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Myanmar national spectrum management policy: Is it best practice?¹

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Abstract

Over the past decade, several debates on spectrum management regimes in the developed countries have been held. However, the spectrum management regimes of developing countries are relatively understudied, especially least-developed countries. This paper studies current spectrum management reform in Myanmar. Myanmar has pursued reform of its telecommunication sector over the past two years. The initial round of reform resulted in the issuing of two nationwide telecom-operating licenses, followed by development of a regulatory policy framework to promote competition. Yet, the development of the country's regulatory policy is still on going. In terms of spectrum management, spectrum is regulated and allocated by the Department. At present, valuable spectrum is critically under-utilized in Myanmar. As part of the allocation of licenses to other operators, a clear allocation of spectrum is important in enabling cost and time efficient provision of services to the market. Therefore, the need for a transparent spectrum policy, that is, monitoring, identifying spectrum that is already in use, and protection of assigned frequencies still needs development.

As a greenfield market, Myanmar has the opportunity to benefit from an improved use of its spectrum and to adopt efficient spectrum management policies. This paper will review three basic approaches for spectrum management regime, study the current spectrum management reform in Myanmar, offer policy recommendations and provide implications for future research on spectrum management and related areas. The findings show that Myanmar government had been using obsolete policies for ages. Until recent two years, major policy changes were happened. In addition, the spectrum management reform in Myanmar is going through a transition from the government-based approach to the market-based approach. Liberalized spectrum management policies have been issued, but not yet put into action.

¹ This paper is based on the research conducted by the first and second author for the second edition of Pacific Telecommunications Council Broadband Reports, Myanmar: Telecoms' Last Frontier, available at www.ptc.org.

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Hence, the study argues that the government should have a strong, committed regulatory environment in place before embarking on a transition in order to facilitate the transition process. Finally, this study provides further studies on liberalization, the digital divide, the development of telecom and broadband policy and specific reform in Myanmar.

Keywords: spectrum management, policy, liberalization, Myanmar

1. Introduction

Isolated, after many years of military rule, Myanmar's new regime is pursuing political, social and economic reforms. The process began in 2010 when the first general democratic elections were held. The country's political opening also has offered new opportunities for foreign investors. Myanmar has received enormous attention from the international community that has shown eagerness to support the country's reform process and modernization efforts. The country's strategic location, located at the heart of the world's fastest growing economic region has also motivated interest in its growth potential. Myanmar is the second largest country in Southeast Asia in terms of total land area and is bordered by Bangladesh, India, the People's Republic of China, Lao People's Democratic Republic (Lao PDR) and Thailand. The country is rich in natural resources such as minerals, metals, petroleum, natural gas, mines and forests. This greenfield situation presents Myanmar with an opportunity to leapfrog over intermediate stages of economic, political and social development.

Telecommunications is viewed as one of the fundamental pillars for Myanmar to modernize and improve economic growth (Chhor et al., 2013; Fife, 2014). In 2012, Myanmar was one of the least developed telecommunications markets in Asia (Goeres et al., 2013). Official Myanmar government reports indicate that market penetration was 2.5 million mobile subscribers in 2012 (Nomura Research, 2012). As a least-developed nation with less than 10% teledensity (4% Internet penetration and 6% mobile penetration) and a market of over 60 million customers, the potential is massive for the telecom industry. Myanmar has held intense interest for global telecom providers given this unique opportunity to build networks and services for a substantial customer base in an economy that is expected to grow dramatically in the next few years. The rarity of such a market with low penetration and yet growth potential has been described as the "last frontier" for Asian telecom (Fife, 2014).

Myanmar's telecom sector is rapidly changing and foreign investment is increasing. A robust telecommunications regime that supports competition and liberalization is critical to supporting market growth, advanced technologies and user adoption. With the right policy formulation and strategies, Myanmar's telecom sector is expected to boom in the next five years with the mobile broadband market likely driving Internet penetration. Current reforms are supporting mobile telecommunications and mobile services such as mobile banking and mobile payments (Economist, 2013; Fife, 2014). The potential increased demand in wireless communications will require access to more spectrums.

Spectrum is a natural, non-depleteable, but scarce resource. The radio frequency spectrum is a key element of the telecommunications infrastructure that supports an information society. It

is also a major strategic asset for the economies of many developed and developing countries. The recent development of new telecommunications technologies and services, rapid demand growth of wireless services, changing patterns of spectrum use and, especially, the introduction of high-speed mobile broadband has increased demand for access to this limited resource to support more users, more usage and higher capacity. Hence, spectrum management policy has become an important issue among regulators and policy makers around the world, to achieve efficient distribution of this scarce resource.

