THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF TRANSPORT AND COMMUNICATIONS

Nay Pyi Taw

Spectrum Roadmap:

Meet the Needs Over Next 5 Years

8th April 2016

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Executive Summary

The Roadmap will play a critical role in the efficient use of spectrum and in the overall development of the Myanmar telecommunications industry. It will inform stakeholders about the current status of the Ministry Of Transport And Communication's spectrum management program, planned activities to enhance program delivery, current spectrum usage and overall plans. The Roadmap constitutes a critical step in ensuring that appropriate spectrum resources are available to meet the demand of users over the next five years. The Roadmap will assist operators to plan the development of current and new systems, and for operators, service providers and other stakeholders, to plan future investment in telecommunications in Myanmar.

In the past few years, significant policy and regulatory changes in the spectrum management framework have occurred, opening opportunities for the leveraging of spectrum as a national asset that enables the introduction and development of new services. The Ministry of Transport and Communications, the oversight Ministry for the telecommunications sector- prior to the creation of Ministry, had set out a vision based on Myanmar becoming ***mobile-first, digitally connected nation*** based on three connected themes*:*

1. ***Connect the people of Myanmar*** *through a series of initiatives and policy measures to be implemented over the next five to seven years to create a broadband infrastructure asset for Myanmar.*
2. *This infrastructure will connect most Myanmar citizens to high-speed Internet services, assisting economic advancement through* ***Innovation and digital transformation*** *in many industries.*
3. *Digital technology and high speed connectivity to support* ***eGovernment*** *services, in order to make public services and information more easily accessible to everyone and increase the efficiency with which the Union Government and State Governments work together*

In 2014, the PTD licensed 2 new mobile operators: Telenor and Ooredoo and these operators have quickly built out their networks to cover most of the nation, offered new services and increased the number of mobile subscribers.

Due to liberalization of telecommunications and the introduction of private enterprise, the telecommunications market in Myanmar has evolved from the least developed to one of the fastest growing markets in the world. Increased liberalization of spectrum policy and the entry of new competitive telecommunications providers is bringing immense social and economic benefits to the people of Myanmar as well as opening new avenues for business investment. In the brief (two year) period since the implementation of this new framework, Myanmar has witnessed the arrival of new service providers, the introduction of new services and handsets. With new competition, there have been improvements in the quality of service, delivery of new services quicker deployment of new technologies and networks, improvement in system performance, availability of the latest end-user devices and a reduction in prices for consumers.

This Spectrum Roadmap has been developed in the context of current legal and policy frameworks guiding spectrum management and available licensing information. The Roadmap takes into consideration the comments and recommendations by stakeholders to identify key issues to be addressed and provide a way forward to further improve spectrum management in Myanmar.

There are significant challenges in transition from the historical approach of spectrum management and state-deployed services to a liberalized market approach that encourages foreign investment and greater access to radio spectrum for a variety of operators and the deployment of private competitive telecommunication services. PTD recognizes that change will require a meaningful shift in government thinking to focus on governing and management of the spectrum resource and on assisting a plethora of users, operators and service providers – public and private, in the development of spectrum use and the development of new technologies services.

While this rapid liberalization of telecommunications market has brought both immense benefits to the people of Myanmar, it also poses significant regulatory and policy challenges. The Government of Myanmar has agreed that Posts and Telecommunications Department (PTD) - the telecommunications regulatory body – currently embedded in the Ministry of Transport and Communications, will become an independent regulatory body – the Myanmar Communications Regulatory Commission (MCRC). As the regulator, the challenges faced during this transition period are described below:

- Ministry of Transport and Communications/PTD/MCRC operational readiness,
- Effective institutional arrangements with stakeholders to assist in spectrum management and development and,
- The need for the negotiation of fair international coordination arrangements for spectrum use in border areas.

Spectrum Landscape: Spectrum Demand, Availability and Future Releases

The Myanmar Posts and Telecommunication (MPT)'s monopoly in telecommunications services ended in August 2014 with the competitive entry of Telenor and Ooredoo. Over this very short period of competition in the wireless market as of end of March, 2015, the mobile telecommunications market has grown to a total of 18.1 million subscribers(pre- and post-paid combined), more than double the figure reported a year before and up from an estimated 4.4 million subscribers in March 2013.[1].

The mobile market growth hasn't slowed down based on the November 2015 data. The competitive landscape of the three operators at the end of November 2015 was as follows: Telenor: 13 million, Ooredoo 5.5 million, and MPT17.3 million subscribers[2].

PTD's estimates place the current mobile population coverage at approximately 50% of the population. Limited wireline infrastructure and the insatiable appetite for telecom services in Myanmar means wireless demands are increasing and more spectrum need to be made available. PTD will, over time, consider licensing a full range of spectrum availability options to meet the need of competitive Fixed and Mobile services, in order to make efficient use of spectrum and to provide consumers with choice of services and service providers at a reasonable cost.

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[1]TeleGeography CommsUpdate, 12 May, 2015, available at: www.telegeography.com/products/commsupdate/articles/2015/05/12/myanmar-mobile-growth-beats-expectations-with-18-1m-active-users/

[2]PTD (November, 2015)

The following bands could potentially be made available by PTD for assignment in the next 5 years:

- Unassigned portions of the 850/900 MHz and 2100 MHz bands;
- 700 MHz;
- 1800 MHz;
- 2300 MHz; and,
- 2600 MHz.

These bands were identified for consideration in light of the allocations of the updated NTFA (National Table of Frequency Allocation), spectrum already assigned and spectrum release activities internationally with a particular emphasis of Asia-Pacific Telecommunity (APT) countries.

This Roadmap sets out the release of 2.6 GHz, a portion of 900 MHz, followed by 1.8 GHz, 700 MHz and the balance of unassigned 800 and 900 MHz over a 5-year period. The Roadmap is consistent with the priorities established by PTD and has considered the comments received from stakeholders in the consultation process. Previously, Ministry/PTD had made provision in a separate process for the 4th operator including a portion of spectrum in the 900MHz and 2100MHz bands.

Following the release of the additional spectrum in the individual bands, PTD can monitor deployments over the period and reassess its release plan to include additional allocated spectrum as appropriate.

Technological Options for Operators to Improve Spectral Efficiencies

Globally, many mobile service operators are deploying heterogeneous network architectures, which are a mix of large and small cells, this mix helps meet the explosive growth in traffic and address traffic requirements in specific areas. These small cells, called femtocells and picocells, are low-power base stations operating within licensed spectrum, allow operators to increase their network capacity by reusing spectrum, offloading traffic from their macro networks, resulting in more capacity and improved service to subscribers.

In addition to using their licensed spectrum, operators are increasingly turning to licence-exempt spectrum to meet the bandwidth requirements for mobile data. In the United States, for example, AT&T supports approximately 45,000 licence exempt hotspots, providing Wi-Fi access for the company's wireless customers.

A recent study found that the number of Wi-Fi hotspots is expected to increase by three hundred and fifty percent over four years (2011-2015) as more and more operators around the world deploy hotspots to offload traffic from their mobile networks.[3]

With the growth in wireless services to subscribers, spectrum necessary to support backhaul for mobile network deployments has become a critical component for the

[3]See the Wireless Broadband Alliance's 2011 report entitled *Global developments in Public Wi-Fi* (http://www.wballiance.com/wba/wp-content/uploads/downloads/2012/07/16_WBA-Industry-Report-2011-_Global-Developments-in-Public-Wi-Fi-1.00.pdf).

operation of mobile networks and consequently, a very important consideration in calculating spectrum needs of the operators.

This Roadmap includes a discussion of the current situation and makes recommendations to improve effective and efficient utilization of this equally essential spectrum for backhaul microwave links. Mobile broadband networks and supporting backhaul will continue to evolve to meet increasing capacity needs. Microwave carrier aggregation, along with a host of other technical advances, will facilitate the efficient use of spectrum in short haul, high frequency bands. These efficiency gains are critical in meeting the capacity needs of operators not only in densely-populated areas, but also in rural areas where lower frequency bands are typically used.

Further details regarding technological changes are presented in section 2.2.

This Roadmap should be seen as an evolving document that necessarily will evolve with the advancement of domestic spectrum policies, introduction of new technologies and international activities including spectrum allocations, treaties with neighbouring countries, and the recommendations from ITU, WRC and the APT.

The Roadmap will deal with the following issues:

- Current Landscape, spectrum supply and demand; inventory of spectrum licensed and available;
- The challenges of transitioning from legacy Ministry/PTD to the new modern Spectrum Management regime including supporting spectrum policies, procedures as well as development of internal processes;
- Global/Regional considerations (ITU, WRC, neighbouring countries, treaties, APT, etc.);
- Possible allocations that could be made available;
- Consultative approach for the release of specific identified bands and bandwidths (BWs);
- Identify key stakeholders;
- Provide stakeholders with and overview of approach and planned Spectrum management activities;
- Provides Ministry/PTD planned initiatives for the provisioning of domestic satellite services in Myanmar.

1. Introduction

The radio frequency spectrum is a natural, finite, non-depleting and valuable national resource. Radiofrequency spectrum is used for a broad range of applications serving private- and public sector activities and provides many important social and economic benefits to the citizens of Myanmar. Over the last two years Myanmar has seen steady growth in demand for spectrum used to support a variety of commercial mobile broadband voice, data' and video services. Along with the deployment of commercial systems, Myanmar has experienced significant growth in microwave backhaul systems used to support the new commercial wireless services.

The radiofrequency is currently managed through the Ministry and its PTD – the de facto regulatory body. Under Ministry- the legacy Ministry, the Minister announced that PTD would evolve into a new independent regulator the Myanmar Communications Regulatory Commission (MCRC) within the next one to two-year period[4]. The management of the radiofrequency spectrum is guided through the provisions of the Telecommunications Law and Spectrum rules.[5]. It is expected that the Ministry will continue to have responsibility for high-level spectrum policy and strategy – including spectrum allocations and the MCRC will be responsible for the management of the spectrum.

The rapid growth of telecommunications has placed increasing demand on the spectrum currently available and licensed. At the same time, increased liberalization of spectrum access results in spectrum management challenges to ensure proper processes and procedures are in place to manage transition in regulatory regime.

Ministry recognizes that transparency and predictable policy making are keys to promote investment in networks and new services. In this context, PTD is committed to support growth of new services with an emphasis on commercial mobile services over the next five years and beyond. With the completion of the Roadmap, PTD will provide stakeholders with an outline of its planned activities that will enable orderly development and release of spectrum and correspondingly, spectrum resources necessary to help meet demand of users are available. This Roadmap provides stakeholders and interested parties with information concerning Ministry/PTD views on, and correspondingly, plans to address current spectrum utilization issues. This Roadmap also identifies plans for spectrum release - in the next 5 years, designed to ensure that adequate spectrum is available for growth of communications systems as well as the introduction of new competitive service. The plan provides for orderly development and makes recommendations - based on internationally established best practices, on steps to minimize incompatible assignments resulting in radiofrequency interference.

It should be noted that effective spectrum management program requires a number of integrated activities including appropriate legal frameworks, effective policy, spectrum planning (International and domestic), licensing frameworks for efficient assignment, interference management, compliance programs, institutional relationships with key

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[4]The actual name of, and the time to implement the new independent regulator are influenced by a variety of factors, including regulatory reform and therefore are still to be confirmed.

[5]The Telecommunications Law (The Pyidaungsu Hluttaw Law No. 31, 2013)

The 4th Waxing Day of Thadingyut, 1375 M.E. (8th October, 2013)

stakeholders and efficient administrative business processes. Implementation requires a Regulatory agency with committed and trained staff, with the tools and the capacity to manage the program. Since spectrum management is a program that requires numerous integrated activities the Roadmap occasionally makes reference to various activities and issues identified. However, the focus of the Roadmap is on spectrum needs and how best to satisfy those needs for spectrum through effective and efficient planning and allocation. As a separate related activity, Ministry/PTD will assess recommendations made by a consultancy firm concerning approaches to streamline radiofrequency spectrum assignment and licensing within allocated bands in order to ensure efficient utilization.

1.1. Approach

While developing the Roadmap, the Ministry – the legacy ministry and PTD - its regulatory arm, gave due consideration to all existing material that provided insight into spectrum and telecommunications development in Myanmar. Inputs were sought early on from a broad range of stakeholders. This provided a baseline of the current frameworks (policy, regulatory and precedents) now guiding spectrum development, where Ministry/PTD stands in development of the spectrum management program and development of the spectrum resource. Also identified are the needs and challenges both from a regulatory point of view and from a client perspective in order to assess gaps and develop priorities to address gaps laying out the Roadmap. The scope of our review included a review of the following:

- Legal Frameworks
    - Legislation
    - Policy
    - Licensing frameworks
- Technical Standards
- Treaties
- Approaches to Assign Spectrum (Tools)
    - Procedures and processes
    - Licence Records
- Stakeholder Consultation
- Spectrum assigned in Myanmar and nearby countries
- International frameworks to minimize interference
- Spectrum needs
- Ministry Priorities
- Proposals going forward
- Institutional arrangements

1.2. Purpose

The telecommunications industry relies heavily on the use of the radiofrequency spectrum and in the last two years there has been an increasing demand for spectrum access. As other markets and industries grow we will also see increasing demand for spectrum access

by business and government to support increased efficiencies in their operations. The radiofrequency spectrum is a limited natural resource and ensuring it is allocated and assigned effectively and efficiently allows the Government to maximize its use so that it provides the maximum return to the Union of Myanmar. Ministry of Transport and Communications is the lead Ministry for the telecommunications sector and PTD – Ministry's regulatory arm manages the radiofrequency spectrum. Through this consultation we invite all stakeholders to put forward, with supporting rationale, alternative proposals to those presented in this paper.

1.3. Consultation Process with Stakeholders

The final Roadmap document reflects comments received from stakeholders on or before February 29th following the publication of the draft Roadmap as well as comments received during or after the February 16th Powerpoint presentation and public information session. The PTD presentation included the following:

- Overview of the Roadmap Process
- Key Objectives
- Key Proposals
- Key Questions

The comments received from stakeholder will be released on the Ministry web site http://www.mcit.gov.mm/news/ptd_news except where these contain confidential information.

1.4. Structure of Report

The Roadmap is presented in three main parts:

1. **Part 1 – Drivers of the Spectrum Roadmap**

   There have been significant developments since liberalizing the spectrum management in Myanmar. These changes have resulted in an explosion of new products and services resulting in a growth in demand for spectrum access. The significant increase in demand for spectrum has had a significant impact on availability of clear interference free spectrum. This and the need to maximize the return possible from this limited and valuable resource are now primary drivers of the Roadmap and the plan for specific initiatives that are proposed to take place over the next 5 years. The initiatives will form the focus of spectrum management activities over the next 5 years.

2. **Part 2 - Regulatory Initiatives**

   There are significant challenges in transition from the historical approach of spectrum management and state-deployed services to a liberalized market approach that encourages foreign investment and greater access to radio spectrum for a variety of operators and the deployment of private competitive telecommunication services. The PTD recognizes that this change will require a meaningful shift in government thinking to focus on governing and management

of the spectrum resource and on assisting a plethora of users, operators and service providers – public, government and private, in the development of spectrum use and the development of new technologies services.

3. Part 3 – Rapid Growth of Infrastructure and Service

Demand within specific frequency bands and services offered are growing at enormous rates placing significant pressures on these licensees and bands in which they operate. The Roadmap outlines plans to release more spectrum to meet current and anticipated demand going forward.

2. Part 1: Drivers of the Spectrum Roadmap

In this section, we look at drivers and review changes taking place that should be factored into the spectrum management plan for the release of future spectrum.

2.1. Changes at home

Political, social and economic reforms as well as specific initiatives to modernize have created demand for telecommunications services in Myanmar.

Myanmar's economy is poised for growth as part of South East Asia - the world's fastest growing economic region and its strategic position between larger, diversified economies: India, the People's Republic of China, and Thailand. Recent reforms have also motivated interest in leveraging this momentum and maximizing its domestic growth potential. Asian markets offer huge potential for harmonization of trade rules, attraction of new investment in telecommunications infrastructure, leveraging technology advances and economies of scale for radio equipment.

The total population of Myanmar is roughly 51.4 million[6] and while still predominantly rural, there are several metropolitan areas with significant populations: Yangon (7.4M), Ayeyawady (6.2M), Mandalay (6.1), Sagaing (5.3M), Bago (4.9M), Mon (2M) and Naypyitaw (1.2M).

Myanmar's economy has traditionally been dependent on resource industries such as mining and forestry that in most countries are typically users of the radio spectrum supporting land mobile communications, data, and fixed systems and various industrial applications. Infrastructure related to electrical distribution and supporting utilities are also growing and are also dependent on access to radio frequencies for mobile and fixed applications. As the economy develops we expect increase spectrum requirements across all industries, similar to all other developed countries.

Myanmar was - until the licensing of new operators in 2014, one of the least connected countries in the world. The context of this radical change was set out in the Myanmar Master plan:

- **Among the lowest fixed and mobile teledensity rates in the world**, long waiting times for a fixed line, prohibitive prices for acquiring a mobile connection, and internet connections available to very few had been characteristics of the market until 2014. Myanmar ranks close to the bottom in the World Economic Forum's networked readiness index.
- **Thinly spread telecommunications infrastructure**, that is concentrated in the main towns and cities, with few fibre links, a limited mobile towers infrastructure across the country and restricted capacity for handling incoming and outgoing international traffic.

[6]Population and housing census, 2014

- **Only basic services available in most of the country**, comprising voice services, limited data connectivity and very few locally developed value added services or applications.
- **Weak telecommunications policy and regulatory framework**, with an incomplete institutional framework to address challenges and capture the opportunities mass telecommunications offers Myanmar's citizens, businesses and Government.

Since 2014 with the launch of new mobile operators, Myanmar has witnessed a transformation in the pace of mobile telecom industry evolution. Almost overnight, Myanmar's 130-year old telecommunications sector has rapidly moved ahead from the past through measures to connect more of the Myanmar people and expose them to a new world of possibilities. The latest digital network technologies and handset equipment are facilitating this, with mobile as the clear connection choice for the people. This transformation can be summarized in the following metrics:

- **Explosive connections growth**: connections amongst Myanmar population rising from around 10% in 2013 to over 40% today (measuring all connections[7] as a % of population)
- **Smartphone-led**: between 60-70% of customers are using smartphones, a uniquely high uptake at this early stage of development compared to anywhere else in the world
- **Internet in the people's hands**: Myanmar is witnessing data usage of around 500 Mb per month with promising uptake where mobile internet is available in rural areas
- **A foreign investment success story**: with an estimated 250,000 new jobs to be created over the coming 15 years through investment of over USD 2.8 billion in just two years from China, Japan, Norway, Qatar and other countries, placing telecommunications as one of the lead sectors for FDI into Myanmar

As of end of March, 2015, the mobile telecommunications market has grown to a total of 18.1 million subscribers (pre- and post-paid combined), more than double the figure reported a year ago and up from an estimated 4.4 million subscribers in March 2013.[8] The mobile market growth has not slowed based on the latest mobile subscribership data in Myanmar. The competitive landscape of the three operators at the end of November 2015 was as follows:

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[7]The difference between the number of mobile connections (the metric frequently used by the industry to measure market size and penetration) and what we term unique mobile subscribers. 'Subscriber' refers to a single individual that has subscribed to a mobile service and that person can hold multiple mobile connections (i.e. SIM cards). A single subscriber may use two SIM connections, and is counted by the as two mobile connections.

[8]TeleGeography CommsUpdate, 12 May, 2015, available at: www.telegeography.com/products/commsupdate/articles/2015/05/12/myanmar-mobile-growth-beats-expectations-with-18-1m-active-users/

Telenor: 13million, Ooredoo 5.5 million, and MPT 17.3 million subscribers[9]. The prime connectivity in Myanmar is via wireless networks, to meet demands of subscribers and to remain competitive. Licensees will want to deploy higher capacity 4 G LTE in the near future.

As the economy improves and the Industry grows we anticipate spectrum demands from numerous industries. While actual growth targets vary[10], the Asia Development Outlook 2015 - After moderating in FY2014, growth is forecast to accelerate to 8.3% in FY2015 and remain close to this pace in FY2016 as it is propelled by investment stimulated by structural reform, an improved business environment, and Myanmar's gradual integration into the sub-region.

Historically, decisions concerning spectrum access and use were made at a time when spectrum resources were plentiful and the primary user was the category: Government users. Assignments were made without benefit of spectrum utilization planning and without the discipline of band plans and standards or appropriate records. As a result, as spectrum demand increased, new competitive entities entered the market and certain high demand bands became congested and interference became common. In addition, consumers are increasingly levering the benefits of new technology. Consequently, consumers have imported and installed radio systems comprised of equipment from various countries that incorporate a range of technical standards. The utilization of such equipment is a frequent source of interference in Myanmar.

2.2. Technology

New services and ecosystems as well as rapid advancements in radio access technologies such as those enabling simultaneously sharing of a given band of spectrum, have significantly changed the way spectrum is being used. Growth in network coverage, penetration rates and uptake of services are educating consumers and this in turn is expected to further increase consumer demand for newer and more advanced products and services.

Fast evolving technologies present new opportunities for as well as existential threats to traditional ways of doing business. New technologies drive new applications; increased demand, falling prices, a growing knowledge base and expertise provide opportunities for improved efficiencies and radically change on how we work. The concept of the "Internet of Things" (IoT) connecting millions of devices presents a whole new paradigm in technology and connectivity. Breakthroughs in new products connectivity through Wi-Fi and commercial networks offer opportunities for technology use and sources of revenue.

The role of technology is an important a driver of competitive advantage and innovation in the business framework[11]:

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[9]PTD (November, 2015)

[10]World Bank recently cut regional growth forecasts to 6.5pc

[11]Source: Boundless. "Technology as a Driver and Enabler of Innovation." *Boundless Management*. Boundless, 21 Jul. 2015. Retrieved 15 Dec. 2015 from https://www.boundless.com/management/textbooks/boundless-management-textbook/organizational-culture-and-innovation-4/technology-and-innovation-37/technology-as-a-driver-and-enabler-of-innovation-201-3574/

- Innovation is a primary source of competitive advantage for companies in essentially all industries and environments and drives efficiency, productivity, and differentiation to fill a higher variety of needs;
- Innovation builds upon itself, enabling new approaches within the evolution of technology;
- Innovation works best in hubs such as California's Silicon Valley which provide powerful resources that entrepreneurs and businesses can leverage in pursuing innovation;
- In pursuing innovation, Singapore and South Korea are all strong representations of how embracing technology leads to innovation, which in turn leads to economic growth.

According to a recent Goldman Sachs Investment Research report[12], the Internet of Things (IoT) will be the next driver of spectrum demand. IoT has an enormous scope that touches every facet of consumer and business on a daily basis. The report organizes into five key verticals of adoption:

1. Connected Wearable Devices,
2. Connected Cars,
3. Connected Homes,
4. Connected Cities, and,
5. The Industrial Internet.

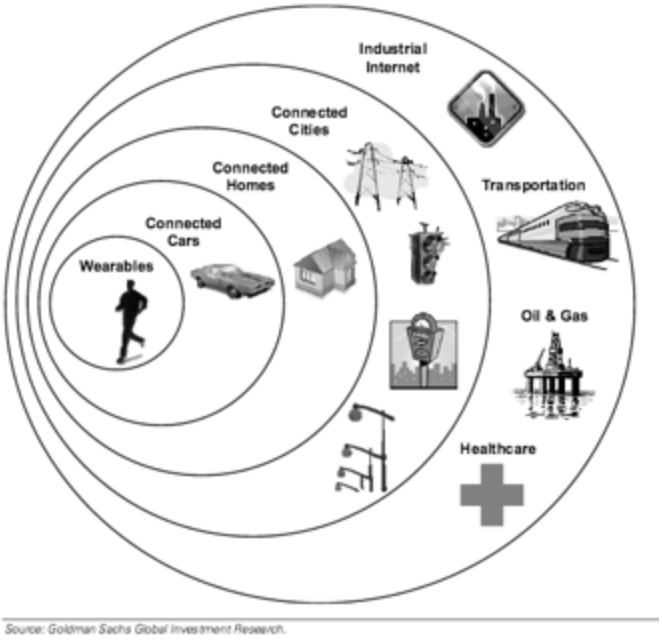
Enablers of the IoT include:

1. Cheap sensors,
2. Cheap bandwidth,
3. Cheap processing,
4. Smartphones,
5. Ubiquitous wireless coverage,
6. Big data, and,
7. IPv6 - the newest version of Internet Protocol

[12]Goldman Sachs Global Investment Research, September 3, 2014

The verticals are summarized in the following schematic diagram:

Figure 1: The IoT Landscape



As Mobile broadband networks and supporting backhaul continue to evolve spectrum and new technological enhancements will be required to meet increasing capacity needs. Microwave carrier aggregation, along with a host of other technical advances, will facilitate the efficient use of spectrum in short haul, high frequency bands. These efficiency gains are critical in meeting the capacity needs of operators not only in densely populated areas, but also in rural areas where lower frequency bands are typically used.

A developing trend is the use of front-haul[13]. In this scenario, operators that are looking to increase capacity have proposed C-RAN[14] architectures that co-locate BBUs in order to allow sharing of resources. Front-haul is a fundamentally different architecture from the mobile

[13] Front-haul is the link that connects the Baseband Unit (BBU) to the associated Remote Radio Head (RRH)

[14] C-RAN – "Cloud Radio Access Network"

backhaul approach that has been widely implemented around the world. Both architectures offer their own benefits and drawbacks when it comes to deploying and operating the connectivity network for supporting mobile broadband expansion. Operators today require the flexibility to combine multiple different technologies and concepts including front-haul and backhaul, microwave and optical fibre, small cells and macro cells resulting in heterogeneous networks that employ different mobile technologies within the same zone to meet the range of needs they today face.

