LTE (SE_{LTE}) and LTE-Advanced ($SE_{\text{LTE-A}}$) are set to 1.3 bps/Hz/cell and 2.6 bps/Hz/cell⁷. The last value corresponds to MIMO 2x2 configuration which is assumed as easy to implement for MNO without the need to invest in more complex site configurations.

Figure 3.10 illustrates the values of spectrum efficiency for different radio technologies. The diagram was prepared for OFCOM in the United Kingdom to provide a strategic forward looking, high level view on the evolution of mobile broadband networks up to 2025.

Figure 3.10: Spectrum efficiency by different radio technologies



Source: 4G Capacity Gains. Real Wireless Ltd., 2011

Network growth assumptions

In order to estimate network growth rates in Brunei Darussalam, AITI staff provided data on the number of sites in mobile networks as of the December 2014. The figures are presented in Table 3.4.

⁶ Data Capabilities: GPRS to HSDPA and Beyond. Rysavy Research, 2005.

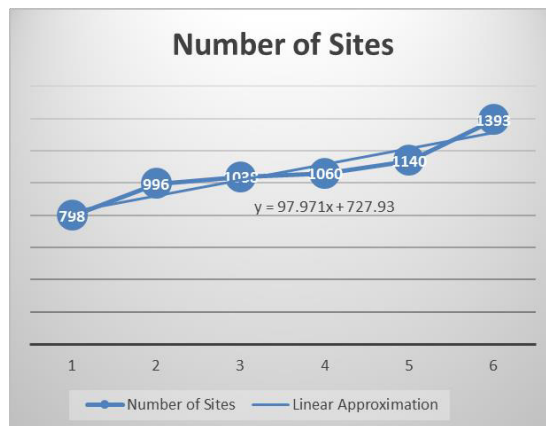
⁷ 4G Capacity Gains. Real Wireless Ltd., 2011.

Table 3.4: Number of sites deployed up to the end 2014

Operator	Network	License Ref.	Years					
			2009	2010	2011	2012	2013	As of December 2014
DST	3G	109976		127	169	171	251	494
	LTE	111995					95	310
	GSM	107403	641	641	641	661	661	671
PCSB	3G	110006	157	228	228	228	228	228
Total number of sites			798	996	1038	1060	1140	1393

The increase in the number of sites has been approximated by linearization in order to define annual increment. The resulting diagram is shown in Figure 3.11. It can be concluded from the diagram that the number of sites increases in average by around 98 per year that corresponds to 9.5 per cent of annual growth. Ten per cent of annual growth of network infrastructure development was taken in further estimations.

Figure 3.11: Network growth from 2009 up to the end of 2014



Source: ITU

Resulting spectrum requirements for mobile networks

The results of calculations are demonstrated in Figures 3.12 to 3.21. Two scenarios applying the traffic growth values of 25 per cent and 40 per cent annually were studied. Both scenarios intentionally are not assuming licensing of additional spectrum during the analysed period as this approach makes spectrum shortage clearly evident at particular points in time. Ten per cent of annual network growth is taken into account in the calculations, adequately corresponding to the existing cellular market in Brunei Darussalam. The increasing traffic demand is being satisfied by the transition from old to new radio technologies with higher spectrum-efficiency.

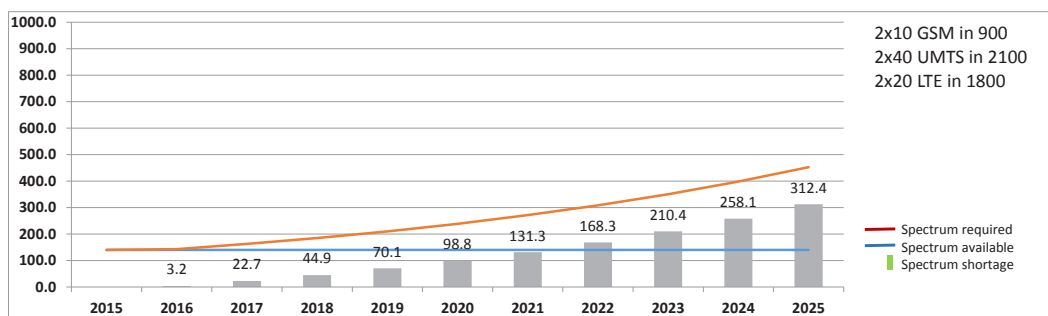
The evolution of spectrum utilization simulated in the calculations is the same for both scenarios. At the beginning spectrum shortage demand is estimated under the conditions that the existing technologies are not converted to the new ones and remain within initially allocated bands (Figures 3.12 and 3.17). The next step is conversion of GSM900 band to UMTS900 band in 2017, the resulting spectrum shortage is shown in Figures 3.13 and 3.18. Subsequently, the 2x30 MHz part of the current UMTS2100 bands will be converted to LTE2100 in 2019 resulting in a spectrum shortage depicted in Figures 3.14 and 3.19. For LTE-A deployment in the 900 MHz and 2100 MHz bands in 2022, the spectrum shortage is illustrated in Figures 3.15 and 3.20. Finally all existing cellular bands will be converted to LTE-A, and the spectrum shortage is provided in Figures 3.16 and 3.20.

Analysis reveals that methodology is sensitive to the value of traffic growth. Spectrum shortage in the 40 per cent traffic growth scenario is several times higher compared to the 25 per cent scenario. Assuming a 25 per cent traffic growth annually, AITI will be able to resolve partly the problem of spectrum shortage by means of a well-timed conversion to up-to-date radio technologies with increased spectrum efficiency.

On the other hand, the scenario based on 40 per cent annual traffic growth cannot be resolved solely based on converting to new radio technologies. AITI suffers spectrum shortage up to 300 MHz depending on the year of analysis despite the increased spectrum efficiency. Consequently, this will encourage AITI to licence additional spectrum bands for the mobile broadband networks over the coming years. Presumably, the 800 MHz LTE band can be licensed closer to 2018, following by the 700 MHz LTE band to be licensed around 2022.

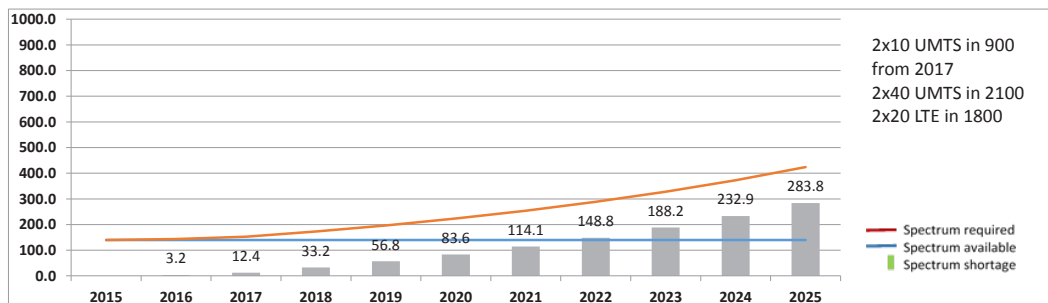
In general, three major conclusions result from the simulations. First, AITI should be careful with monitoring statistical data on actual network capacity in order to make proper time-sensitive decisions on awarding market with the required additional spectrum resources. Second, the technology neutral regulatory mechanisms should enable operators to handle a seamless and effective transition to new spectrum efficient technologies. Third, as soon as additional spectrum bands are used by incumbent applications, AITI should create the operational regulatory mechanisms of spectrum refarming and reallocation allowing advanced release of the bands.

Figure 3.12: Network growth: 10% annually. Traffic growth: 25% annually. No technology changes. No new spectrum.



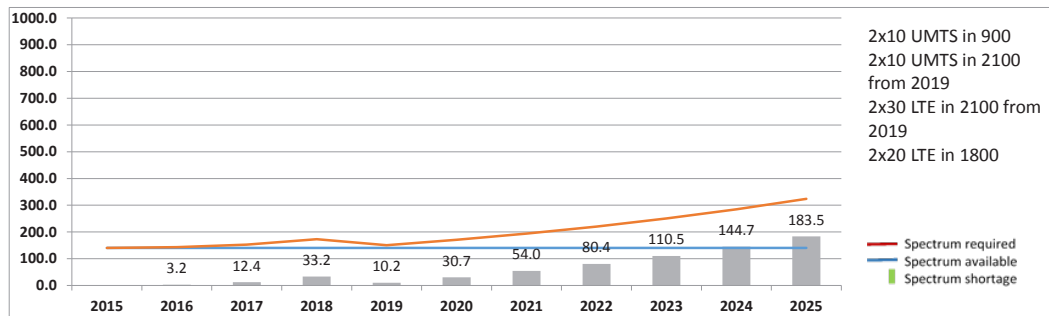
Source: ITU

Figure 3.13: Network growth: 10% annually. Traffic growth: 25% annually. GSM900 converted to UMTS900 in 2017. No new spectrum.



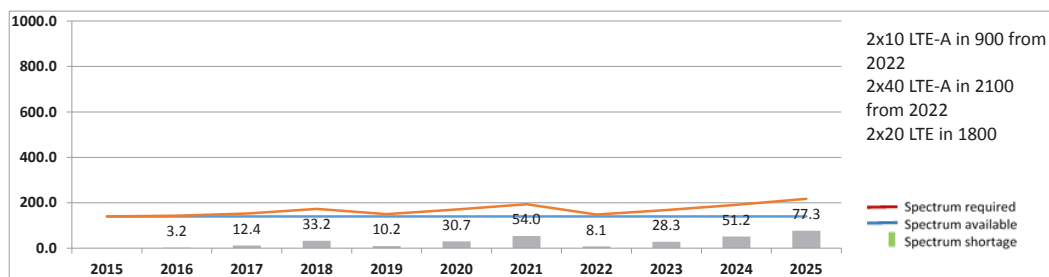
Source: ITU

Figure 3.14: Network growth: 10% annually. Traffic growth: 25% annually. 2x30 MHz converted to LTE2100 in 2019. No new spectrum.



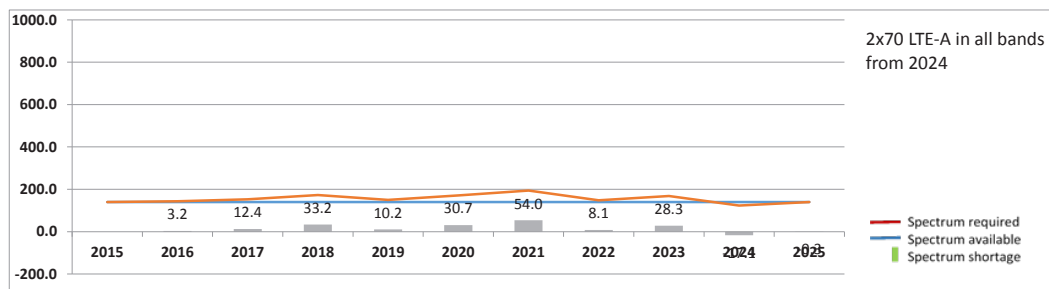
Source: ITU

Figure 3.15: Network growth: 10% annually. Traffic growth: 25% annually. 2x10 MHz converted to LTE-A in 900 from 2022. 2x40 MHz converted to LTE-A in 2100 from 2022. No new spectrum.



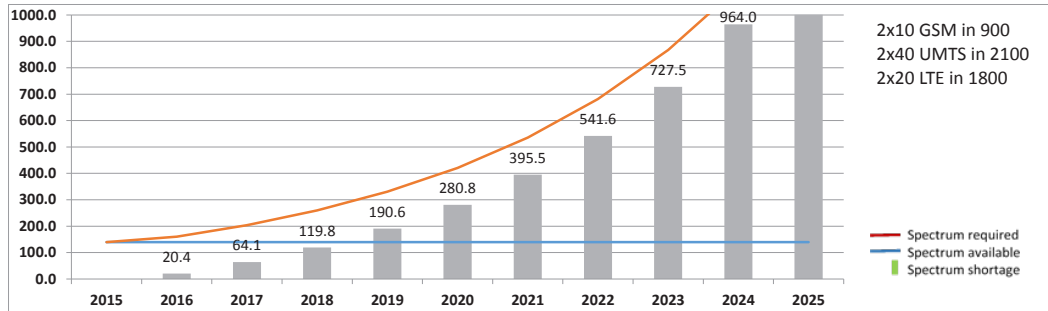
Source: ITU

Figure 3.16: Network growth: 10% annually. Traffic growth: 25% annually. 2x70 MHz used for LTE-A in all bands from 2024. No new spectrum.



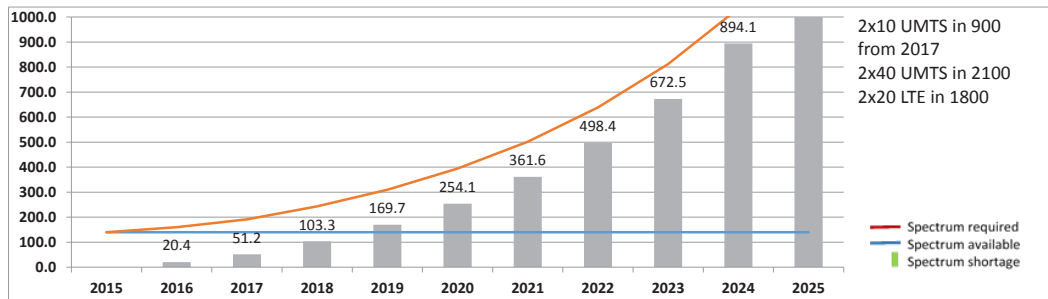
Source: ITU

Figure 3.17: Network growth: 10% annually. Traffic growth: 40% annually. No technology changes. No new spectrum



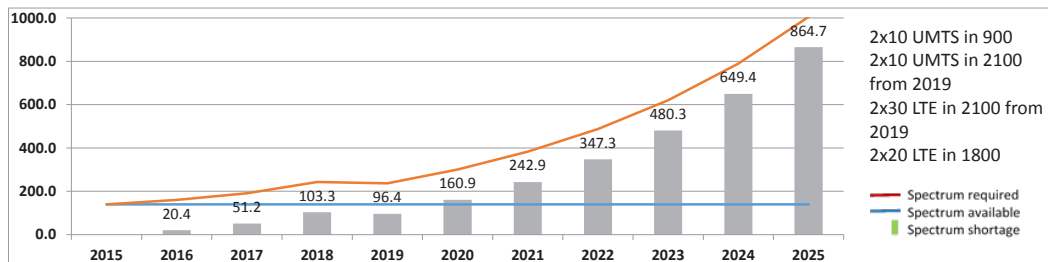
Source: ITU

Figure 3.18: Network growth: 10% annually. Traffic growth: 40% annually. GSM900 converted to UMTS900 in 2017. No new spectrum.