In the past decade, there has been debate on spectrum management reform in the industrialized nations. Much research has been put into developing a wide range of spectrum management regimes for developed countries to adapt to innovative wireless communications systems (Faulhaber, 2005; Cave et al., 2007; Pogorel, 2007; Bohlin et al., 2008; Freyens, 2009; Sridhar et al., 2013; Minervini, 2014). However, the spectrum management regimes of developing countries are relatively understudied. Wellenius and Neto (2005) find that spectrum management reforms in developing countries are relatively important since the changes underway are of global significance. In addition, it is thought that it can be easier for developing countries to adopt more efficient spectrum management regimes and to reap larger payoffs than it is for developed countries since developing countries have less investment in telecommunication infrastructure (Wellenius and Neto, 2008).

At present, valuable spectrum is critically under-utilized in Myanmar. Until recently, there was only one provider of telecommunications services, namely Myanmar Posts and Telecommunications (MPT). Hence, there was little discussion on the use of spectrum for its network and dealing with interference issues. There was no clear spectrum policy to monitor and identify the spectrum that is already in use and protection of assigned frequencies. Spectrum management in Myanmar was not able to keep up with current changing technology, business practice and economic policy (ITU, 2012). Since Myanmar is starting with a fresh slate, the country has the opportunity to benefit from an improved use of its spectrum and adopt efficient³ spectrum management policies. Thus, the purpose of the paper is to review briefly three principal approaches for spectrum management reform, examine which approach was used in the current radio spectrum management reform in Myanmar, provide policy recommendations and suggest an agenda for future research on spectrum management and related areas.

The paper is organized as follows. Section 2 describes briefly the history of the telecommunication sector and telecom regulatory environment in Myanmar. Section 3 reviews the different options for spectrum management regimes. Section 4 illustrates current state of spectrum management policy in Myanmar, while Section 5 provides a discussion of Myanmar's current spectrum regimes and recommendations of suitable regimes for Myanmar. Section 6 gives implications for future research on spectrum management. Lastly, it concludes with Section 7.

³ This paper frequently refers to efficient spectrum management or efficient use of spectrum, implying that allocation of frequencies should ideally be based on technical, commercial and societal requirements. Without consideration of these factors, valuable spectrum may be underutilized.

2. Overview of Myanmar's Telecommunications Sector

While Myanmar was under military control, its telecoms markets were firmly regulated by the Ministry of Communications and Information Technology (MCIT), which was formerly referred to as the Ministry of Communications, Posts and Telegraphs (MCPT)⁴. MCIT was founded in 1884. Until 2012, the state-owned monopoly Myanmar Posts and Telecommunications (MPT) dominated Myanmar's telecommunication sector and MPT was the primary provider of telecommunications services in the country. Furthermore, Posts and Telecommunications Department (PTD) has acted as Myanmar's telecom regulator. Both MPT and PTD are operating under MCIT and were founded in 1972. Myanmar now has three Internet service providers (ISPs) that include MPT, Yatanarpon Teleport (YTP), which is partially owned by government and Redlink Group, a privately owned company, which is owned by family members of government officials.

2.1 Brief History of Myanmar's Telecom

In 1861, the first telegraph lines were built in Myanmar. However, services were not offered until 1884. The total number of telephones in Yangon at that time was about 1,300. In 1937, telegraph and telephone services in provincial areas were launched by using open wire lines and open wire carrier systems. In the same year, Myanmar became a member of the ITU. Crossbar automatic exchanges were introduced in 1956. By the early 1970's, there were 143 exchanges in the country of which 6 were automatic exchanges located in Yangon. The total number of telephone had grown to 17,400 in Yangon and nationwide numbered about 22,000. In 1960, the first low capacity microwave transmission system was established for national long distance communication. High frequency (HF) radio communication was used for international telephone and telex services. The standard-B satellite earth station with an international gateway switch and 6 GHz 960 channel baseband analog microwave systems was installed in 1978. The satellite earth station had a capacity of 60 SCPC/IDR (single channel per carrier/ intermediate data rates), circuits and had direct connections to six countries. In 1987, digital electronic exchanges were installed which led to the growth of telephones to around 73,000. Domestic satellite earth stations and VSAT systems were employed in 1991 to provide long distance telephone services (Nomura Research, 2012).

In the 1990's, the following technologies were introduced mainly in Yangon: cellular mobile telephone system (Analog AMPS 800), Digital AMPS (D-AMPS), standard-A satellite earth station with a new international gateway switch, International Direct Dialling Service, Wireless in the Local Loop (WLL) automatic radio telephone systems (TDMA), Digital European Cordless Telecommunications (DECT) radio telephone system and CDMA network (800 MHz). At the time, Myanmar was the first country that had introduced the CDMA 800 MHz in South-East Asia (Evans, 2013). MPT commissioned GSM (900 MHz) in 2002, targeted 70,000 connections in Yangon and 30,000 in Mandalay. As shown in Table 1, a third generation network, W-CDMA (2100 MHz) was launched by MPT in 2008. At the same time,

⁴ In November 2012, Myanmar's Parliament changed the name of the Ministry of Communications, Posts and Telegraphs (MCPT) to the Ministry of Communications and Information Technology (MCIT).