2.3. International Activities

With intensification in the use of spectrum and rapid changes in the wireless ecosystems, harmonization of spectrum has become ever more essential and conversely, non-harmonization results in ever more severe impacts. At a broader level, harmonization involves:

- Alignment of Spectrum allocations,
- Utilization policies and Equipment standards with neighbouring countries,
- Effective and efficient sharing of spectrum in border area through negotiated coordination arrangements, reduce incompatible spectrum use, and
- Access to other markets for import and export of services and equipment.

Myanmar's participation in ITU, WRC and the APT (the APT representing about 60% of the world population) is important to ensure understanding, participation and alignment with major decisions concerning spectrum allocations, use and international standards. Harmonization of spectrum use and standards translates into more choice of products for consumers, reduced costs due to economies of scale, improved roaming capabilities and simpler frameworks to minimize interference with neighbouring countries. Development of capacity to assume leadership roles in these forums is also essential to build consensus with other countries that reflect Myanmar's and South East Asian interests and preferences and to identify opportunities for working with gear suppliers in the application new technologies.

2.4. Improved spectrum services

Ministry/PTD the regulatory body responsible for spectrum management in Myanmar wishes to facilitate spectrum access to those that need it. This requires the development of appropriate regulatory frameworks to ensure this valuable national resource is developed in an efficient manner, while at the same time avoiding imposing an unnecessary regulatory burden on users. Various regulatory initiatives have been identified that will be implemented over the next 5 years, each with a view to improve spectrum access, promote efficiencies and streamline the licensing process. Initiatives include implementation of standards, transparent processes and partnership arrangements with industry.

3. Part 2: Regulatory Initiatives

There are specific needs and challenges from a regulatory point of view that impact the delivery of spectrum management services to both to operators providing wireless services and to users requiring access to spectrum for their private use, often supporting commercial

businesses. This, in turn, impacts the subscribers of wireless services and the productivity and efficiency of commercial businesses.

3.1. The Creation of Myanmar Communications Regulatory Commission

The radio frequency spectrum is currently managed by PTD – the de facto telecommunications Industry regulator. This regulatory body is currently embedded within the Ministry of Transport and Communications. The Myanmar government has agreed to create the Myanmar Communications Regulatory Commission (MCRC) – an independent spectrum regulator incorporating the functions and staff of the current PTD.

It is expected that the essential components for the new Myanmar Communications Regulatory Commission - including enabling legislation, organizational structure, processes and procedures, staffing, etc. will be implemented on a priority basis.[15] Following this period, it will take time to build the organizational capacities needed; however, we expect to see immediate improvements in the efficiency and effectiveness of regulatory services by just having an organization with resources dedicated to managing the spectrum.

Among other responsibilities, the MCRC will have the prime responsibility to manage spectrum access and client services delivery including licensing, interference mitigation/enforcement, interfacing with neighbour countries regulatory agencies concerning spectrum sharing in border areas. Radiofrequency spectrum is an enabler of economic development. Working with other domestic regulatory authorities, MCRC will enable spectrum access facilitating the effective and efficient development and use of the radio frequency spectrum resource that benefits both Industry and consumers.

Action Planned by Ministry/PTD:

Ministry has engaged the service of an external consulting company to provide the framework of the Myanmar Communications Regulatory Commission to in line with the international practice.

[15] Incyte Consulting - an Australian consultancy has been retained to assist MINISTRY in the creation of the new regulator.

4. Myanmar Telecommunications Framework

Ministry maintains a number of official policy documents that provide guidance on the administration and implementation of Telecommunications in Myanmar. Frameworks are important for the orderly development of the radiofrequency spectrum and provide the necessary legal basis, policy direction and tools providing access to radiofrequencies. The key frameworks are outlined below, noting that - with the exception of the Telecommunications Law, they have yet to be promulgated by the government.

4.1. Telecommunications Law

The legal framework for the management of the radio frequency spectrum can be found in Telecommunications Law (TL)[16]. The TL incorporates a comprehensive approach to spectrum management including the applicability, objectives of the law as well as licensing requirements for operation for telecommunications services, possession of radio apparatus, responsibilities of licensees, management of the radiofrequency spectrum and orbital slots, technical standards, installation, inspection and enforcement.

4.2. Spectrum Rules

The Spectrum Rules provide a framework for the management and utilization of radio frequencies and Radio Apparatus. These Rules also contain the rights and obligations of organizations and individuals involved in the management and use of radio frequencies in the Republic of the Union of Myanmar. Finally, these Rules govern the process to authorize the use of Frequency Spectrum by eligible licensees.

The Telecommunications Act sets out the spectrum rules for the major bands as follows:

1. Final Spectrum Rules
2. Final Spectrum Rules - Annex A – National Table of Frequency Allocations (NTFA) – 23 Dec
3. Spectrum Rules - Annex B - Distress and Safety Communications Frequencies 7Dec. 13
4. Spectrum Rules - Annex C - Spectrum Fees 7Dec13
5. Spectrum Rules - Annex D - Public Land Mobile 7Dec13
6. Spectrum Rules - Annex E - Frequencies and Channelling Arrangements 7Dec13
7. Spectrum Rules - Annex F - Aeronautical Mobile Frequencies 7Dec13
8. Spectrum Rules - Annex G - Broadcasting Frequencies 7Dec13
9. Spectrum Rules - Annex H - Specification of Emissions 7Dec13

[16]The Telecommunications Law (The Pyidaungsu Hluttaw Law No. 31, 2013). Available at: http://www.mcit.gov.mm/sites/default/files/Telecom%20Law%20English%20Version_0.pdf

4.2.1. Register of Frequencies Assigned

A Register of frequency assignments contains technical information about Frequency assignments made by PTD, or any other authorized agencies in Myanmar. Maintaining an up-to-date list of all frequencies assigned, including pertinent technical information about the assignment is essential information to carry out the following functions:

a) Identify potential frequencies for assignment

b) Carryout compatibility studies to assess the impact of interference

c) Conduct cross border as well as inter-user frequency coordination

d) Evaluate the degree of frequency reuse

e) Investigation of radiofrequency interference

f) Assess frequency congestion within a specified band or frequency range

g) Identify unlicensed operation

Action Planned by Ministry/PTD:

Consistent with section 9 of the Spectrum Rules, complete a frequency register of all authorized assignments and relevant data elements.

4.3. Licensing Rules for The Republic of the Union of Myanmar December 23, 2013

In Myanmar, there are specifically defined licences, each with associated privileges and proscribed activities. Licensees eligible to hold spectrum must also apply for spectrum use authorizations. In addition, according to the Telecommunications Law, Chapter IV, any entity wishing to possess or use telecommunications equipment shall apply to the Department for a telecommunications equipment licence.

The objectives of Licensing Rules are to promote competition and liberalization of the telecommunications market; ensure transparency in licensing application, award and administration process; establish a technology and service-neutral approach; and to ensure non-discriminatory treatment of similarly situated licenses in the Republic of the Union of Myanmar.

Licensing Rules set forth the following scope:

a) The framework for the licensing of Telecommunications Networks and Telecommunications Services;

b) The authorized activities, rights, and obligations associated with Telecommunications Service Licenses and Telecommunications Equipment Licenses;

c) Overview of authorizations to scarce resources for Licensees of Telecommunications Networks and Telecommunications Services;

d) Monitoring and enforcement mechanisms for Licensees of Telecommunications Networks and Telecommunications Services; and

e) Transitional provisions from the current licensing regime to the framework specified under these Licensing Rules.

4.4. Policy

In this section of the Roadmap, were view various policies, frameworks and reports that govern the management of spectrum in Myanmar with a particular focus on the deployment of commercial spectrum and services.

4.4.1. Myanmar Telecommunications Master Plan

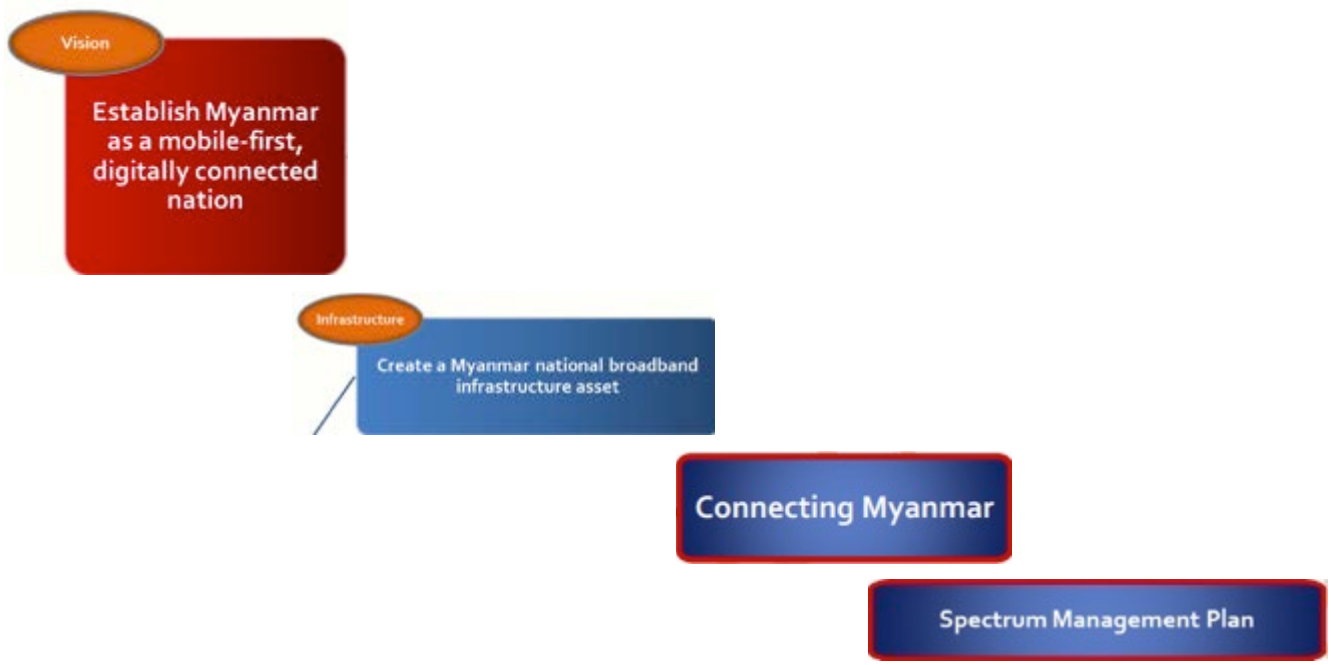
As part of its policy priorities, the (Ministry) enunciated in a Master Plan its vision for Myanmar to become a **mobile-first, digitally connected nation**. This vision is centred on three connected themes:

1. **Connect the people of Myanmar** through a series of initiatives and policy measures to be implemented over the next five to seven years to create a broadband infrastructure asset for Myanmar.
2. Use this broadband infrastructure to connect most Myanmar citizens to high-speed Internet services, in order to assist economic advancement through **Innovation and digital transformation** in many industries.
3. Apply digital technology and high speed connectivity in order to support the emergence of **eGovernment** services, in order to make public services and information more easily accessible to everyone and increase the efficiency with which the Union Government and State Governments work together

The Telecommunications Master plan also develops these themes into three enabling objectives:

1. Create a Myanmar national broadband infrastructure asset – through initiatives to Connect Myanmar to broadband services, to encourage Affordability and Quality, and to safeguard security
2. Deliver communications content and services for the Myanmar people – to foster a mobile-first orientation in the delivery of many goods and services in the economy, to encourage truly local innovation, to understand and protect consumer rights and drive customer value
3. Create an enabling institutional framework – envisioning a dynamic Ministry setting policy, an empowered and independent Regulator, accountable and autonomous service providers, and most important of all, enriched and satisfied customers who benefit from a wide choice of high quality, competitive and affordable services.

There are policy programs to support each of the objectives. The Policy program "Connecting Myanmar" will be one of the most substantial elements of Ministry's policy strategy. This program will focus directly on supporting the market in deploying, leasing and wholesaling networks as Myanmar builds its national broadband telecommunications infrastructure. A critical component of creating a "national broadband infrastructure asset" is wireless infrastructure and the preparation of a Spectrum Management Plan.



Source: Myanmar Telecommunications Master Plan (2015)

The existing Telecommunications Plan provides a vision reflecting best practices and has been approved by the Minister. The plan provides a guiding instrument to form future policy.

4.4.2. The Wireless Broadband Master Plan (WBB) for the Union of Myanmar

The WBB Master Plan, developed by the ITU, provides an important input into the development of a Radiofrequency Spectrum Roadmap. Drafted in 2012, the report describes the broadband market in Myanmar, provides international context and in particular, highlights the need for radiofrequency spectrum. The report provides specific objectives[17] for the Management of the radiofrequency spectrum –some elements of which are incorporated as recommendations and objectives in this Radio Spectrum Roadmap.

4.4.3. Roadmap for transition from Analog to Digital Terrestrial and Mobile television in Myanmar

The Roadmap for the transition from analogue to digital terrestrial television broadcasting has been jointly developed by an ITU expert and the National Roadmap Team (NRT) of Myanmar.

[17]WBB Masterplan, section 5

The report provides a good background of the existing broadcast systems and service, as well as the evolving regulatory reforms (some of which have since come to fruition).

The Plan is comprehensive and describes the deployment strategy for a phased approach to the Digital Switchover, including: standards, station deployments, set-top-boxes and antennas, etc. and the roles and responsibilities of the Regulator and operators through the deployment phases.

RF Roadmap includes specific items such as Analog to Digital transition, assignment and licensing conditions (as well as later licensing deliverables), issues surrounding site approvals, site sharing, RF safety and protecting the public, and recommendations regarding the 'digital dividend'.[18] There was no associate frequency plan showing the frequencies allocated for migration.

Action Planned by Ministry/PTD:

Develop a Policy that:

a. Sets out the objectives of the Spectrum Management program;
b. Guides the development and implementation of Broadcast Spectrum including assignment policies, technical standards and licensing requirements; and
c. Distinguishes spectrum regulatory objectives for Broadcast allocated spectrum.

[18]Section 4.7 states: Analogue TV in Myanmar is now using channels in Band III. It has been envisaged that DTTB/MTV operations will be in UHF band to take advantage of the 8 MHz bandwidth. The VHF Band III frequencies as freed on implementation of ASO or a part of it could be auctioned to generate necessary funds for the DSO and ASO strategy.

5. Technical standards

This section presents the technical standards set forth by the Ministry as well as those planned for development.

5.1. National Table of Frequency Allocation (NTFA)

Incorporated as part of the Spectrum Rules, Annex A has been reviewed and updated. NTFA governs the use of the national spectrum resource for specific radio services.

5.2. Equipment Standards

Technical standards ensure compatibility in frequency allocation, assignment of systems and deployment of equipment. Telecommunications Law, provides specific requirements with respect to standards for equipment as outlined in Sections:

> ***24**. The Department shall determine and publish the relevant technical standards according to service in respect of the licenses with the approval of the Ministry.*
>
> ***25**. The Department shall supervise the licensees to comply with the technical standards.*
>
> ***26**. The Department shall determine the standards of types of Network Facilities and Telecommunications Equipment for import and export.*
>
> ***27**. A person desirous of manufacturing, selling or distributing any Network Facilities or Telecommunications Equipment shall apply to the Department in order to get the technical standard approval of the Network Facility or Telecommunications Equipment to be manufactured, sold or distributed by him in accord with the stipulations.*
>
> ***28**. The Department may issue or refuse to issue a technical standard approval after scrutinizing the application.*

As part of Ministry/PTD move to liberalise the telecommunications sector, it is important to establish a proper Equipment Standardization and Certification Framework in order to facilitate both the orderly transition to, and maintenance of equipment deployed in the market.

Equipment standards and certification schemes in many jurisdictions typically include the power to prescribe, or otherwise identify, technical standards or specifications for particular types of telecommunications equipment as follows:

1. To establish, or otherwise identify, authorized testing laboratories and certification bodies;
2. Identified procedures for testing equipment for certification or for demonstrating conformity to standards and requirements;
3. To establish domestic certification programs, or alternatively, the entry into agreements concerning equipment certification by other countries or authorities; and
4. The maintenance of registries identifying certified equipment and applicable certification criteria and standards.

The purpose of standards and certification schemes is to ensure compatibility of telecommunications equipment with the telecommunications networks to which they are connected, and to protect the public from improperly functioning or unsafe telecommunications equipment. The use of radiocommunications equipment raises additional concerns about safety, the possibility of harmful interference and for equipment to function in accordance with frequency and output specifications.

Within Myanmar, there are currently no published equipment standards or a framework for equipment certification.

Action Planned by Ministry/PTD:

Develop a framework for establishing standards and the approval of equipment permissible for use or licensing in Myanmar.

5.3. Spectrum Planning

Spectrum planning anticipates and responds to the major trends and developments in technology and the needs of both current and future users. Spectrum Planning identifies the bands and technical considerations for the assignment and licensing of spectrum and allowing its efficient use in an orderly manner. The degree of detail that may be included in a spectrum plan can be quite detailed, particularly when specific policies are developed for the many uses accommodated; we suggest as a starting point a national spectrum plan be developed for services now being licensed and deployed.

Publishing a PTD plan in the form of a national spectrum plan serves as an umbrella document describing how spectrum is to be used and would be comprised of various individual Spectrum plans. This plan would serve to guide interested parties in the planning of radio systems for specific services such as:

- Land mobile radio systems
- Point-to-point and point to multipoint systems
- Commercial radio systems
- Broadband fixed networks

Harmonization is an important element in spectrum planning. Projections based on historical growth domestically, as well as in other markets, provide some insight into spectrum needs over time. PTD understands the importance of spectrum planning and has started a process to develop a comprehensive spectrum planning process.

Action Planned by Ministry/PTD:

Develop a Spectrum Plan that provides information on spectrum available for use and assignment in order to meet the needs of interested parties requiring access to the radio Spectrum.

5.4. Band Plans

Band plans typically should provide the minimum technical requirements as well as equipment characteristics necessary for the efficient use of specific frequency bands. Sub-allocations should add further precision by specifying channeling for simplex operations, as well as, go and return channels for duplex split arrangements. Provisions should also be specified for the operation of frequencies in border areas, such as sharing arrangements, coordination requirements, technical requirements and often include roles and responsibilities of licensed operators.

Within Myanmar, PTD is in the process of developing formalized channeling plans. The Spectrum Rules, section 13 provide General terms and Condition to issuing a spectrum authorization stating:

> *"Consistent with National Table of Frequency Allocations. All authorizations to use frequencies or a frequency band shall be consistent with the National Table of Frequency Allocations."*

However, this is far too broad to guide efficient spectrum assignment decisions. The result of not having proper Spectrum Plans and Band Plans has resulted in inefficient spectrum assignment and use, and created artificial congestion impacting the ability to make further assignments in some bands.

However, limited information and guidance has been developed by Ministry/PTD for certain bands as follows:

- Spectrum Rules Annex B incorporates the Distress and Safety frequencies for non- Global Maritime Distress and Safety (GMDSS) and GMDSS. The frequencies follow ITU RR.
- Spectrum Rules Annex D – Public Land Mobile Spectrum Assignment Plan contains the specific arrangements that have been established for the public land mobile Telecommunications Services sector in Myanmar.
- Spectrum Rules Annex E – Frequencies and Channelling Arrangements for Maritime Mobile as extracted from the ITU RR.
- Spectrum Rules Annex F – Frequencies related to Aeronautical Mobile are provided based on ITU RR.
- Spectrum Rules Annex G – Frequencies identified for Broadcasting in Myanmar are provided including shortwave, AM, FM and TV.

Action Planned by Ministry/PTD:

Develop Standard Radio Plans that detail channeling plans and specific minimum requirements for operation of systems in designated bands.

5.5. Compliance program

Interference can occur in a number of bands. Without proper procedures in place to investigate and make determinations of relevant cases of reported interference, cases cannot be systematically addressed with some assurance that PTD findings can be reasonably enforced. A proper systematic approach to interference or any compliance investigation also lends confidence to stakeholders of PTD regulatory proficiency. Compliance programs are needed to ensure spectrum quality.

Action Planned by Ministry/PTD:

Develop a compliance framework for reporting, investigations, enforcement and maintaining compliance in order to minimize interference issues. Elements of the compliance program would include: Regulatory capacity building, implementation of compliance sampling programs, on-site Inspections, off-air Monitoring and an appropriate and implementable enforcement program.

6. Treaties

6.1. Bi-lateral/Multi-lateral Spectrum Sharing Agreements in Myanmar

Radio waves propagate through space and transcend national borders. Spectrum is a valuable national resource and countries should protect its sovereign right to interference free access. Frequencies in border areas should be carefully planned and coordinated to minimize the risk of interference in either country. Treaties ensure a compatibility of spectrum use and standards with a view to Regional and global harmonization and for fair access to interference free spectrum.

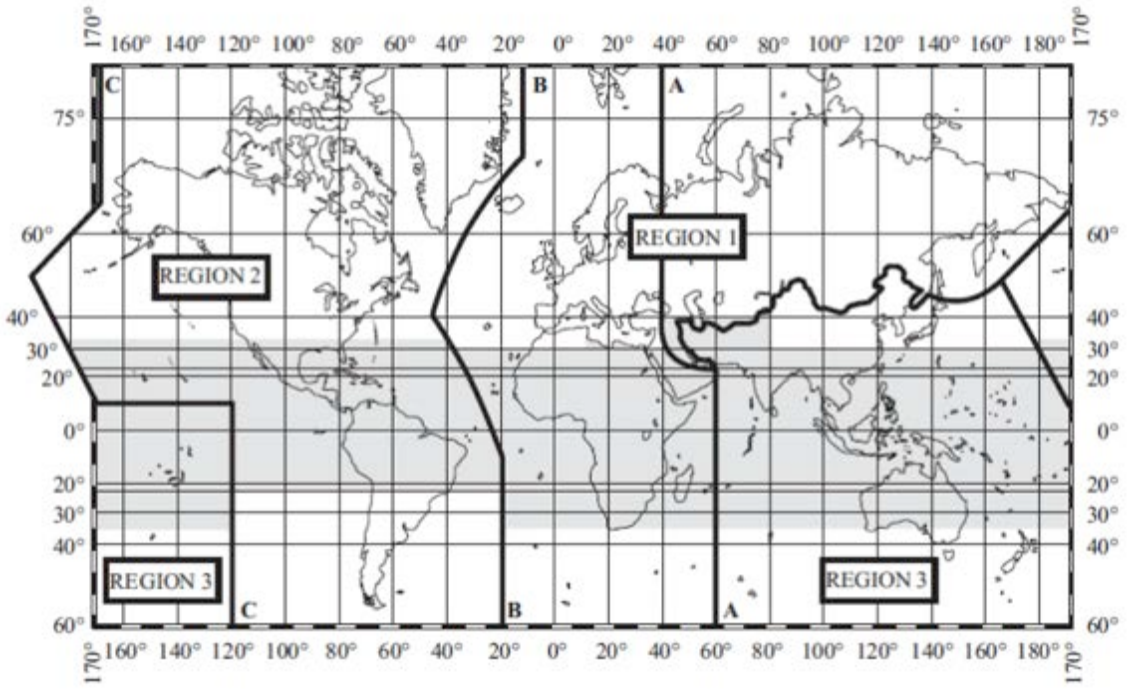
Myanmar currently has no bilateral or multilateral spectrum sharing agreements with neighbouring countries; however, Myanmar has initiated discussion with Thailand to pursue a bilateral framework in order to minimize the risk of interference in the border area. Similarly, Myanmar has plans for negotiations with other neighbouring countries – starting with Laos in the near future. Myanmar also participates in international wireless industry groups and spectrum regulatory planning forums and monitors the developments of ITU, APT and various other organizations.[19]

6.2. ITU

The Radiocommunication Sector of the ITU (ITU-R) serves to facilitate the equitable, efficient and economic use of spectrum among all radiocommunication services. The ITU-R maintains the international Radio Regulations, which define the allocation of spectrum bands to various types of services on the basis of the International Table of Frequency Allocations. Additionally, the ITU-R specifies technical standards to be observed by radio stations, as well as procedures for international coordination, in order to ensure technical compatibility of radio systems between countries. The Radio Regulations are reviewed and amended at the ITU's World Radiocommunication Conferences (WRCs), which are typically held every three to four years. The last WRC was held in November 2015 this year.

[19] Various regional, international and UN organizations include: 1) International Civil Aviation Organization (ICAO), 2) International Telecommunication Union (ITU), 3) United Nations (UN), 4) United Nations Development Programme (UNDP), 5) United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP), 6) Asia-Pacific Broadcasting Union (ABU), 7) Asian Development Bank (ADB), 8) Asia-Pacific Economic Cooperation (APEC), 9) Asia-Pacific Satellite Communications Council (APSCC), 10) African Telecommunications Union (ATU), 11) European Conference of Postal and Telecommunications Administrations (CEPT), 12) Inter-American Telecommunication Commission (CITEL), 13) Commonwealth Telecommunications Organisation (CTO), 14) European Communications Office (ECO), 15) Information for Development Program (InfoDev), 16) Pacific Economic Cooperation Council (PECC), 17) Pacific Islands Forum Secretariat (PIFS), 18) Pacific Islands Telecommunications Association (PITA), 19) Pacific Telecommunications Council (PTC), 20) UMTS Forum, 21) World Bank, 22) WiMAX Forum, 23) World Trade Organization (WTO).

Asia Pacific is in Region 3. The Asia Pacific Telecommunity (APT) organises Preparatory Group meetings (APG) to formulate common positions among members for consideration at the WRC.



6.3. APT

The Asia Pacific Telecommunity (APT) was founded on the joint initiatives of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the International Telecommunication Union (ITU). The APT is an intergovernmental organization and operates in conjunction with telecom service providers, manufacturers of communications equipment, and research and development organizations active in the field of communication, information and innovation technologies. APT serves as the focal organization for ICT in the region.