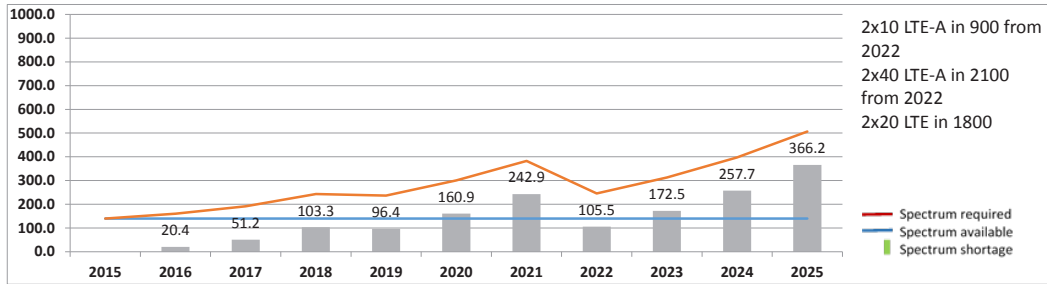
Source: ITU

Figure 3.19: Network growth: 10% annually. Traffic growth: 40% annually. 2x30 MHz converted to LTE2100 from 2019. No new spectrum.



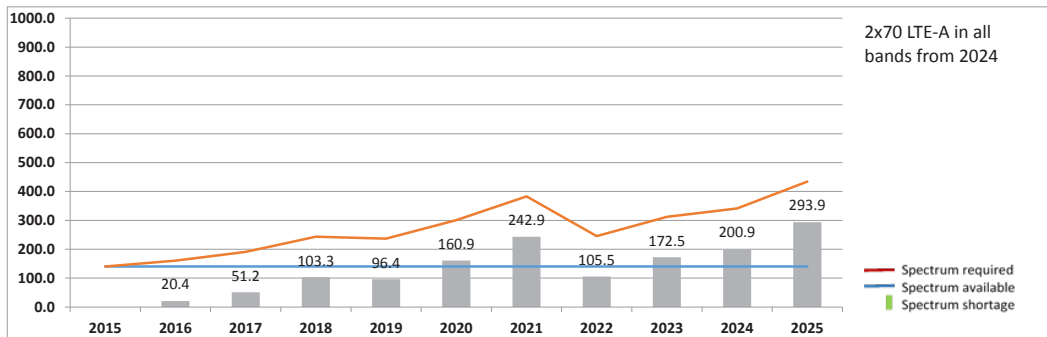
Source: ITU

Figure 3.20: Network growth: 10% annually. Traffic growth: 40% annually. 2x10 MHz converted to LTE-A in 900 from 2022. 2x40 MHz converted to LTE-A in 2100 from 2022. No new spectrum.



Source: ITU

Figure 3.21: Network growth: 10% annually. Traffic growth: 40% annually. 2x70 MHz used for LTE-A in all bands from 2024. No new spectrum.



Source: ITU

4 Recommendations and key issues in implementation of master plan

4.1 Possible alignment of the primary legislation

Existing primary legal acts of Brunei Darussalam have only minor provisions on frequency issues in the primary legislation, and those are in the AITI Order specifying that AITI can give advice to the Minister on allocations and co-ordination, interference with radiocommunications, on matters concerning codes of practice, and performance of operation. Telecommunications acts tend to determine further spectrum-specific aspects and some of the most useful are summarized below.

4.1.1 Legislative provisions related to limited resources

Telecommunication administrations applying the process allocations of limited spectrum resources through market-based mechanisms usually include provisions in the primary or subordinate legislation related to an estimation of spectrum limitations and rules to assess demand for limited spectrum resources. For some radio technologies, this has given rise to market-based mechanisms of awarding these scarce resources (auctions etc.) to candidates. The existing primary and subsidiary legislation of Brunei Darussalam does not incorporate any provisions of that nature. Thus the legal framework of policy and rulemaking based on estimations of spectrum supply and demand is not defined.

It is quite possible that high spectrum consuming technologies will drive the corresponding amendments as the limited spectrum resources become a vital issue. The introduction of competition laws and competition codes in the coming months may implicitly require the following measures:

- to create enough pool of resources to allow competition on equal terms. Further, allocation planning should create enough room for other players to acquire spectrum directly on an equitable basis.
- to check on the concentration and hoarding at band-level as well as in aggregate may prevent further complexity.

4.1.2 Amendments to the Broadcasting Act

The regulatory regime in Brunei Darussalam is in transition to a new converged framework. The initial stage of transition highlighted in Section 2.2 did not intend to radically overhaul existing legislation. The regulator decided to leave legislation covering telecommunication and broadcasting sectors both separate and in their current form. In other words, the current legislation was left structurally intact, as there were no plans to implement an umbrella ICT legislation in Brunei Darussalam. The concept aims to avoid radical modification of primary legislation as well as the relevant regulatory practices at the beginning of the process. Nevertheless, it is recommended to amend the existing Broadcasting Act in the medium-term based on the results of applying the innovative regime.

4.1.3 Period of radio spectrum plan revisions

The telecom legislation in Brunei Darussalam does not regulate the amendment process of the National Frequency Allocation Table (NFAT), which can create some formal difficulties in spectrum management area. A framework of spectrum allocations and utilization is constantly changing within most telecommunication administrations and regulators attempt to track those changes to provide the market with up-to-date data.

For instance, within CEPT special attention is given to the maintenance of the European Table of Common Allocations (ECA) in order to incorporate the most recent data. The factual information of the ECA Table is typically updated by the European Communications Office (ECO) three times a year or after publication of the harmonized standards in the Official Journal of the European Union. A fundamental update on the ERC Report 25 and its Attachments is carried out at least after every WRC through the CEPT wide public consultation.

It is highly recommended to AITI to consider the adoption of legal provisions and appropriate procedures relevant to updating of the Brunei Darussalam radio spectrum plan (NFAT). The corresponding provisions could be incorporated in the text of future primary acts.

4.2 Envisaged alignment of allocation policy

4.2.1 Information on spectrum utilization

The current situation related to NFAT and the process of spectrum planning in Brunei Darussalam has been discussed in sections 2.1.2.1 and 2.3.1. This section intends to make further proposals on ways to increase information capacity of the Brunei Darussalam radio spectrum plan. Some telecommunication administrations produce radio frequency utilization plans either by a separate utilization plan or by expanding the NFAT with supplementary information on current/planned applications and utilization types.

This is of great value for spectrum users, industry and importing parties. It is recommended that the European Common Allocation (ECA) Table be considered as a possible approach. The detailed review of the key principles of ECA accomplished in 2010 delivered essential information on existing spectrum usage, as well as some future oriented information for certain specific frequency bands (see Table 4.1).

Table 4.1: Excerpt from the ECA for 1710 – 1785 MHz sub-band

RR Region 1 Allocation and RR footnotes applicable to CEPT European	European Common Allocation	ECC/ERC har- monisation measure	Applications	European footnotes	Standard	Notes
1710 – 1785 MHz FIXED MOBILE 5.384A 5.149 5.341 5.385 5.386 5.387	FIXED MOBILE 5.384A 5.149 EU29 5.341 5.385	ECC/REC/(05)08 ERC/DEC/(95)03 ECC/DEC/(06)13 ECC/REC/(08)02 ECC/DEC/(08)08 ECC/DEC/(06)07	GSM TRA-ECS MCV MCA Radio Astronomy	EU33	EN 301 502 EN 301 511 EN 300 609 EN 301 908 EN 302 480	IMT is con- sidered as a part of TRA-ECS Spectral line observations (e.g. hydroxyl line), VLBI

From time to time telecommunication administrations include an additional informative tier to national allocations tables: inter alia, the references to harmonized standards, domestic regulations, rules etc. could be incorporated. The next recommendation for AITI is to improve the quality of the NFAT by means of implementing an additional column with supplementary information. For instance, ECA uses the “Notes” column reflecting any other relevant information, such as the nature of use of a radio application or decisions, which might affect the future use of the band. Table 4.2 show proposals based on NFAT of Bosnia and Herzegovina.

Table 4.2: Excerpt from the allocation and utilization plan of the radio frequency spectrum in Bosnia and Herzegovina for 1710 – 1785 MHz sub-band

Frequency band	Allocation	Notes	Utilization	Documents	Standards
1710 – 1785 MHz	MOBILE FIXED 5.149 5.341 5.384A 5.385	EU29 EU33	GSM IMT	BH Rule 46/2009 ECC/DEC/(06)07 ECC/DEC/(08)08 ECC/REC/(05)08 ERC/DEC/(95)03 ECC/DEC/(06)13 ECC/REC/(08)02	EN 301 511 EN 301 908 EN 301 419 EN 301 502

4.2.2 Spectrum reallocation and refarming

Over the last 10 to 15 years, the demand for the services has created a spectrum shortage within the most popular frequency bands, and additional pressure on spectrum availability has been supplemented by mobile broadband applications requiring the extended radio frequency channel bandwidth.

Even with the naturally limited size of wireless applications market in Brunei Darussalam, future development of spectrum technologies will require frequency resources in addition to those allocated to existing systems and networks. On the other hand, it is hardly possible now to identify unencumbered bands to satisfy estimated increases in future spectrum demand. This means that

AITI alongside other regulators worldwide will meet the need for spectrum re-planning in order to accommodate emerging radio technologies and to comply with the changing priorities in spectrum utilization. With the intensive entrée of newcomers to wireless market, the process of spectrum renovation will become more critical, dynamic and pressing. The above mentioned factors make spectrum re-allocation or spectrum redeployment the cornerstone of the present-day spectrum management process.

Spectrum conversion and spectrum marketing plans in Brunei Darussalam are stipulated by the Telecommunications (Radio-communication) Regulations, 2013, pending practical implementation. AITI staff and spectrum stakeholders were in favour of refarming in the 400 MHz bands for implementing private mobile radio (trunked radio) networks, 2500 – 2690 MHz for the anticipated introduction of LTE networks etc. Marketing spectrum plans for the 700 MHz band is believed to become valuable as soon as this band constitutes the essential part of lower spectrum for LTE in APT countries. Spectrum conversion and spectrum marketing plans are important for AITI, and the following subsections provide additional information.

The concept of spectrum reallocation process in Brunei Darussalam.

AITI has no practical mechanisms related to spectrum re-allocation in the form of approved legislative instruments. The concept proposed in this section might be used by AITI as the background for the corresponding future subsidiary regulation.

It is suggested that the minister responsible for telecommunications in Brunei Darussalam be vested by law with the power to issue a spectrum re-allocation declaration. Such a declaration states that one or more specified parts of spectrum are subject to the re-allocation process. A spectrum re-allocation declaration should have a status of a legislative instrument. A spectrum re-allocation declaration while specifying that one or more parts of spectrum are subject to re-allocation should also define its period (the re-allocation period). Incumbent station licences affected by a spectrum re-allocation declaration will be cancelled at the end of the period specified in the declaration. A spectrum re-allocation declaration may provide that the part or parts of the spectrum should be re-allocated by issuing spectrum rights or by issuing apparatus (spectrum) licences.

The declaration must specify the starting time of the re-allocation process and the re-allocation deadline. That time must be at least 12 months before the end of the re-allocation period. A particular part of the spectrum is specified in the declaration whether or not any station licences are in force authorising the operation of radiocommunications devices at frequencies that are wholly or partly within that part of the spectrum.

The Minister must give a copy of a spectrum re-allocation declaration to AITI. As soon as practicable after receiving a copy of the declaration, AITI must:

- prepare a written public notice stating that the declaration has been made;
- make reasonable efforts to give each affected station licensee a copy of the notice;
- publish a copy of the notice on the AITI website.

A station licence is affected by a spectrum re-allocation declaration if the licence authorises the operation of radiocommunications devices at frequencies that are wholly or partly within the part or parts of the spectrum specified in the declaration and within the area or areas specified in the declaration for re-allocation process.

The Minister must not revoke and vary a spectrum re-allocation declaration if the declaration states that a particular part of the spectrum should be re-allocated by issuing spectrum rights and AITI has

begun allocating any or all of those licences. For the purposes of these revocation and verification, AITI is considered to begin allocating licences if:

- in a case where the licences are to be allocated by auction- AITI publishes an advertisement for that auction;
- in a case where the licences are to be allocated by tender- AITI publishes an advertisement calling for suitable tenders;
- in any other case- AITI invites applications for the allocation of the licences.

Nevertheless the Minister should be vested with the right to vary a spectrum re-allocation declaration so as to extend the re-allocation deadline if the Minister is of the opinion that there are special circumstances. Automatic revocation of spectrum re-allocation declaration occurs if no licences are allocated before the re-allocation deadline stipulated in the declaration. In its turn, AITI may apply to the Minister with the request to make a spectrum re-allocation declaration. In its application to the Minister, AITI may give the Minister a written recommendation to make a spectrum re-allocation declaration in relation to one or more specified parts of the spectrum. AITI recommendation must specify the period that the declaration should specify as the re-allocation period.

Before applying to the Minister with the request for spectrum re-allocation declaration, AITI must:

- prepare a written notice stating that AITI has prepared a draft version of the recommendation and setting out the terms of the draft version;
- make reasonable efforts to give each potentially-affected station licensee a copy of the notice;
- publish a copy of the notice on the AITI website.

The notice must invite each potentially-affected station licensee⁸ to give written comments to AITI about the draft version of the recommendation within the specified period. The specified period must run for at least 120 days. If a potentially-affected station licensee has given comments in accordance with a notice, then, in preparing the final version of the recommendation, AITI must take into account the comments.

Usually re-allocation is achieved by means of issuing spectrum rights or apparatus (spectrum) licences. The method of spectrum re-allocation should be specified in declaration. If a spectrum re-allocation declaration states that a part or parts of the spectrum should be re-allocated by issuing spectrum licences, the licences must be issued in accordance with a marketing plan prepared under Article 7 of the Telecommunications (Radio-communication) Regulations, 2013. If a spectrum re-allocation declaration states that a part or parts of the spectrum should be re-allocated by issuing apparatus (spectrum) licences, the licences must be issued in accordance with a price-based allocation system determined under the provisions of Telecommunications (Radiocommunication) Regulations, 2013.