MPT also introduced CDMA (450 MHz). Due to infrastructure inadequacies, MPT introduced 3G on a limited basis. As of 2013, MPT was still performing a limited LTE trial in the 1,800 MHz (TeleGeography, 2013; Evans, 2013). In the beginning of 2014, international roaming services for GSM and WCDMA were launched in Myanmar, through a contract with France Telecom/Orange (Bushell-Embling, 2014).

Table 1. Mobile network in Myanmar

Mobile Service	Generation	Frequency	Service Provider	Launch
AMPS	1G	800 MHz	MPT	1993
D-AMPS	2G	800 MHz	MPT	1993
TDMA	2G	800 MHz	MPT	1995
CDMA	2G	800 MHz/ 450 MHz	MPT	1997/ 2008
GSM	2G	900 MHz	MPT	2002
W-CDMA	3G	2100 MHz	MPT	2008
LTE	4G	1800 MHz	MPT	Trail

Source: TeleGeography (2013); Evans (2013)

As for broadcasting, TV broadcasts were not available in Myanmar until 1985. All broadcasting within the country was heavily regulated by the government. Until 1995, there was only one government-run TV station, Myanmar TV (MRTV-3). The channel has long been used as a propaganda tool of the ruling military elite. In 1995, a new TV channel, Myawaddy TV was established in order to reach a younger audience with its propaganda. Both channels were strictly controlled by the government (Fink, 2009).

The existing telecom infrastructures in the country remain relatively poor and insufficient. At present, Myanmar has approximately 400 base stations, 1,800 towers and 15,000 km. of fiber (TMT Finance, 2013). These facilities are mainly located between the major cities of Yangon, Nay Pyi Daw and Mandalay. Due to the lack of submarine cable links, Myanmar has very limited capacity (Nomura Research, 2012). Myanmar currently has about 2.8 million telephone lines; 2 million are mobile lines and the rest are fixed lines. In terms of teledensity, even including mobile telephony, it is only 1.32% which is the lowest in the ASEAN (Fife, 2014). Official Myanmar government reports showed that market penetration was 5.44 million subscribers in 2012 (Nomura Research, 2012).

Table 2. Mobile subscribers in Myanmar (As of 2011)

Technology	Subscribers	Number of Cities
GSM	836 967	98
W-CDMA	28 000	1
CDMA 2000 (450 MHz)	698 060	210
CDMA 2000 (800 MHz)	382 750	19
Multi-carrier WiLL	150 000	12

Source: ITU (2012)

2.2 Myanmar's Telecom Regulatory Background

To regulate the telecommunication sector, the primary instruments of legislation have been the Myanmar Telegraph Act, 1885 and the Myanmar Wireless Telegraph Act, 1934 (TeleGeography, 2013). The State-owned Economic Enterprises Law, enacted in 1989, assigned the property of the radio waves, all telecommunication services and facilities to the government. However, the law permitted government-private joint ventures (Ure, 2008). The Computer Science Development Law was issued in 1996 to develop computer networks in Myanmar. According to this law, any individual who imported or purchased computer technology is required to apply and register with the government (Labbé, 2010). In 2002, the Government developed an ICT master plan to harness the ICT industry, emphasize potential employment opportunities and an identify priority areas such as ICT infrastructure, legal and regulatory frameworks, human resource development and education. To support the electronic transactions technologies, it passed the Electronic Transactions Law in 2004 (UNESCAP, 2004; SEACOO, 2010).

Table 3. Laws and regulations in Myanmar

Year	Law and Regulation
October, 1885	Myanmar Telegraph Act (India Act XIII) ¹
January, 1934	Myanmar Wireless Telegraph Act (India Act XVII) ²
March, 1989	State-owned Economic Enterprises Law ³
October, 1993	Amendment of Myanmar Wireless Telegraph Act ⁴
September, 1996	Computer Science Development Law ⁵
April, 2004	Electronic Transactions Law ⁶
January, 2011	Myanmar Special Economic Zone Law ⁷
October, 2013	Telecommunications Law ⁸
December, 2013	Licensing rules ⁹ , Interconnection and access rules ¹⁰ , Spectrum rules ¹¹ , Numbering rules ¹² and Competition rules ¹³