The Asia Pacific Telecommunity includes 38 member countries, 4 associate members, and 131 affiliate members of which Myanmar is a member.

The 13th Session of the General Assembly of the Asia-Pacific Telecommunity was held from 25 to 26 November 2014 in Yangon, Myanmar. The Ministry of Transport and Communications of the Republic of the Union of Myanmar hosted the meeting.

In the short-term, the PTD will look closely at neighbouring countries spectrum agencies or agencies of countries where they see alignment in philosophical approach to spectrum management, and work in collaboration with those countries in order to leverage spectrum management tools (policies, procedures and standards) where possible. This is practical for tools such as spectrum band plans, utilization policies, licensing procedures and equipment standards, even if some modifications are considered appropriate. As spectrum management

include many functional areas where detailed technical analysis capability is required, appropriate tools to undertake this analysis needs to be available with staff trained to use them.

Action Planned by PTD / Ministry:

Continue to participate in International forums such as WRC, APT, etc. in order to ensure Myanmar's spectrum interests are well represented.

7. Approaches to Spectrum Assignment

Frequency allocation and assignment is a central key activity of spectrum management. Once allocated, the specific spectrum assignments significantly impact how efficiently the band is used. Spectrum assignment approaches are often made by factoring various broader policies and objectives. There are generally three accepted approaches used for spectrum assignment:

- Traditional or 'command and control',
- Competitive, and
- Commons/licence exempt.

Each approach has associated advantages and disadvantages and all three have a place in spectrum management and are commonly used by regulatory agencies as tools to allocate and assign spectrum.

(Note: This section included in the Roadmap because it is a part of PTD's strategic considerations for the Department for good governance. However, detailed discussion on *approaches to assign spectrum* will be included in a separate licensing report that PTD has commissioned).

7.1. Traditional Approach

The traditional approach, often referred to as *Command and Control*, relies on the administrative decision approach to assign spectrum based on the type of use (how spectrum may be used - e.g. fixed, mobile, or possibly further to dispatch, paging, etc.) or type of user (spectrum earmarked or sub-allocated to a type of user such as public safety, military, commercial, government. The process is accomplished using an integrated spectrum management system that is comprised of existing spectrum allocation as per the National table of Frequency Allocations (NTFA) and spectrum use policies, licensing policies, regulations, administratively established fees and technical and radio system standards. It is this integrated spectrum management system that makes the effective and efficient management of spectrum users and their systems and frequency assignments possible. The end result is that a large number of users can be accommodated with an efficient use of limited spectrum. The FCFS approach is used in instances where there is sufficient spectrum to meet the demand in a given frequency band. Assignments are generally made on a First-come, First serve (FCFS) basis. Almost all agencies use the traditional approach to spectrum management as a tool in spectrum management. Spectrum access and licensing decisions are generally administratively decided following defined procedures. Authorizations do not normally confer any tenure or rights (exclusivity) and frequently have associated operating conditions. Where the demand for spectrum in any given band is expected to exceed, supply regulators may change from a FCFS licensing process to a competitive process.

7.2. Competitive Approach

Competitive approaches to spectrum access and licensing decisions range from comparative reviews to varying degrees of mechanisms that are market-based. A comparative review approach involves a comparative assessment of defined attributes of a given application relative to other competing applications. Market-based mechanisms may

involve satisfying some administrative qualifying criteria and submission of bids in some form of an auction. Licences frequently (but not always) include exclusive rights and may include privileges to participate in secondary market activities such as to sell, trade or lease spectrum to a third party, sometimes requiring additional regulatory approvals. Market mechanisms constitute a more liberalized approach to spectrum management. These are generally preferred because they are more economically efficient. In effect, the market determines who gets access to spectrum and bidders determine the spectrum fees based on the value entrants place on the spectrum and the associated rights/privileges. Generally, depending on the particular auction approach used, bidders that value the spectrum the most would win the rights/privileges associated with the assignable resource. Auctions are now the globally preferred method of spectrum assignment.

7.3. Commons/Licence Exempt Approach

In designated bands equipment (usually approved or certified), meeting specified technical criteria is preapproved for operation without the need to apply for an authorization or licence. The designated licence exempt frequencies are available to all users on an equal and shared basis. Interference management relies on the technical protocols and characteristics of the equipment. Licence exempt equipment is commonly found in consumer goods like garage door openers, remote control models, cordless phones, alarm systems, wireless speakers and wireless Internet, etc. As bands become heavily used, radiofrequency (RF) noise levels increase and interference occurs resulting in deteriorated system performance.

7.4. Triggers to initiate Competitive Process

It is important to demarcate spectrum resources and situations that would continue to use a first-come, first-served (FCFS) licensing process and those that would use a competitive licensing process (comparative selection or auction).

As noted above, a competitive process would be considered in situations where there is, or is likely to be, more spectrum demand than resources available.

FCFS processes would normally be used where spectrum supply is adequate to meet demand or spectrum access requests can be managed and reasonably be accommodated. Bands and services captured under FCFS processes would frequently apply where a modest amount of spectrum is requested such as to point-to-point microwave systems and conventional land mobile systems; point-to-multipoint applications; and satellite earth stations. Change from FCFS based on factors such as spectrum policies and spectrum demand.

FCFS processes will also continue to be used to meet the requirement of national security and defence as well as services related to the safety of the general public, such as emergency response e.g. Police, Fire and Ambulance.

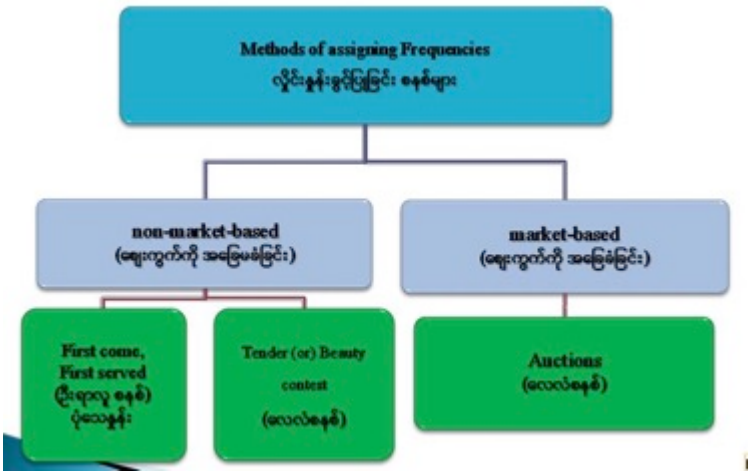
Ministry/PTD as a matter of good spectrum governance will closely monitor resource demand to identify, to the extent possible, the frequency bands or situations where there is, or could be, excess spectrum demand relative to supply or where there is a Government identified need to pursue certain telecommunications policy objectives. In these cases, a competitive licensing process may be initiated.

Where it is determined that sufficient spectrum is available to reasonably meet the needs of all applicants, it would be logical to proceed on a FCFS basis.

Ministry will also monitor FCFS licensing activities in order to determine where licensing activities may appropriately trigger excess demand for a particular band. In cases where excess demand is noted, Ministry will notify the industry that the traditional FCFS licensing process needs to be altered or will no longer be used for certain situations. Ministry would normally consult with stakeholders prior to establishing a new framework for a competitive radio licensing process.

When developing frameworks for a specific competitive spectrum licensing process, the Ministry will be guided by the vision and specific objectives of the Master plan and applicable licensing policies furthering competition in the provision of national broadband telecommunications infrastructure asset, advancing broadband services to all areas of Myanmar.

In Myanmar, the method of assigning spectrum frequencies is depicted below:



7.5. Redeployment of encumbered spectrum

"Spectrum redeployment (spectrum re-farming)" is a combination of administrative, financial and technical measures aimed at removing users or equipment of the existing frequency assignments either completely or partially from a particular frequency band. Redeployment is a normal and necessary part of spectrum management. Redeployment may be required to changes in frequency allocation, national utilization policies,where equipment becomes obsolete and inefficient or where congestion in a given band warrants steps be taken to optimize utilization efficiencies of the spectrum resource. The frequency band may then be allocated to the same or different service(s). These measures may be implemented in short, medium or long time-scales."[20]

Effective spectrum management requires planning the development of radio services in advance of their requirement. In some cases, strategies may involve the introduction of

[20]Rec. ITU-R SM.1603

new services or possibly extending the coverage of existing services. Sometimes making spectrum available for new services or expanding existing services requires the displacement or relocations existing and previously authorized assignments.

Redeployment of Government systems is generally more complex than public or private, often as a result of long planning and budget approval cycles.

Prerequisites for the deployment of both commercial and government systems include adequate notification and planning timelines as well as the identification of options to assist migration.

Spectrum refarming /redeployment is an important and integral part of spectrum management and includes strategies for implementation. These implementation strategies include:

- Advanced notification
- Timelines to redeploy
- Options of alternative spectrum
- Licence expiry
- Voluntary/regulated
- Assessment of operational or cost impacts
- Compensation mechanisms, particularly when involving expedited timelines
- Improved spectral efficiencies/benefits

In cases where spectrum has been previously assigned and licensees have on-going operations, Ministry/PTD endeavours to provide licensees adequate time to transition operations to an alternative band.

When it becomes necessary to displace an existing system Ministry/PTD will normally apply a minimum notification period of two years to any system where system changes are required (modification, replacement or removal). Where possible, Ministry/PTD will endeavour to identify alternative spectrum if a change of frequency assignment is required. If it is economically feasible to make changes sooner, the two-year period may be accelerated. Sooner displacement may occur where incumbent operators and licensees eligible for licensing in the spectrum reach a negotiated arrangement.

In cases of interference, where a system is not operating in accordance with authorized parameters or applicable radio standards a shorter time frame may be specified including immediate termination of operations.

Action Planned by Ministry/PTD:

The process for redeploying spectrum is proposed to be detailed in a policy concerning recovery of spectrum for redeployment (re-farming) so that licensees fully understand the process.

8. Spectrum Inventory

8.1. Scope

Spectrum roadmaps generally provide a medium term (5-year) perspective on those radiofrequency bands that have the greatest commercial potential and correspondingly, technology pathways. In this Spectrum Roadmap, the PTD has primarily focused on bands below 5 GHz. Ministry has a primary focus on Commercial broadband and its priorities for deployment of public broadband services and the creation of a broadband national asset.

The PTD intends to review and renew the spectrum roadmap on a regular basis as regulatory priorities change, technologies, user needs and competitive landscapes evolve. Typically, spectrum practices are updated every 5 years in best practice jurisdictions.

This Roadmap includes the following elements:

- A review of current services and allotted bands being assigned;
- Users assigned;
- Identification of forecasted needs and planned initiatives;
- A description of users impacted;
- A review of Ministry spectrum management records - along with interviews, to assess current allocation, licensing policies, spectrum assigned and spectrum that could be assigned.

When evaluating the spectrum needs, the following services (table 1) were considered and preliminary information was requested from stakeholders commercial mobile, fixed systems (backhaul and other permitted services including fixed wireless access), land mobile, public safety, broadcasting, satellite services, aeronautical services and applications, marine mobile, radio-determination and licence-exempt devices.

Table 1: Review of Telecommunications Services in Myanmar

Service	Users	Needs	Planned initiatives
Mobile	Commercial Broadband	While not all bands have been assigned, the ability accommodate evolving traffic profiles, to deploy new 4G services and to facilitate new entrants will require more spectrum	▪ Identify new bands to be released and initiate consultation on a licensing policy and process. X-border framework
	Private LM: These systems are Point-to-Area systems and may be point-to-multipoint systems where end points are not known. Systems coverage range from in-building to wide area of many kilometres and consist of a single LP site to multiple sites. PTD licensing information includes about 3,000 records.	Businesses of all sorts rely on radiocommunications to support efficient operations. Myanmar with (60 million, growing GDP) can expect many licensing requests. Countries much smaller have 100's to 1000's of such licensees.	▪ Identify bands and release plans ▪ Develop band plans ▪ Licensing processes ▪ Client circular for application submission ▪ Focus will start with planning VHF ▪ X-border framework
	Government (excluding Public Safety)	Under Study	PTD studying future requirements, including radiolocation
	Trunked systems	It is anticipated that trunked radio systems will be required over the next 5 years.	• Spectrum will be allocated to accommodate trunked systems within band plans to be created
	Public safety	Under Study	PTD studying future requirements. PTD will in its review consider REV.WRC RESOLUTION 646-15) Public protection and disaster relief
Fixed	Systems typically operate in the microwave region of the spectrum of usually 1 to 60 GHz. Backhaul users including Cellcos, Utilities and other industries. These systems are *point-to-point* and at times *point-to-multipoint* systems, where end points are known.	Critical for infrastructure to support network deployments including: Commercial Mobile, Government, utilities, broadcasters, Fixed facilities, anywhere point-to-point (or point-to-multipoint)	• Spectrum Utilization Plan defining how spectrum is to be used • Band plans and standards • Licensing Processes • Client circular to assist in application submission • Refarming of existing bands, work has started in this area

Service	Users	Needs	Planned initiatives
		communications links may be required	• Release plans • X-border framework
	Broadband Fixed systems		Identify spectrum and develop a spectrum policy and licensing process. This is important to address some of the interference issues in Licence exempt bands.
Broadcast	HF		No change
	MF (AM)		No change
	FM		No change
	TV		Refer to NTFA use of 698-806 band allocated for mobile in Myanmar.
Aeronautical			No change
Maritime			No change
Satellite		Myanmar market includes services provided exclusively by foreign /international space station providers. Myanmar needs a satellite policy concerning satellite services. Consultation is required on a policy that includes domestic satellite services.	Develop an appropriate Satellite policy for Myanmar and undertake a consultation.
Licence Exempt		Valuable asset to support low power /SRD devices in ISM and other bands	• Establish equipment standards, appropriately harmonized with neighbour countries • Harmonized bands • Certification process • List of equipment • Labelling program • User education pamphlet • Design a compliance program

This 5-year Roadmap evaluated spectrum availability, current options to satisfy needs and included consultations within Ministry and sought preliminary input from stakeholders', from this, priorities were established. It was clear that to ensure continued growth and development of telecommunications in Myanmar, all services needed to have a way forward and that spectrum would need to be available to meet growing user demands. The spectrum review also highlighted key areas where there was rapid growth and new spectrum would be particularly beneficial and a detailed release plan is needed. PTD will review and revise the Spectrum Roadmap at a minimum, every 5 years and as circumstances warrant, during the period.

Part 3: Rapid Growth of Infrastructure and Service

In order to establish priorities for the 5-year Roadmap, the PTD project team undertook multiple lines of research including analysis of global trends and best practices, as well as consultations with industry and within Ministry. Through a process of comparing and integrating the lines of evidence produced from the research, we then were able to develop an evaluation of spectrum currently authorized and deployed, spectrum needs, spectrum availability, current options to satisfy needs.

It was clear that a fundamental requirement for continued growth and development of telecommunications in Myanmar, would be for all services to have a pathway forward and that spectrum would need to be available to meet growing user demands. The spectrum review also highlighted key areas where there was rapid growth and new spectrum would be particularly beneficial and a detailed release plan is needed on a priority basis.

For each of the bands and services captured in our review, we examine the following:

1. Trends/Technology
2. Assignments in nearby or similar countries
3. Current commercial assignments
4. Going Forward, including spectrum release plans, where appropriate

In this document, the timings of specific spectrum releases are identified to the extent they are known today. Spectrum development is evolving, therefore, PTD plans to follow a consultative approach to release plans factoring domestic, global, regional activities and the comments by interested parties as part of a consultation for the release of new bands.

We start with a focus on the priority bands - as defined by the lines of evidence: commercial bands and bands to support deployment. Once these are set out, we describe options for other services to grow. A number of bands are not yet assigned and are proposed for release, however, as spectrum is a limited resource, licensees must use existing spectrum allocations efficiently in order to provide improved service without requiring additional spectrum resources. Greater spectrum use efficiency can be achieved by optimizing infrastructure deployment (for example, increasing network density in order to increase frequency re-use) or by adopting innovative technologies (such as 4G wireless mobile broadband technologies). Operators are encouraged to augment deployment by implementing innovative network designs and technologies in order to improve coverage and capacity in restricted areas. These include Wi-Fi offloading, Femtocell deployment, smart repeaters and distributed antenna systems.[21]

[21]Femtocells and Pico cells, which are low-power base stations, they use licensed spectrum to provide for enhanced coverage and capacity in areas of high data usage and weak signal levels such as in-building and high traffic density areas, such as, airports.

9. Commercial Bands

Commercial bands encompass those bands that are used to provide Mobile voice and broadband data services to the people of Myanmar. There has been a rapid and steady growth of commercial mobile services since the introduction of competition and correspondingly, Myanmar has reaped significant economic and social benefits for its citizens. As a result of telecommunication reform, the introduction of competitive operators, new networks and services have been growing, leading to increasing demand in the amount of spectrum required to deliver these services. Demand forecasts from various sources – both for Myanmar and for markets with similar characteristics, indicate that there will be continued requirements for more spectrum as new services and products are introduced and as user demands placed on networks continue to evolve.

9.1. Demand Trends/Technology

As indicated in the introduction to this section, an understanding demand trends and technology evolution are important elements to the accurate definition of current and future spectrum needs.

9.1.1. Devices

Technological developments have resulted in an evolution in service definition. Network deployments and new innovative devices are driven by the consumer's appetite for information and functionality. This evolution has resulted in a convergence of functionality and services available to users. Increasingly, consumers' use of on-line program content - formerly limited to' programmed broadcasting' services, has now evolved into a range of video content delivered over a variety of fixed and increasingly, mobile platforms. Most of this video content is comprised of un-programmed social media and movies available over the Internet and delivered by wireless fixed and mobile networks. Services that previously were limited to fixed wired networks - due to bandwidth requirements, are now available to wireless fixed and mobile users. This 'mobile first' delivery of content has resulted in a significant shift of traffic to mobile networks, new traffic characteristics and the evolution in devices and the network technologies necessary to support them.

A wide range of enhanced devices that incorporate cellular connectivity has entered the market during the past three years, including smartphones, USB dongles, tablets, e-book readers and gaming consoles. These devices offer larger screen sizes and higher resolution and hence, increased data consumption as well as encourage the use of traffic-intensive applications - such as video calling, gaming, social media applications, etc.

9.1.2. Changing traffic characteristics

New devices have been a key driver of increased mobile broadband traffic.[22]A wide range of new, connected devices, have a significant impact on mobile traffic volumes. Content is rich in applications: video entertainment, video sharing, YouTube, access to on-line education, multi-media and gaming. People now commonly use any Internet application ('app') on their mobile devices and in addition, mobile devices enable new applications such as location-based services.

[22]ITU-R M.2243, Assessment of Global Mobile deployments and forecasts for mobile IMT

Between 2008 and 2010 alone, over 300,000 mobile apps have been developed for smartphones. The most used mobile apps are games, news, maps, social networking, music and more recently medical apps. Many stakeholders are now offering mobile apps through commercial online stores and application stores.

In 2009, worldwide mobile app downloads amounted to approximately 2.52 billion and are expected to reach 268.69 billion in 2017.[23]

Figure 2: Changing Broadband Traffic Characteristics

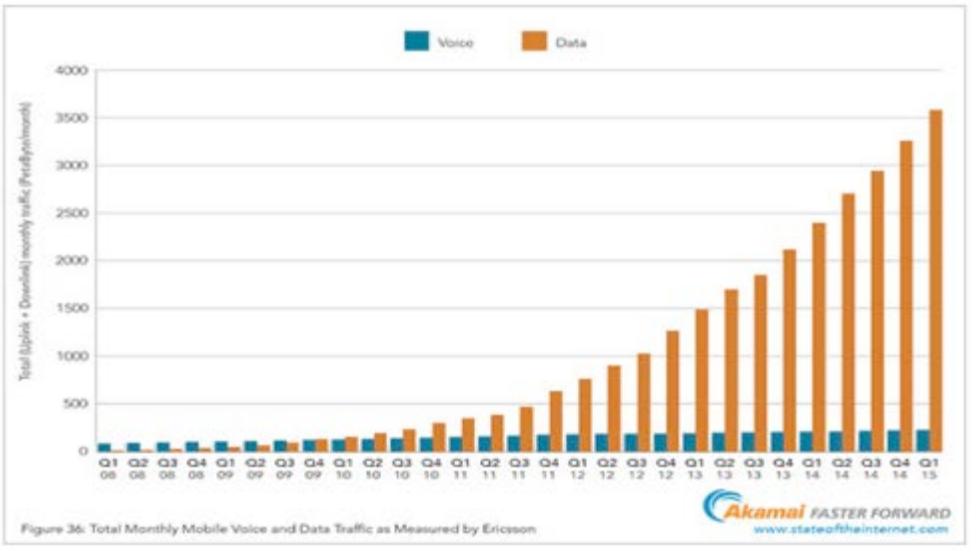
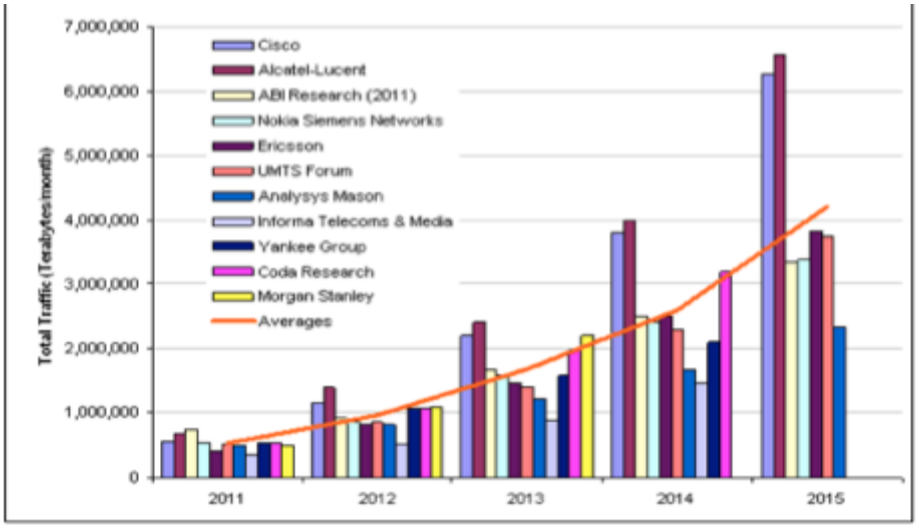
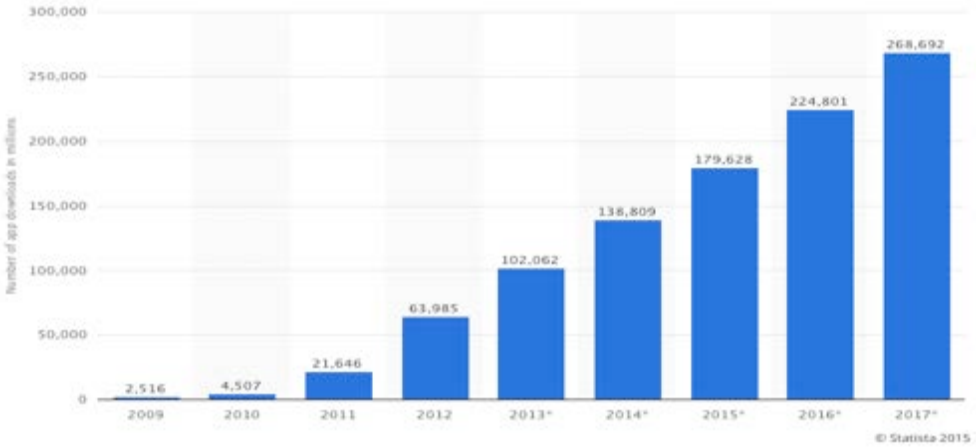


Figure 3: Mobile global data traffic estimates from 2011 - 2015 based on multiple sources



[23]Source ITU R M. 2243

Figure 4: Number of App Downloads (Millions)



Source: Statista, available at: http://www.statista.com/statistics/266488/forecast-of-mobile-app-downloads/

In addition to terminals used by individuals, there has been an increase in applications related to machine-to-machine usage. Examples of industrial/commercial applications now include security monitoring, point-of sale terminals, health care, asset management along with many others yet to be developed.

In order to provide an idea of the progression of mobile services in emerging economies, the PTD considered the case of India. In that country, data growth in its four top cities expanded 120 per cent over the past year. Mobile Internet users are forecasted to jump from 254 million in 2013 to 436 million by 2017. Almost 70% of traffic is now data and is driving their push to 4 G[24].

Myanmar's objectives, as stated in the Master Plan, will increase network expansion, spur innovative service offering and drive demand by users. The Master Plan emphasizes mobile-first in the growth of connections as the most efficient means to enable its goals for the development and delivery of new services such as e-health, e-learning and e-Government.

The policy initiatives of Ministry will translate into more users, more terminals, and increased use of data application. On the network side, the policy initiatives are expected to enable wide deployment of broadband infrastructure, wireless networks as well as a significant increase in spectrum access.