During the re-allocation period, AITI must not issue a station licences that authorises the operation of radio-communications devices at frequencies that are within that part, or those parts, of the spectrum.

4.2.3 Proposed mechanism for making spectrum marketing and conversion plans

The principle idea of the AITI strategic spectrum planning should be the transition from the current station licensing regime to spectrum rights licensing scheme. From this perspective, designation of particular frequency bands for marketing and spectrum conversion plans becomes the top-priority task.

It is proposed that AITI designate a specified part of the spectrum for re-allocation by issuing spectrum rights. Before making a decision, AITI must give the affected spectrum stakeholders reasonable opportunity to contribute to AITI about the decision on re-allocation.

⁸ Potentially affected station licensee means the station licence holder where it becomes an affected licensee if the spectrum re-allocation declaration were to be made in accordance with the recommendation.

Before making a conversion plan or a marketing plan AITI may prepare a radio spectrum plan under Section 3 “Radio Spectrum Plans” or a radio frequency band plan under Section 4 “Radio Frequency Bands Plans” of the Telecommunications (Radio-Communication) Regulations, 2013. AITI may vary the existing radio spectrum plan or radio frequency band plan in accordance with Section 5 “Variation and revocation of radio spectrum plan and radio frequency band plan” of Telecommunications (Radio-Communication) Regulations, 2013 in order to assist it in preparing the conversion plan or marketing plan.

4.2.4 Outline and template text for a spectrum conversion plan

Purpose

The purpose of the spectrum conversion plan is to set out the procedures and timetables for issuing the spectrum rights (to replace existing station licences) in the frequency band specified in the spectrum re-allocation declaration. The conversion plan also sets out the conditions that will apply to those spectrum licences.

Legislative provisions

Section 8 of the Telecommunications (Radio-communication) Regulations, 2013 provides that AITI might prepare a conversion plan which designates a specified part of the spectrum to be allocated by issuing a spectrum rights based on the spectrum re-allocation declaration. The conversion plan has a status of a legislative instrument.

Background

The frequency band designated for the re-allocation process is used for certain incumbent applications or spectrum users awarded with the station licences. However, this band is identified for other innovative applications. In order to define future usage of this band AITI commenced a review of the band to plan and allocate the band to maximize the overall benefit derived from that spectrum and to provide the incumbent licensees with greater long-term certainty in light of strong emerging demand for the band to be used for competing purposes. Based on the results of this review AITI released a discussion paper “Review of the band and its long-term arrangements”. The discussion paper included the AITI preliminary view on its preferred approach for the band, which was broadly:

- reallocation of the band for spectrum rights, with technical frameworks that are technology flexible but are optimised for advanced wireless services;
- conversion of the existing station licences to spectrum rights in the re-allocated band;
- facilitation of transition of the existing station licences to identified alternative bands.

Following consideration of submissions received in response to the discussion paper, AITI announced its intention to give existing services access to alternative bands and to make the re-allocated bands available in Brunei Darussalam to support innovative radio technology. To assist stakeholders in understanding how AITI reached a view on appropriate future arrangements in the band and on alternative bands, AITI released a response paper, *Review of the band and its long-term arrangements – Response to Submissions* that summarized the issues raised in response to the discussion paper and set out the AITI preliminary response to those issues.

To provide long term access in the band AITI proposed to convert the existing station licences in the band to spectrum licences in the same band or to facilitate transition of the existing station licences to the alternative spectrum bands. The technical framework defines a spectrum licensee rights and obligations and provides an interference management framework for the band.

Operation

The conversion plan explains how existing station licences authorising the use of radio-communications in the band under re-allocation will be converted to spectrum rights and sets out the timetable for issuing the spectrum rights.

Schedules to the conversion plan contain sample spectrum rights that sets out information relating to the core conditions and other conditions applicable to the operation of a service under the spectrum rights. The conversion plan also sets out the geographic region and frequency bands covered by the licences.

Consultation

AITI has consulted extensively with stakeholders about its plans to develop a spectrum licensing technical framework for the band. AITI also undertook public consultation on a draft of the conversion plan. AITI set up a number of short-term industry technical liaison groups to assist with the development of technical frameworks including the support of the existing station licences to be transferred to the alternative bands.

AITI had regard to the views expressed by the incumbent licensees when preparing the final conversion plan. AITI also undertook wider public consultation in relation to the conversion plan and released the draft legislative instruments (including the conversion plan) for comments. These instruments were accompanied by an information paper to explain the draft instruments and provide context to assist interested parties in making a submission.

Detailed description of the instrument

Section 1 – Title: This section provides the full name of the conversion plan.

Section 2 – Commencement: This section specifies that the conversion plan will take effect from the day after it is registered.

Section 3 – Purpose: This section states that the purpose of the conversion plan is to set out the procedures and timetables for converting existing station licences authorising the use of radio-communications devices in the band under re-allocation to spectrum licences.

Section 4 – Interpretation: This section provides definitions for terms used in the conversion plan.

Section 5 – Approval of Acceptance Form: This section explains that AITI will approve, in writing, a form (the Acceptance Form) for use by a licensee to accept an offer of a spectrum right.

Section 6 – Preparation of draft spectrum rights: This section explains that the AITI will prepare a draft spectrum rights to replace each existing station licence. The draft licence will be sent to the licensee, and the licensee will be invited to make representations on the draft licence.

Section 7 – Sample spectrum licence: This section explains that a sample spectrum rights is set out in schedule of the conversion plan.

Section 8 – Core licence conditions: This section provides that the spectrum rights will contain core conditions which will define the parts of the spectrum that can be used in the licence. The conditions will be included in the draft licence.

Section 9 – Other licence conditions: This section provides that the spectrum rights will set out other conditions which are not core conditions. These other conditions will be included in the draft licence.

Section 10 – Determination of core licence conditions: This section provides that AITI will identify the geographic areas and bands to be included in the spectrum rights proposed for replacement.

Section 11 – Emission limits: Spectrum rights cover a spectrum space defined by frequency and geographical area. This section provides that the methods for calculating the limit of emissions that can be caused outside of the defined frequency and geographical area.

Section 12 – Agreements about emission limits: This section provides that a licensee may enter into an agreement with another licensee about emission limits outside the defined frequency or geographic area that may be caused in that other licensee's spectrum space.

Section 13 – Extent of operation of devices under replacement of station licences: This section explains that AITI will, so far as is practicable, prepare a draft spectrum rights that authorises the operation of radio-communications devices to the same, or to a greater extent than the station licence it replaces.

Section 14 – Spectrum access charge: This section explains that a spectrum access charge is payable by a licensee for the issue of a spectrum rights that replaces the licensee's existing station licence. AITI will determine the amount of the spectrum access charge and may be directed by the Minister in making that determination.

Section 15 – Representations about draft spectrum rights: This section provides that a licensee will have at least one month to make representations about the draft spectrum rights it receives. AITI will consider all representations made by the due date. AITI may discuss proposed changes to the draft spectrum rights with the licensee and will advise the licensee as to whether or not it has altered the draft spectrum rights as a result of the licensee's representations.

Section 16 – Formal offer of spectrum rights: This section explains that AITI will make a written offer to the licensee to issue a spectrum rights to replace the licensee's existing station licence. This offer will be made as soon as practicable after the last day for making representations. The offer will be sent to the licensee's last known address, will specify a closing date (the last date on which the offer can be accepted), identify the spectrum rights that AITI proposes to issue and will specify the applicable spectrum access charge that has been determined by AITI.

Section 17 – Accepting the offer: This section provides that a licensee that wants to accept an offer for a spectrum rights must provide to AITI a written notice of acceptance by the closing date specified in the offer. The notice must be provided in accordance with the approved Acceptance Form (described in Section 5). The Acceptance Form will contain a clause requiring the licensee to agree to pay the spectrum access charge.

Section 18 – Issue of spectrum rights: This section provides that AITI will issue the spectrum rights in accordance with the AITI Order. The spectrum rights will come into force on the date specified in the licence and immediately before it comes into force, the station licence which it replaces will cease to be in force.

Section 19 – Failures to accept offers: This section explains that if a licensee does not accept an offer, AITI may allocate the spectrum licence to another person under procedures determined.

Section 20 – Duration of spectrum licences: This section specifies the period for which spectrum rights will be issued.

Section 21 – Re-issue of licences: This section provides that AITI may re-issue a spectrum rights at its expiry. AITI may re-issue an expiring spectrum rights to the same licensee. However, AITI may also divide and distribute a spectrum rights in a manner that differs from the originally issued spectrum rights. Consequently, a licensee should not assume that a re-issued licence will be exactly the same as their previous licence. Although AITI may not re-issue a licence to the same licensee, that licensee is not precluded from applying for a lot covered by the new licence in a subsequent re-allocation process.

Section 22 – Guidelines: This section states that AITI may take into account any guidelines made by it when settling interference disputes.

Schedule 1 Geographic area covered by spectrum rights resulting from conversion in the band

Schedule 2 Sample spectrum licence

Schedule 3 Emission limits outside the geographic area

Schedule 4 Emission limits outside the band

4.2.5 Outline and template text for a spectrum marketing plan

Purpose

The spectrum marketing plan specifies the spectrum assets available in the band under re-allocation, the method by which the assets will be allocated, and conditions that will apply to the spectrum rights issued after that allocation process.

Legislative Provisions

The marketing plan is prepared by AITI based on the provisions of Section 8 of the Telecommunications (Radio-communication) Regulations, 2013, stipulating that AITI might prepare a marketing plan before issuing spectrum rights in parts of the radio-communications spectrum that are the subject of a spectrum re-allocation declaration.

Background

Currently, the band under consideration is used in Brunei Darussalam by incumbent applications and spectrum users authorized with station licences. However, for a number of years this band is designated internationally as available for use by telecommunication administrations wishing to implement other types of innovative radio technologies. There has been increasing demand from telecommunication operators and equipment manufacturers for access to the band for the provision of innovative services around the world, including in Brunei Darussalam.

After several comprehensive rounds of public consultation processes, AITI announced its intention to re-plan part of the band to facilitate new uses, primarily focusing on innovative technology. Allowing the use of the band for this technology will enable Brunei Darussalam to take advantage of the globally harmonized band. It is expected that the public will benefit from lower costs and a wider range of devices that the economies of scale inherent in such large scale equipment production can offer.

The spectrum re-allocation declaration identified separate blocks of spectrum for re-allocation. These frequencies will be re-allocated across Brunei Darussalam. The specific frequency and geographic boundaries for the band re-allocation are set out in the spectrum re-allocation declaration. The spectrum re-allocation declaration also sets the re-allocation period. All station licensees using the parts of the spectrum described must cease operating radio-communications devices by the end of the re-allocation period. The re-allocation period is intended to provide sufficient time for incumbent licensees to leave the band. New licences will only authorise the use of radio-communications devices after the re-allocation period has elapsed in the coverage area of the licence.

A re-allocation deadline is also stated in the spectrum re-allocation declaration. This sets the date by which AITI must have allocated at least one spectrum licence for the parts of the spectrum affected by the spectrum re-allocation declaration. If this does not occur, the spectrum re-allocation declaration will automatically be considered to have been revoked, and will cease to apply immediately after the re-allocation deadline. However, this deadline date does not preclude the spectrum being allocated earlier.

AITI must prepare a marketing plan for issuing spectrum licences that authorise the use of radio-communications devices in parts of the spectrum described by the spectrum re-allocation declaration. AITI must also determine the procedures for allocating spectrum licences. AITI will be allocating spectrum under the spectrum re-allocation declaration in an auction process. Licences in the band issued in this allocation will commence after incumbent services have been cleared from the band.

Marketing plan operation

The marketing plan is one of a set of legislative instruments that gives effect to the spectrum re-allocation declaration to re-allocate the specified range of frequencies. The purpose of the marketing plan is to describe the spectrum 'product' that will be offered at auction. In doing so, it identifies the spectrum that will be allocated and defines how this spectrum will be divided into lots for applicants

(bidders) to acquire in the auction process. In addition, it sets out some of the technical and non-technical conditions that may apply to spectrum licences and other matters that licensees should take into account when operating devices.

The marketing plan also notes the method by which AITI will conduct the allocation, although limited details of the allocation procedure and related administrative arrangements are included in this document. Full details of the allocation procedure by auction are set out in the dedicated document – the Allocation Determination. With the expected high demand for spectrum in the band, AITI considers that a price-based method of allocation, namely an auction, to be the most efficient means of allocating this spectrum.

The band spectrum to be re-allocated will be divided into auction lots that are defined by their geographic area and bandwidth range. The technical conditions applied to spectrum rights are drawn from the AITI technical framework developed for the band in consultation with industry stakeholders. The technical framework is partly set out in the marketing plan sections on licence conditions and the sample spectrum rights licence.

In addition, the marketing plan discusses other relevant obligations, including spectrum trading rules, use by third parties, and registration of transmitters. Licence commencement and licence duration are also described.

A sample spectrum rights licence provided in the schedules to the marketing plan also contains information relating to core and other conditions that may apply to the operation of a service under the spectrum rights. The spectrum rights issued by AITI may contain additional or varied conditions.

Consultation

AITI has consulted extensively with stakeholders about its plans for the re-allocation of the band, generally, and on the marketing plan in particular. A variety of communication methods have been used to reach as many stakeholders as possible at each stage of the re-allocation planning process.

AITI undertook a review of the band and released the discussion paper *Review of the band and its long term arrangements*. This paper sought public comment on a range of options for future licensing arrangements, planning and pricing for the band. The purpose of the review was to determine the use of this band that would maximise the overall benefit derived from that spectrum. It also sought to identify long-term arrangements for services that currently use this band. Such arrangements included finding alternative bands that could accommodate services in the future.

AITI received written submissions in response to the discussion paper. All submissions are published on the AITI website. Stakeholder views expressed in these submissions have been taken into consideration in subsequent auction planning.

AITI also consulted with potentially affected station licence holders and the public prior to specify the band for re-allocation. AITI prepared a draft recommendation, published the terms of this recommendation, and sought comment from potentially-affected licensees. All written submissions are available on the AITI website.