1. <http://www.mcpt.gov.mm/mcpt/myanmar-telegraph-act.htm>
2. <http://www.mcpt.gov.mm/mcpt/myanmar-wireless-telegraphy-act.htm>
3. <http://www.mcpt.gov.mm/mcpt/miscellaneous.htm>
4. <http://www.mcpt.gov.mm/mcpt/amendment.htm>
5. <http://www.mcpt.gov.mm/mcpt/myanmar-computer-science-development-law.htm>
6. <http://unpan1.un.org/intradoc/groups/public/documents/un-dpadm/unpan041197.pdf>
7. <http://www.mcpt.gov.mm/mcpt/miscellaneous.htm-0>
8. <http://www.mcit.gov.mm/content/telecommunications-law.html>
9. <http://www.mcit.gov.mm/sites/default/files/1 - MCIT - Final Licensing Rules - 122013 CLEAN.pdf>
10. <http://www.mcit.gov.mm/sites/default/files/2 - MCIT - Final Interconnection Rules 122213 CLEAN.pdf>
11. <http://www.mcit.gov.mm/sites/default/files/3 - MCIT - Final Spectrum Rules - 122213 CLEAN-1.pdf>
12. <http://www.mcit.gov.mm/sites/default/files/4 - MCIT - Final Numbering Rules - 122213 CLEAN-1.pdf>
13. <http://www.mcit.gov.mm/sites/default/files/4 - MCIT - Final Competition Rules - 122213 CLEAN.pdf>

In October 2013, the new regulatory regime, based on the Telecommunications Law, was promulgated. The law provides a broad-based framework governing the conduct of telecommunications-related activities in Myanmar (Polastri & Peng, 2013). The approval of the Telecommunications Law was followed by the issuance of two new telecommunications service licenses and the adoption of five key regulations. The five regulations were intended to implement the Telecommunications Law and set out the framework for MCIT and PTD to follow. The next set of regulatory instruments that will be developed include universal access strategy, consumer protections, standardization and type approval (Aung, 2013). Steps for establishing an independent regulator by 2015 are noted in the Telecommunications Law. The independent regulator will be established either through amendments to the existing Telecommunications Law or through the approval of new legislation that exclusively creates the regulator in 2015. Until then, MCIT acts as the policy maker and PTD as the regulator and licensor (Aung, 2013). The law also provides MCIT the ability to set up various mechanisms to fulfil universal service obligations, including the establishment of a Universal Service Fund (World Bank, 2013).

3. Different Models for Spectrum Management Reform

Spectrum management rests on a framework that will optimize the efficient use of spectrum (Bauer 2002). Traditionally, spectrum management by regulators has been mainly focused on the allocation of spectrum bands to certain uses (e.g., military, commercial, emergency service, etc.) and the assignment of usage rights to certain users (e.g., telecom operators, broadcasters, military, etc.) (Valletti, 2001). However, efficient spectrum management needs to address the clearance of spectrum frequency bands for new applications and users migration. Policy flexibility to incorporate new technological and commercial developments is also needed (Bauer, 2002; Freyens, 2007; Sridhar et al., 2013).

The three principal models for spectrum management regimes include: command-and-control, market-based and commons approaches. The command-and-control model is the traditional centralised system that has been used to manage spectrum for the last 100 years. The market-based and commons models are the two alternative approaches that are currently used for spectrum management reform (Freyens, 2007). In terms of spectrum usage rights, the command-and-control and market-based approaches allow the licensees to have the exclusive right to use a selected frequency band. However, the commons model permits all users to use a selected frequency band without a license.

3.1 Command-and-control Model

The command-and-control model is a traditional spectrum management regime which is based on administrative decisions. In this approach, spectrum is state-owned property. Hence, historically, the government or an independent regulator under the government's control is responsible for granting exclusive, but not transferable right to a sole user to use some spectrum bands with conditions to protect harmful interferences. These conditions consist of power limitation, antenna specification, and technical requirements of radio-communication equipment (Ard-Paru, 2013). Over time, a more liberal attitude has been practised by allowing competition in spectrum allocation. However, the assumption is still that the national

government knows best (Bohlin et al., 2008). In this model, spectrum licenses can be allocated in several different ways: first-come-first-served, comparative hearings, lotteries and beauty contests. The most common approaches are first-come-first-served and beauty contests.