9.1.3. Global smartphone penetration

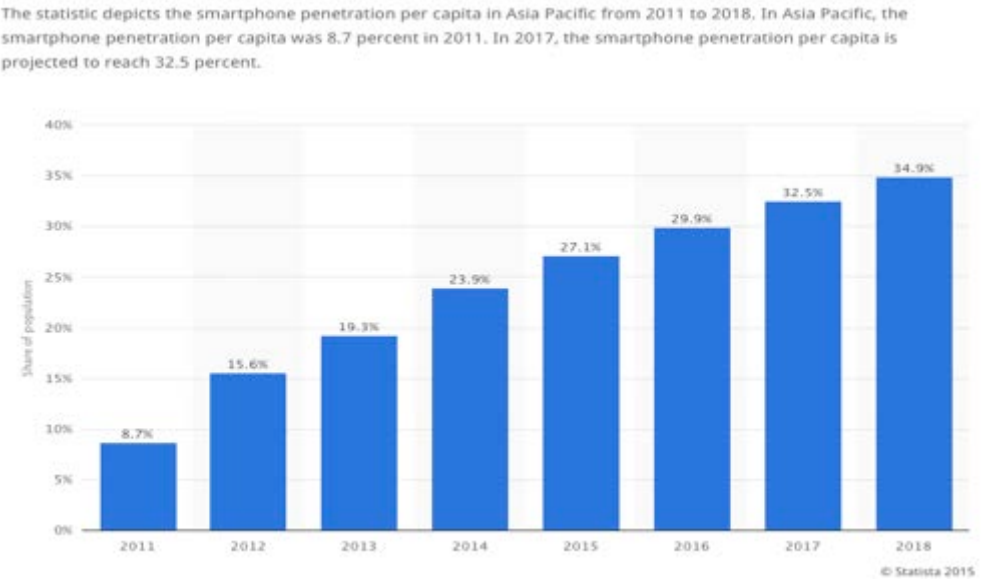
Over a third of the world's population is projected to own a smartphone by 2017, up from less than 10 percent in 2011. Western Europe is due to become the largest regional market as almost 65 percent of its total population is forecast to own a smartphone by 2017, over twice the figure in 2012. Within North America, around 64 percent of the population will own a smartphone in 2017, an increase of 13 percent on the figure from 2014. The smallest

[24]Source: Aircel, as reported in Mobile World Live, Oct 7, 2015.

regional market for smartphones is the Middle East and Africa, where smartphone penetration will stand at an estimated 13.6 percent by 2017.

In Asia, it has been estimated that smartphone penetration will be almost 35% in 2018.Almost one billion smartphones were sold to end users in 2013, an increase from less than 300 million units in 2010. The two most popular smartphone operating systems in 2014 were Android and iOS, which sold a combined 288 million units to end users worldwide in the third quarter of the year. The Google-backed Android held a global market share of 84.4 percent in the third quarter of 2014, whilst Apple's iOS held 11.7 percent of the market. The leading smartphone vendors in the global market were Samsung and Apple, who both held a share of around 20 percent by the end of 2014.[25]

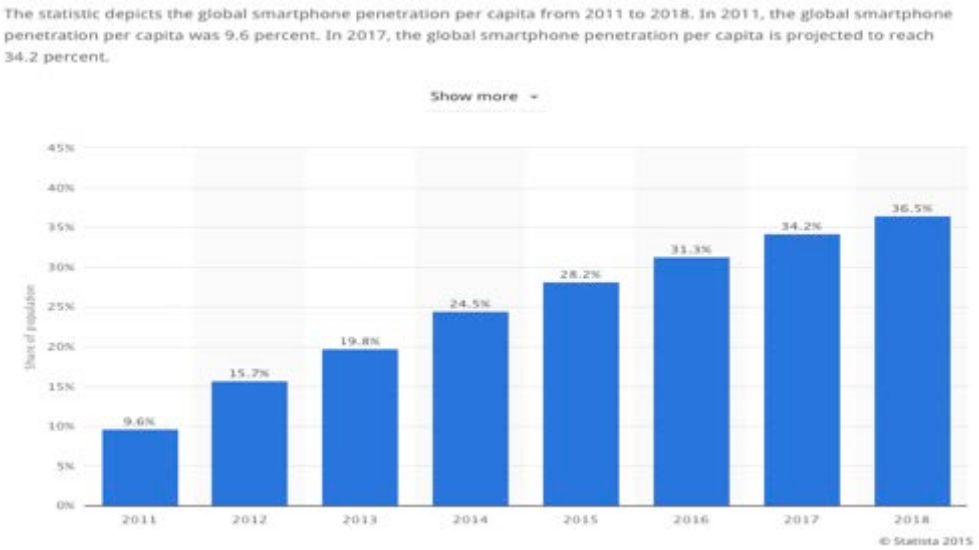
Figure 5: Smartphone Penetration per Capita in Asia pacific (%)



Source: Statista

[25]http://www.statista.com/statistics/203734/global-smartphone-penetration-per-capita-since-2005/

Figure 6: Global Smartphone Penetration per Capita (%)

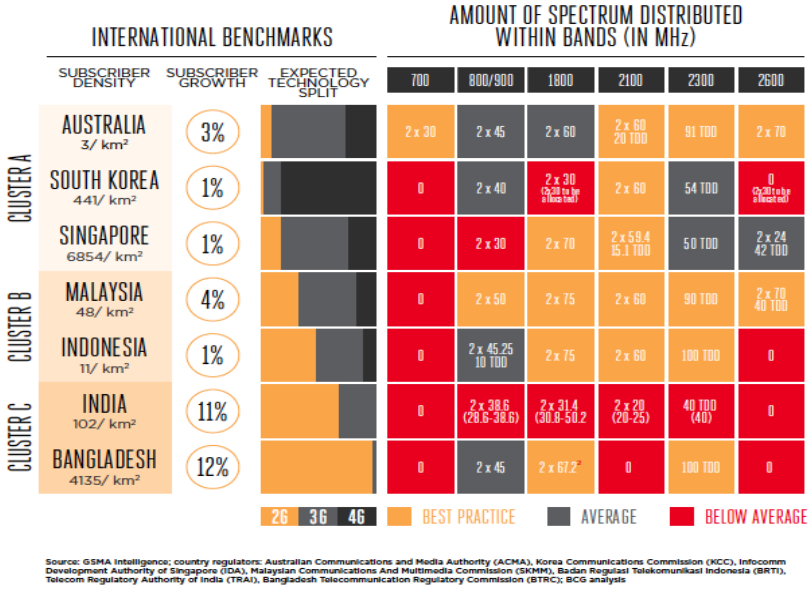


Source: Statista

Telenor forecasts 2020 mobile SIM penetration in Myanmar to reach 140% (70% real subscriber penetration @ 2 SIMs/subscriber).[26]

While almost all countries are experiencing the same consumer demand and technology drivers for spectrum, as shown in the following figure, spectrum availability to satisfy 'mobile first' varies greatly in the key commercial bands.

Figure 7: Spectrum Available for Mobile Operators in Various Asia Pacific Countries



[26] Telenor white paper on Spectrum, October 14, 2015

9.2. Global and regional considerations for Myanmar in assigning spectrum

Spectrum assignments in nearby countries are critical to Myanmar in order to avoid interference, promote the efficient use of spectrum, co-ordinate the roll out of new technologies and in the longer term, as a basis for a common vision in the allocation of bands.

Below we provide a list of mobile frequency bands used by neighbouring and nearby countries[27]:

Bangladesh	
CDMA450	450 – 455 / 460 – 465
CDMA800	825 – 845 / 870 – 890
E-GSM	880 – 890 / 925 – 935
GSM900	890 – 915 / 935 – 960
GSM1800	1710 – 1785 / 1805 – 1880
CDMA2000	1890 – 1910 / 1970 – 1990
BWA systems (Mobile WiMAX)	2330 – 2400 TDD
BWA systems (Mobile WiMAX)	2585 – 2620 TDD

China (People's Republicof)	
CDMA800	825 – 835 / 870 – 880
GSM900	889 – 915 / 934 – 960
GSM1800	1710 – 1755 / 1805 – 1850
IMT	1755-1785 / 1850-1880
CDMA2000	1920 – 1935/2110 – 2125
IMT	1935-1940 / 2125-2130

[27] INFORMATION OF MOBILE OPERATORS' FREQUENCIES, TECHNOLOGIES AND LICENSE DURATIONS IN ASIA PACIFIC COUNTRIES, No. APT/AWG/REP-15 (Rev. 1), Edition: March 2013

China (People's Republicof)	
UMTS (WCDMA)	1940 – 1955/2130 – 2145
IMT	1955 –1980 / 2145-2170
TD-SCDMA	1880 –1900 TDD
IMT	1900 – 1920 TDD
TD-SCDMA	2010 – 2025 TDD
TD-SCDMA	2300 – 2400 TDD
IMT	2500 – 2690 TDD

Malaysia	
E-GSM900	880 – 890 / 925 – 935
P-GSM900	890 – 915 / 935 – 960
GSM1800	1710 – 1785/ 1805 –1880
UMTS (WCDMA)2100	1920 – 1980/ 2110 –2170 1900 – 1920 (TDD) 2010 – 2025 (TDD)
BWA (WiMAX)	2300 – 2400 (TDD)

Thailand	
CDMA2000 1X	479 – 483.5 / 489 – 493.5
CDMA2000 1X EV-DO/HSPA	824 – 839 / 869 – 884
AMPS800/HSPA	839 – 849 / 884 – 894
GSM900/HSPA	897.5 – 915/ 942.5 – 960
GSM1800	1710 – 1785/ 1805–1880
IMT	1920 – 1980/ 2110 –2170 2010 – 2025
BWA	2300 – 2400 2500 – 2690

Vietnam (Socialist Republic of)	
CDMA 450	453.08 – 457.37 / 463.08 – 467.37
CDMA800	824 – 835 / 869 – 880
eGSM900	880 – 890 / 925 – 935
GSM900	890 – 915/ 935 – 960
GSM1800	1710 – 1785/ 1805 –1880
IMT 2000	1920 – 1980/ 2110 –2170

Laos	
CDMA 800	824-849/869-894
EGSM	880-890/925-935
PGSM	890-915/935-960
GSM1800	1710-1785/1805-1880
2300	2300-2330
2500	2500-2690
3500	3400-3600
5800	575-5825

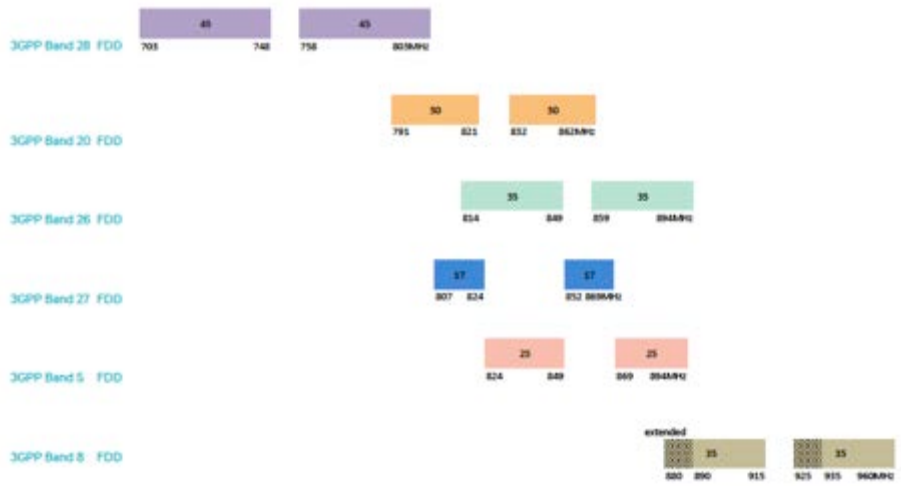
The band 450-470 MHz is identified for use by administrations wishing to implement International Mobile Telecommunications (IMT). See Resolution 224 (Rev. WRC 07) *. This identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations(WRC 07). Regionally the 450 MHz band is used by a range of land mobile (LM) systems.

The above tables indicate that band edges vary widely among region 3 countries, depending on the band configuration, particularly relevant in Myanmar the 800MHz (806-880)[28] and 900 MHz (880-915/925-960). See figure below.[29]

[28]The 800 MHz band in Myanmar follow part of the 850 (824-849/869-894)

[29]Extract from the article: 'Re-farming 2G Bands –ASEAN Situation', Alex Orange, Director, Government Affairs, Southeast Asia and Pacific

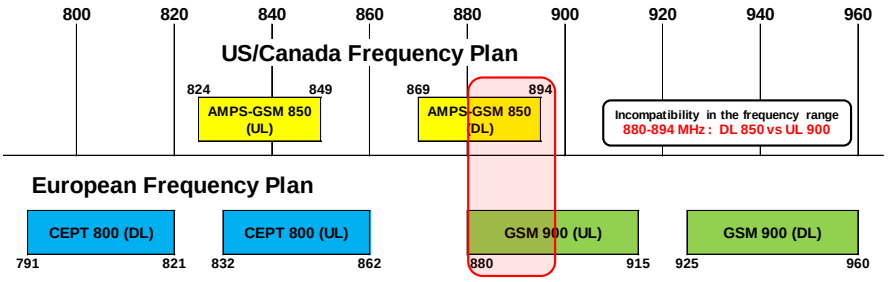
Figure 8: Components for Sub 1Ghz spectrum Assignments in ASEAN



Source: Qualcomm (2015), Re-farming 2G bands – ASEAN situation

The complexity of the global / regional arrangements in the 850 MHz (824-849/869-894) and 900 band (880-915/925-960) –can result in orphan spectrumin domestic assignments as well as increased complexity to coordinate, potential interference, particularly in border areas.

- Unassigned spectrum in the 850 band includes the 835-849/880-894 MHz bands, due to overlap of 850 MHz DL (880-894) with 900 MHz band UL.



The impacts of this global/regional complexity in spectrum in Myanmar include a mix of 850 MHz(824-849/869-894) and 900 MHz band (880-915/925-960). The PTD is also investigating reports of interference MPT in the 850MHz band and Ooredoo in the 900MHz band. We note that APT AWG Report 35 provides guard band recommendations to minimize interference issues caused by the use of different technologies in adjacent bands.

Spectrum coordination issues with neighbouring countries

The complexity of the global / regional arrangements result in challenges for national regulatory authorities in ensuring efficient coordination and use of spectrum as well as the ex post factor resolution of potential interference in border areas.

Myanmar operators have reported that mobile operators from Thailand use almost all available spectrums at the border of Myanmar – in particular in the 900MHz band but also, in the 2100MHz band. As a result of this interference in the border areas, MPT, TML and OML are not able to fully exploit their spectrum licences.

Ministry/PTD have initiated preliminary discussions with their counterparts in Thailand and cross border discussions were initiated with the Thai Regulator in 2015.

Similarly, there are several mobile operators from China that use spectrum on the Myanmar side of the border. There are also reports of operators from one country, serving subscribers across the border. Only MPT operates currently in that area and is severely impeded in its operations. Ooredoo and Telenor have plans to expand in the north as well.

In light of the increase in 'mobile first' applications and consumer demand in the regional markets, the PTD recognizes that it is in the interests of Myanmar and its neighbours to negotiate – on a priority basis, bi-lateral arrangements for sharing issues in border areas in order to minimize economic disruption and to maximize spectrum use efficiency. The scope of these discussions will likely include technical standards and operational concerns regarding sharing, licensing, operating parameters.

9.3. Myanmar Commercial Assignable Spectrum Bands

Below we highlight commercial spectrum bands for future assignments.

Table 2: Commercial Spectrum bands

Technology	Frequency MHz (UL/DL)	Band
CDMA800 / TDMA 800/ GSM 800	824 – 849 / 869 – 894	A
GSM900	890 – 915/ 935 - 960	B
EGSM 900	880 – 915/ 925 - 960	B2
GSM1800	1710 – 1785/ 1805 -1880	C
CDMA 1900 / GSM1900	1850-1910/ 1930-1990	D
UMTS (WCDMA)/ CDMA 2000	1920 – 1980/ 2110 -2170	E
CDMA450	450-460/ 460-470	F
PDC800	893 – 898 / 838 - 843 940 – 948 / 810 – 818 925 – 940 / 870 – 885	G
UMTS(WCDMA)1500/CDMA1500	1427.9-1452.9 / 1475.9 - 1500.9	H
UMTS (WCDMA) 800/ CDMA 800	815-845 / 860 - 890	I
CDMA800	887 – 889 / 832 - 834 898 - 901 / 843 - 846 915 – 925 / 860 – 870	J
UMTS (WCDMA)1500/CDMA1500	1427.9 - 1452.9 / 1475.9 - 1500.9	K
UMTS(WCDMA)1700/CDMA1700	1749.9 - 1784.9 / 1844.9 - 1879.9	L
PHS	1884.5 - 1919.6 (TDD)	M
TDD mobile communication systems	2 010 – 2 025 (TDD)	N
BWA systems (WiMAX, Next Generation PHS)	2 545 – 2 625 (TDD)	O

Source:Ministry/PTD spectrum plans.

9.4. Current commercial licensees

Ministry/PTD authorizes 4 types of telecommunication license categories:

1. Network Facilities Service (Individual) License – general licence for fixed or mobile telecoms operators.
2. Network Facilities Service (Class) License - limited to tower leasing and self-provision of telecoms services, - applies to tower companies and business users of voice-over-the-internet services.
3. Network Service License, for telecoms services resellers.
4. Application Service License, which permits the licensee to lease transmission capacity directly from telecoms providers and resellers.[30]

[30] 'Myanmar Telecommunications Law 2013. Industry articles: Recent Developments in Myanmar's New Telecommunications Law. 'Jones Day. Published in Lexology See http://www.lexology.com/library/detail.aspx?g=c6839a83-34d6-49f6-94ef-835fd1b07f53

Up to the licensing of the 2 new mobile operators Telenor and Ooredoo in June 2013, MPT had the sole Network Facilities Service licence for the provision of public land mobile services in Myanmar.

In 2015, Ministry – the legacy ministry, issued 21Network Facilities Services (Individual) licences. These licences permit their holders to construct networks, lease access to service providers and to offer any type of public or private telecom service.[31] In addition, 25Network Facilities (Class) licences were awarded. Network Facilities (Class) concessions permit licensees to deploy and maintain passive infrastructure and to lease access to service providers.

9.4.1. Current spectrum licence holders and overall spectrum holdings

In the following table, we provide a synopsis of the 3 mobile operator's spectrum licensees Spectrum licences:

Table 3: Summary on Spectrum Licences of Three (3) mobile Spectrum Operators in Myanmar

Frequency Band	Licensee	Technology	Uplink (MHz)	Down Link (MHz)	BW (MHz)
450 MHz	MPT	CDMA	453.35-457.1	463.35-467.1	2 X 3.75
850 MHz	MPT	CDMA	825-835	870-880	2 X 6.25
900 MHz	MPT	GSM	900-915	945-960	2 X 10[32]
	Ooredoo	GSM	890-895	935-940	2 X 5
	Telenor	GSM	895-900	940-945	2 X 5
2100 MHz	MPT	WCDMA	1935-1950	2125-2140	2 X 15
	Ooredoo	WCDMA	1950-1960 (1965)	2140-2150 (2155)	2 X 15
	Telenor	WCDMA	1965-1975 (1980)	2155-2165 (2170)	2 X 15

Note: Telenor/Ooredoo: Option to add 5 MHz pair @ 2100 MHz

Of the mobile operators, MPT has by far the largest holding of spectrum. Incumbent MPT has 70 MHz of spectrum, 30 MHz more than its competitors. Following discussions between PTD and MPT, an agreement was reached in December, 2015 whereby MPT would relinquishes 5 MHz @ 900 MHz, thus reducing its holding to 2x10 MHz.

As the spectrum authorizations for MPT were granted prior to the adoption of the new Telecommunications Law, a transition period will be required for formal licensing of their commercial spectrum.

Ooredoo and Telenor were provided 10MHz (5 up, 5 down) licenses in the 900MHz band and 30 MHz (15 up, 15 down) in 2100 MHz band.[33] In Appendix A, we provide a website link from the Ministry, that includes a list of current commercial operators in Myanmar. New entrants - Ooredoo and Telenor, each have 40 MHz of spectrum in the same bands.

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[31] 'MCIT Issues New Licences'. TeleGeography, March 2015

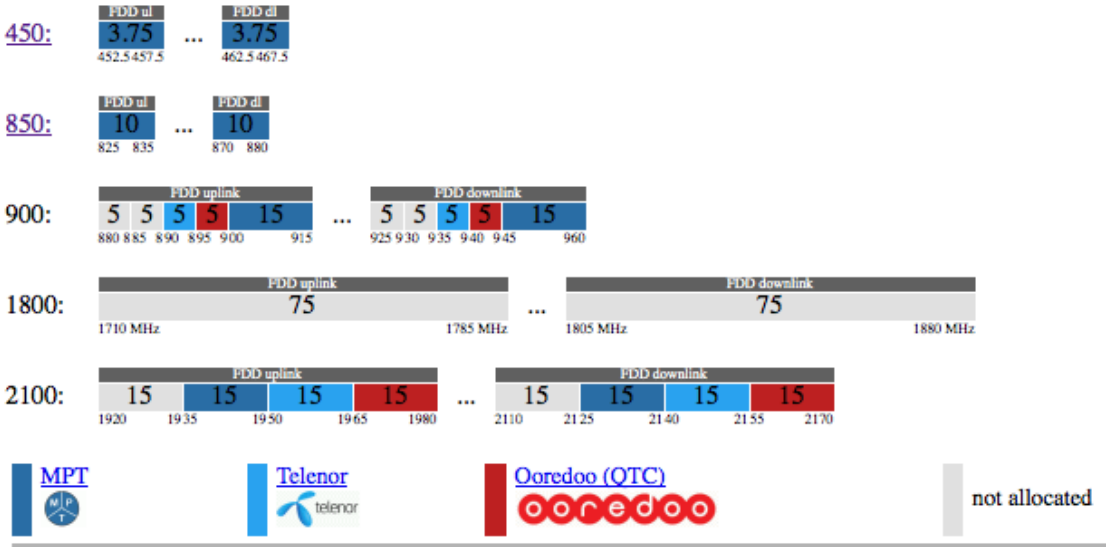
[32] 5 MHz to be returned to PTD and to be made available to a 4th operator 2016

[33] Includes 5MHz of additional spectrum held by Ministry/PTD in reserve for Telenor and Ooredoo – under their current Licencing option would effectively preclude assignment to any other operator.

Not all entities holding licences have associated spectrum licences. MecTel operates as an MVNO - using spectrum provided by MPT.[34]

Below is a pictorial representation of Myanmar's mobile telephone frequency assignment blocks[35].

Figure 9: Myanmar Phone Frequency Assignments



Source :http://www.spectrummonitoring.com/frequencies/frequencies3.html#Myanmar

In addition, since 2013 MPT has been given a temporary non-commercial authorization in the 1800 MHz band. This spectrum was provided to MPT to support its role as a host organization for the Asian Games as well as for LTE development /experimentation for LTE technology and services. We note that global best practices generally limit the duration of developmental / experimental non-commercial authorizations to 6 months or less and would normally have attached specific objectives and reporting requirements. While extensions are frequently granted, in the overall perspective, if such extensions are to become prevalent, they will effectively block the longer term objective for national regulators of making spectrum available to the most efficient, higher economic usage.

9.4.2. Aggregate Mobile spectrum holdings above and below 1GHz

In the mobility world, it is generally recognized that spectrum holdings below 1GHz confer significant advantages to licences in terms of capital requirements for towers as well as operating cost efficiencies. Spectrum below 1 GHz is generally preferred, particularly in early deployment phases, due to the requirement of fewer base stations to achieve coverage and in-building penetration.

[34] MecTel is a NFS (I) licensee.

[35] Prior to the relinquishing of spectrum 5+5 MHz at 900 MHz

Incumbent MPT has 40 MHz of spectrum below 1 GHz, compared to its competitors with 10 MHz each. However, at the time competitors Telenor and Ooredoo entering the market MPT legacy assignments were known.

In the following table, we provide a synopsis of the current spectrum holdings of the mobile operators in the bands above and below 1GHz:

Table 4: Current Spectrum Holdings of Mobile Commercial Operators in the Bands above and Below 1 GHz

Licensee	450 MHz	850 MHz	900 MHz	1800MHz	2100 MHz	2300 MHz	2600 MHz	Aggregate <1 GHz	Aggregate >1 GHz
MPT	7.5	12.5[36]	20	Temporary authority (>1year)[37]	30			40	30
Ooredoo			10		30			10	30
Telenor			10		30			10	30

9.4.3. Global and Regional considerations in use of sub 1 GHz bands

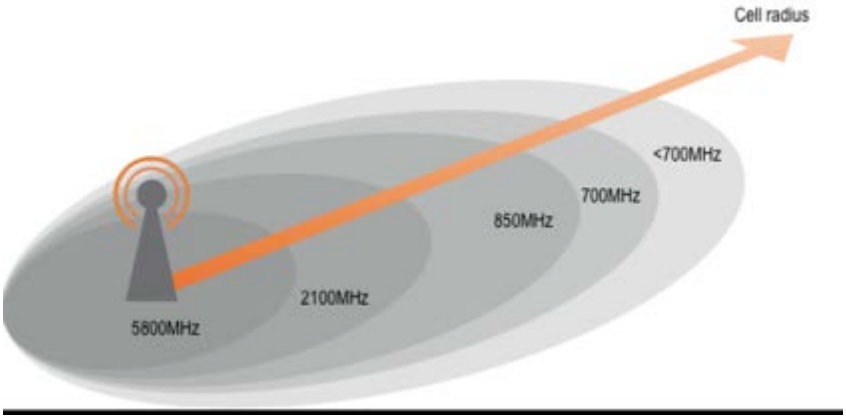
Overall, given the legacy spectrum authorizations to MPT, this has resulted in a vast majority of holdings being in the hands of the incumbent.

Lower frequency bands are generally preferable for mobile communications. For a given height and power, lower frequencies propagate further providing for favourable coverage characteristics, lower frequencies also better penetrate buildings providing better in-building coverage. Licensing and deployment of systems in lower frequency bands can result in faster deployment since a single cell has a greater coverage radius than a similar (Height and power) cell at a higher frequency, this translates to fewer cells to cover a geographic area. In rural and less densely-populated areas, lower frequencies frequently have critical advantages in coverage, service reliability and costs. To cite just one study, GSMA[38] estimated that the price of providing mobile broadband is 70% lower than providing similar services at 2100 MHz.

[36] Assigned BW.