AITI has engaged with incumbent licensees, prospective new licensees, and other public stakeholders during the development of the marketing plan and associated legislative instruments. In addition, spectrum licensees and industry representatives have provided input for the preparation of the technical framework that forms part of the marketing plan through extensive involvement in technical working discussions chaired by AITI. AITI also undertook preliminary consultation (through the AITI website) on its proposed approaches to key auction planning issues, such as lot configuration and licence commencement.

A draft version of the marketing plan was subsequently released for detailed public consultation. The marketing plan was released as part of a package of draft allocation instruments, together with the explanatory information paper.

Regulation impact statement

A regulation impact statement entitled *Lot configuration for the auction*, was prepared by AITI on how to divide the spectrum for re-allocation into lots for auction. The definition of lots available in the spectrum auction is included in the marketing plan.

Detailed description of the marketing plan

Part 1 – Introduction

Section 1.1 – Name of plan: This section gives the full name of the marketing plan.

Section 1.2 – Commencement: This section specifies when the marketing plan will come into effect. The marketing plan commences the day after it is publically registered.

Section 1.3 – Purpose of this Plan: This section lists the matters contained in the marketing plan, which should be taken into account by prospective auction applicants. The marketing plan should be read in conjunction with the Allocation Determination for a more complete understanding of all allocation procedures.

Section 1.4 – Definitions: This section provides definitions of terms used in the marketing plan. These are designed to assist the reader in interpreting the marketing plan.

Part 2 – Allocation of spectrum licences

Section 2.1 – Purpose of this Part: This section provides a brief description of topics that are covered by Part 2. These include the procedures and timetable for allocating spectrum under the marketing plan.

Section 2.2 – Parts of the spectrum: This section explains that the band spectrum defined in the spectrum re-allocation declaration will be allocated under the conditions and procedures described in the marketing plan and accompanying Allocation Determination. If the spectrum re-allocation declaration is revoked, the marketing plan will have no effect.

Section 2.3 – How licences will be allocated: This section states that the primary means of allocating spectrum licences in the band will be by auction. The rules and procedures that apply to the auction are set out in the Allocation Determination for this re-allocation process.

Section 2.4 – The auction: This section sets out how the allocation will take place, partly by reference to the procedures set out in the Allocation Determination. It also provides a detailed summary of the allocation process. It explains that the spectrum being reallocated in the band has been divided by AITI into smaller blocks (referred to as lots) for auction. Each lot is defined by a specific geographic area (regions) and a frequency bandwidth.

Section 2.5 – Advertising the auction: This section refers to the requirement that AITI advertise the details of the spectrum auction in accordance with the Allocation Determination, in which this process is described in more detail. The notice published will invite persons to apply to participate in the auction.

Section 2.6 – Taking part in the auction: This section specifies that detailed information about the auction and the application process will be made available by AITI in the special document – the Applicant Information Package (the AIP) in accordance with the Allocation Determination. The AIP will be made available prior to the application process. The AIP will contain important information about the auction for potential participants. It will describe how to apply to participate in the auction, and will include copies of all necessary forms and documents to participate in the auction.

Part 3 – Spectrum licences to be issued

Section 3.1 – Purpose of this Part: Part 3 describes the spectrum rights that will be issued in accordance with the marketing plan, as well as some of the matters that prospective applicants should consider when deciding whether to apply for a spectrum rights under this marketing plan. It also covers some of the matters that a licensee must take into account when operating a radiocommunications device under a licence obtained under this marketing plan.

Section 3.2 – Issue of licences: This section describes when AITI will issue spectrum rights in the band. The licence will be issued to a successful applicant as soon as practicable after that applicant has paid the balance of the winning price in accordance with the Allocation Determination.

Section 3.3 – Duration of licences: This section explains that spectrum rights issued in the band allocation will generally last for a period of [TBD] years from the date the licence commences.

Section 3.4 – Commencement of licences: This section specifies when a spectrum rights issued as a result of the auction will commence. Upon commencement, a spectrum rights holder is entitled to use the spectrum in accordance with the conditions of that licence.

Section 3.5 – Core licence conditions: There are a number of core conditions which a spectrum licence must include. This section sets out these core conditions, including the geographic area and frequency bandwidth in which a radio-communications device can be operated under a spectrum rights.

Section 3.6 – Determining core licence conditions: This section explains how the core conditions for spectrum rights issued in the band as a result of the auction are determined.

Section 3.7 – Other licence conditions: This section identifies other kinds of statutory licence conditions and other licence conditions that will also apply to each spectrum rights issued under this allocation process, but which are not included in the core conditions of a licence.

Section 3.8 – Draft sample licence: This section states that a sample spectrum rights is available at Schedule of the marketing plan. The sample spectrum rights sets out the technical and other conditions that may apply to licences issued in a part of the spectrum referred to in the spectrum re-allocation declaration.

Part 4 – After allocation

Section 4.1 – Purpose of this Part: This section sets out the purpose of this Part, which is to explain matters that apply after the spectrum rights are issued under the marketing plan.

Section 4.2 – Third party use: This section highlights that a licensee may permit third parties to operate radio-communications devices under any licences it holds.

Section 4.3 – Trading in licences: This section provides that a licensee may assign, or otherwise deal with, the whole or any part of a spectrum rights. Section 4.4 of the marketing plan provides further details about the rules for trading in spectrum rights issued under this Plan.

Section 4.4 – Trading rules: This section ensures that licensees who wish to trade part or all of a spectrum rights in a secondary market are made aware that they must comply with the trading rules made by AITI.

Section 4.5 – Agreements about emission limits: This section explains the purpose for which an agreement about emission limits can be made.

Section 4.6 – Re-issue of licences: This section explains what AITI will do when spectrum licences expire. AITI may decide to re-issue a spectrum rights to the existing licence holder when it expires, if it is in the public interest to do so. Alternatively, AITI may offer the spectrum rights for re-allocation by auction, tender, or pre-determined or negotiated price. A re-issued licence may be different to the original licence, including by having different conditions placed on the licensee.

4.2.6 Spectrum refarming fund

The specified subsidiary legislative instruments usually regulate the procedure of spectrum refarming. As a general recommendation, this procedure should be based on a sustainable economic approach and should make it possible to meet the demands of all the stakeholders involved. Furthermore, it does not put into question the procedures for allocation and assignment of frequencies agreed at international level. The next aspect for the regulator is to set up a working group/commission to study cases where international obligations accepted and adopted by telecommunication administrations lead to the necessity of changing, usually in a shorter term than the usual life-time of the equipment, the usage of spectrum. The best practice procedure for spectrum refarming is comprised of several integral elements:

- evaluation of the cost of the refarming;
- establishment of the time schedule of spectrum redeployment;
- management of a spectrum redeployment fund needed to finance the refarming;
- control of redeployment implementation.

Elements of refarming procedure fall within the responsibilities of national spectrum management authorities. The idea is to provide the user who is to leave a frequency band with sufficient compensation. Compensation often takes the form of a financial contribution and re-assignment of frequencies to alternative frequency bands, except when a wire-based technology may be used as a substitute. It is advisable that the compensation process should be discussed by all concerned parties within a specific working group or advisory commission, set up by the regulator to deal with the financial aspects of spectrum refarming.

Sometimes (e.g. France, United States of America), the state plays the role of intermediary by initially financing the fund for re-allocation of old services from the state budget, with subsequent reimbursement of these funds from the new users of refarmed spectrum once they have obtained their frequencies. An intermediary role played by the state makes it possible to increase significantly the speed of refarming process, by making the spectrum available when it is needed for the new entrant. Normally the cost of refarming depends on how fast it takes to replace old equipment and the cost of new equipment. This cost is ultimately levied on the new users of the spectrum.

4.3 Improvements in spectrum licensing and spectrum pricing practices

4.3.1 Transition from station licensing to spectrum rights

The administration of a spectrum rights based licensing system is fundamentally different to that of station licensing (or apparatus licensing). The difference is based primarily on the fact that the spectrum right is issued at the start and this licence covers the operation of all devices under the licence. Station licences on the other hand are issued individually in response to individual applications. In general, spectrum rights would require radio station registration prior to devices being used. Despite the fundamental differences, the radio equipment registration under spectrum rights is often seen as an equivalent to frequency assignment under station licensing.

Radio equipment registration should achieve two objectives: the creation of a record in the AITI database to identify the operation of the device in order to proceed with coordination issues at a detailed level, and the certification that the operation of the device is in accordance with its core and other licence conditions. Certified registration in a public database creates both a technical basis and a clear chain of legal liability for the detailed management of interference by a licensee. Basically, unlike station or apparatus licensing, the responsibility for interference management under spectrum rights rests with the licensee whilst AITI may prepare guidelines for the management of interference.

The experience gained by other telecommunication administrations with spectrum rights licensing regime demonstrates the considerable improvements in the efficiency of spectrum management as the result of its introduction. It was achieved by forcing both regulators and licensees to apply more flexibility on spectrum usage and management while applying additional marketing leverage in the system. In the future, AITI intends to come over to spectrum rights. The indicated transition should be supported by all means. As the matter of assistance to the process pointed out, several practical recommendations are specified below.

According to the concept spectrum rights provide a licensee with access to a portion of spectrum space. The spectrum space is defined usually as the part of spectrum band, geographical area, time and maximum emission levels, accompanied with other licence conditions that control access to the spectrum space (access conditions). Various access conditions may be applied to different licences. The access to spectrum space should be fully defined through negotiations to allow accurate estimate of its economic value and provide certainty especially by minimizing the need for, and cost of, interference management.

The spectrum space may be used for any type of radiocommunication station as long as its emission complies with the conditions of the licence. The access conditions create the so-called buffer zones along both the frequency and area boundaries of the licence that act to reserve the total spectrum space free from encroachment by neighbouring licensees and conversely provide for the protection of devices operated by those neighbouring licensees. Thus, the access conditions are the basis for the design of coordination rules by the licensee to protect their receivers from external interference.

Radiocommunications equipment that operates under spectrum rights and has a high likelihood of causing interference (e.g. high-power devices) should be registered with AITI in order to have usage authorized. An important part of this process is calculation of a device boundary. The device boundary is calculated to check that a nominal geographic area used by its in-band emission fits within the space of the spectrum rights under which it operates.

The device boundary must therefore be located within the geographic area of the spectrum rights. The device boundary is not designed to fully manage interference; it is primarily designed to define the maximum power spectral-density for a transmitter in relation to its location relative to the licence area boundary. Consequently, it informs a neighbouring licensee about what levels of interference their receivers may be subject to. The concept of a device boundary provides a simple facility for establishing agreements between licensees for sharing spectrum space across area boundaries by varying a single parameter to expand or contract the device boundary to provide more or less in-band protection. This approach may assist in HetNet co-ordination. ITU has started the project at the ASEAN level dedicated to this task from 2015.

The next area of possible improvements in licensing practice concerns the urgent need for alignment by means of implementing apparatus (spectrum) licencing. Section 24 (Licencing Requirement) of the Telecommunications (Radio-communications) Regulations, 2013, defines basic requirements for licensing as follows:

“... a radio-communication equipment shall not be possessed, established, installed, maintained, provided or operated by any person otherwise than as authorized by:

- an apparatus (spectrum) licence;
- an apparatus licence; or
- class licence.”

Accordingly, the spectrum rights licensee should be authorized with an apparatus (spectrum) licence. However, spectrum rights holders in Brunei Darussalam are still regulated with station licences. It reduces significantly the flexibility of such a spectrum rights licensee in spectrum utilization and contradicts the concept of spectrum rights licensing. Furthermore, it introduces an element of redundancy with several types of licensing documents. AITI is encouraged to initiate urgently the

transition from station licences to apparatus (spectrum) licences for those operators awarded with spectrum rights.

4.3.2 Technology neutrality framework of spectrum rights

Section 2.4 explains spectrum rights, the flexibility they provide to both the regulator and the licensee, and the importance of technology neutrality. The linkage of the existing spectrum rights with InTi licence calls into question the technology neutral character of the regulatory regime. Section 2.1 of spectrum rights being issued currently contains the following provisions:

“The Grantee shall not use the Assigned Radio Frequency Spectrum for the purposes of operating the Infrastructure described in the Infrastructure Provider for Telecommunication Industry (InTi) Licence unless:

2.1.1.1. the Grantee’s Infrastructure Provider for Telecommunication Industry (InTi) Licence is valid;

2.1.1.2. the Grantee holds a valid apparatus (spectrum) licence for the establishment, installation and operation of radio-communication equipment; ...”

Objectively, the linkage of spectrum rights to InTi licences, which specify the technical aspects of the network, to a certain extent contradicts the idea of operator flexibility to choose or change the radiocommunication equipment assumed by the concept of technology neutrality. In turn, the InTi licence further restricts the targeted flexibility:

“The licensee shall seek AITI’s prior written approval from time to time for any other telecommunications equipment (including any new technology or change in any technology deployed) to be used in the operation of the Infrastructure or which is to be connected to the Infrastructure for which the approval has not been granted under Section 9 of the Order, whether such other equipment is in addition to or intended to replace the existing equipment or parts thereof.”

Since AITI binds spectrum rights with InTi licences, it would be useful to soften the InTi licence by limiting the parameters. This case may apply to allocation of spectrum rights while not affecting other data.

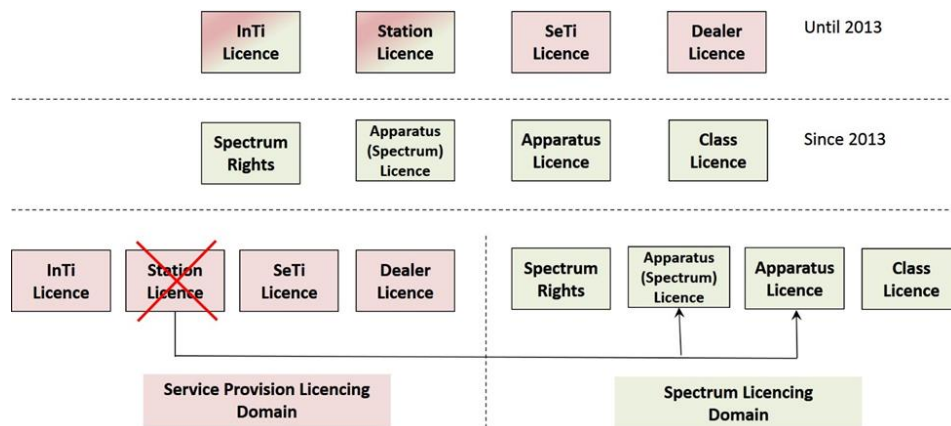
Another key feature of spectrum rights is the sufficiently long fixed and not-renewable period of validity. Usually the terms of spectrum rights licences are from 15 to 20 years providing the licensee with sufficient certainty and time to plan network investment, bearing in mind the ability to change infrastructure with the technology neutral approach.