3.2 Market-based Model

The market-based model is a widely used spectrum management regime, which is based on market-based mechanisms and operates in a more open and decentralised basis. In this approach, spectrum is treated as property rights. The licensee is granted exclusive rights to use a specified spectrum, and at the same time, has the right to sell, lease and trade to third parties. Spectrum usage rights are controlled by technical rules with guaranteed interference protection (Hwang & Yoon, 2009). The market-based method comprises spectrum trading and spectrum liberalization. Spectrum trading means “*the spectrum license is transferred between two licensees on the premise that they both provide the same type of service*” (El-Moghazi et al., 2008, p. 3). Spectrum liberalization means that “*the spectrum license is both service and technology neutral, i.e., the sold spectrum can be used to deliver any service with any technology*” (El-Moghazi et al., 2008, p. 3). The assumption of this model is that market forces are the best mechanism to use spectrum efficiently and flexibly (Bohlin et al., 2008). With this model, spectrum licenses are allocated through a market pricing mechanism such as trading, auctions, tenders, administrative pricing and cost-benefit analysis (Freyens, 2007). Auctions are the most popular approach in both developed and developing countries. This approach award licences to the most willing user who values spectrum most highly.

3.3 Commons Model

The commons model, also known as license-exempt, is a spectrum management regime, which permits all potential users to use frequency unlicensed under certain technical conditions by the regulator (Pattal & Zeng, 2008). No one has an exclusive right to use frequency. Spectrum is treated as a public good. Thus, this approach is more decentralised and less bureaucratic, and it is also driven by radical technology innovation such as cognitive radios (Bohlin et al., 2008). The technology itself administrates interference disputes without regulator’s involvement and optimizes use of spectrum by operating in the vacant unutilised spectrum frequencies (El-Moghazi et al., 2008). Common spectrum is widely used in day-to-day activities, such as remote controls, card readers, closed-circuit television (CCTV), navigation systems, Wi-Fi Internet connection, etc. There are two types of common approaches: open access and spectrum sharing. The open access approach allows spectrum access and usage without limitation to the unlimited number of unlicensed users (Freyens, 2007). Spectrum sharing permits unlicensed devices to share spectrum with licensed devices. In another words, some licensed and unlicensed users can share the same spectrum with licensees with a condition that they do not interfere with licensees (Hwang & Yoon, 2009). This method encourages a more efficient use of assigned spectrum.

The advantages and drawbacks of each approach are summarized in the table below.

Table 4. Brief details of spectrum management approaches

	Command-and-control	Market-based	Commons
Features	<ul style="list-style-type: none"> ▪ Spectrum allocation and conditions of use is administrated by the Government ▪ Frequencies within each band are assigned to individual users for exclusive or shared use by the Government ▪ Harmful interference is prevented by detailed technical and operating rules and standards ▪ Government knows best ▪ First-come-first-serve, Beauty contests 	<ul style="list-style-type: none"> ▪ Individual users are assigned exclusive and transferable rights to use specific frequencies, by the government ▪ Spectrum may be sold, leased, divided or aggregated by the Rights holders ▪ Harmful interference is prevented by rules and rights of use ▪ Market knows best ▪ Auction, Second trading 	<ul style="list-style-type: none"> ▪ All users have the right to use spectrum ▪ Users are subject to minimal technical standards to limit interference ▪ The right to use of technology is barely limited, if at all ▪ Interference-free operation is not guaranteed ▪ Nobody knows best ▪ Spectrum sharing
Advantages	<ul style="list-style-type: none"> ▪ Mature practice, ample experience on which to draw ▪ Proven effective in preventing harmful interference 	<ul style="list-style-type: none"> ▪ Inefficient initial assignment and allocation can be corrected ▪ Incentives for efficient use are created ▪ Accelerates response to changing technology and demand ▪ Enhances transparency and reduces opportunities for corruption ▪ Reduces regulatory burden ▪ High flexibility 	<ul style="list-style-type: none"> ▪ Encourages use of spectrum-efficient technologies ▪ Lowers entry barriers, enhances competition, facilitates innovation ▪ Reduces some forms of anticompetitive behavior ▪ Reduces regulatory burden ▪ High flexibility
Disadvantages	<ul style="list-style-type: none"> ▪ No efficient use of spectrum; create spectrum divide ▪ Distort the opportunity cost of spectrum ▪ Open to abuses in allocation ▪ Discourage the development of new technologies and services ▪ Expensive – regulatory costs are high ▪ Prevent new entry 	<ul style="list-style-type: none"> ▪ Excessive market power ▪ Spectrum hoarding ▪ High transaction costs and inefficiencies ▪ Fairly expensive to regulate trading ▪ Registries of owners, trades and prices are required 	<ul style="list-style-type: none"> ▪ High congestion and Interference ▪ Reduce the performance due to overused ▪ Irreversibility of deregulation ▪ Create uncertainties about dispute resolution ▪ The government losses related revenues

Source: Geiss (2004); Bohlin et al.(2008); Wellenius and Neto (2008)

4. Spectrum management in Myanmar

After the Myanmar Telegraph Act was passed in 1885, all radio communication activities in Myanmar were prohibited. Radio communication licenses were needed for the right to use the radio communication services. Authorization was granted by MCIT. In addition to the State-Owned Economic Enterprise Law enacted in 1989, MCIT gained more power of control over the country's telecommunication sector. Later on, MCIT used the Wireless Telegraphy Act, promulgated in 1934, to manage its spectrum. Initially, frequency allocation and assignment was made by MCIT. After 1972, spectrum was regulated and allocated on an administrative basis by PTD. PTD controlled the use of spectrum in deploying its network and resolving interference issues (Goeres et al., 2013).