[37] Temporary authorities could be used to serve a number of purposes such as special events and technology development. With clearly defined objectives, reporting and timeframes Temporary authority is a useful tool to spur innovation. Developmental/experimental authorizations would normally not exceed 6 months and not provide for early access or be seen to provide tenure on the assignment.

[38] Mobile broadband Roadmap Cambello Sebastian, Director Public Policy, GSMA quoted from SCP Associates Study.



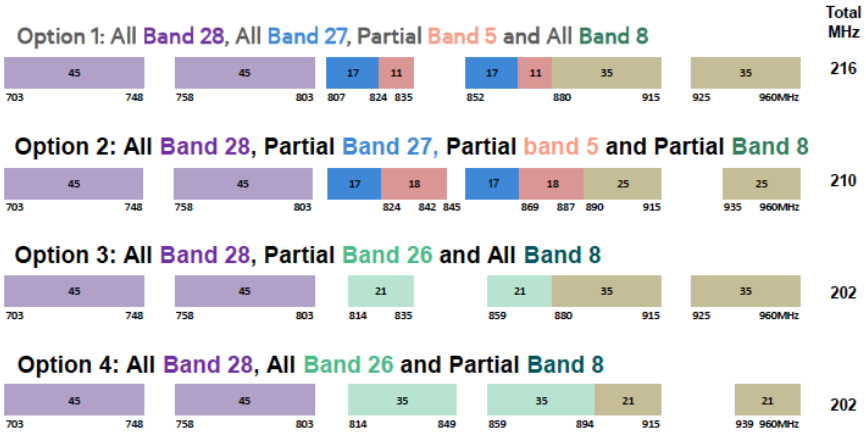
Source: GSMA Spectrum Policy Digital dividend paper

Since radio frequencies are a limited resource, while frequencies below 1 GHz provide superior coverage and in-building penetration, frequencies above 1 GHz allow for the provision of higher capacity systems.

Below is a list of bands assigned that PTD considered for future assignment:

1. 700 MHz has been assigned in a number of countries in Region 3[39].
2. 850 MHz reconfiguration could result in improved utilization, possible options below[40].

Figure 10: Options for Sub 1 GHz Spectrum Arrangements in ASEAN



Source: Qualcomm (2015), Re-farming 2G bands – ASEAN situation

3. 900 MHz allows for the use of three 5 MHz pairs.[41]

[39]Australia, New Zealand, Taiwan and Japan.

[40]Extract fromthe article 'Re-farming 2G Bands –ASEAN Situation', Alex Orange, Director, Government Affairs, Southeast Asia and Pacific. Source: http://readi.asean.org/readi.asean.org/media/files/3_Alex-Orange_READI_ASPF-5_180315.pdf

4. 1800 MHz band is unassigned in Myanmar (except for a temporary assignment to MPT for special event) and common throughout R3.
5. 2100 MHz has a 3 pairs of 5 MHz pair unassigned.
6. Unassigned spectrum in Myanmar in the 2300[42] and 2600[43] bands.
7. 3500 MHz[44] band is currently unassigned in Myanmar.

In the following table and figure, the PTD highlights the assigned and unassigned spectrum in Myanmar in various bands[45]:

Table 5: Assigned and Unassigned Spectrum Bands:

Bands	Assigned	Unassigned
450	7.5	6.25
700	0	90
850	20	54
900	40	30
1800	0	150
2100*	90	30
2300**	20	79
2600***	0	190

*2100 MHz: 1) MPT: 15+15 MHz;2) Ooredoo: 10+10MHz, plus 5+5MHz Reserve;3) Telenor 15+15 MHz

** 2300 MHz: Department of Civil Aviation 20 MHz.

*** 2600 MHz: YTP: 54+40 MHz (All Licences to be returned to PTD for reassignment).

[41]The extended GSM band, plus the pair to be returned by MPT.

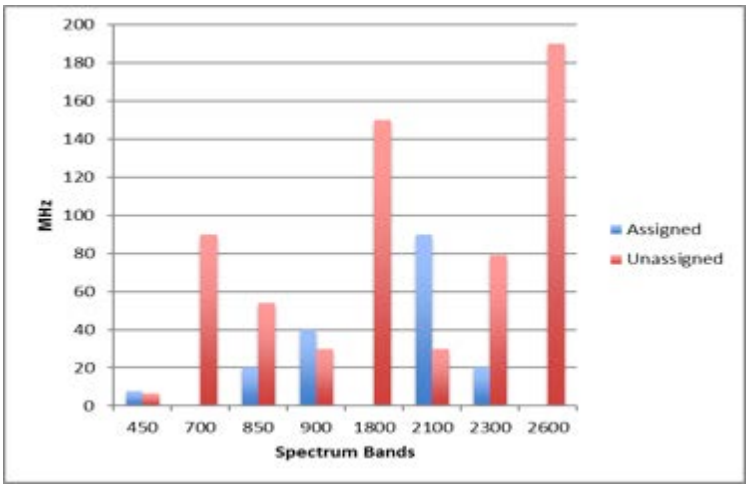
[42]Assigned in China, Hong Kong, India.

[43]Assigned in Australia, China, Hong Kong, Malaysia, New Zealand,

[44]The band is identified for IMT by some countries of Asia-Pacific Region, utilization is recorded in APT/AWG/REP-37

[45]For most bands, assigned and unassigned spectrum reflects allotments as per the spectrum rules, adjusted to reflect current users. In a few cases the bandwidth reflects actual assigned bandwidth.

Figure 11: Assigned and Unassigned Commercial Spectrum (MHz)



Device availability is, and will remain an important consideration in the assignment of bands in order to ensure that a number of competing operators have cost efficient options for deployment. As an example, according to GSA "1800 MHz (3GPP band 3) continues to be the most prominent band for LTE network deployments globally and enjoys the largest devices ecosystem with 1,141 user devices. Over 43% of all LTE devices can operate in this band. 532 LTE1800 devices were announced during the past year."[46]

9.4.4. IMT bands – Recommended priority areas for Ministry/PTD in working with global spectrum planning bodies

IMT bands along with associated footnotes (FN's) are listed in the following tables.

Table 6: IMT Bands and Associated Footnotes

Band (MHz)	Footnotes identifying the band for IMT for all Regions	Region 3 Some countries (Note1)	
450-470	5.286AA	20 MHz	–
470-694	5.idR2a,5.idR2b,5.idr3		88 MHz(610-698 MHz)
694-960	5.313A, 5.317A	170 MHz	92 MHz (694-790 MHz)
1427-1518	5.R1a,5.R2a,5.R3g,5.R3h	91 MHz	
1 710-2 025	5.384A, 5.388	315 MHz	–
2 110-2 200	5.388	90 MHz	–

[46]Global Suppliers Association http://www.gsacom.com/news/gsa_422.php

Band (MHz)	Footnotes identifying the band for IMT for all Regions	Region 3 Some countries (Note1)	
2 300-2 400	5.384A	100 MHz	–
2 500-2 690	5.384A	190 MHz	–
3300-3400	5.R1b,5.C11,5.R3d,5.R3e		100 MHz
3 400-3 600	5.430A, 5.IMT,5.IMT2,5.432A, 5.432B, 5.433A	–	200 MHz
4800-4990	**5.R3f,5.A11**		**Upto 190**
	Total	**976 MHz**	**670 MHz**

Note1:

In the band 470-698 MHz, Bangladesh, New Zealand and some Pacific island states have identified all or part of the band 88 MHz for IMT.

Band 698-790 MHz: This band is identified in 25 countries including Myanmar for IMT through FN 5.313.AThis band is part of the APT band plan for the 700 MHz. Since Myanmar is planning to license the 700 MHz

Band 790-960 MHz is identified for IMT in R3 and provides remaining part of the 700 MHz APT band plan i.e. 790-806 MHz

Band 3300-3400 MHz is identified for IMT at WRC-15, FN 5.R3e for Cambodia, India, Lao P.D.R., Pakistan, Philippines and Viet Nam

The band 3.4-3.6 GHz has become an almost global band for IMT (R1+R2 and 12 R3 countries).

Band 4800-4990 MHz or parts thereof are identified through FN 5.R3f at WRC-15 in Cambodia, Lao P.D.R and Vietnam for IMT

The identification of spectrum for a specific service requires satisfying certain requirements:

- Assessment of compliance or impacts of international allocations;
- Assessment of compliance or impacts of regional allocations;
- Updating the National Table of Frequency Allocations and,
- Harmonization of standards.

Finally, Ministry needs to have in place appropriate supporting utilization and licensing policies and technical requirements.

9.4.5. Additional Spectrum Going forward – A 5-year perspective for spectrum planning

In this section, we provide a view on the release of spectrum, anticipated timing and the planned generic licensing consultation process proposed over the next five years. In cases where a competitive licensing process is expected, Ministry would first initiate a public consultation specific to that process.

The idea of a spectrum release plan is to notify to stakeholders including industry and licensees as well as other interested parties of new frequency resources that may be

opened for licensing in the near future. The spectrum release plan is beneficial to stakeholders to assess evolving market dynamics and for spectrum users to plan future deployment strategies.

Ministry/PTD considers that spectrum releases would further the vision of the Master Plan (and its objectives):

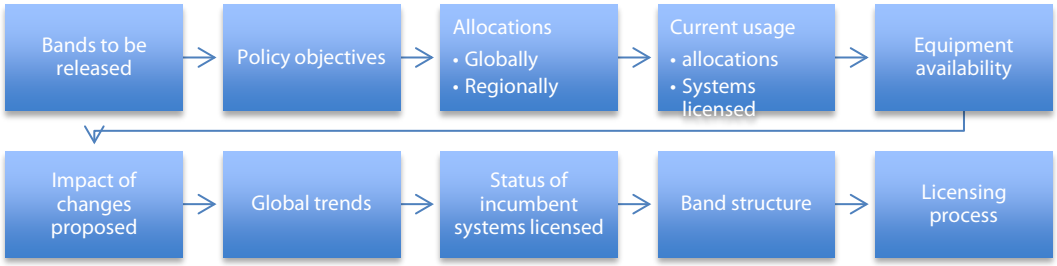
- 'Spectrum broadening': ensuring adequate spectrum for new 3 G and 4 G advanced mobile services,
- 'Spectrum extending': ensuring adequate spectrum for existing broadband wireless access services, [satellite orbital positions and associated spectrum].

Recognizing that current deployments are based on using 2 G and 3 G technologies, it is anticipated that operators will want to deploy 4 G LTE to support increasing data traffic profiles and evolving broadband applications and to compete with improved service offerings. User terminals operating at 2Gand 3G will not be upward compatible with 4 G, therefore, 2G and 3 G networks will need to be operational for some time in order to support current 2G and 3G subscribers.

Proposed generic Consultation Process

The following figure provides an overview of the steps that would typically be included in a consultation process leading to the release and licensing of a band:

Figure 12: Consultation Process



The timing of release of spectrum - as proposed in figure 13 below, takes into account various factors for Ministry/PTD to manage the spectrum planning, licensing processes and the anticipated needs of Commercial users. Over the course of the next 5 years, Ministry may decide to release additional spectrum - as warranted and subject to availability of professional resources.

Licensing processes may take into account various factors including the applicant's past performance and records of licence compliance.

1. <u>2600 MHz</u>

The Ministry/PTD proposes to release spectrum to meet the needs of wireless broadband services, wireless broadband is considered a priority and PTD is considering the release of 2600 MHz to meet this demand.

<u>Action Planned by Ministry/PTD:</u>

Develop a policy and a process for the release of 2600 MHz band with the intention of auctioning this spectrum.

2. <u>1800 MHz</u>

The 1800 MHz (1710-1785/1805-1880 MHz) band is widely used for LTE deployments around the world. Ministry proposes to release this band following the release of 2600 MHz. Currently MPT is authorized to temporarily use 1730 – 1750 / 1825 – 1845 MHz for special events.

If it is necessary to assign around MPT's temporary assignment of 1710-1730 MHz and 1750-1785 MHz for Uplink, then bands1805-1825 MHz and 1845-1880MHz could be assigned for Downlink. This will provide 55+55 MHz of spectrum for FDD.

Action Planned by PTD / Ministry:

Develop Policy and process for the release of 1800 MHz band with the intention of auctioning this spectrum.

3. 850/900 MHz

800 MHz (806-880) - 825-835/870-880 are assigned as CDMA 800 mobile and CDMA WLL.

806-825 +835-870 are unassigned. According to Ministry/PTD Spectrum Rules, 54 MHz of spectrum is available.

900 MHz: (PGSM 890-925/935-960) +(EGSM (880-890/925-935)

Subsequent to the 2012 licensing decision awarding two additional nationwide telecommunication licences to foreign telecommunications operators Telenor and Ooredoo, the Union Government initiated a process to issue a fourth and final nationwide 15 year Operating Licence and Spectrum Licence to a 4th Operator. Spectrum to be assigned to the 4th Operator includes 900-905/945-950 (5+5MHz) [47].

EGSM (880-890/925-935) is unassigned, allowing for two 5 MHz pairs

Two 5 MHz pairs in the EGSM 900 MHz band provides for 2x5 MHz of assignable spectrum.

There is a history of reported interference in extended GSM band. PTD will consider granting short-term authorizations to interested parties to conduct technical trials. There will be strict terms and conditions associated with these authorizations.

ActionsPlanned by Ministry/PTD:

1) PTD will provision for the temporary licensing of short-term experimental systems in these bands. Licensees granted authorization will be required as a condition of authorization to provide information supporting their proposed trial, including details of tests to be conducted and commit to file a findings report to PTD at the end of the trial. PTD may also observe or participate in specific tests to be conducted.

2) Develop a policy and consultation to optimize 850 and 900 MHz bands

[47]The 4th operator will also receive 20MHz of spectrum as follows: 1920-30/2110-2120 and an option for reserve spectrum: 1930-1935/2120-2125. It is important to note that as the commitment to provide spectrum to the 4th operator pre-dates and is being managed in parallel to the Roadmap process, the spectrum release for the 4th operator is not shown in Figure 13 the Release Plan.

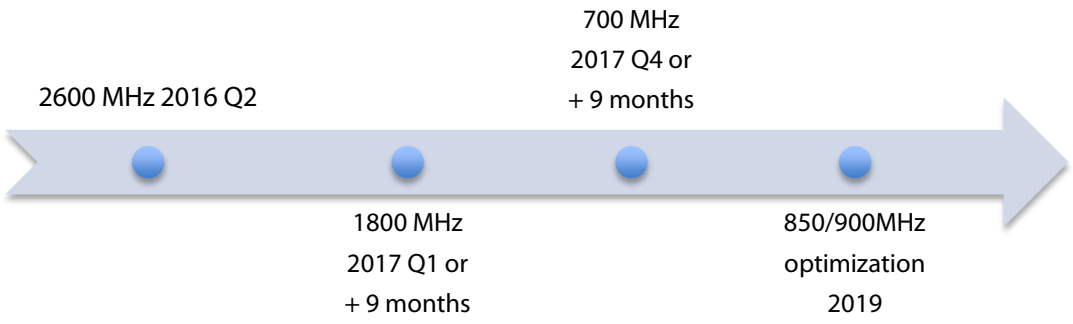
4. 700 MHz

The 700 MHz: Bands 703-803 MHz are unassigned.

Action Planned by Ministry/PTD:

Develop a policy and consultation to release 700 MHz band with the intention of auctioning this spectrum.

Figure 13: Proposed Release Schedule of Available Spectrum in Myanmar



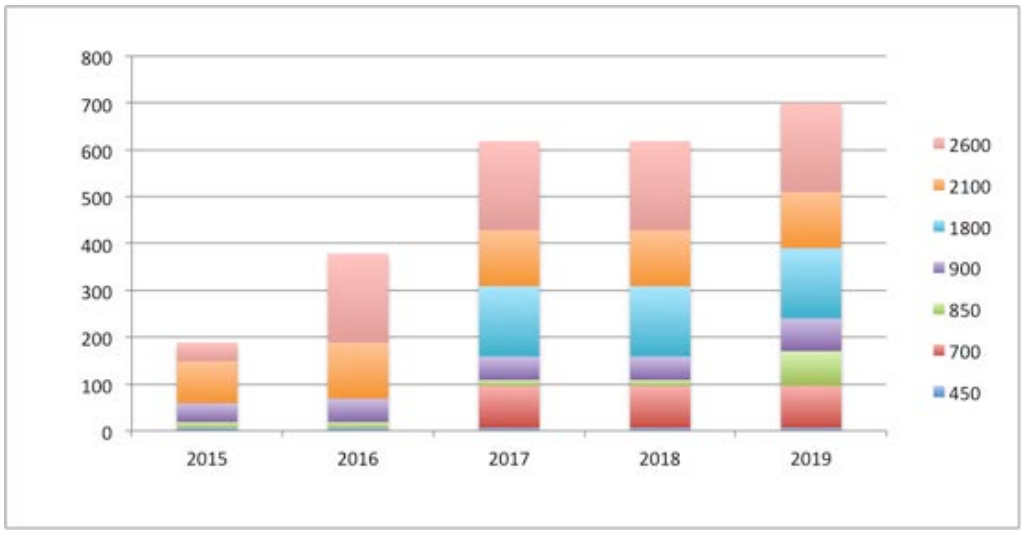
The following table and figure provides an overview of spectrum release plan in Myanmar:

Table 7: Current and Expected Spectrum Availability Plan over Next 5 years

Yearly	450 MHz	700 MHz*	850 MHz	900 MHz	1800 MHz	2100 MHz	2300MHz	2600MHz
2015	6.25	0	12.5	40	0	90	20	40
2016	6.25	0	12.5	50	0	120	20	190
2017	6.25	90	12.5	50	150	120	20	190
2018	6.25	90	125	50	150	120	20	190
2019	6.25	90	74	70	150	120	20	190

* Assuming APT 700 MHz Band plan

Figure 14: Current and Expected Spectrum Availability Plan over next 5 Years



It should be understood that the plan reflects current forecasts and the plan continues to provide Ministry/PTD sufficient flexibility to adjust the timing of release and the designation of specific frequency bands to be licensed in order to take into account evolving technological advancements, changes in market conditions resulting in new

business opportunities and to ensure orderly development of communications in Myanmar.

9.4.6. Future Spectrum Demand for Commercial Mobile Services in Myanmar

There are a number of sources forecasting the amount of spectrum required to meet commercial mobile requirements. Many administrations have also made forecasts to guide their spectrum planning decisions. ITU-R Report M.2290-0[1] present forecasts for growth in the total amount of mobile traffic in the world to 2020 and then models spectrum demand based on traffic density in across a variety of service environments that include urban, suburban and rural areas. It concludes that the demand for spectrum in 2020 is between 1340 MHz and 1960 MHz (in low and high demand situations respectively). However, a number of industry experts have challenged the results, claiming the forecasts are too high[48].

> "Future spectrum forecast assessment makes necessary assumptions about future technologies and market developments on some tangible basis, however, the use of any particular assumption should not be taken to imply that an alternative development is not equally likely."[49]

Growth: Since the introduction of competitive services in Myanmar there has been a growth in mobile subscribers from an estimated 4.4 M in March 2013, to about 9 M in March 2014 and subsequently to 18.1 M in March 2015. As only 14% of the population in Myanmar are using mobile phones solid growth is expected to be seen for at least a couple of years.

Forecasted Subscribership Growth: According to the latest figures [50] mobile subscriptions will grow at a 21% CAGR, to reach 38.5 million subscriptions at end-2019, as operators expand their networks to new cities and rural areas.

Smart phones: Both Telenor and Ooredoo report a high 80% smartphone usage rate.

Traffic: Telenor reports that its voice traffic grew 90% in the first half of 2015, but data usage grew a stunning 200%. 55% of Telenor subscribers are data users on a monthly basis and web browsing consumes 43% of all data costs, followed by Facebook at 24%, and 14% for streaming video. Games account for 8% while other uses at 11% round out total data consumption on Telenor's network.[51]

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[48]LS Telcom, TMF, The European Broadcasting Union (EBU)

[49] ITU – MCMC International Training Program 2015, 26 - 28 August 2015, Kuala Lumpur, Malaysia

[50]http://www.ovum.com/press_releases/myanmars-mobile-market-sees-phenomenal-growth-after-liberalization/

[51]http://www.ictworks.org/2015/09/30/wow-myanmar-is-going-straight-to-smartphones/

As noted previously, there is an aggressive growth in the mobile market that correspondingly signals that commensurate spectrum will be required to support this growth. However, in order for PTD to accurately forecast spectrum requirements specific to Myanmar, substantial additional information is required. Spectrum forecasts require country-specific detailed information including:

- Network configuration,
- Number of base stations,
- Subscriber traffic densities, and,
- Technology migration plans.

In order for PTD to assess longer-term spectrum requirements for Myanmar, it would need to work in concert with operators in order to:

- Develop the appropriate methodologies to be used;
- Gather the required information;
- Make assumptions – supported by data, about technology and services evolution;
- Analyze the data sets according to the methodological framework;
- Make allowances for uncertainties and alternative outcomes; and,
- Monitor the evolving market needs closely on and on-going basis and make appropriate adjustments to the long-term spectrum plans.

We note that each assumption supporting each input introduces potential inaccuracies in determining spectrum requirements, thus results should be viewed and used cautiously.

In this Spectrum Roadmap for Myanmar, a provision is made for a total of 625 MHz of licensed Terrestrial IMT over the five-year period, ending in 2020.

10.Fixed services

Backhaul facilities form an essential part of the infrastructure backbone that facilitates mobile and broadband networks. Backhaul systems are also used to link a broad range of telecommunications requirements between sites.

In Myanmar, wireless microwave solutions are more prevalent [due to the limited availability of fibre as a solution] for backhaul infrastructure in urban as well as remote and rural areas. Backhaul is a critical component for the deployment of mobile networks in that it enables fast deployment of cell sites.

The focus of this Roadmap discussion revolves around the "mobile first" initiative and back haul to support these growing networks. However, we should not lose sight of the fact that as other industries continue to grow, a broad range of users in these industries, as well as government will also require wireless connectivity to support their internal operations.

10.1. Demand for backhaul in Myanmar

The suggestions and comments from the Master Plan consultations are considered and accepted:

> *"Industry is in need of clean spectrum, in addition spectrum should be made available commercially. The areas/topics in need of urgent attention are fibre deployment, spectrum and competition."*

The demand for microwave backhaul continues to increase. Without appropriate spectrum planning, backhaul will become a bottleneck to the deployment of Commercial services, as well as impeding other users of the spectrum.

The key trends driving the rapid increase in the spectrum requirements for commercial mobile services are as follows:

- Growth in connections and the number and types of mobile devices,
- Consumer demand for faster data rates to support traffic intensive applications and,
- Networks increasing geographic coverage.

As networks grow in coverage and capability, demand is expected to grow further with a consumer expectation for instant fast reliable service everywhere. This all translates into more cell sites and correspondingly, more wireless microwave infrastructure with increased capacity.

International Forecasts of Future Backhaul Demand[52]

In 2011, a consortium of Aegis Systems Ltd., Ovum Consulting and dB Spectrum Services Ltd. provided the UK regulator, Ofcom, with a report that outlined the drivers of wireless backhaul demand.[53] The study indicated that although there is sufficient spectrum to meet

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[52]Industry Canada, Commercial mobile spectrum outlook, March 2013

[53]See the full *Frequency Band Review for Fixed Wireless Service* report (http://stakeholders.ofcom.org.uk/binaries/consultations/spectrum-review/annexes/report.pdf).

anticipated needs in the frequency bands above 20 GHz, additional spectrum might be required in the lower and medium frequency bands (3 GHz to 20 GHz frequency range).

Similarly, the Australian Communications and Media Authority (ACMA) has identified continued pressure within lower frequency bands (1.5-8 GHz), while sufficient spectrum exists to accommodate demand in the higher frequency bands.

In 2011, the United States' FCC made additional spectrum available for backhaul use in bands below 13 GHz, and provided additional flexibility to facilitate the use of backhaul in rural areas with the release of its Wireless Backhaul Report and Order(R&O).

We believe these international forecasts are reflective of similar requirements expected in Myanmar.

10.2. Other countries framework for assigning spectrum and licensing backhaul

In other countries, Microwave fixed systems support the operation of a host of industries including commercial telecom, utilities, broadcasting and government.

PTD considers it useful to review and factor the spectrum utilization plans of neighbouring countries when developing plans for Myanmar. Harmonization assists in developing frequency sharing arrangements in border areas and the coordination of individual systems to minimize interference.

IDA - Singapore's regulator, has adopted the ITU frequency plans in their Radio Frequency Master Plan. They have also sub-allocated certain bands for specific services.

Malaysia has developed SRSPs for frequency bands[54] assigned. The SRSPs describe the technical requirements for systems in these bands.

10.3. Current spectrum assignments and licensing framework for backhaul in Myanmar

According to the Myanmar Spectrum Rules, PTD may authorize Persons to establish fixed communications systems by means of fixed Radio Apparatus for the purpose of providing communications services to itself or for sale to another Person. Frequencies for fixed services are assigned according to the National Table of Frequency Allocations. Fixed licenses will generally be granted on a first-come, first-served basis[55]. If necessary, an auction or tender process may be used.

In Myanmar, backhaul in support of Commercial networks is in high demand. Wireless backhaul networks are designed employing a diverse range of frequency bands. The selection of a particular frequency band is primarily dependent on a variety of technical

[54]http://www.skmm.gov.my/Spectrum/Standard-Radio-System-Plan-Resources/Standard-Radio-System-Plan/List-of-current-SRSPs.aspx

[55]Throughout this document we recognize the need to for detail channel arrangements and technical requirements in al bands as well as utilization plans providing greater precision over the NTFA.

requirements (e.g. long-, medium-or short-haul capacity), design characteristics, operational practicalities and the availability of spectrum.