AITI current licensing practice allows for a 20 year InTi licence validity period and the terms of spectrum rights is 20 years or less according to Telecommunications (Radiocommunication) Regulations, 2013. Another challenge is likely to occur if newly issued spectrum rights overlap with existing InTi licensees issued in the past. AITI needs to provide correlation of the periods of validity of different licences while trying to allow sufficient time to ensure effective application of a technology-neutral approach.

4.3.3 Evolution of licensing scheme

Adoption of the Telecommunications (Radio-communication) Regulations, 2013 has resulted in implementation of innovative tools in spectrum licensing, such as spectrum rights, apparatus (spectrum) licences, class licences etc. These innovative elements have supplemented inherited schemes and has resulted in a mixture of different elements of licensing and corresponding spectrum charging schemes. Figure 4.1 presents the inherited and contemporary licensing regimes and their evolution.

Figure 4.1: Evolution of licensing scheme



Source: ITU

Figure 4.1 distinguishes between spectrum licensing and service provision domains by using different colours. Before 2013, two out of the four elements of the licensing structure were linked to spectrum related issues. In particular InTi licences and station licences contained the essential piece of information on frequency bands and frequency assignments attributed to telecommunication networks, radio installations and individual radio stations (the corresponding structural elements at the figure have two colours gradient).

With the adoption of the Telecommunications (Radio-communication) Regulations, 2013 the dedicated layer of spectrum licensing was inserted in the national licensing scheme by means of implementing spectrum rights, apparatus (spectrum) licences, apparatus licences and class licences. It is clear that parts of traditional licensing elements are cross-correlated to newly established elements. For instance, the spectrum rights licence effectively embeds spectrum related information traditionally included in the InTi licences. Apparatus (spectrum) licences and apparatus licences will incorporate data contained previously in station licences.

Since 2013, AITI has successfully introduced the practice of awarding operators with spectrum rights. However, it issues station licences and not use the apparatus based licensing regime. In the context of spectrum regulation, this makes the national licensing scheme both comprehensive and redundant. In practice, it may affect the efficiency of future telecom players to enter the Brunei Darussalam ICT market.

There is a need for an object-oriented revision of the AITI existing licensing scheme as related to spectrum issues. Undoubtedly, the transition from station to apparatus based licensing should be originated as soon as possible. Station licences should be excluded from the regulatory practice as shown in Figure 4.1 and should be replaced with apparatus and apparatus (spectrum) licences.

AITI is recommended in a rapidly changing radio technology environment to avoid issuing station licences and as far as possible issue the more flexible apparatus (spectrum) licences. AITI should define types of radio technologies potentially suitable to this generalized regulatory regime. Radio applications in cellular mobile networks and VSAT stations are the natural candidates to become the subjects of an apparatus (spectrum) licensing regime.

InTi licences are envisaged in future service licensing regime of AITI. This will duplicate spectrum information in InTi licences and spectrum rights/apparatus licences (illustrated in Figure 4.1) assuming that the full scope of spectrum licensing issues are attributed to the spectrum licensing domain. From this perspective frequency related issues are recommended to be exempted from service provision licence. Another possible advantage of the proposed extract of spectrum context from InTi is organizational by nature. This will distinguish different areas of regulation (spectrum and service provision) between separated institutional units within AITI. As a result, service provision licensing will

be entirely covered by the licensing unit while spectrum licensing will be performed by the spectrum dedicated units.

AITI recognizes the drawbacks described above and has already made an attempt to improve the licensing framework. A public consultation process has been initiated earlier by AITI to simplify the existing licensing structure. Among the other issues, the transition framework was proposed for consultations in 2012 as shown in Figure 4.2.

Figure 4.2: New licensing structure envisaged in the consultations, 2012

PROPOSAL							
Existing Licences		Converged Licensing Structure					
InTi Licence		Network Facilities Licence (Class) or (Individual)	Network Services Licence (Class) or (Individual)	Applications Services Licence (Class) or (Individual)			
SeTi Licence							
Broadcasting Licences							
Dealer Licence (and Dealer Type Approval Certificate)							
Station Licence							

According to preliminary discussed concept AITI envisaged three type of licensed activities and/or the type of licensees:

- Network infrastructure facilities:* This category generally applies to owners/providers of network facilities such as cable systems, satellite earth stations, broadband fibre-optic cables, telecommunication lines and exchanges, radio-communication transmission networks, mobile communications base stations as well as broadcasting transmission towers and equipment.
- Network services:* This category generally applies to entities wishing to provide basic connectivity and bandwidth to support a variety of applications. A network service is generally provided by an entity that is using the infrastructure owned by another licensee.
- Applications services (including content applications services):* This category generally applies to entities that provide particular applications such as voice services, data services, Internet access and electronic commerce.

Later in 2013, AITI reconsidered the licensing structure described above, and retained the essence of the concept to facilitate transition to a unified (converged) licensing regime. AITI intends to migrate InTi, SeTi and broadcasting licences to a unified licence. The new licensing structure is awaiting final approval and publication.

Focusing on the need to simplify the existing licensing framework, AITI is seeking to update licensing schemes to make licensing more flexible and technology neutral. An area of potential contradiction exists in the anticipated content of a future unified licence with the main objective to make it more generalized.

Similar to the existing InTi licences, the template of a future unified licence includes special provisions on technical specifications and network components of operator infrastructure. Technical information anticipated to be included in a unified licence is sufficiently detailed to define infrastructure components rigorously. This fact could have a negative effect on the need for operators to proceed with permanent revision of licences alongside with network evolution. For instance, cellular mobile network operators would be bound to modify their licences while introducing new elements of a radio access network (RAN). Taking into account the regular evolution of network infrastructure, it might lead to numerous updates of licences assuming obvious drawbacks for the operator as well

as unjustified waste in human resources for the regulator. It is therefore recommended that AITI reconsiders the need for the detailed data on network infrastructure envisaged for inclusion in future unified licences.

4.3.4 Alignment of licensing and spectrum pricing

This section outlines the diversity of one-time and recurring fees related to granting service provision licences and operation of radiocommunication equipment.

Telecommunication administrations apply one-time and recurring payments in their licensing process. For example, the most traditional method of licence awarding - beauty contests – assumes that licences are awarded based on a detailed description of the technology and evaluation of how the submissions reflect established criteria. The precondition of a granted licence is the payment of a one-time, fixed licence fee, which can be defined in several ways.

The major method of service licensing in Brunei Darussalam is the ‘beauty contest’ and spectrum authorization is done primarily by issuing station licences. In both cases one-time fees are levied in the form of application/granting fees, namely InTi and SeTi licences granting fees for service authorization and application processing fees for frequency authorization.

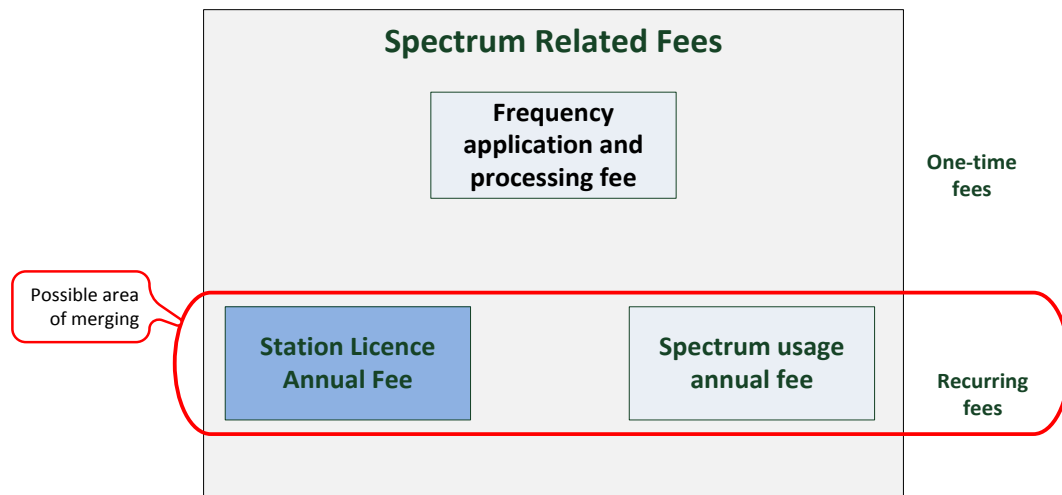
In addition to one-time charges, the regulator imposes other forms of recurring charges or fees to recover administrative costs and to finance specific telecommunication initiatives such as universal service programmes. One of the most widely used approaches to set recurring fees is to base them on a percentage of licensee annual gross revenue (gross turnover). Some deductions from the gross revenue fee basis account for tax payments and other obligations attributed to operators. Revenue-based fees are usually paid annually, after the licensee fiscal year ends. In some instances, a minimum annual payment is made in advance. Such payments are often not refundable if the licensee revenues subsequently fail to generate a percentage that measures up to the minimum it has already paid.

In addition to annual revenue-based levies, some regulators have adopted other cost-recovery mechanisms. The most prevalent form of non-revenue-based fee is a recurring annual licensing fee. This can be of a fixed amount, or it can be adjusted each year to reflect evolution in the regulator costs.

Usually telecommunication administrations are applying either revenue-based (turnover) method or fixed annual licensing fees. The distinguishing feature of the AITI approach is the usage of both methods, e.g. an InTi licensee should pay periodic licence fees for service provisioning (see Table 2.3) representing first category of revenue-based recurring fees as well as station licence annual fees (see Table 2.6) representing the category of cost-recovery recurring fees. This complicates existing pricing and may be reconsidered.

The next challenge discovered by the author of the report is associated to spectrum related prices. The structure of spectrum related fees is shown in Figure 4.3. It is the opinion of the expert that the existing structure presumes a sort of duplication. Annual station licence and spectrum usage fees are similar in essence when dealing with radio-communication stations. The close conformity in nature of both types of fees makes it possible for future merger. The proposed evolution of spectrum related prices is shown in Figure 4.3.

Figure 4.3: Proposed evolution of spectrum related prices



Source: ITU

One-time and recurring licence fees, along with different types of spectrum fees usually serve as funding sources to finance regulatory oversight of the sector. In particular, spectrum management authority requires a number of resources, namely in skilled labour, IT resources, investment in technical monitoring equipment, expenditures to pay for participation in ITU and other international meetings, related directly to frequency regulation. The broad goals and objectives associated with spectrum pricing are focused on recovering costs of the spectrum management authority. This approach is known as the cost-recovery mechanism of spectrum pricing.

Regulators can also deal with spectrum management related costs directly from general revenue (as a part of the annual budget) or by making spectrum licensees or groups of spectrum licensees liable for them on the grounds that such costs are 'caused' by each spectrum licensee. Each spectrum user should then expect a direct cost-based charge when accessing spectrum. Some costs will be common to a band or to a radio service (such as band planning), whereas others will be common to a group of bands and some, such as management overheads, will straddle all licensees.

Spectrum pricing constitutes one of several other sources of AITI revenue. AITI could adjust the existing pricing model specifically to recover spectrum administration costs. However, current spectrum pricing is hardly recovering enough funds to cover current regulator expenditure for spectrum management.

In general money levied from spectrum users may not meet the financial resources required to cover spectrum related costs. To avoid this spectrum pricing methodology should be adjustable by means of variable coefficients (unit prices, band factors etc.) if incoming funds are to recover time-varying costs. Unfortunately, this task seems to be burdening for AITI because unit price and coefficients are included in the main body text of the Telecommunications (Radio-communication) Regulations, 2013. It is understood that targeted or regular revision of this act represents a formal and time-consuming process, and it reduces flexibility of the regulator to make time-sensitive alignment of the spectrum pricing system in a changing environment. Mobile terminal licence fees illustrate this well. With reasonable certainty this fee will be eliminated in the short-term. Consequently, AITI will lose part of its income, but this part can be easily compensated by means of aligning spectrum pricing methodology. As a result of AITI attempts to modify some coefficients in the methodology, the Regulations 2013, should be revised.

4.3.5 Practical recommendations to improve the spectrum pricing regime

Rule-making for spectrum auctions

According to the Telecommunications (Radio-Communications) Regulations, 2013, spectrum rights can be granted based on the results of spectrum auctions. AITI has not used auctions yet partly based on the natural limitations of the telecommunication market. Nevertheless along with the transition of spectrum management to market-based mechanisms, AITI will implement auctions as it awards limited frequency resources to those who value them most. From this perspective, AITI should determine the conditions for auction participation, inter alia, types of auction, advertising of auction, entry fees for participants, methods of payment for allocated spectrum rights.

The details of spectrum auctions still have to be decided. Taking into account the potential interests of existing market players in Brunei Darussalam for spectrum rights enabling implementation of wireless networks, AITI is recommended to develop the corresponding subsidiary legal instruments (code of practice etc.) to identify how the scarce resources can be auctioned. An example text of a regulatory document is in the annex: the Allocation Determination Document – Radiocommunications (Spectrum Licence Allocation—Combinatorial Clock Auction) Determination 2012 – used by the Australian Communications and Media Authority (ACMA) for their licence auctioning in 700 MHz and 2600 MHz spectrum bands for LTE.

The AITI policy on numbering management and domain name allocation may also be looked at from the angle of resource management.

Spectrum pricing related to VSAT stations

There is an urgent need to improve the regulatory regime for satellite telecommunication providers in light of spectrum fees levied. The fixed station licence fee is BND 2 400. The recommendation to AITI is to distinguish pricing regimes for Central Earth Satellite Stations (Hubs) and VSATs. The hubs can be regulated based on the traditional station or new apparatus licence scheme, while it is proposed that VSATs be regulated by means of future apparatus (spectrum) licensing rather than the burdening station licensing and corresponding fees.