Spectrum allocation and spectrum assignments were made on a first-come first-serve basis and priority was given to the incumbent operator MPT and national interests. The National Table of Frequency Allocations was established in August 2001. Since MPT was the sole operator in Myanmar, it controlled the provision of public land mobile services in Myanmar. Therefore, the major bands were assigned to MPT for its 2G and 3G mobile services, as shown in Table 5 (MCIT, 2013a).

Table 5. Spectrum assignment for MPT

Frequency Band	Assigned User	Current Use	Bandwidth (MHz)
450 MHz	MPT	CDMA 450	2 x 3.75
800 MHz	MPT	CDMA 800	2 x 10
900 MHz	MPT	GSM 900	2 x 25
1800 MHz ^a	MPT	LTE Trial	2 x 20
2100 MHz	MPT	WCDMA	2 x 15

a. Note that 1800 MHz band spectrum is not formally assigned to MPT, just for trial use.

Source: MCIT (2013a)

Under the military regime, the government controlled entry and limited licences arbitrarily. Foreign nations were not allowed to apply for a licence. This led to a high cost for services, relative poor coverage and lack of choice for consumers. In terms of spectrum management, there was an absence of monitoring and no defined mechanism to protect assigned frequencies. Management policies did not take into account changes in technology, business practice and economic policy. In addition, valuable spectrum was severely under-utilized (ITU, 2012). After the election in 2010, the government decided to reform its telecom sector and spectrum management to encourage competition. Major changes occurred in Myanmar's telecommunication sector during 2012 and 2013.

In January 2013, Myanmar's government announced plans to liberalize its telecom sector. The spectrum management reform was initiated with the issuance of two nationwide telecom-operating licenses by June 2013. The government permitted both international and national companies to participate in the tender. The licence process was proceeded by a 'beauty contest,' and interested parties were invited to submit an Expression of Interest (EoI) by the end of January 2013. The criteria for qualification included the following: applicants needed to have least four million subscribers in one or more countries and needed annual gross

revenues of at least USD 400 million, or hold a minimum 50.1% stake in an operator that met those requirements. In April 2013 the government announced that 12 companies out of 23 bids passed pre-qualification. Pre-qualifiers then submitted applications to the committee (Evans, 2013).

During the process, the government selected an international consulting company to help with selection criteria of the beauty contest. The selection qualifications were based on technical and financial scores. The technical selection criteria consist of eight categories, including network rollout, customer care and social responsibility capabilities, while the financial selection was mainly based on the licence fee offer. The two winning operators were required to have a technical score of 67% and a financial score of 33%. In June 2013, the government announced Telenor and Qatar's Ooredoo had won the mobile licenses. At the same time, France Telecom-Orange and Marubeni Corporation were selected as backup applicants in case any of two winning operators failed to fulfil the post-selection requirements. The licences were awarded with a 15-year term and 10-year renewal and fee of USD 500 million. However, the licences were delayed by the parliament until the beginning of 2014 because the new telecommunications law was not yet passed. The other reason was MPT was looking for a foreign partner before issuing mobile license to compete with the other three operators. In January 2014, four mobile licenses were issued in Myanmar: two to foreign operators (Telenor and Ooredoo) and two to native operators MPT and YTP (Evans, 2013; Fife, 2014).

Regarding activities on radio spectrum management, the PTD has drawn up the Myanmar National RF Spectrum Allocation Plan with the assistance of the ITU (Nomura Research, 2012). The government also adopted many ITU-R recommendations on RF channel management on all major bands. Furthermore, the new National Table of Frequency Allocations has been updated according to the international Table of Frequency Allocations stated in Article 5 of the Radio Regulations (RR-2012). As part of the allocation of licenses to other operators, the ITU suggested that a refarming of certain spectrum is required to enable the entry of new competitors into the Myanmar mobile market. Such a refarming entails reassigning the current 900 MHz spectrum allocated to MPT and reallocating the assignment of D-AMPS spectrum in the 800 MHz band for 3G services (ITU, 2012). Hence, PTD requested MPT to free up 2 x 10 MHz in the 900 MHz band by the end of 2013. However, no changes were proposed to the mobile service in the 800 MHz band. The two blocks of 2 x 5 MHz spectrum in the 900 MHz band and two blocks of 2 x 10 MHz spectrum in the 2100 MHz band were assigned to the two new operators, Telenor and Ooredoo. The second Myanmar operator, YTP was also assigned the same bands as the other two new operators, whereas, MPT has maintained possession of its existing spectrum, except for the 900 MHz band (MCIT, 2013a).