Wireless service providers' microwave backhaul networks are typically designed using a range of frequency bands. The size and scale of these networks depend on the specific operator's business needs. Depending on the application some networks may consist of only a few links, whereas the deployment of mobile networks is comprised of hundreds of links that span the entire country. While there are a host of frequency bands allocated to the fixed service and available for backhaul, the following traditional bands are highlighted by PTD as being primarily utilized by wireless service providers in their networks: 6,7,8, 11,13,15,18,19,23 GHz.

While backhaul spectrum has historically been authorized for the use of MPT rather than licensed. In developing the Spectrum Rules, PTD have made progress for planning and licensing of back haul. However, there are further steps are required to develop a best practice framework.

It is noted that Myanmar's Spectrum Rules provide that:

- Applicants may request exclusive use of a frequency or frequencies only in the bands 11.13,15,18,23 and 26 GHz
- Allows point-to-point, and point-to-multipoint
- Maybe used for portable applications such as ENG or nomadic applications.
- Various operational conditions of licence (CoLs) including minimum path lengths

The Spectrum Rules do not specify band limits, minimum efficiency standards, or antenna performance requirements or specify band arrangements.

As it is in Myanmar's interests that a best practices framework for band limits and arrangements be adopted on a priority basis, in the table below, we provide ITU Recommendations concerning radio-frequency (RF) channel arrangements for high-capacity fixed wireless systems (FWSs) for each of the bands allocated for assignment in the Spectrum Rules. Also included in the table are radio allocations that are co-primary with Fixed services (as indicated in the NTFA) – an important consideration when making assignments to Fixed services. And finally, the table lists the path length in km based on Spectrum rules:

- < 11 GHz are used for long-haul links.

These frequencies should be considered along certain corridors to reach areas where other backhaul options may be cost-prohibitive.

- 11-23 GHz typically are used for medium-haul links
- > 23 GHz are generally used for short-haul links

Spectrum, in higher ranges, is ideally suited to address the needs of operators for additional backhaul capacity in dense urban areas. Thus, the combination of small cell sites, spectrum in this frequency range and the latest technologies used in commercial mobile deployments can provide an efficient solution in order to support the deployment of broadband applications. This would provide for a large increase in short-haul spectrum availability is expected to address the demand for short-haul, high-capacity links both in and around urban areas.

Table 8: Spectrum Allocations

Band Limits (assumed based on ITU)	ITU Plan	NTFA(examples Co-Primary shared services in portions of bands)[56]	Path length(km)[57]
4GHz (3800-4200)	ITU-R F.382		10
6GHz (lower:5925-6425 MHz)	ITU-R F. 383	FIXED-SATELLITE (Earth-to-space)	10
6 GHz(upper:6425-7125 MHz)	ITU-R F. 384		10
7 (7125-7725 MHz)	ITU-R F. 385	FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE(space-to-Earth)	9.5
8 (7725-8500 MHz)	ITU-R F. 386	FIXED-SATELLITE (space-to-Earth) METEOROLOGICAL-SATELLITE(space-to-Earth) FIXED-SATELLITE (Earth-to-space) EARTH EXPLORATION-SATELLITE(space-to-Earth) FIXED-SATELLITE (Earth-to-space) MOBILE	7.5
10 (10.15-10.68 GHz)	ITU-R F. 1568	MOBILE RADIOLOCATION EARTH EXPLORATION-SATELLITE(passive	5
11 (10.7-11.7 GHz)	ITU-R F. 387	MOBILE except aeronautical mobile FIXED-SATELLITE (space-to-Earth)	5
12 (12.2-12.7 GHz)	ITU-R F. 746	FIXED MOBILE except aeronautical mobile BROADCASTING	5
13 (12.75-13.25 GHz)	ITU-R F. 497	MOBILE FIXED-SATELLITE (Earth-to-space)	5
15 (14.4-15.35GHz)	ITU-R F. 636	MOBILE	5

[56]Based on NTFA, Dec 23, 2013 (some allocations and associated FN may have been recently up-dated, or under review.

[57]Spectrum Rues

Band Limits (assumed based on ITU)	ITU Plan	NTFA(examples Co-Primary shared services in portions of bands)[56]	Path length(km)[57]
		FIXED-SATELLITE (Earth-to-space)	
18 (17.7-19.7 GHz)	ITU-R F. 595	MOBILE except aeronautical mobile EARTH EXPLORATION-SATELLITE(passive) FIXED-SATELLITE (space-to-Earth)	2
23 (21.2-23.6 GHz)	ITU-R F. 637	MOBILE EARTH EXPLORATION-SATELLITE(passive) SPACE RESEARCH (passive) BROADCASTING-SATELLITE EARTH EXPLORATION-SATELLITE(passive) RADIO ASTRONOMY INTER-SATELLITE	1

10.3.1.Backhaul Spectrum Planning

Based on PTD information the reported users of the microwave fixed bands are MPT, Ooredoo and Telenor, MRTV and Forever.

Historical approaches to spectrum assignment involved systems primarily dedicated to Government entities and assignments were made without the benefit of a planning framework, band plans, standards or an approach to coordination domestically or internationally.

As a result of this approach assignments were made randomly made, without consideration of maximizing use of the spectrum and not properly documented.

The introduction of new competitive services requiring access to microwave spectrum for backhaul has resulted in spectrum being assigned around legacy systems. This in turn has resulted in inefficient utilization and interference in the microwave bands.

In June 2014, MPT, in concert with KDDI, began revamping their backhaul microwave network structure and management outside the government operations.

In addition, two microwave (MW) experts were provided, one by Ooredoo and one by Telenor, who were set out to undertake the identification and mapping of, formerly unrecorded data, of the current use of the MW spectrum in Myanmar. In September 2014 a Backhaul Task Force was formally implemented. Revamping the bands was a priority in order to assist PTD in the mapping and allocation of unused MW spectrum for the new competitive entrants' deployment of backhaul in the microwave bands. The Task Force members reported that bureaucracy and nondisclosure or lack of network documentation

hindered the effort. The Task Force's main tasks were to manage/oversee the spectrum clearance project and jointly mediate/mitigate interference issues nationally as well as any interference issues along the neighbouring country borders.

Specific spectrum bands were identified along with the specific links that to be cleared, retuned or replaced with new equipment. As part of a Pilot project, the Task Force agreed that (151 links) for optimizing and clearing in the Lower 6GHz, 11 GHz and the 15 GHz bands. As of November 2015, the Task Force reported clearance includes 6 GHz(6 links), 11 GHz (77 links), identified but not yet cleared 15 GHz (68 links). This initiative was a significant and major effort to clean-up spectrum assignments and band arrangements.

Recommendations for improved efficiencies:

1. The Pilot project enabled the successfully documentation of links, to the extent that sufficient information was provided to the task force. However, in most cases, technical details of each installation are not complete.
2. With the creation of the Backhaul Task force, there has been a major effort to improve coordination, to complete the database of locations, description of equipment, etc. and to improve efficiencies of backhaul bands. The Task Force has proven to be an effective forum for the new entrant Commercial operators to coordinate their efforts with the incumbent.
3. It should be recognized that refarming of bands is a normal part of spectrum management when conditions change such as changes in allocation, demand/availability or technology.
4. PTD supports and commends the approach of industry stakeholders taking a lead role in inter-user planning and coordination and suggests this as an effective way to manage the band, particularly microwave bands, where there is a high degree of expertise required and industry users have the necessary competencies to carryout this function;
5. PTD recommends and identifies as a future initiative that a comprehensive spectrum utilization plan for Fixed bands be developed, these plans would factor the accommodation of existing as well as future needs and further improve efficiencies;
6. While assigned spectrum blocks are now known, there appears to be a void of specific links licensed and the associated technical parameters authorized; this should be acquired and recorded;
7. Specific assignment information should be made publically available so that all proponents developing new plans can properly factor existing assignments in their planning and design;
8. PTD acknowledges that the reported use of illegal and/or unlicensed operations in the backhaul bands needs to be addressed through establishing a compliance program, this is identified by PTD as a going forward initiative;
9. Demands in these bands will continue to grow as systems are deployed and the required capacity of links will increase as data demand continues to increase. PTD suggests the development and implementation of minimum performance standards for new microwave systems including throughput and antennas performance. This would be undertaken with full industry consultation;
10. The reported interference between operators, including between services (FSS), these cases involve FSS and terrestrial FS. Procedures for shared use bands should be followed as well as addressed in a future satellite policy;
11. The task force was created to clean-up currently deployed spectrum, record assignments and to implement standardized channel arrangements on a pilot

basis. Recognizing that it will take some time for PTD/MCRC to build the capacity to take over microwave licensing, PTD proposes the creation of a full-time industry sponsored group to plan microwave spectrum and to manage inter-user coordination, prior to filing application for licence with PTD/MCRC.

12. PTD has agreed, at least on an interim provisional basis, that frequencies may be allocated to each operators on an exclusive basis, this should be reviewed with a view to change "exclusive" to "preferential" basis, meaning allotted frequencies may be used to also accommodate other users as appropriate.
13. Exclusive assignment of frequencies could result in under-utilization and inefficient use of the spectrum. The high reuse capabilities in the microwave bands indicate that operators don't necessarily need to be assigned the same frequencies across the nation.

10.4. Going forward

The actual backhaul capacity needed on a per microwave hop or per base station basis differs substantially, depending on target data rates and population density driving the traffic requirements. The overall network requirements are a determined by the level of maturity of the mobile broadband network and services provided. As is the case for all other communications networks as technology evolves capabilities and capacities of these networks grows. New modulation schemes, new network connectivity ecosystems, higher frequency bands as well as fibre all influence opportunities for increased network connectivity capacity. Fibre is expected to continue to expand and to become available and all service providers reported including fibre as part of their network strategy. Microwave, however, will continue to be the dominant technology used for base station network connectivity and capacities will continue to grow.

Regulatory standards and plans are necessary to ensure spectrum is being used efficiently. Spectrum utilization plans, identifying how spectrum will be used, through the publication of Spectrum utilization plans, would ensure the adoption of efficiency standards and by sub-allocating portions of the band ensure that all user groups are accommodated going forward. Standard Radio System Plans /band plans would assist in the orderly selection of frequencies and the parameters guiding the deployment of systems in the fixed bands. Standard Radio Spectrum Plans/band plans need to be developed or formalized for all bands assigned to Fixed services. PTD has identified specific objectives in this regard; these would be created in full consultation with stakeholders.

ITU Recommendations for Fixed service bands provide information concerning technical requirements to guide in the development of SRSPs/band plans. Detailed compatibilities studies should also be performed when planning to introduce new system into the existing environment, see relevant ITU recommendations for guidance.

Licences for planned Fixed radio stations (>1GHz) should be granted after submissions are evaluated and approved by PTD (and correspondingly, the Myanmar Communications Regulatory Commission (MCRC) in the future). As a pre-requisite for this evaluation, applicants need to provide detailed, comprehensive information necessary for the assessment of environmental impact. PTD currently has limited capacity to undertake a detailed analysis of proposed networks and requires that applicants for radio licences cooperate and coordinate with other licence holders to permit reasonable and orderly sharing of the spectrum. It is recognized that Industry should form an effective part of

inter-user coordination, a proposed approach is discussed further in section 10.4.1 and PTD solicits stakeholder input in this regard.

Where fibre is available it should be considered to be the preferred solution as it provides virtually unlimited capacity, avoids wasteful duplication of infrastructure and urban blight and in most cases a more economical solution than microwave. Microwave requires the establishment of multiple links over great distances with associated costs of site acquisition, towers, radio equipment and antennas, installation and maintenance. In low-density markets and areas of rough terrain, microwave may prove to be more economical than fibre and in some very remote areas where even microwave infrastructure is not feasible, licensees will need to consider satellite services for backhaul. A domestic Satellite policy would assist in the procurement of services for those areas.

When evaluating submissions and making assignments, the following guiding principles apply:

1. Consider among the wireless alternatives, the solution that provides the best combination of amongst the selection criteria of costs, environmental impacts and duplication of infrastructure;
2. Optimize the utilization of the radio frequency spectrum, use non radio alternatives where feasible;
3. Provide for the planning of the efficient and orderly growth of telecommunications network as an entire system;
4. Ensure that the public interest is served through the consideration of all relevant factors in the granting of licences for new radio transmission facilities;
5. Anticipate, analyze, and resolve harmful interference problems in the early stages of system development;
6. Consider future system expansion plans and provide for frequency protection to the extent possible; and
7. Ensure that radiocommunication systems in Myanmar conform to the provisions of the regulatory frameworks and the International Telecommunication Union (ITU) *Radio Regulations*.

Bands used by more than one service

PTD notes that some bands are being shared among a variety of services and applications, and some cases of interference have been reported. To limit the potential risk to existing licensees and proponents, frequency coordination is required. Spectrum utilization plans would also assist applicants being accommodated in compatible bands.

The frequency allocations to different satellite services (e.g. FSS, MSS, BSS), mostly above 1 GHz are shared in many bands with the terrestrial services, in particular with fixed and mobile services.

For terrestrial assignments, International coordination is triggered either by station location being within a specified distance to the international border in accordance with established border sharing arrangements, or, exceeding pre-specified power flux density limits.

In some cases, fixed microwave system may use the same frequency bands as satellite systems and inter-system interference is a possibility. Radio frequency coordination

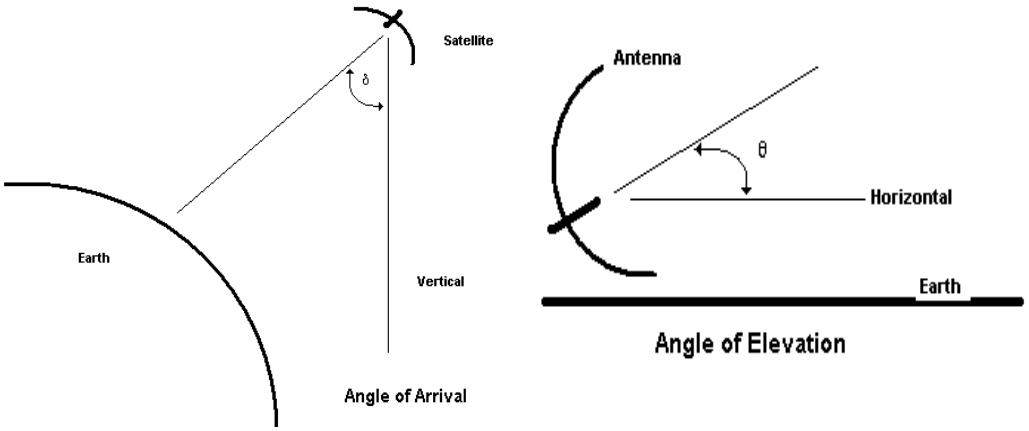
procedures for fixed microwave system and satellite systems require coordination to minimize the risk of interference.

When making assignments in bands above 1 GHz to space and terrestrial systems, due consideration should be given to the ITU requirements described in Articles 9, 13 and 21.

When frequency bands are shared between terrestrial and earth stations (ES), the potential for interference exists and increases for stations in close proximity. ITU Article 21 requires that terrestrial stations and earth stations, operating in frequency bands shared with equal rights between terrestrial radiocommunication and space radiocommunication services, shall be selected having regard to the relevant ITU-R Recommendations with respect to geographical separation between earth stations and terrestrial stations.

For the shared frequency bands by the terrestrial and space systems, Article 21 prescribes maximum equivalent isotropic radiated power (EIRP) for terrestrial and ES and requires the sites to be selected such that the direction of maximum radiation of any terrestrial system antenna will be separated from the geostationary-satellite orbit (GSO) by at least the angle (delta, δ) prescribed by tables provided in the Article 21 and of the ES with respect to the horizon (theta, θ). (See figure below).

Figure 15: Diagrams of scenarios between terrestrial and space stations



Other Microwave users

Other services frequently using microwave include or other applications where the Radio Apparatus can be moved, such as, Electronic News Gathering associated with TV operations and are used to cover breaking news and special events, these systems traditionally need to be deployed quickly. Frequencies would be identified as part of a sub-allocation plan. To accommodate this requirement in designated areas, special domestic inter-user coordination on an event-by-event basis is effectively used in countries such as Canada. Given the unpredictable and itinerant nature of TV pickup operations, sharing with future backhaul systems may not be practical in geographic areas where TV operations are licensed. However, for areas without TV pickup licensees, sharing is feasible.

In time PTD plans to have in place the tools to ensure orderly spectrum development and efficient assignment and utilization.

10.4.1.Institutional arrangements with Industry

Institutional frameworks are particularly helpful in the development of Microwave Fixed services >1 GHz. As demonstrated through the pilot clean-up of microwave bands, microwave users are typically representative of user groups that are well informed, that understand the importance of spectrum management and the orderly deployment of systems. These companies frequently have staff that is technically astute in the design of networks and in undertaking electromagnetic (EMC) studies. As proposed above, PTD proposes that Industry take a lead role in inter-user coordination of networks planning. It is important that industry players be well organized, all-inclusive, and has processes and procedures in place such that systems are designed in such a manner as not to cause, or suffer, objectionable interference with other systems operating in the same or adjacent frequency bands. There must be a system in place for the coordination and assessment of individual proposed assignments between users in Myanmar. Properly developed institutional arrangements would mutually benefit users and PTD/MCRC. In this regard, PTD proposes the establishment of a permanent industry led "microwave coordination committee".

Spectrum coordination is facilitated when there is sharing of data among users, so that accurate and up-to-date information is available to enable accurate estimates of potential interference during the system design stage, follow sound engineering practices. Radio frequency interference studies and frequency coordination are necessary not only when designing a new radio system, but also when a network planner studies the potential interference effects of other users' radio construction proposals on existing and planned systems. Thus coordination involves the sharing of construction plans and commenting on other parties' plans in the early stages of design. A cooperative approach around users results in a win-win outcome.

Licensees would be expected to apply and self-coordinate among domestic users preferable through an Industry sponsored body; "the microwave coordination committee" (similar to the pilot "The Microwave Task Force") when new systems are proposed or where modifications to existing fixed radio systems are proposed:

- Changes to the route design, including changes to station locations, or if new radio stations are to be added;
- Additional radio channels are added to a system;
- Modifications to the operating frequency of existing radio channels;
- Changes to the antenna radiated power;
- Changes to the antenna characteristics, elevation angles, or azimuths; and/or
- Modifications to the equipment characteristics such as bandwidth, modulation characteristics, or capacity.

Role of PTD/MCRC and Industry

Proper organization and governance would include both government and user groups of the microwave bands. Not all users will be equally motivated to coordinate and make room for competitors, for this reason governments would normally develop the operational and technical criteria associated with systems in the band and the coordination requirements, in consultation with Industry.

In the case of Myanmar, pending the creation of a framework for microwave bands under the new MCRC agency (and migration of Ministry/PTD functions and staff), participation by PTD staff in the Microwave Coordination by Industry is also proposed. PTD would regularly meet with and monitor and over-see the activities of the committee. In addition, PTD would expect to only intervene in the operations of the Microwave Coordination Committee when there are impasses or when there are new users requesting access to spectrum. Detailed Terms of Reference for the Industry "Microwave coordination group" would need to be developed along with principles, procedures and service level roles and agreements.

Cross border coordination with administrations of other countries is normally the responsibility of the regulatory agency. However, it may be useful for PTD/MCRC to facilitate and promote consultation between operators in border areas to "pre-coordinate" planning of proposed networks. Coordination at the user level can be implemented as part of bi-lateral sharing agreements between countries.

A critical requirement of coordination is that every country should have a single frequency register available that lists all assignments and includes the necessary technical information allowing users to plan systems.

Domestic coordination requirements

The following makes some recommendations concerning domestic coordination among users. A process for domestic coordination would be based on standard requirements and responsibility of proponents. Such that prior to initiating a request for frequency coordination, applicants are expected to have performed their own internal studies to determine that their proposed system will not create harmful interference into existing or proposed domestic terrestrial systems and earth stations. Applicants must confirm that frequency coordination with the operators of these radio facilities has been successfully completed. Information on other spectrum users would be provided by PTD/MCRC's website, along with instructions on doing licence data searches. Where licence records are not fully disclosed due to licence security reasons, sufficient information should enable applicants to contact the protected licence holders in order to perform frequency coordination.

Requests for frequency coordination should include enough technical information for a full assessment of whether the proposed system, and any planned growth of the system, will cause harmful interference. PTD suggests the minimum information that would be included in a frequency coordination request would be:

Administrative Information

- Originating coordinator's name, address, and internal contact
- Phone number, fax number, and e-mail address
- Date coordination request sent
- Confirmation of whether this a new system or a modification to an existing licensed system
- In-service date of the proposed system

Station Data

- Site names and licence numbers (if existing)
- Latitude and longitude
- Ground level above mean sea level

Radio Equipment Details

- Equipment makes and models
- Power output (include information on ATPC if utilized)
- Transmit and receive frequencies
- Polarization
- Bandwidth and type of modulation
- Capacity

Antennas

- Makes and models
- Gains
- Radiation patterns
- Azimuths and elevation angles
- Height of each antenna centreline above ground level
- Antenna system losses between the radio antenna coupling and the antenna input

Passive Reflector or Repeater (if used)

- Latitude and longitude of passive reflector or repeater
- Ground level above sea level
- Passive reflector surface area, azimuth normal to the reflecting surface, and elevation angle
- Passive repeater antenna makes and models, gains, polarizations, and azimuths
- Height above ground level of the centre line of the reflecting surfaces

System Growth (optional)

All technical information on system growth that is to be included in the licence application must be part of the frequency coordination request and include:

- Additional RF channels and dates of implementation up to 5 years in the future;
- Bandwidths, type of modulation, and capacities of future channels; and
- For any future planned expansion of an RF channel bandwidth, the final bandwidth, capacity, and type of modulation.

Additional Comments

Any additional information that may be relevant to the frequency coordination request should be included.

<u>International coordination</u>

In the border areas applicants are encouraged to pre-coordinate with network licensees on the other side of the border wherever possible to help avoid unnecessary delays. Any information regarding pre-coordination which has been completed should be included with the licence applications to PTD/MCRC.

Frequency coordination with international authorities will be carried out by the PTD/MCRC on the applicant's behalf. If coordination is unsuccessful, the PTD/MCRC will notify the

applicant and provide sufficient information on the anticipated conflict in order to assist the parties involved in developing a resolution.

Actions Planned by Ministry/PTD:

1. Initiate discussion with industry concerning the development of a longer-term framework for planning and coordination of Microwave Fixed bands. Ideally this involves establishing an institutional arrangement with Industry partners by establishing an Industry-sponsored coordination body for the microwave bands, similar to the "Microwave Task Force";
2. Implement spectrum policy based on minimum throughput performance and minimum antenna performance standards;
3. Release bands of bands including 18 &23 GHz bands as well as the higher bands >23GHz (26,70, 80, 90 GHz) for very short hops; and,
4. Due to the limited propagation and high reuse capabilities of the 70, 80, 90 GHz bands, the PTD will consult on a simplified licensing regime and a commensurate low, flat spectrum fee for these bands reflecting the economic value of the spectrum to the operators[58].

[58]Bands above 40 GHz have not yet been allocated in Myanmar

11.Land Mobile

Land mobile systems are typically terrestrial Point-to-Area (PTA) systems comprised of fixed base-to-mobile, mobile-to-mobile, transportable base-to-mobile stations. One-way and two–way paging systems are also included in the LM category. These systems support a broad ranges of services including transportation, government, military, public safety, as well as service providers providing two-way radio communications infrastructure and applications to businesses. Land mobile systems capture a broad range of systems where there is a need to communicate to or between nomadic stations travelling in a defined coverage area. Spectrum should be made available to support sovereignty, security and public safety needs within Myanmar and many of these systems would be PTA LM.

11.1. Demand

As new businesses emerge and existing ones grow,there will be increased requirements for two-way radio to support business operations. These systems are typically dispatch type service offering the unique capability of one-to many communications or the placement of group calls.

As there are a number of configurations that systems may take, consideration needs to be given to the configuration and types of systems PTD would like to accommodate. Systems can be simple simplex systems consisting of a base station with associated handsets or mobiles or in some cases only mobiles. Also, possible systems may be duplex (two frequency) where a base(s) operate through a repeater and communicates with mobiles.

Systems authorized could be licensed as stand-alone private systems, where business owners operate their own system or PTD-licensed public service providers, where systems licensed by PTD would offer dispatch type services to private entities. Public service providers could be licensed on a number of radio channels and these could be conventional duplex or more efficiently as trunked radio services.

While many requirements will be met by advanced mobile service now available from Commercial operators there will be an on-going requirement for smaller stand-alone simplex, duplex and trunked radio systems. In some cases, radio systems will be centric to a particular business (Private Mobile), in other cases, there will be radiocommunications services providers (Public Mobile), such as spectrally-efficient trunked radio networks that would offer broader coverage, improved technologies and various other communications related services. In many cases, where the equipment life-cycle associated with Land Mobile systems is long, proper band planning, standards and authorization processes would improve utilization and a migration path to more efficient use over time.

11.2. Other Countries

It is useful to examine the spectrum development and utilization plans of neighbouring countries that shows how the regulator agencies have allocated and assigned spectrum to meet the need of conventional simplex, duplex and trunked land mobile services.[59]

[59]In some cases, PTD may consider leveraging band plans from other countries where considered appropriate.