Spectrum pricing for cellular operators

Base stations are authorized by awarding operators with station licences accompanied with the corresponding frequency application fees, granting fees and spectrum usage fees. It is clear that cellular operators are developing by adding base stations. This is the prerequisite for maintaining its market position as well as for the required QoS. In turn, QoS is monitored and administrated by AITI. In parallel, the extension of network infrastructure within the allocated spectrum band increases efficiency of spectrum utilization.

It is apparent that a spectrum pricing regime based on station licences contradicts the natural inclination of cellular operator to provide services of the required quality to the highest possible number of customers. Spectrum pricing regimes should establish incentives to maximize frequency resource efficiency.

On the other hand, it is also clear that base stations could not be excluded from the authorization regime due to the need to make an expertise of frequency assignments in the process of cross-border coordination, and to administrative reasons noted by AITI. A possible compromise can be found based in the form of a new regulatory regime focused on charging cellular operators not for station licences but for bandwidth allocated to the operator. The fees levied for frequency application and processing should be maintained.

Mobile terminal fees

Mobile terminals in Brunei Darussalam are charged on a per SIM card basis. This charge is imposed on mobile subscribers and is collected by operators on behalf of AITI. It does not lend any impetus for the market or have any other incentives from a regulatory point of view. Mobile terminal fees may, however, have negative effects on market development and AITI is recommended to modify licensing frameworks to avoid this type of levy being imposed on subscribers.

4.4 Spectrum management strategy

AITI is trying to identify a framework to develop a strategy for spectrum management in Brunei Darussalam. A spectrum management strategy is a valuable contribution to strengthen the national regulatory background in radio communications and will facilitate implementation of innovative technologies requiring spectrum resources.

In order to assist AITI to create a national spectrum management strategy this section summarizes the results of initiatives from other telecommunication administrations and is background information when drafting the spectrum management strategy. AITI should take into account its role, statutory objectives, all relevant obligations as well the development of ICT market that will impact national spectrum policies in due course. The aim of spectrum management strategy is to guarantee that Brunei Darussalam derives the maximum economic, strategic, and social benefits from the use of the radio spectrum.

- I. AITI current and future role in spectrum management:** This part of the strategy should incorporate the information on the methods to drive consumer choice and access through efficient management and use of the national radio frequency spectrum. The role of radio spectrum in meeting national needs for a universal telecommunications service should also be considered. In order to encourage competition AITI should establish the framework ensuring efficient release of radio spectrum using technology and service neutral mechanisms as well as ensuring flexible access and management of resources. Through this practice AITI should guarantee that spectrum is used to promote competition and not to restrict or distort competition.

In broad terms, the first part of the strategy should define the ways for AITI to be an effective, innovative and adaptable organisation with the appropriate systems, structures and skills for effective spectrum management to ensure its continuous performance improvement and best practice through benchmarking against international standards with regard to spectrum management processes and procedures. It should also include the provisions for AITI to become the recognised centre of excellence playing its full part in shaping the development of a competitive communications industry, driving access and investment in high-speed broadband networks through cross-platform competition and promoting innovation by providing a predictable regulatory framework.

- II. Encouraging economical contribution of spectrum management:** It is necessary for AITI to assess the economic contribution made by the use of radio spectrum to the economy and to plan for this contribution in the short-, medium-, and long-term.

Special attention should be given to issues relating to spectrum management practices in promoting competition, contributing to the development of internal markets, promoting the interests of citizens, enhancing competitiveness by ensuring that adequate spectrum is allocated and assigned to add the most value to society.

- III. AITI position on certain current spectrum management issues:** This part of the strategy should define the AITI position on existing and future spectrum licences awarding procedures. It is recommended that AITI should not favour any specific approach for awarding spectrum rights, but to consider each award on its merits. In all cases, the selection criteria must be objective, transparent, non-discriminatory, proportionate, and consistent with AITI statutory objectives and duties. In making such an assessment AITI should balance the size and scale of the market, public

policy considerations, social considerations, economic and market considerations, legal factors and, where relevant, expected demand and use in order to determine the most appropriate allocation method to deliver an efficient allocation outcome.

Among the other issues for inclusion in this part of the strategy, technology/service neutral regulation and spectrum trading are suggested. It should be noted that spectrum trading is an important right that spectrum rights holders should have. It should, in many circumstances, lead to market-based exchanges that increase the welfare not just of the trading parties but society generally.

On the other hand, a spectrum trading regime will need to ensure that spectrum rights do not become concentrated in too few hands such that competition would be restricted to a significant extent or otherwise foreclosed. AITI should carefully study technology/service neutral regulation and spectrum trading as soon as both of them are becoming widely implemented worldwide. The market and regulation development should take into account the applicability of these issues in Brunei Darussalam.

IV. Short-term spectrum management initiatives: This section lists tasks in spectrum management under the current AITI agenda or for resolution in the short-term (1 to 3 years):

- Consider approaches to the future use of the 800 MHz band and digital dividend in 700 MHz band, initiate the corresponding consultation process with parties concerned.
- Initiate the decision making process relevant to broad implementation of technology neutral regulation in Brunei Darussalam, possible implementation of UMTS900 or LTE 900 technologies as the first step of technology neutral regulation.
- The urgent transition from analogue TV and the rollout of Digital Terrestrial Television in Ultra High Frequency (UHF) bands IV and V below 694 MHz and the switch-off of analogue television transmissions.
- Consider the utilization of new higher spectrum ranges for fixed links to meet market demand.
- Carry out a review of the current usage of 3.6 GHz, 10.5 GHz and 26 GHz frequency bands.
- Consider approaches to the future use of 2500 – 2690 MHz band taking into account the rights of current licensees as well as the worldwide deployment of IMT based networks in this band (3GPP Band 7).
- Carry out consultation on technical and spectrum release options relating to 2300 – 2400 MHz band.
- Carry out consultation on future use of 1900 – 1920 MHz and 2010 – 2025 MHz frequency bands.
- Consider approaches to the future use of 5G oriented spectrum bands, e.g. 27.5 – 29.5 MHz band.

V. Strategy for spectrum usage by different radio services: The details relevant to the usage of applications within the particular Radio Services could be included in this section of future strategy. Radio spectrum is available for the provision of a variety of communications services and networks. These include radio transmission networks, public access services (such as mobile telephony and broadband access networks), broadcast networks as well as radio navigation systems, business radio, amateur radio, consumer products and equipment used in industry, medicine and commerce. In addition, the nature of the spectrum means that certain parts of the spectrum are more suitable for some purposes than others. This section could contain details of the AITI spectrum management strategy for each radio service. The proposed subjects for establishing strategy are:

- public mobile services;
- trunked mobile services;
- wireless broadband services;

- broadcasting services;
- terrestrial fixed services;
- licence-exempt services;
- short range devices;
- satellite services;
- aeronautical services;
- amateur services;
- scientific services.

VI. Medium and long term spectrum management initiatives: It is clear that the demand for spectrum will continue to increase and that AITI must continue to ensure spectrum is an enabler and not a constraint on service provision. In this context AITI should take into account the emerging trends and developments that will have a longer term impact on spectrum management strategy. There are three important issues for medium- and long-term spectrum usage initiatives AITI should define its position on:

- 1 Cognitive technology: This is an exciting development, particularly when applied to radiocommunications as it has the potential to deliver significant efficiency gains in the management and use of the radio spectrum. The technology holds the promise of more intelligent radios able to sense the local radio environment and, on the basis of that information, including data on the rules to be obeyed (technical operating parameters, etc.) to make a decision on which frequencies to use, when to transmit and other characteristics, such as filter shaping, to be used.
- 2 Digital dividend: This is the next medium term spectrum initiative currently under discussion. It is the next step in releasing lower spectrum bands for IMT-based networks. AITI should follow the ITU and regional discussions of this issue as it will provide essential spectrum resources to future wireless broadband applications in 700 MHz and bands below 694 MHz.
- 3 Convergence: With the convergence of fixed, broadcasting and mobile services over digital wireless platforms, a regulatory approach promoting flexible use of spectrum is increasingly important. Several countries that initially considered the 1452 - 1492 MHz band (L-Band) for DAB services have recently begun to reconsider use of the spectrum for a range of broadcasting and multimedia applications within the international regulations and allocations. AITI is recommended to define its position on this issue, as it could become the next essential spectrum asset for wireless broadband systems.

5 Finding and conclusions

5.1 Institutional aspects and strategy

The converged regulatory institution

AITI is actively involved in the ongoing process of merging regulatory responsibilities in both telecommunication and broadcasting areas within a single converged authority. The existing telecommunication and broadcasting primary legislation are at the final stages of the approval process.

In this respect AITI complies with current trends. Similar to independent regulators in other countries AITI seeks to incorporate both telecommunication and broadcasting technical administrative practices in the converged entity. In practice, even though administratively AITI has embedded telecommunication and broadcasting regulatory issues, its legal basis has not yet been finalized. This

process should be promoted as much as possible, as it will become the prerequisite to the successful introduction of new approaches in spectrum management. Simultaneously it will facilitate effective implementation of innovative converged radio technologies and services.

The existing national legal acts are at their final stage of approval. The content of the amended acts would update administrative functions vested in AITI. The updated terms of responsibilities of AITI has been included into the list of regulatory acts to be adopted.

Actions to be taken

It is recommended that AITI finalizes corresponding organization and human capacity changes to comply with new responsibilities.

Technical and spectrum management strategies

It is highly advisable for AITI to decide on and to establish the technical strategies for the designated radio services and radio technologies (e.g. broadband mobile strategy). This would assist frequency managers to define spectrum resources to facilitate most efficient implementation of up-to-date technologies.

The AITI spectrum planning unit may consider establishing a strategy for spectrum management. It is anticipated that such a strategy would include the most significant provisions for medium-term and long-term technical aspects necessary to satisfy ICT demand in frequency resources (radio technologies). The most contemporary regulatory regime for spectrum management could become another subject of this future spectrum management strategy.

Actions to be taken

The issue of spectrum demands in Brunei Darussalam for future technologies in different radio services should be further studied, and technical strategies as well as a spectrum management strategy could be developed based on the results.

Working methods to develop spectrum strategy

Bearing in mind the need to identify medium and long-term requirements for spectrum resources by different radio technologies in Brunei Darussalam, AITI should apply suitable working methods to seek appropriate data, such as forecasting of service demands provided by wireless technologies and expressed in quantitative indicators (traffic, data rates, networks capacity, programmes capacity, customer base gain etc.). Most of these indicators are the subject of planning inherent to major market players. The working methods of spectrum strategy development should establish communication with stakeholders aimed at obtaining the key indicators. The statistics collected by AITI from the market on a regular basis is the next valuable source of information that should be used for approximations.

Actions to be taken

It is recommended that AITI develop working methods of collecting data related to major market player estimations of future demands in their services. This can be achieved by means of task-oriented communication with stakeholders (questionnaires, public consultation etc.).

Structural aspects

The spectrum planning and frequency assignment units are involved in planning and handling the intensive application flow within AITI. The frequency assignment unit is composed of four staff officers. The comparison of the list of responsibilities and examinations imposed on spectrum planning and frequency assignment units of AITI with the number of staff involved in the workflows provides evidence of the urgent requirement for the available staff to be increased.

The frequency assignment unit staff is not attributed to particular radio technologies, which may result in a scattering of competences. To concentrate staff skills and experience, AITI may distribute responsibilities between staff based on radio services.

Actions to be taken

AITI should increase staff of frequency assignment and spectrum planning units with respect to radio services.

5.2 Primary and subsidiary legislation

Legal provisions on limited spectrum resources

The existing primary and subordinate legislation of Brunei Darussalam do not include provisions on estimation of spectrum limitations or rules to assess demand for limited spectrum resources. In practical terms, limited spectrum associated with particular types of radio technologies launches market-based mechanisms of awarding these resources (auctions etc.).

Actions to be taken

It is quite possible that along with implementation of high spectrum consuming technologies, amendments to legislation corresponding to limited spectrum resources would become a vital issue in the short term.

Further improvements to the National Frequency Allocation Table

The NFAT of Brunei Darussalam can be supplemented with information on current and future spectrum utilization as well as with references to standards and rules of utilization. The primary legislation should include provisions on NFAT amendment including timelines of amendment.

Actions to be taken

The NFAT of Brunei Darussalam needs to include details on spectrum band utilization and the primary legislation need to include details on NFAT periodic modification.

Subsidiary legislation development plan

The Telecommunications (Radio-Communications) Regulations, 2013 complies with the requirements of ICT market development in Brunei Darussalam. This legal act embraces the majority of the spectrum management concepts and principles recommended by ITU.

The Telecommunications (Radio-Communications) Regulations, 2013 incorporates provisions establishing the basis for secondary legislation in spectrum management. These provisions deal with future implementation, such as spectrum auctions, spectrum trading etc., and require separate subordinate regulations for short- and medium-term implementation. A time-plan to develop subsidiary legal instruments is also required.

Actions to be taken

AITI spectrum management team should perform detailed analysis of the required subsidiary legal instruments arising from the Telecommunications (Radio-Communications) Regulations, 2013 and approve the time-table of their development.

As a matter of urgency, AITI should establish subordinate legislation (presumably in the form of codes of practice) dealing with mechanisms of conversion and marketing spectrum plans, guidelines for auction rules and proceedings, and spectrum trading.

Rulemaking for spectrum auctions

According to the Telecommunications (Radio-Communications) Regulations, 2013, the spectrum rights in Brunei Darussalam can be granted based on the results of spectrum auctions. AITI should determine the conditions for participation in the auction, inter alia, types of auction, advertising of auction, entry fees for participants, and methods of payment for allocated spectrum rights.

The issue of defining the details of spectrum auctions still have to be decided on. Taking into account the potential interests of existing market players for spectrum rights, AITI is recommended to develop the corresponding subsidiary legal instruments to identify how the resources are to be auctioned.

Actions to be taken

As the matter of urgency, the subsidiary legislation that specifies procedures to allocate spectrum rights by auction, needs to be developed. Policy on numbering management and domain name allocations may also be looked at from the angle of resource management.

5.3 Licensing

Unified licensing regimes

AITI recognises that the emergence and development of new and existing services are expected to expand the ICT sector. To promote well-proven regulatory approaches towards the converged communications sectors and eliminate regulatory barriers to the efficient development of sectors, AITI proposes to streamline the existing licensing categories by implementing a unified licensing framework. AITI will undertake additional consultations on the introduction of a competition code for the converged communications sector, and legislative amendments to accommodate the converged regulatory framework and licence pricing.