Table 6. Spectrum assignment to new operators

Operator	Frequency Band	Bandwidth (MHz)	Duration	License Fees (USD)	Purpose of Use
Telenor	900 MHz	2 x 5 MHz	15 years	500 million	2G
	2100 MHz	2 x 10 MHz			3G
Ooredoo	900 MHz	2 x 5 MHz	15 years	500 million	3G
	2100 MHz	2 x 10 MHz			
YTP ^a	900 MHz	2 x 5 MHz	-	-	-
	2100 MHz	2 x 10 MHz			

a. Yatanarpon Teleport.

Source: MCIT (2013a); Morris (2014)

Along with the Telecommunications Law, the spectrum rules were established in December 2013. The objective of these spectrum rules is to create a simple, liberalized, transparent, and non-discriminatory spectrum management framework that promotes harmonization, efficient use of the spectrum resource and encourages innovation. The spectrum rules are aimed to implement the Telecommunications Law and provide a clear and simple transition to a more transparent licensing regime. The current spectrum rules address spectrum property rights, trading, license-exempt as well as spectrum sharing. As for license mechanisms, auction, tender and fixed price methods will be used. One or a combination of these methods can be used in the allocation of spectrum licences to the operators (MCIT, 2013b). For efficient use of spectrum, spectrum sharing is permitted in such a way that a licensee can sub-license their spectrum to other users. In addition, the spectrum rules also state that a National Frequency Assignment Register will be created to monitor and administrate the spectrum use and the ministry will create and update its National Table of Frequency Allocations at least every five years (MCIT, 2013a).

5. Discussions and Policy Recommendations

In Myanmar, spectrum resources are managed by the command-and-control approach. Traditionally spectrum was usually allocated on a first-come-first-serve basis, subject to MPT fulfilment of certain technical criteria without consideration of spectrum scarcity. As for the recent spectrum allocation to the new operators, the government did not hold auctions, even though the reform in spectrum management policy was in progress. Instead, spectrum was allocated through a ‘beauty contest’ regime. Next, a flexible spectrum management regime, which addresses both market-based and common methods, was established in Myanmar to encourage efficient use of spectrum such as implementation of technology and service neutrality, spectrum property right and trading, spectrum sharing and monitoring and promoting increased spectrum utilisation.

The spectrum management reform in Myanmar is going through a transition from the government-based approach to the market-based approach. Lehr (2005) and Bohlin et al. (2008) claim that a mixed approach of spectrum regime is better to avoid the uncertainty,

promote competition, neutrality and flexibility, maintain harmonisation and protect interference. However, El-Moghazi et al. (2008) argues that the improvement of existing legacy spectrum policy in developed and developing countries is needed before its possible to adopt new policy that affects spectrum demand and supply balance. This could lead to delay in adopting either market-based or common regime. For example, the UK went through a long transition from a command-and-control approach to market-based approach, due to the resistance by powerful incumbent interests (Pattal & Zeng, 2008). Hence, the government should have a strong, committed regulatory environment in place before embarking on a transition.

Even though Myanmar's government has adopted best practices such as spectrum harmonization, technology neutrality and the presumption of license renewal, there is a lack of contiguous spectrum, which will discourage the rollout of new technology. By creating a spectrum roadmap, setting a clear assignment plan for future spectrum release and making it public, this will increase the operators' confidence to invest in future growth, fuelling innovation, jobs and economic dynamism in the sector. In terms of policy leapfrogging to accommodate current technologies, the Ministry should consider the costs and administration of future network infrastructure and align its spectrum band plans with those in the neighbouring countries, particularly the proposals regarding use of the 700 MHz band for 4G, by the Asia Pacific Telecommunity.

According to Chapter 4 of the Telecommunications Law, MCIT remains the authority to control and manage the frequency spectrum and satellite orbital positions; determine a national frequency spectrum plan and prescribe rules and regulations on matters concerning access to and interconnection of network facilities. In addition, an independent regulator has not yet been established in Myanmar. Until 2015, the PTD will act as regulator, operating under the Ministry. Hence, Myanmar's spectrum policy is still government-driven, even though the Ministry and PTD are trying to show transparency through public consultation. This affects the implementation of the spectrum scheme for the benefit of the stakeholders. By looking at the recent spectrum allocation, MPT retains its existing spectrum bands such as 450 MHz, 800 MHz, 900 MHz and 2100 MHz, whereas, only the 900 MHz and 2100 MHz spectrum bands are assigned to the new operators. One could question the goal of creating liberalized, transparent and non-discriminatory spectrum management framework.