The radio Spectrum Management Plan of IDA Singapore has allocated the following bands for land mobile systems including Trunked Mobile services:

Table 9: Bands Allocations for land Mobile Systems in Singapore

Frequency Range	Existing/Planned Systems	Status
380-400 MHz	TETRA	Mostly assigned
400-410 MHz	Land Mobile Radio	Mostly assigned
410-430 MHz	Digital Trunked Radio	Fully assigned
440-450 MHz	Land Mobile Radio	Mostly assigned
806-823 MHz/851-868 MHz	Digital Trunked Radio	Mostly assigned

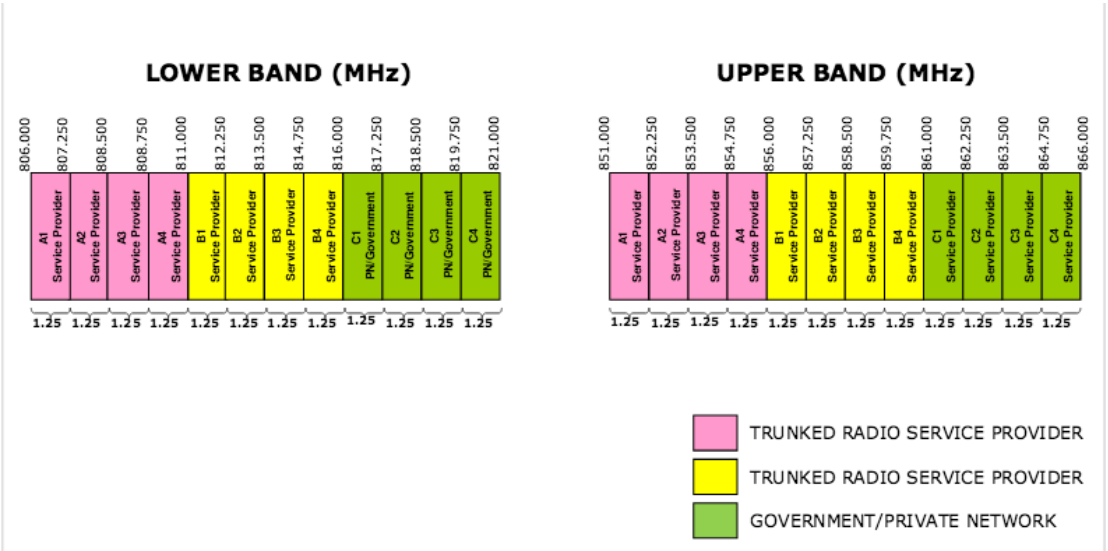
Source: IDA, Singapore

In Malaysia, the regulator (Malaysian Communications and Multimedia Commission) publishes Standard Radio Spectrum Plans (SRSPs).[60] These SRSPs - following best practices of other developed countries, these plans spell out how spectrum is assigned for various services. With respect to land mobile trunked radio services, spectrum is assigned in the bands 380-399.8 MHz, 410-430 MHz, and 800 MHz. The SRSPs provide information on the minimum requirements for the use of a frequency band as described in the Spectrum Plan. Information is provided on technical characteristics of radio systems, frequency channelling plans and, coordination initiatives in order to maximise the utilization, minimise radio frequency interference and optimise the usage of the spectrum. The intent is to apply the SRSPs in order to enable efficient regulation of spectrum usage and not cover detailed equipment standards, as this is a separate activity.

An example of the SRSP band plan for 800 MHz (806-821/851-866 MHz) is shown below:

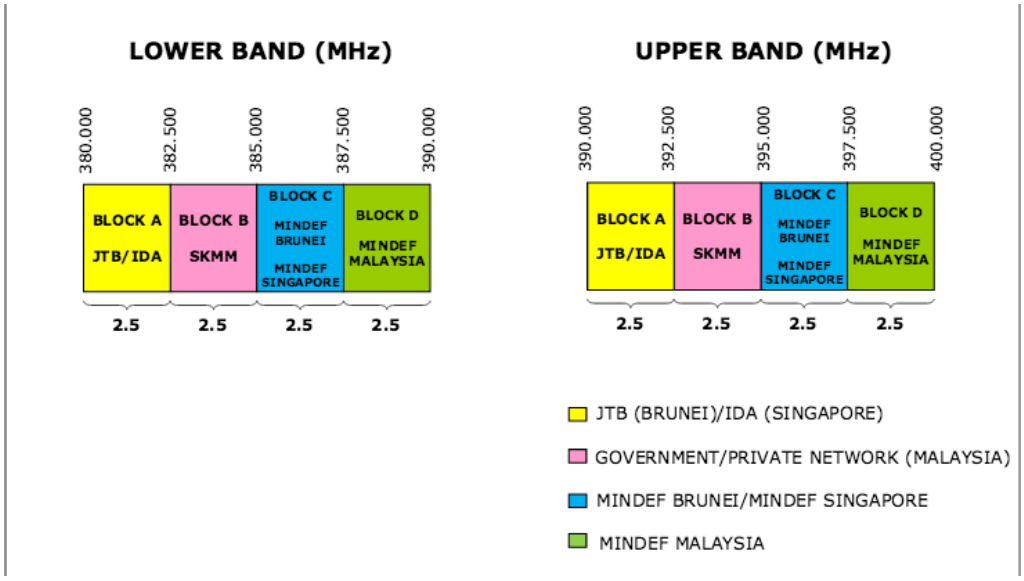
[60]http://www.skmm.gov.my/Spectrum/Standard-Radio-System-Plan-Resources/Standard-Radio-System-Plan/List-of-current-SRSPs.aspx

Figure 16: Spectrum Allocation Trunked Radio in Band 806 MHz and 851 MHz to 888 MHz



Similarly, in the 400 MHz range, the following allocated bands are made available to meet the needs of trunked radio services:

Figure 17: Spectrum Allocation Trunked Radio in Band 380 MHz to 400 MHz



11.3. Current Assignments

The NTFA indicates that there is a very high demand for radiofrequency spectrum in the VHF band and the NTFA allocates 410-420 MHz and 420-430 MHz for use by Trunked radio systems. The Spectrum rules make provision for the authorization of terrestrial Radio Apparatus for the purpose of providing two-way communications services amongst users within companies (e.g., between a company's base station and the associated vehicular or

hand-held portable units). Licensing would generally be on a FCFS basis, except in situations where Demand exceeds supply.

Currently in Myanmar, upon request from another government authority of the Union Government, the Department may authorize the use of frequencies to provide all forms of government services.

11.3.1.Spectrum Planning

PTD proposes that the following factors be considered, allowing for development of services that will rely on these bands:

1. Map existing users and coverage areas
2. Define bands that are harmonized with neighbouring countries
3. Develop band plans, align with neighbour countries
4. Develop technical standards for systems (e.g. maximum for height, power, emission)
5. Negotiate sharing arrangements/MOU in border areas securing future access to the spectrum

11.4. Going forward

As noted above, Myanmar can expect demand to meet the needs of conventional simplex and duplex as well as trunked dispatch type services that support both government and public/private operations. Facilitating access would result in benefits to users and industry supplying equipment and radio installation and maintenance services.

Possible allocations to meet the needs of Land Mobile radio are identified in the updated NTFA. Below are bands for consideration.

Lower frequency bands in the VHF and UHF bands would be preferred for systems serving users in topographic areas with hills and valleys, due to more favourable propagation in these areas.

Table 10: Possible Allocations for Land Mobile in Myanmar

Possible allocations for LM (Frequency Range)	Comments regarding utilization and channelling plan
VHF Myanmar NTFA allocates various bands for LM service allowing FX and ML. Careful consideration should be paid to Foot Notes that may limit utilization. **137-138** **138-144** **144-145.8** **146-148** **148-149.9** **150.05-156.7625** **156.8375-174**	Channelling plans commonly accommodated are 6.25, 12 or 25 kHz, however, for broader channelling, minimum spectrum voice channel efficiencies should be specified. Standard Radio System Plan should be developed for bands identified for LM services and band planning should consider the allocations and assignments made in neighbouring countries. Band plans should also be subject to frequency sharing arrangements with neighbouring countries for the use of frequencies in border areas. Shared allocations should be considered and Consideration should be given to neighbouring country spectrum utilization plans noting that harmonization within the region will simplify border sharing, minimize interference and increase access to affordable equipment and services.
UHF **406-410** **410-420** **420-430** **440-450** **450-456** **456-459** **459-460** **460-470**	The Frequency Rules - Annex D for Public Land Mobile Spectrum only show 467.475-470 MHz for the use of walkie-talkie equipment users (construction companies). No associated band pan is identified.
800/900 MHz	In concert with internationally harmonized domestic spectrum utilization policies, it is useful to refer to the existing channelling plans in neighbouring countries.

11.4.1.Planned Release

PTD proposes the development of Standard Radio System Plans in order to meet the needs of systems wishing to operate in the VHF, UHF and 800/900 MHz bands. VHF bands should be assigned on an FCFS basis and coordinated appropriately.

PTD/MCRC may consider first developing band plans to accommodate trunked radio systems in the 400 MHz and 800 MHz range.

Actions Planned by Ministry/PTD:

1) Identify the Land mobile spectrum to be made available to for Private as well as Commercial LM dispatch type operations. This exercise should include separate identification of spectrum available for simplex, duplex and trunked radio systems;

2) Develop band plans that leverage existing band plans of neighbouring countries in order to ensure harmonization and spectral efficiency; and

3) Negotiate border-sharing arrangements.

12.Licence Exempt

Around the world a growing number of consumers use a special category of radio equipment, referred to as **licence-exempt** radiocommunication devices or Short Range Devices (SRDs). There are many different types of short-range devices, and different devices in different frequency bands require specific technical standards. These devices are of low power and operate on designated frequencies. In most jurisdictions only approved devices, meeting prescribed technical specification are permitted. Permitted equipment meeting the prescribed specifications radiocommunications is *authorized* to operate in these bands without the need to apply for a licence. Any equipment proposed outside of the prescribed specification requires a licence. PTD resource constraints have limited progress developing and releasing standards. A standard for licence exempt equipment is anticipated in the near future.

The benefit and convenience of not requiring a licence also has limitations. Licence exempt equipment share common spectrum and operate on a no interference/ no protection basis, meaning equipment is usually designed such as to have inherent interference mitigation techniques.[61] Licence exempt equipment commonly encounters various forms of radio interference, this may be the result of many users sharing the band in the same general area or interference may be encountered from licensed users. Interference can result in degradation to system performance.

12.1. Demand

Common uses of licence exempt equipment are cordless telephones, baby monitors, walkie-talkies, remote garage door openers, or wireless local area networks such as wireless LANs or Wi-Fi devices. These same bands are frequently used for WiFi hotspots, Blue tooth connections.

Licence exempt bands and standards are not necessarily common in all countries. Devices manufactured for licence-exempt use in other countries may not meet domestic

[61]Examples of protocols and standards are: 1) Orthogonal frequency division multiplexing (OFDM): is the modulation and multiplexing of Wi-Fi 802.11a and g; 2) Coded Orthogonal Frequency Division Multiple Access (COFDM) is used in Wi-Fi 5GHz (IEEE 802.11.a) as signal modulation technique; 3) Direct-sequence spread spectrum (DSSS) is used at Wi-Fi IEEE 802.11b and ZigBee IEEE 802.15.4; 4) Frequency-hopping spread spectrum (FHSS) is used for Bluetooth IEEE 802.15.1;

regulatory or technical standards and may cause or receive radio interference. Only approved equipment that complies with applicable technical standards, operational and regulatory licence exempt requirements, is permitted for sale and use in Myanmar.

Industrial Scientific and Medical (ISM) is another category of equipment that shares the same spectrum, although they are not communications devices. Examples of ISM equipment are radio-frequency process heating (use in Industrial manufacturing), microwave ovens, and medical diathermy machines. These devices offer another source of potential interference.

Access to the Internet is a key enabler to information access and communications. Learning, e-commerce and social media are all facilitated through the Internet connectivity. Connection to the Internet through the use of Licence exempt devices is a predominant mode of access. Technically, it could be argued that the common use of spectrum by licence exempt systems is more spectrally efficient when compare to dedicated licensed systems. Many services are now offered using licence-exempt spectrum and this enables the availability of broadband access. Hotspots are used for laptop, tablet and WiFi-enabled smart phones to connect to the web.

Licence exempt spectrum is now also a factor in the deployment of Commercial mobile systems. Around the world, licensed commercial service providers are increasingly turning to licence-exempt spectrum to meet the bandwidth requirements for mobile data. WiFi hotspot deployments were predicted to rise 350% by 2015. 58% of operators - including 47% of mobile operators Wi-Fi hotspots are either very important or crucial to enhance their customers' experience; offload busy mobile broadband networks; and provide a value-added services platform.[62]AT&T in the United States supports approximately 45,000 hotspots, which provide Wi-Fi access for the company's wireless customers.[63]

There is an increasing demand for, and use of SRDs for a wide variety of applications throughout the world, many different applications provided by these devices, such as, telecomm and, telemetry, voice and video, detecting system, broadband radio local area networks, railway applications, road transport and traffic telematics, alarms, model control, inductive applications, radio microphones, RFID systems, ultra-low power active medical implant, RF level gauges, etc. Harmonization of frequency bands and equipment standards should be pursued to the extent possible.

12.2. Other Countries

Licence exempt bands are not common in all countries. To better understand the frequency bands that have been opened up for SRD operations, APT published a report and result of a survey among APT-member countries on the technical and procedural regulations of Short-Range Devices (SRDs). The objective of the survey on the technical

[62] Wireless Broadband Alliance http://www.wballiance.com/wba/wp-content/uploads/downloads/2012/07/16_WBA-Industry-Report-2011-_Global-Developments-in-Public-Wi-Fi-1.00.pdf

[63] http://www.att.com/gen/general?pid=5949

regulations is to determine, among other technical requirements, the operating specifications of SRDs across different types of applications. For procedural regulations, the key focus is on the type approval process, MRA arrangement, licensing requirements, operating parameters as well as future policies.[64]

Most countries have standards for SRDs. A number of countries have in place Mutual Recognition Agreements (MRA) for Conformity Assessment of Telecommunications Equipment. MRAs are frequently used by many countries to provide for recognition of test reports and allow for recognition of certification for product approvals. Looking at neighbouring countries such as Malaysia, Thailand and Vietnam, we summarize below specific requirements.

[64] *APT* survey *Report* on. OPERATION OF SHORT-RANGE DEVICES (SRDs). No. *APT/AWG/REP-07* (Rev. 3). Edition: March 2015. Adopted by The 18th APT Wireless Group Meeting, 9 – 13 March 2015, Kyoto, Japan

Table 11: Country-Specific Requirements for the Regulation of SRDs

Country	Type approval/Certification	Mutual Recognition Agreements	SRD Licensing	Future regulatory changes
Malaysia	- Generally have some type approval process.	Yes, with Singapore	Class Licence	Nil planned
Singapore	Equipment registration shall be based on the submission of the Supplier's Declaration of Conformity (SDoC) to signify that the supplier has carried out conformity assessment on the equipment to IDA's Technical Specifications.	Yes, with Australia, Brunei, Canada, Chinese Taipei, Hong Kong, India, Indonesia, Japan, Malaysia and United States	Generally, low powered SRDs operating within IDA's technical specifications are licence-exempted.	SRD licensing framework will be reviewed periodically, with the aim to streamline licensing processes and relax technical conditions where appropriate.
Thailand	-Type approval process	No	Some SRDs licensed. L.E. are must comply with certain technical conditions such as maximum transmit power limit and compliance with technical standards	Regulations define only for license-exempt equipment, but do not have explicit definitions of unlicensed spectrum or "spectrum commons." Thailand will incorporate the concept of "spectrum commons" into modification of future NBTC Regulations in order that, in general, SRDs would be able to use unlicensed bands or spectrum commons.
Vietnam	Type approved SRD allowed for use	Vietnam has entered into MRA with Korea, USA, Canada and Singapore. The test reports from designated laboratories of those countries should be recognized.	All the SRDs operating within technical specifications of Ministry of Information and Communications (MIC) are exempted from a radio license in Vietnam.	Nil Planned

List of APT countries with regulatory frameworks covering short-range devices (SRDs) that can operate on licence-exempt basis is shown in the table below.

Figure 18: List of Countries with Regulatory Frameworks covering SRDs that operate on licence-exempt basis

Frequency band	Remarks	AUS	BRU	CTN	CHN	J	KOR	LAO	MLA	MYN	Macao	PNG	RMI	SNG	THA	VTN
9-148.5 kHz		Y	P	Y	Y	N	Y	Y	Y	N	Y	N	N	Y	P	P
148.5-315 kHz		N	N	U	P	N	P	N	Y	N	N	U	N	N	N	N
3 155-3 400 kHz	RR No.5.116	Y	Y	U	Y	P	Y	Y	Y	N	N	U	N	N	N	N
6 765-6 795 kHz	RR No.5.138	U	Y	Y	Y	Y	U	U	Y	N	N	U	N	N	N	N
7 400-8 800 kHz		Y	Y	Y	P	N	P	N	U	N	N	U	N	N	N	N
13.553-13.567 MHz	RR No.5.150	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	N	Y	Y	Y
26.957-27.283 MHz	RR No.5.150	Y	Y	Y	Y	Y	P	Y	Y	Y	Y	U	N	Y	P	Y
40.66-40.7 MHz	RR No.5.150	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	N	Y	P	Y
312-315 MHz		Y	Y	N	P	Y	N	N	Y	Y	N	U	N	Y	Y	Y
433.05-434.79 MHz		Y	Y	Y	Y	P	P	Y	Y	N	N	U	[P]	Y	Y	Y
401-402 MHz		Y	N	U	N	N	U	Y	U	N	N	U	N	Y	Y	Y
402-405 MHz		Y	N	U	N	Y	Y	Y	Y	N	N	U	N	N	Y	[P]
405-406 MHz		Y	N	U	N	N	U	Y	Y	N	N	U	N	N	Y	Y
862-875 MHz		N	P	P	N	N	N	Y	Y	N	N	U	U	P	N	P
875-960 MHz		N	P	P	P	P	P	N	Y	N	N	N	[P]	P	P	P
2 400-2 483.5 MHz	RR No.5.150	P	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	N	Y	Y	Y
5 150-5 350 MHz		Y	P	Y	N	Y	Y	Y	N	Y	N	U	[P]	Y	Y	Y
5 470-5 725 MHz		Y	P	Y	N	Y	P	Y	N	Y	N	U	[P]	Y	Y	Y
5 725-5 875 MHz	RR No.5.150	Y	Y	Y	Y	Y	P	Y	Y	Y	P	U	[P]	Y	P	P
24.00-24.25 GHz	RR No.5.150	Y	Y	Y	Y	Y	P	Y	Y	N	N	U	[P]	Y	P	Y
61.0-61.5 GHz	RR No.5.138	Y	N	Y	N	Y	Y	Y	Y	N	N	U	N	Y	U	N
76-77 GHz		Y	Y	Y	Y	Y	Y	N	Y	Y	N	U	N	Y	Y	N
122-123 GHz	RR No.5.138	U	U	Y	N	Y	U	Y	Y	N	N	U	N	N	N	N
244-246 GHz	RR No.5.138	U	U	Y	N	Y	U	Y	Y	N	N	U	N	N	N	N

Y: Yes, implemented already P: Partially implemented U: Under implementation N: Not [available or undecided]

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12.3. Current use of licence-exempt spectrum in Myanmar

According to the Spectrum Rules section:

8. Unlicensed/License-exempt Spectrum

a) The following bands, which are identified by the ITU (Section 5.150 of Volume 1 of the Radio Rules) for use by industrial, scientific and medical equipment, may be used by Radio Apparatus without the need for obtaining a License under Part IV of these Rules:

- 13 553-13 567 kHz (centre frequency 13 560 kHz),
- 26 957-27 283 kHz (centre frequency 27 120 kHz),
- 40.66-40.70 MHz (centre frequency 40.68 MHz),
- 2400-2500 MHz (centre frequency 2 450 MHz),
- 5725-5875 MHz (centre frequency 5 800 MHz), and
- 24-24.25 GHz (centre frequency 24.125 GHz)

b) The Ministry may identify additional frequency bands that can be used by Radio Apparatus that are exempt from licensing.

c) Per Section 30 of the Computer Science Development Law, services provided using Radio Apparatus authorized by this Section do not need an Associated Operating

License unless the services are being provided to End Users in return for monetary remuneration.

d) The provisions of Section35 apply to the Radio Apparatus authorized under this Section.

e) To ensure that License-exempt Radio Apparatus does not cause interference:

i. License-exempt Radio Apparatus may not cause Harmful Interference to any individually-licensed Radiocommunication Service and must accept interference from those services as well as from other License-exempt Radio Apparatus.

ii. Additional regulations may be issued from time-to-time by the Department or Ministry in order to address power levels, operating characteristics and limitations, out-of-band emission criteria, and other technical details.

In Myanmar there are currently no associate radio standards or regulations for equipment operating in allocated Licence exempt and Industrial Scientific and Medical (ISM) bands.

12.3.1.Spectrum issues in the use of licence-exempt equipment

PTD has identified regulatory issues concerning the deployment of equipment in unlicensed bands. PTD notes the use of high power equipment in bands identified for Licence exempt equipment, normally used by low power operations. Currently, there are no radio standards or regulations specifying the technical criteria for the operation of equipment in this band. In some countries, bands used for unlicensed equipment may also be authorized for higher power stations; however, only stations meeting radio standard specification for exemption may operate without licence.

The identification of bands for licence-exempt operation along with the absence of radio standards specifying when licensing is, or is not required, has resulted in deployment of systems operating under a mix of technical operating parameters. Without radio standards and effective import control, equipment will likely be imported from various countries.

Most countries have radio equipment standards, equipment certification and labelling requirements for equipment approved for licence exempt operation. There is a broad range of applications and types of equipment that countries permit for operation on a licence exempt basis, some with strict operating conditions.

Myanmar is experiencing a high degree of reported interference in the 2.4 GHz and 5.8 GHz range.

While it is possible to authorize both licensed and unlicensed equipment in a shared band, radio standards along with operating conditions and appropriate licensing procedures are necessary to minimize the risk of radiofrequency interference. PTD recommend not mixing licensed and unlicensed systems in the same frequency bands.

12.4. Going Forward

Many SRD applications and the frequency bands in which they are deployed are described in Report ITU-R SM.2153. ITU-R SM.1896 provides recommendations on Frequency ranges for global or regional harmonization of short-range devices. However, the report cautions: Further studies

may need to be undertaken in ITU R to determine whether global or regional harmonization of these ranges, or portions thereof, is feasible, given that there are many SRD applications, such as those operating across national borders, that would benefit from worldwide harmonization.

Table 12: Possible frequency bands for harmonization of SRD within Asia-Pacific region[65]

Frequency band	Typical Application	Remarks
402-405 MHz	Medical Implant	APT REC-05
433.05-434.79 MHz	RFID	APT REP-07
860-960 MHz	RFID	APT REC-03
5150-5350 MHz	WLAN	APT REC-06
5470-5725 MHz	WLAN	
76-77 GHz	Vehicle Radar	APT REP-07

Myanmar will continue to harmonize spectrum allocated to LE spectrum allocations as well as to develop equipment standards(see footnote 66 below)for equipment that may be used in these designated bands and pursue MRAs. As can be seen in the above table comparing countries, many countries have regulated a number of SRD frequency bands in a common manner. A review of technical criteria for equipment permitted also show many similarities**.**

Actions Planned by Ministry/ PTD:

1) Develop a Framework for Licence-exempt bands and equipment;

2) Publish consumer education information for users providing direction with a list of equipment approved; and,

3) Pursue discussion with border agencies in order to prevent importation of equipment that does not meet the standards of recognized standards setting bodies by listing equipment banned from operation.

[65] APT REPORT on THE FREQUENCY BANDS FOR HARMONIZED USE OF SHORT-RANGE DEVICES (SRDS), No. APT/AWG/REP-35, Edition: March 2013

[66]Establish an appropriate and harmonized regulatory framework for LE bands and equipment standards

13.Broadcasting

13.1. Current TV broadcasting in Myanmar

Ministry of Information is currently responsible for broadcasting matters. Ministry/PTD is responsible for spectrum management, NTFA allocation and spectrum utilization matters including broadcast bands.

13.1.1.Terrestrial broadcasting:

- Analog TV
  - VHF band III 174 – 230 MHz
- Digital TV
  - UHF band IV 470 – 686 MHz

Today there are four TV Broadcasters in Myanmar.

- Myanmar Radio & Television (MRTV)
- Myawaddy (MWD)

13.1.2.Satellite TV:

DTH services are provided by multiple broadcast entities with services provided via foreign satellite. There is no satellite policy concerning which satellite providers can offer service in Myanmar.

13.1.3.Spectrum Issues

Broadcasting spectrum allocation and use is changing globally with most notably with spectrum being reallocated to mobile services. As well, various new wireless telecommunications application shave been developed for the television (TV) broadcasting bands using TV 'white spaces'.

13.2. Going forward

The Roadmap for the transition from analogue to digital terrestrial television broadcasting has been jointly developed by an ITU expert and the National Roadmap Team (NRT) of Myanmar. The Roadmap lays out a phased approach to transition and the deployment of DTTV.

DSO and ASO has been spread over seven years, the final analogue switch-off for Myanmar will be 31st December 2020.

a) A DTTB frequency plan needs to be drawn up for the whole of Myanmar. This frequency plan needs to include UHF channels and take note of neighbouring country assignments and assignments to players within the country.

b) Incorporate the frequency plan in the NSP.

c) Publicize the NSP and revise it, if necessary with public feedback.

The Spectrum Rules for Broadcasting show Television channels VHF channels 7-13, 174-223 (High VHF band); UHF channels 14-32, 470-585 (UHF band). All channels are 6 MHz spacing.

Analogue TV in Myanmar is now using channels in Band III. Based on the DTV transition Roadmap, it was suggested that DTTB/MTV (mobile TV) operations be moved to the UHF band in order to take advantage of the 8 MHz bandwidth. The VHF Band III frequencies that are made available (upon complete or partial implementation of ASO) could subsequently be auctioned to generate necessary funds for the DSO and ASO strategy.

The DTTB plan appears to not yet be developed.

Broadcasters are planning to propose a wide range of new services in unused broadcast bands. The Ministry/PTD, based on some stakeholder comments, identified the need to clarify spectrum policy with respect to broadcast bands not used for broadcasting.