Actions to be taken

AITI is encouraged to establish a new service provision licensing regime and competition code, and to draw the special attention in this process to the potential consequences associated with spectrum licensing, as it should not hamper implementation of innovative flexible spectrum licensing practices (e.g. spectrum rights).

Implementation of the technology-neutral regulation

For the time being, the regulation applied by AITI is effectively migrating to technology neutral regime. Taking into account the transition to innovative unified (converged) service provision licensing regime and market-based spectrum licensing by means of spectrum rights and apparatus-based licensing, the InTi licences might be softened in terms of technical/network specifications. The detailed infrastructure/spectrum content of future unified InTi licences seems to be unreasonably superfluous and may result in staff overloading and application delays. Further provisions related to technology neutrality should be incorporated in the existing subsidiary legislative instruments.

Actions to be taken

AITI is encouraged to identify the licensing policy/subsidiary legislative instruments that require amendments in view of technology neutral regulation, and to reconsider the need to include the detailed information on technical and spectrum specifications envisaged for the new converged licence.

The current 20 year period of validity of InTi licences in Brunei Darussalam should be aligned with the validity period of spectrum rights in case the issued spectrum rights overlaps with existing InTi

licences. The licence period can be increased based on the demand for services, and technology related operational life cycle.

Transition from station licensing regime to spectrum rights

AITI recognises the benefits of an innovative regulatory regime based on spectrum rights. The spectrum rights licensing provides considerable improvement in the efficiency of spectrum management by forcing both regulators and licensees to apply more flexibility on spectrum usage and management while introducing additional marketing approaches in the system. AITI intends to proceed with spectrum rights.

Actions to be taken

The transition from station based licensing to spectrum rights regulatory regime should be supported by all means. AITI should apply the new approach for spectrum bands that will be allocated in the short term.

Implementation of apparatus (spectrum) and apparatus licences

Requirements related to radio equipment are included in both the InTi licences and station licences. This duplication leads to additional processing by AITI staff. Some technologies (mobile networks, VSAT networks etc.) require annual reissuing of licences, becoming an additional burdening factor.

Actions to be taken

AITI needs to distinguish between those radio technologies that require station licences (in the form of apparatus licences) and those that need to be managed under the apparatus (spectrum) licensing regime. AITI should then make the transition to apparatus (spectrum) licensing for technologies using station licences, which should be abandoned in the short-term.

AITI may implement frequency related authorization based on registration of radio stations and launching of those stations based on confirmation of frequency assignments and corresponding parameters.

Elimination of redundancy with dealer licences

Currently AITI issues separate dealer licences to different applicants requesting licences for the same type of equipment. This process seems to be superfluous for type approved equipment.

Actions to be taken

AITI is kindly requested to avoid duplication of dealer licences awarded based on the same type approved equipment.

Introduction of class licences

The Telecommunications (Radio-communications) Regulations, 2013 specify class licences that reflect best practice, where the corresponding provisions establish a reliable basis for this licensing regime.

Actions to be taken

AITI should introduce a class licensing regime, and should examine further opportunities for class licences where a high administrative efficiency exists and where risks of interference are low or acceptable.

5.4 Spectrum planning

Spectrum reallocation and refarming

There is an urgent need for AITI to establish legislation and practices corresponding to spectrum re-allocation and spectrum refarming processes. Certain spectrum bands are unavailable for the implementation of new valuable radio technologies due to incumbent use. The 400 MHz spectrum

range, for example, demonstrates the increased demand for trunked radio systems and the 2500 – 2690 MHz spectrum band for LTE networks.

The re-allocation/refarming fund might become the working mechanism. Part of the revenue earned by AITI may be used as the financial resource to deposit in the spectrum reallocation fund. Funding resources transferred as reimbursement accruing from the reallocation process can be compensated from released spectrum band auctioning contributions. Universal services contributions may constitute an additional source of funds.

Actions to be taken

AITI should develop legislation that embraces spectrum re-allocation/refarming, as well as guidance for practical implementation of the process, taking into account the existing legal basis to assess the applicability of the concept of spectrum re-allocation fund in Brunei Darussalam. A code of practice should be drafted to help establish a spectrum refarming fund including the rules of contribution/expenditure of the fund.

Simplification of frequency assignment process for fixed service

The frequency assignment process for microwave links could be simplified. AITI staff could use frequency arrangements for fixed service from ITU-R Recommendations based on allocating spectrum blocks to major market players. This will release AITI resources and provide operators with flexibility in their frequency planning. AITI should also remain responsible for issues related to border coordination.

Actions to be taken

AITI may consider implementation of band blocks assignments primarily for spectrum ranges above 15 GHz that are not yet heavily used in Brunei Darussalam.

Optimization of 7 GHz fixed service spectrum band

There is an extremely high stakeholder demand in the 7 GHz spectrum band, which is historically densely utilized by the fixed radio service applications in Brunei Darussalam. Unfortunately, this demand embraced applications of different types, occasionally with the lack of justification for the utilization of point-to-point links with intolerably short connections with nearby stations (hops).

Actions to be taken

AITI may consider rearranging the existing usage of the band based on the criteria that short connections should be avoided. It may require elements of spectrum optimization. The process should be under the supervision of the frequency assignment unit.

Temporary spectrum usage.

If AITI is under significant time pressure, the temporary regulatory regime may assist significantly to accomplish the frequency assignment procedure in the most effective way.

Actions to be taken

It is advisable to develop an exclusive frequency assignment regime for temporary spectrum usage to respond to extraordinary/incidental events. The possibility of waiving spectrum fees should also be envisaged.

5.5 Spectrum fees

Technology-neutrality vis-à-vis spectrum fees

While implementing technology neutrality, AITI should encourage the introduction of recent radio technologies in the spectrum bands utilized by incumbent technologies. In fact, migration will take

place in the bands that have been authorized under the old regulatory regime (pre-spectrum rights). This will result in the same charging policy applied to new technology and incumbent technology, offering few incentives to implement innovative radio technologies.

Actions to be taken

AITI should use best practice when issuing spectrum rights for new radio technologies. Charges applied to innovative radio technologies should be low compared to old radio technologies that are being phased out.

Cost-recovery concept of spectrum pricing

For the time being spectrum pricing does not correlate with current AITI expenditure, and there is uncertainty in validating amounts levied from spectrum users. The unit price is included in the subsidiary legal act (Telecommunications (Radio-communications) Regulations, 2013). The regulator has less flexibility in a changing environment to make time-sensitive alignments to the spectrum pricing system.

Actions to be taken

AITI may adjust the existing pricing model in order to imply the cost-recovery approach. The unit price is recommended to be extracted from the main body of the subsidiary legislation in order to provide AITI with flexibility to update spectrum pricing practices based on market/regulation evolution.

Administrative and spectrum fees

To make the existing spectrum fees methodology more attractive, AITI is advised to consider inclusion of coefficients attributed to the type of technology. New technologies should be charged less compared to those being phased out. The coefficients should apply in such a way as to facilitate technology turnover.

Actions to be taken

AITI should consider including a technology type increasing/decreasing coefficient and to amend the pricing methodology. This can be accomplished as an element within a set of other incentives related to the social obligations of spectrum users.

5.6 Radio monitoring

Specification for the fixed radio monitoring stations

The existing radio monitoring system in Brunei Darussalam does not include fixed and remote radio monitoring stations. Measurements are generally executed by means of portable equipment and vessel-based equipment. AITI needs to purchase equipment and deploy fixed radio monitoring station.

Actions to be taken

AITI need to specify the fixed radio monitoring station equipment requirements to initiate the purchasing process.

Spectrum monitoring and spectrum management data exchange

To enable optimum utilization of the frequency spectrum as a limited resource, it is important that spectrum monitoring and spectrum management systems exchange data with each other. The open interface should allow integration of radio monitoring equipment with other spectrum management software.

Actions to be taken

While specifying the requirements for fixed and mobile radio monitoring stations, AITI is recommended to envisage applications to convert the format of measured data into the format used by the spectrum

planning software and database. The open architecture of radio monitoring equipment will strongly assist integration of measurement results into the database for further processing.

5.7 Regulatory practices

Future spectrum bands to be licensed

Mobile market development scenario based on 40 per cent annual traffic growth and 10 per cent infrastructure growth suggests that AITI will suffer spectrum shortage up to 300 MHz. Consequently, AITI will be encouraged to licence additional spectrum bands for mobile broadband networks, possibly within three years. The 800 MHz LTE band may then be licenced close to 2018, followed by the 700 MHz LTE band in 2022.

Actions to be taken

AITI should be wary of monitoring statistical data on actual network capacity in order to make time-sensitive decisions on awarding additional spectrum resources. Technology neutral regulatory mechanisms should enable operators to handle seamless and effective transition to new highly spectrum efficient technologies.

25 Quality of service

AITI regulates quality of service by collecting data from operators. It recognizes the insufficient regulatory tools to influence operators to provide data and suffers from a lack of test equipment.

Actions to be taken

AITI is recommended to employ an independent third party to be responsible for collecting measurement data. In order to streamline the process of quality of service management, essential minimum requirements and a concise list of parameters need to be agreed.

Annex 1: Spectrum management master plan

Short Term (1-3 years)			
No	Definition	Implementation Area	Actions to be taken
1	ICT and broadcasting converged regulation	Institutional	AITI is recommended to finalize corresponding organizational and human capacity changes to comply with new merged responsibilities.
2	Inclusion of technology neutrality within subsidiary legislation	Subsidiary legislation	Identifying the licensing policy/subsidiary legislative instruments requiring amendments in view of technology neutral regulation.
3	Urgent subsidiary legislation	Subsidiary legislation	As the matter of urgency, AITI should establish subordinate legislation (presumably in the form of codes of practices) dealing with mechanisms of conversion and marketing spectrum plans, guidelines for proceeding with auctions, the rules and spectrum trading.
4	Working methods to develop spectrum strategy	Spectrum strategy	AITI is advised to develop the working methods of collecting data related to the major market players' estimations of future demands in their services. This can be achieved by means of task-oriented communication with the stakeholders (questionnaires, public consultation etc.).
5	Spectrum class licences	Spectrum licensing	AITI should introduce class licensing regime in its permanent practice. To accomplish this task AITI should examine further opportunities for class licences where there is the administrative efficiency and where the risks of interference are low or acceptable.
6	Spectrum monitoring fixed station	Spectrum monitoring	AITI is kindly requested to specify the requirements for the equipment of the fixed radio monitoring station. The appropriate specifications should be developed in order to initiate purchasing process.
7	Simplification of frequency assignment for fixed service	Spectrum engineering	AITI may consider implementation of band blocks assignments primarily for the spectrum ranges above 15 GHz which are not heavily used in Brunei Darussalam for the time being.

Medium Term (3-5 years)			
No	Definition	Implementation Area	Actions to be taken
1	Unified licencing regime	Licencing	New service provision licensing regime and code of competition are encouraged to be established. AITI is requested to draw the special attention in this process to potential consequences associated with spectrum licensing as it should not hamper implementation of innovative flexible spectrum licensing practices (e.g. spectrum rights).

Medium Term (3-5 years)			
No	Definition	Implementation Area	Actions to be taken
2	Unified converged licence	Service provision licencing	The detailed infrastructure/spectrum content of new InTi licences seem to be unreasonably superfluous that may result in staff overloading and delay with applications handling. AITI is encouraged to reconsider the need to include the detailed information on technical and spectrum specifications envisaged for the new converged licence.
3	Alignment of current InTi licences with spectrum rights	Licencing	Current 20 years for the period of validity of InTi licences in Brunei Darussalam should be aligned with the validity period of spectrum rights in case the issued spectrum rights touches upon the existing InTi licence. The licence period can be expanded based on the demand/technology.
4	Time-plan for establishment of subsidiary legislation	Subsidiary legislation	The spectrum management team of AITI should make the detailed analysis of the required subsidiary legal instruments arising from the Telecommunications (Radio-Communications) Regulations and approve the time-plan of their development.
5	Technical and spectrum strategy	Strategy	The issue of spectrum demands in Brunei Darussalam for future technologies in different Radio Services should be further studied. Technical strategies as well as spectrum management strategy could be developed based on the results of the aforementioned studies.
6	Managing spectrum reallocation and refarming processes	Spectrum reallocation/ refarming	To develop the legislation embracing the spectrum reallocation/refarming aspects as well as guidance for the practical implementation of the process. Taking into account the existing legal basis to assess the applicability of the concept of spectrum reallocation fund in Brunei Darussalam. To develop draft Code of Practice on establishment of spectrum refarming fund and the rules of contribution/expenditure of the fund.
7	Additional spectrum bands for licencing	Regulatory practices	AITI is recommended to licence additional spectrum bands for the mobile broadband networks already in 3 years perspective. Presumably 800 MHz LTE band can be licenced closer to 2018, following with 700 MHz LTE band to be licenced around 2022.
8	Temporary spectrum usage regime	Spectrum licencing	It is advisable to develop the exclusive frequency assignment regime for the temporary spectrum usage in cases of extraordinary/incidental events. The potential of exclusion from stipulated spectrum fees should also be envisaged for aforementioned events. While specifying the requirements for radio monitoring fixed and mobile stations AITI is recommended to envisage applications to convert the format of measured data into the format used by spectrum planning software and database.

Medium Term (3-5 years)			
No	Definition	Implementation Area	Actions to be taken
9	Amendment of NFAT	Spectrum planning	To consider the need for extending NFAT to include details on spectrum bands utilization. To include provisions into primary legal acts on NFAT periodic modification.
10	Transition from station licences to apparatus (spectrum) and apparatus licences	Spectrum licencing	AITI is kindly requested to distinguish radio technologies still requiring station licences in the form of apparatus licences and those able to be managed under apparatus (spectrum) licensing regime. As the matter of urgency with respect to the chosen technologies AITI should transit to apparatus (spectrum) licensing. For these technologies the practice of Station Licences should be abandoned in the short term. Instead AITI may implement frequency related authorization based on registration of radio stations and launching of those stations based on confirmation on frequency assignments and parameters from AITI.