Myanmar has the opportunity to make efficient use of each band and make processes easier. It is vital that spectrum resources are well-managed and utilized. To be able to provide the best value in the coming years, the most attractive bands should be properly planned and structured. Moreover, the use of future technologies should be accommodated. Operators should preferably have both flexibility and opportunity to make efficient use of resources. Regulators should set openly a clear assignment plan for the future release of spectrum; ensure efficient slot design and a technology-neutral regime in order to assure proper planning and structuring.

6. Implications for Future Research

In terms of spectrum management reform, Myanmar is at the initial stages of transition from the traditional administrative approach to the market-based approach. Liberalized spectrum management policies have been established, however, these policies have not yet been put into action. Hence, many challenges and obstacles are ahead for Myanmar in implementing its current spectrum policies. According to Wellenius and Neto (2005), El-Moghazi et al. (2008) and Sridhar et al. (2013), weak governance, government security concerns, incomplete infrastructure networks, high transaction costs, weakness of the enforcement system and large rural populations with minimal service are among the obstacles faced by most emerging countries during their implementation of market-based mechanisms. Further study on challenges that will be faced by Myanmar is needed to provide the fullest understanding of the situation and a realistic view of how Myanmar's government and policymakers can best design and implement the spectrum policies that are suitable for the country's telecom environment.

Furthermore, Minervini's (2014) study on spectrum policy reforms in some liberalizing countries showed that most countries, that were surveyed, had transitioned gradually from centralized common-and-control regulation to a more flexible, decentralized market-based mechanism for spectrum regulation. To deploy various policy actions effectively, each country had gone through different learning processes at different speeds. They implemented reform process and suggested policy changes through their experiences. In addition, careful examination of relative merits of spectrum in specific contexts is needed to designing effective policies. Many emerging countries are reproducing best practices from advanced countries. In reality, not all the best practices are applicable to developing countries. Wellenius and Neto (2005) and Minervini (2014) show that policy actions cannot be embraced directly from one country to another country as the path of change may vary country by country. Hence, additional research on the path of specific reform in Myanmar is desired after the government has put its spectrum policy into action.

Another interesting area for study of spectrum management in Myanmar is the release of digital dividend spectrum to respond to the growing demand for wireless communication services in the future, particularly in rural areas. Digital dividend is very attractive among regulators, broadcasters and operators due to its special characteristics, that is, radio signals in its low frequency band can travel further distances than higher frequency signals. Since digital dividend spectrum gives higher coverage and is less affected by other obstacles, it is suitable to provide long range mobile broadband coverage in rural areas and increase indoor coverage in urban areas. In developing countries, digital dividend is attractive due to the limited availability of fixed broadband services, especially in rural areas (Yin et al., 2012).

Institutional capacity is also a critical issue for Myanmar. The current regulatory environment in Myanmar is complex and contains a wide level of involvement. The government has limitations in its abilities to coordinate, leading to lengthy processes that hinder operator's planning processes. The current challenges that Myanmar telecom industries, foreign operators and investors are facing, are significant. In theory, Myanmar has the advantage to leapfrog, learn lessons and avoid mistakes from other markets. In practical application, there

still remains a question of the government's willingness and abilities to address these issues regardless of the complexities of existing bureaucracies, social and political forces. From the government's perspective, it needs time to reform, organize and allocate its resources to create growth, while investor's need to see progress which will take time. As in all markets, successful reform in Myanmar depends on careful policy considerations. Myanmar provides a useful setting for further research of the impact of liberalization on telecom carriers and society, the digital divide and the development of telecom and broadband policy.

7. Conclusions

Myanmar is at the dawn of a new era. It can gain benefits from improved use of its spectrum and adopting efficient spectrum management policies. This study provided several insights on telecom regulatory background and current spectrum management reform in Myanmar. It found that a few basic laws were established a long time ago in Myanmar. However, major policy changes were occurred in recent two years. As for spectrum management reform, it is going through its transition stage from the traditional administrative approach to the market-based approach. Liberalized spectrum management policies have been issued, but not yet implemented. Hence, the study argues that, to alleviate the transition process, the government should have a strong, committed regulatory environment in place before embarking on a transition. In addition, it also argues that the government should allocate the most attractive bands and accommodate the use of future technologies in order to provide the best value in the coming years. Finally, this paper provides suggestions for future work on liberalization, the digital divide, the development of telecom and broadband policy and specific reform in Myanmar. For instance, a robust and competitive telecommunications regime through liberalization has a huge role to play in bringing prosperity to the entire nation. In addition, further study on challenges that will be faced by Myanmar could help the government to design and implement the spectrum policies that are suitable for the country's telecom environment.

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