Long Term (5-10 years)			
No	Definition	Implementation Area	Actions to be taken
1	Cost-recovering financial model	Administrative fees	AITI may adjust the existing pricing model in order to imply the cost-recovery approach.
2	Spectrum fees versus technology neutrality	Spectrum fees	Implementation of new technology should require new spectrum rights. It is highly advisable that charges applied to newly implementing radio technologies should stay reasonably lower compared to the old technologies subject to be phased out. AITI should use the best practice.
3	Transition to spectrum rights regulatory regime	Spectrum licencing	The transition from station based licensing to spectrum rights regulatory regime should be supported by all means. AITI is requested to apply the new approach for the spectrum bands that are envisaged to be allocated in the short term.
4	Extension and professional orientation of the staff	Institutional	It is the expert's opinion that AITI should increase personnel capacity of Frequency Assignment (FA) and Spectrum planning (SPN) units while differentiating staff with respect to Radio Services.
5	fixed service in 7 GHz optimization	Spectrum engineering	AITI may consider the need for rearranging the existing usage of the band based on the criteria that short connection should be avoided at maximum extent possible. It may require elements of spectrum redeployment. The process should be done under the supervision of Frequency Assignment unit.
6	Essential requirements for QoS	QoS	To consider imposing of technical duties on collecting measurement data to independent third party. In order to streamline the process of QoS management – to define essential minimum requirement for the agreed concise list of parameters

Annex 2: Proposals on the modification of radio monitoring country-wide system for Brunei Darussalam

(Based on typical technical decisions of ROHDE&SCHWARZ Company)

Composition of the System

- Operating and Control Centre: 1
- Unmanned and remote-controlled radio monitoring test points: 6-8
- Unmanned and remote-controlled direction finders test points: 3-4
- Mobile direction finding and monitoring unit: 1-2
- Portable monitoring units: 2-3
- Technology oriented (GSM, UMTS, LTE, DVB etc.) monitoring kits: 2-3

Ten to fifteen skilled personal are required to provide due maintenance of the equipment listed above.

System capabilities	
Radio monitoring tasks	Frequency band from 10 kHz to 26.5 GHz
Technical analysis (standard measurements)	Frequency band from 10 kHz to 7.5 GHz (Unmanned and remote-controlled radio monitoring test points)
Technical analysis (difficult cases)	Frequency band from 20 MHz to 26.5 GHz (Unmanned and remote-controlled direction finders test points)
Technical analysis (critical cases)	Frequency band from 10 kHz to 26.5 GHz (Mobile direction finding and monitoring unit)
Technical analysis for the particular technologies (GSM, TETRA, UMTS, LTE, DVB etc.)	Within the frequency ranges of the equipment
Direction finding (synchronized)	0.5 MHz – 6 GHz
Direction finding (level of the signal)	10 kHz – 26.5 GHz

Operational and control centre

Operational and control centre is located in the capital of the country. In order to accommodate the equipment the office space is required to provide enough place for four to six computer work stations. The specialized software ARGUS is used to manage radio monitoring devices incorporated in the system. ARGUS software allows spectrum monitoring and spectrum management systems to exchange data with each other. ARGUS provides an open interface with the small application to convert its format into the specific format of the spectrum management database.

The number of work stations and their functions within the operational and control centre:

- Work station 1 – management and control of unmanned radio monitoring test points
- Work Station 2 – management and control of unmanned direction finders and monitoring test points
- Work Station 3 – technical analysis and data processing
- Work Station 4 – critical or operational management point
- Work Station 5 – backup working place

- Working Station 6 – backup working place

Major features of Operational and Control Centre:

- Data processing and analysis of the existing spectrum usage situation.
- Establishment and modification of the management plan for monitoring equipment.
- Establishment of the reports on the current spectrum usage.
- Establishment of critical commands for crisis situations.
- Management of the critical commands for monitoring devices and system.

Unmanned and remote-controlled radio monitoring test points

Unmanned and remote-controlled radio monitoring test points are the major sets of devices for the permanent planned measurements and identification of the harmful interference. These test points are usually used for the planned measurements. Within the planned measurement mode the interface between the test points and Operational Centre is provided by the telemetry sessions subject to accumulation of the required data or extraordinary sessions subject to emergency situation.

Unmanned and remote-controlled radio monitoring test points do not require dedicated rooms as the test points are able to be installed at the roofs of the buildings or masts.

Unmanned and remote-controlled radio monitoring test points may be supplied for the standard frequency range (20 MHz – 3 GHz) or for the extended frequency range (10 kHz up to 6 GHz). The proportion of test points with standard or extended frequency ranges is defined based on the local spectrum usage conditions.

Unmanned and remote-controlled radio monitoring test points provide the following measurements:

- Carrier frequency and carrier offset from the assigned value.
- Signal field strength level.
- Signal bandwidth.
- Signal to noise ratio, occupancy of the frequency channel.
- Uploading and saving of audio data and spectrum diagrams.
- Under operator control the list of measurements and controlled parameters can be expanded.

EM and UMS series measuring and radio monitoring equipment is used as the technical basis for the unmanned and remote-controlled radio monitoring test points. ARGUS software is the managing software tool.

Set of direction finding and measuring test points (unmanned and operator-controlled)

Set of direction finding and measuring test points (unmanned and operator-controlled) is the major source of planned measurements requiring direction finding and more sophisticated data from the measurements. These test points are installed in the capital and in the major provinces centres.

Direction finding and measuring test points may be supplied for the standard frequency range (20 MHz – 3.6 GHz) or for the extended frequency range (10 kHz up to 26.6 GHz). The proportion of test points with standard or extended frequency ranges is defined based on the local spectrum usage conditions. Direction finding and measuring test points (unmanned and operator-controlled) do require the special equipment room 4- 6 sq. meters.

Measuring devices of ESMD and DDF series are used as the technical basis for direction finding and measuring test points. ARGUS software is the managing software tool.

Mobile direction finding and monitoring units (and auxiliary equipment)

The group of mobile direction finding and monitoring units is the major instrument to proceed with unplanned or emergency tasks of radio monitoring requiring the features of direction finding (on the move) and more sophisticated measurements or any other business in the mobile mode (e. g. estimation of the coverage of the terrestrial stations).

The equipment is installed on board of different vehicles.

Mobile direction finding and monitoring equipment is equivalent to the equipment of direction finding with the extended frequency range. Additionally the mobile direction finding and monitoring kit includes the equipment for the technical analysis of the particular radio technologies (GSM, TETRA, DVB, etc.).

Serially manufactured measuring devices PR-100, ETL and TSMW are recommended to be used as the portable measuring and analysis devices.

Indicative time for training of the specialists.

- Specialist on portable measuring devices – up to 5 days.
- Specialist on the mobile direction finding and measuring devices – up to 10 days.
- Specialist on measurements of sound/TV broadcasting signals – up to 5 days.
- Specialist on measurements in the digital land mobile networks – up to 5 days.
- Specialist on the maintenance of stationary unmanned direction finding and measuring test points – up to 10 days.
- Specialist on analysis and data processing – up to 15 days.
- Specialist on planning and automatic management of radio monitoring – up to 15 days.

Abbreviations

Term	Definition
3G	Third Generation Mobile, e. g. UMTS/IMT-2000
AITI	Authority for Info-Communications Technology Industry of Brunei Darussalam
APG	APT Conference Preparatory Group for World Radiocommunication Conference
APT	Asia-Pacific Telecommunity
ASEAN	Association of Southeast Asian Nations
BS	Broadcasting Service
BTS	Base Transceiver Station
CEPT	European Conference of Postal and Telecommunications Administrations
DTT	Digital Terrestrial Television
ECA	European Common Allocation Table
ECO	European Communication Office
EMC	Electro Magnetic Compatibility
EMR	Electro Magnetic Radiation
ETSI	European Telecommunications Standardization Institute
FACSMAB	Frequency Assignment and Coordination, Singapore, Malaysia and Brunei Darussalam
FS	Fixed Service
FSS	Fixed Satellite Service
GDP	Gross Domestic Product
GMDSS	Global Maritime Distress and Safety System
ICT	Information and Communications Technologies
InTi	Infrastructure Provider for Telecommunications Industry Licence
ISDN	Integrated Services Digital Network
MSIP	Ministry of Science, ICT and Future Planning of Republic of Korea
NFAT	National Frequency Allocation Table
PMR	Private Mobile Radio
RSM	Radio Spectrum Monitoring
SeTi	Service Provider for the Telecommunications Industry Licence
SM	Spectrum Management
VSAT	Very Small Aperture Terminal
WCDMA	Wideband Code Division Multiple Access (3G technology)

Term	Definition
WRC	World Radiocommunication Conference
WTDC	World Telecommunications Development Conference

International Telecommunication Union (ITU)
Telecommunication Development Bureau (BDT)
Office of the Director
Place des Nations
CH-1211 Geneva 20 – Switzerland
Email: bdtdirector@itu.int
Tel.: +41 22 730 5035/5435
Fax: +41 22 730 5484

Deputy to the Director and
Director, Administration and
Operations Coordination
Department (DDR)
Email: bdtdeputydir@itu.int
Tel.: +41 22 730 5784
Fax: +41 22 730 5484

Infrastructure Enabling
Environment and
e-Applications Department (IEE)
Email: bdtiee@itu.int
Tel.: +41 22 730 5421
Fax: +41 22 730 5484

Innovation and Partnership
Department (IP)
Email: bdtip@itu.int
Tel.: +41 22 730 5900
Fax: +41 22 730 5484

Project Support and Knowledge
Management Department (PKM)
Email: bdtipkm@itu.int
Tel.: +41 22 730 5447
Fax: +41 22 730 5484

Africa

Ethiopia
International Telecommunication
Union (ITU)
Regional Office
P.O. Box 60 005
Gambia Rd., Leghar ETC Building
3rd floor
Addis Ababa – Ethiopia

Email: itu-addis@itu.int
Tel.: +251 11 551 4977
Tel.: +251 11 551 4855
Tel.: +251 11 551 8328
Fax: +251 11 551 7299

Cameroon
Union internationale des
télécommunications (UIT)
Bureau de zone
Immeuble CAMPOST, 3^e étage
Boulevard du 20 mai
Boîte postale 11017
Yaoundé – Cameroon

Email: itu-yaounde@itu.int
Tel.: +237 22 22 9292
Tel.: +237 22 22 9291
Fax: +237 22 22 9297

Senegal
Union internationale des
télécommunications (UIT)
Bureau de zone
19, Rue Parchappe x Amadou
Assane Ndoye
Immeuble Fayçal, 4^e étage
B.P. 50202 Dakar RP
Dakar – Senegal

Email: itu-dakar@itu.int
Tel.: +221 33 849 7720
Fax: +221 33 822 8013

Zimbabwe
International Telecommunication
Union (ITU)
Area Office
TelOne Centre for Learning
Corner Samora Machel and
Hampton Road
P.O. Box BE 792 Belvedere
Harare – Zimbabwe

Email: itu-harare@itu.int
Tel.: +263 4 77 5939
Tel.: +263 4 77 5941
Fax: +263 4 77 1257

Americas

Brazil
União Internacional de
Telecomunicações (UIT)
Regional Office
SAUS Quadra 06, Bloco "E"
11^o andar, Ala Sul
Ed. Luis Eduardo Magalhães (Anatel)
70070-940 Brasília, DF – Brazil

Email: itubrasilia@itu.int
Tel.: +55 61 2312 2730-1
Tel.: +55 61 2312 2733-5
Fax: +55 61 2312 2738

Barbados
International Telecommunication
Union (ITU)
Area Office
United Nations House
Marine Gardens
Hastings, Christ Church
P.O. Box 1047
Bridgetown – Barbados

Email: itubridgetown@itu.int
Tel.: +1 246 431 0343/4
Fax: +1 246 437 7403

Chile
Unión Internacional de
Telecomunicaciones (UIT)
Oficina de Representación de Área
Merced 753, Piso 4
Casilla 50484, Plaza de Armas
Santiago de Chile – Chile

Email: itusantiago@itu.int
Tel.: +56 2 632 6134/6147
Fax: +56 2 632 6154

Honduras
Unión Internacional de
Telecomunicaciones (UIT)
Oficina de Representación de Área
Colonia Palmira, Avenida Brasil
Ed. COMTELCA/UIT, 4.^o piso
P.O. Box 976
Tegucigalpa – Honduras

Email: itutegucigalpa@itu.int
Tel.: +504 22 201 074
Fax: +504 22 201 075

Arab States

Egypt
International Telecommunication
Union (ITU)
Regional Office
Smart Village, Building B 147, 3rd floor
Km 28 Cairo – Alexandria Desert Road
Giza Governorate
Cairo – Egypt

Email: itucairo@itu.int
Tel.: +202 3537 1777
Fax: +202 3537 1888

Asia and the Pacific

Thailand
International Telecommunication
Union (ITU)
Regional Office
Thailand Post Training Center, 5th
floor,
111 Chaengwattana Road, Laksi
Bangkok 10210 – Thailand

Mailing address
P.O. Box 178, Laksi Post Office
Laksi, Bangkok 10210 – Thailand

Email: itubangkok@itu.int
Tel.: +66 2 575 0055
Fax: +66 2 575 3507

Indonesia
International Telecommunication
Union (ITU)
Area Office
Sapta Pesona Building, 13th floor
Jl. Merdan Merdeka Barat No. 17
Jakarta 10001 – Indonesia

Mailing address:
c/o UNDP – P.O. Box 2338
Jakarta 10001 – Indonesia

Email: itujakarta@itu.int
Tel.: +62 21 381 3572
Tel.: +62 21 380 2322
Tel.: +62 21 380 2324
Fax: +62 21 389 05521

CIS countries

Russian Federation
International Telecommunication
Union (ITU)
Area Office
4, Building 1
Sergiy Radonezhsky Str.
Moscow 105120
Russian Federation

Mailing address:
P.O. Box 25 – Moscow 105120
Russian Federation

Email: itumoscow@itu.int
Tel.: +7 495 926 6070
Fax: +7 495 926 6073

Europe

Switzerland
International Telecommunication
Union (ITU)
Telecommunication Development
Bureau (BDT)
Europe Unit (EUR)
Place des Nations
CH-1211 Geneva 20 – Switzerland
Switzerland
Email: eurregion@itu.int
Tel.: +41 22 730 5111



International Telecommunication Union
Telecommunication Development Bureau
Place des Nations
CH-1211 Geneva 20
Switzerland
www.itu.int

ISBN: 978-92-61-21781-5



9 789261 217815

Printed in Switzerland
Geneva, 2016