Actions Planned by Ministry/PTD:

1) Clarify the roles and responsibilities of Ministry/PTD and the Ministry of Information and make these known to stakeholders;

2) Identify current channels allotted to Broadcasting and the transition channels for DTV in the broadcast allotment plan;

3) Clarify the spectrum utilization plan by showing the frequency bands that are allotted to broadcast and the spectrum that is being allotted for future mobile use;

4) Develop a clear policy concerning the use of unassigned broadcast band for new services;

5) Clarify for stakeholders the policy and procedures for the reallocation of channels to Mobile; and,

6) Develop a policy for broadband services in unused broadcasting spectrum.

14.Satellite Services

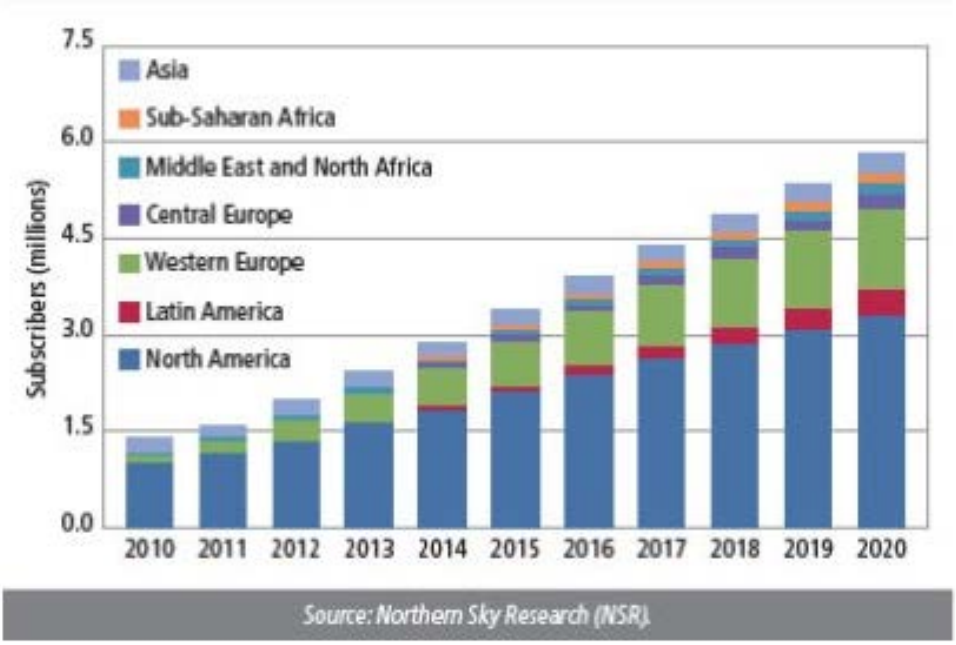
14.1. Demand

Satellites can provide global, ubiquitous and multipoint communications.

A comprehensive telecommunications strategy includes the provisioning of satellite services as part of its communications infrastructure. Broadband has long been recognized as an enabler for economic growth. Satellite services are sometimes the only solution to connect remote areas in the country or to provide coverage where terrestrial infrastructure just is not feasible due to terrain. Satellite systems also provide an important part of a strategy for international communications.

The number of satellite subscribers is forecast to grow to 6 Million.[67]

Figure 19: Projected Growth in Satellite Broadband Subscribers



There are a broad variety of services provided by the 994 satellites that orbit the earth as depicted in the figures below[68].

[67]ITU News Nº 5 2012 > Satellite broadband

[68]Satellite Industry Associations, SATELLITE 101: Satellite Technology and Services Satellite Industry Association (May 2012)

Figure 20: commercial Communications Satellites – Geosynchronous Orbit

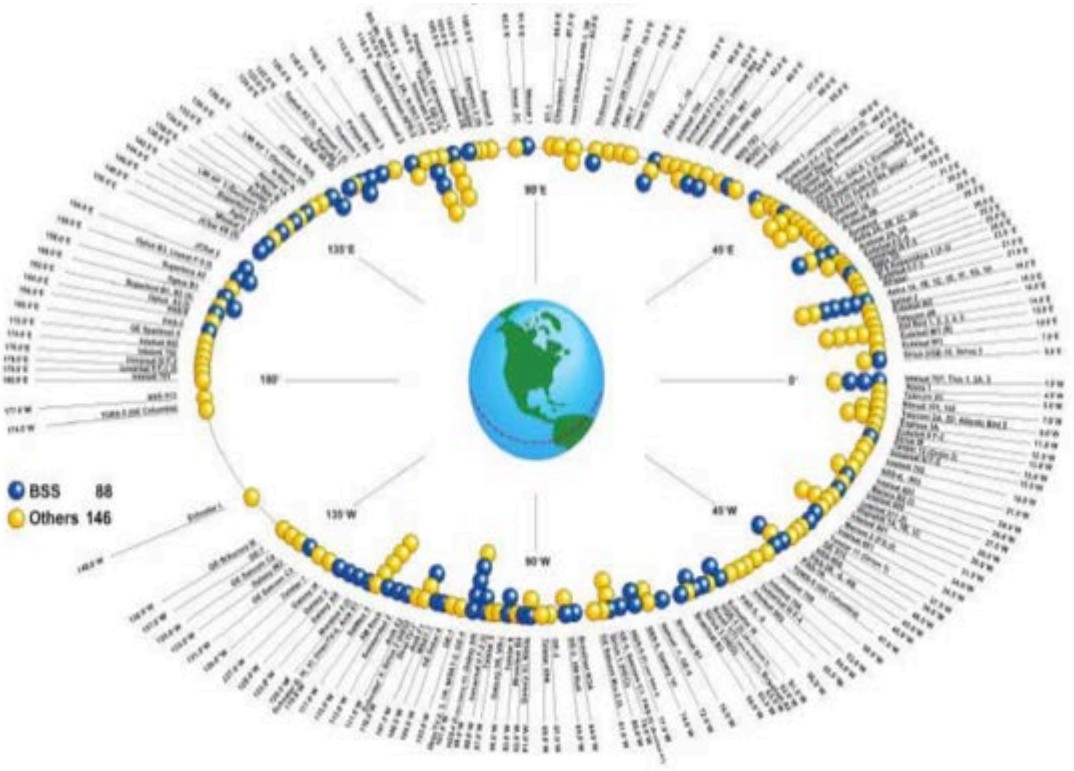
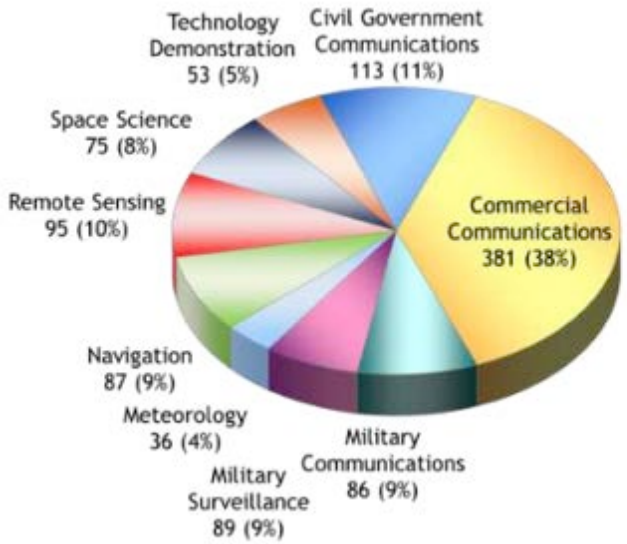


Figure 21: Operational Satellites (May 2012) by Function



Myanmar

Myanmar geographical characteristics impose challenges including mountainous terrain and a widely dispersed population most of who are in rural communities. The unique attributes offered by satellites can play a vital role in providing telecommunications and broadcasting infrastructure.

The licensing of commercial satellites in Myanmar will help to ensure that users have

- Access to the satellite capacity that they need in order to carry out their respective functions; and,
- Ubiquitous services across Myanmar.

An appropriate regulatory framework will help to provide assurance to stakeholders that Myanmar is an attractive place to invest when compared with other jurisdictions. While licensing requirements are addressed in the Spectrum Rules and operator requirements in the Licensing Rules, there are many complex policy issues that need to be addressed as part of an appropriate framework.

14.2. Technologies

Satellite technology has become a flexible and cost-effective solution for domestic and international networks, irrespective of the user's geographic location. There are a host of diverse purposes encompassing: wide area communications networks, backhaul for commercial fixed and mobile services, Internet and DTH television broadcasting and connecting rural areas.

Satellite systems have unique attributes:

- Large Geographic Coverage
- Allow for the interconnection of widely distributed networks
- Provide broadcasting services over a country, region, or entire hemisphere
- Providing "last mile" connectivity for telecom services, broadband and video services
- Instant infrastructure, a key requirements emergency and disaster communications support
- Fixed or Mobile voice, data or broadband or mobile video

Traditional satellite technology uses a broad single beam to cover entire continents and regions. More recently, the use higher Ka band frequencies and deployment of multiple narrowly focused spot beams and illuminating a smaller area (100s of kilometres instead of 1 000s of kilometres) allows for frequency reuse, providing increased bandwidth compared to traditional satellites. However, the higher attenuation experienced at higher frequencies places limitations on these bands. New technologies are being implemented to mitigate fading due to propagation. Despite the higher costs associated with spot beam technology, the overall cost per circuit is considerably lower than for shaped beam technology.

Satellite broadband services are offered in five basic technology categories:

1. C-band (4–6 GHz) fixed-satellite service (FSS)
2. Ku-band (11–14 GHz) fixed-satellite service (FSS)
3. Ka-band (20–30 GHz) bent pipe (with no on-board processing in the satellite)
4. Ka-band (20–30 GHz) with on-board processing in the satellite
5. L-band (1.5–1.6 GHz) mobile-satellite service (MSS).

Stepping-up its initiative to develop this sector of its connectivity objectives Myanmar hosted Satellite forum 2015, as part of Communicast showcase, scheduled for November 18, in Yangon.

14.3. Global Satellite Regulatory Framework

ITU is mandated by its Constitution to allocate spectrum and register frequency assignments, orbital positions and other parameters of satellites, "in order to avoid harmful interference between radio stations of different countries". The international spectrum management system is therefore based on regulatory procedures for frequency notification, coordination and registration.

Major tasks of ITU-R also include developing standards for radiocommunication systems, ensuring the effective use of the radio-frequency spectrum and studies concerning the development of radiocommunication systems.

Radiocommunication systems have been expanding at an incredible rate in the last decades. Their importance as development infrastructure and as a major asset for governments, the telecommunications industry and the general public is unquestionable.

Radio-frequency spectrum is a natural resource, and its rational and efficient exploitation can enhance a nation's productivity as well as the quality of life of its citizens. In order to derive its full benefits, it is critical to develop and implement efficient national frameworks for spectrum management.

The ITU Radio Regulations, and particularly its Table of Frequency Allocations, have been revised and updated almost regularly in view of the enormous demand for spectrum utilization. This is critical to keep pace with the rapid expansion of existing systems as well as the spectrum-demanding advanced wireless technologies that are being developed. The ITU World Radiocommunication Conference (WRC), which convenes every three to four years, is at the core of the international spectrum management process and constitutes the starting point for national practices. WRC reviews and revises the Radio Regulations, an international treaty establishing the framework for the utilization of radio frequencies and satellite orbits among ITU member countries, and considers any question of a worldwide character within its competence and related to its agenda.

Equitable access to spectrum and orbital resources is of special concern, given the uneven needs of developed and developing countries. As a consequence, the principle of a priori planning of spectrum and orbit resources is considered in conjunction with a series of plans established by radiocommunication conferences.

Through its various activities covering the implementation of Radio Regulations to the establishment of recommendations and guidelines on the usage of radio systems and spectrum/orbit resources, ITU-R plays a vital role in the global management of radio-frequency spectrum and satellite orbits. These limited natural resources are increasingly in demand from a large and growing number of services such as fixed, mobile, broadcasting, amateur, space

research, meteorology, global positioning systems, and environmental monitoring that depend on radiocommunication to ensure safety of life on land, at sea and in the skies.[69]

14.3.1.ITU Definition of satellite services

There are a variety of satellite services. The ITU Radio Regulations Article 1, Terms and Definitions provides a description of each service:

> **1.21** *fixed-satellite service:* A *radiocommunication service* between *earth stations* at given positions, when one or more *satellites* are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases, this service includes satellite-to-satellite links, which may also be operated in the *inter-satellite service*; the fixed-satellite service may also include *feeder links* for other *space radiocommunication services*.
>
> **1.25** *mobile-satellite service :* A *radiocommunication service :*
>
> - Between *mobile earth stations* and one or more *space stations*, or between *space stations* used by this service; or
> - Between *mobile earth stations* by means of one or more *space stations*.
>
> This service may also include *feeder links* necessary for its operation.
>
> **1.39** *broadcasting-satellite service:* A *radiocommunication service* in which signals transmitted or retransmitted by *space stations* are intended for direct reception by the general public.
>
> In the broadcasting-satellite service, the term "direct reception" shall encompass both *individual reception* and *community reception*.
>
> **1.41** *Radiodetermination-satellite service:* A *radiocommunication service* for the purpose of *radiodetermination* involving the use of one or more *space stations*.
>
> This service may also include *feeder links* necessary for its own operation.
>
> **1.115** *feeder link:* A radio link from an *earth station* at a given location to a *space station*, or vice versa, conveying information for a *space radiocommunication service* other than for the *fixed-satellite service*. The given location may be at a specified fixed point, or at any fixed point within specified areas.

Simplifying, Fixed satellite services are systems communications are established between fixed earth stations via satellite (FSS) or communications via satellite with stations in motion (MSS) as well as broadcast services distributing broadcast programming (BSS].

14.3.2.ITU Regulatory Framework for Space Services

Myanmar has expressed interest in provisioning domestic satellite services. Initially, this would be done through leasing capacity via a service provider while the longer-term plans would be to establish its own domestic satellite service.

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[69]Extract from ITU, see http://www.itu.int/net/about/itu-r.aspx

The rights and obligations of ITU member states in the domain of international frequency management of the spectrum/orbit resources are incorporated in the Constitution (CS) and the Convention (CV) of the ITU and in the Radio regulations that compliment them.

These instruments contain the main principles and lay down the specific regulations governing the following major elements as follows:

- Frequency spectrum allocations to different categories of radiocommunication services;
- Rights and obligations of member administrations in obtaining access to the spectrum/orbit resource-;
- International recognition of these rights by recording frequency assignments and, as appropriate, any associated orbits, including the geostationary-satellite orbits(GSO)used or intended to be used in the Master International Frequency Register(MIFR).

The above regulations are based on the main principles of efficient use of and equitable access to the spectrum/orbit resource- laid down in provision No. 196of the ITU Constitution (Article 44), which stipulates that "In using frequency bands for radio services, Members States shall bear in mind that radio frequencies and any associated orbits, including the geostationary-satellite orbits are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of the Radio Regulations, so that countries or groups of countries may have equitable access to those orbits and frequencies, taking into account the special needs of the developing countries and the geographical situation of particular countries". As indicated in the above provision, further detailed regulations and procedures governing spectrum/orbit use are contained in the Radio Regulations, which is a binding international treaty (No. 31of the ITU Constitution).

Specific procedures have been established to ensure international recognition of the frequencies used and to safeguard the rights of administrations when they comply with those procedures. The fact that the ITU Constitution and Convention

And the Radio Regulations that complement them are intergovernmental treaties ratified by governments-means that those governments undertake:

- To apply the provisions in their countries; and
- To adopt adequate national legislation that includes, as the basic minimum, the essential provisions of this international treaty.

The international Radio Regulations are nevertheless oriented mainly towards matters of a global or regional character, and in many areas there is scope for making special arrangements on a bilateral or multilateral basis.[70]

The NTFA allocates a number of frequency bands for fixed, broadcasting and mobile satellite services. Specific requirements for bands or services are sometimes established and these may evolve as needed in the future.

[70] Extract from ORBIT/ SPECTRUM ALLOCATION PROCEDURES REGISTRATION MECHANISM, Yvon Henri, Space Services Department, Radiocommunication Bureau, ITU

14.4. Other countries

It is useful to look at developments in neighbouring countries in order to assess relative positioning of existing services, considerations for development and state of competitiveness. Below are examples of developments and plans in nearby countries, as well as, potential developments in Asia as a region.

Malaysia

MEASAT Satellite Systems Sdn. Bhd, formerly Binariang Satellite Systems Sdn. Bhd is a Malaysian communications satellite operator, which owns and operates the MEASAT (Malaysia East Asia Satellite) and AFRICASAT spacecraft. The company provides satellite services to leading international broadcasters, Direct-To-Home (DTH) platforms and telecom operators. With capacity across six (6) communication satellites, the company provides satellite services to over 150 countries representing 80% of the world's population across Asia, Middle East, Africa, Europe and Australia.[71]

Singapore

The IDA Master Frequency plan identifies the following frequencies for the FSS: 4-6 GHz, 7- 8 GHz, 11-14 GHz, and 17-19 GHz, as per the table below, with additional allocations of bands >20 GHz but none currently assigned. Companies in Singapore can select any fixed satellite network to set up communications to their remote overseas offices to provide point-to-point international leased circuit (ILC) connectivity using Very Small Aperture Terminal (VSAT) technology. This ILCcan be used for a variety of applications (telephone, data, fax, video-conferencing, etc.).

Table 13: Singapore Fixed Satellite Service

Frequency Range	Uplink/Downlink
3400-4200 MHz	Downlink
4500-4800 MHz	Downlink
5850-7075 MHz	Uplink
7250-7750 MHz	Downlink
7900-8400 MHz	Uplink
10.7-11.7 GHz	Downlink
12.2-12.75 GHz	Downlink

[71]https://en.wikipedia.org/wiki/MEASAT_Satellite_Systems

13.75-14 GHz	Uplink
14-14.5 GHz	Uplink
17.3-18.1 GHz	Uplink
18.1-18.4 GHz	Downlink
18.4-19.3 GHz	Downlink

Source: Radio Spectrum Master Plan, iDA Singapore (2014)

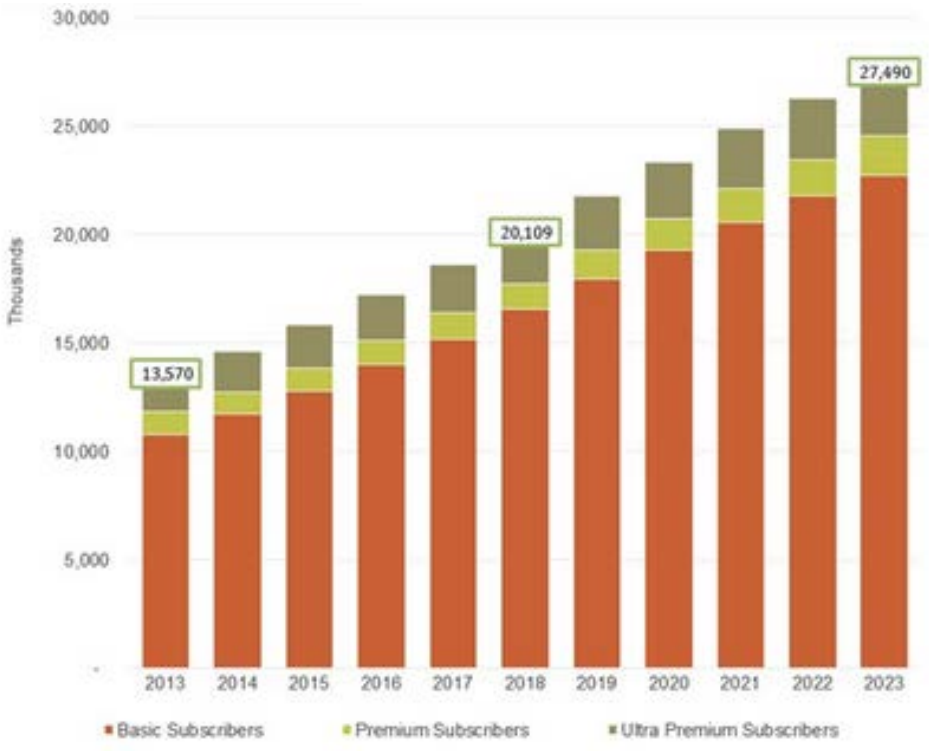
Asia

A 2012 ITU Report, based on a survey of satellite operators (sourcing: Satellite-link.co.uk/directory/aonexplorer.html) stated Asia had the largest number of operators, at the time 9 International and 18 Regional with more planned. The report sited that Asia's rural areas were largely underserved due to poor infrastructure penetration, attributed at least party to the difficult mountainous terrain. These conditions make for opportunities for existing and new satellite operators. More recent reports (2012) indicate a flourishing DTH industry across Asia[72].

According to Northern Sky Research, the SEA market is set for some exceptional DTH growth.

[72]http://www.satellitetoday.com/publications/2013/04/01/dth-flourishes-across-asia/

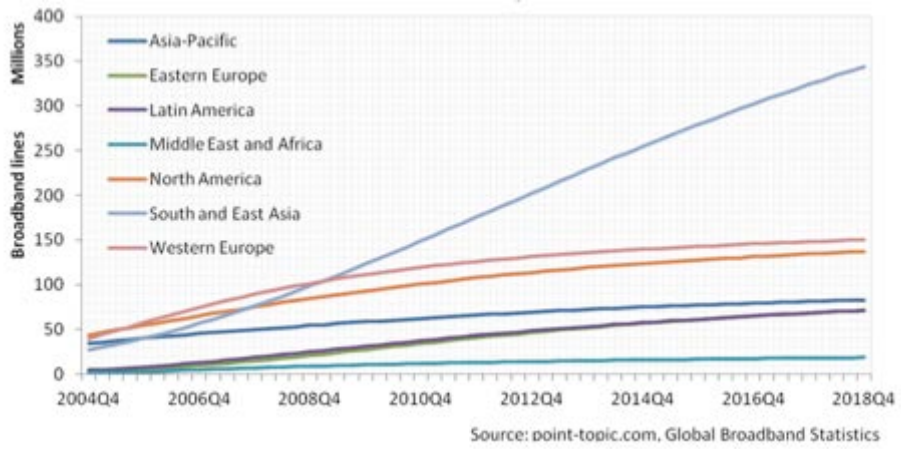
Figure 22: SEA DTH subscribers, by Type



Source: Northern Sky Research

While growth projections are encouraging, the competition is fierce due to the number of operators. Developed and fast-developing countries such as Indonesia, Thailand, Philippines, and Vietnam drive estimates. It is important to note that markets are fragmented due to the various countries' different stages of development. DTH growth stimulates growth of other satellite services.

Figure 23: World Broadband Subscriber Forecasts, to 2018



At the end of 2018, South and East Asia will have by far the greatest volume of broadband subscribers. Point Topic forecasts that subscriber numbers will grow by 70% over the next five

years. In particular, this is due to strong growth expected in Indonesia and Thailand. Growth will be slowest in the developed markets of Western Europe, Asia-Pacific and North America.

14.5. Current

In accordance with the Spectrum Rules, PTD may authorize communications as well as content services using a satellite for the purpose of providing Telecommunications Services to themselves or for sale to third party End Users. The rules indicate that licenses will generally be granted on a first-come, first-served basis.

Spectrum Rules require Satellite Spectrum Licenses that may be granted include (but are not limited to) those for:

i) Very Small Aperture Terminals (VSAT);

ii) Satellite News Gathering (SNG);

iii) Satellite Radio Apparatus installed on ships and aircraft;

iv) Earth Stations transmitting to satellites;

v) Mobile Satellite Service (e.g., portable satellite communication terminals); and

vi) Satellite broadcasting (one-way) services, including Direct-to-Home (DTH).

vii) Such authorizations may include handheld, portable, transportable (vehicle mounted and re-locatable) and fixed Radio Apparatus.

International Satellite Operators may provide services to End Users in Myanmar and/or may provide capacity to satellite service providers offering services to End Users (both businesses and individuals).

i) A Satellite Spectrum License will be issued to authorize the use of specific frequencies and Radio Apparatus.

ii) Such operators must also obtain the appropriate Associated Operating License as set forth in the Licensing Rules if Telecommunications Services are provided to End Users.

iii) If an international satellite operator directly, or through an Affiliate, sells or otherwise distributes Radio Apparatus to End Users, it must obtain the technical standard approval of the Department as required by Section 27 of the Telecommunications Law.

Receive-only Radio Apparatus that is only capable of receiving transmissions from a satellite (no transmit capability) does not require an individual Satellite Spectrum License, but may need a Telecommunications Equipment License, per Section 13 of the Telecommunications Law.

Entities, including affiliates, providing Telecommunications Services through the use of receive-only apparatus sold or otherwise distributed to End Users must obtain the appropriate Associated Operating License and must obtain the technical standard approval of the Department as required by Section 27 of the Telecommunications Law.

DTH satellite broadcasting providers or other one-way services (e.g., Direct-to-Home video programming or data broadcasting) must obtain a Satellite Spectrum License.

Providers of satellite broadcasting services may also be required to obtain a separate broadcasting service License from the Ministry of Information. An authorization from the Ministry of Information is required prior to applying for a satellite-broadcasting spectrum License.

Services pertaining to satellite systems in Myanmar are currently limited services provided by foreign owned satellite systems. There is currently no published policy framework concerning the provisioning of services and what satellites are approved to provide services.

A variety of satellite services are being provided within Myanmar today.

14.6. Going forward

14.6.1.Strategy

The Government of the Republic of Union of Myanmar has formulated a space program (the "Myanmar Space Program") that aims at embedding the space aspirations of the Republic of Union of Myanmar. These aspirations seek to strike a balance strategic and commercial objectives including

- Acquisition of broadcast independence;
- Gaining control over strategic national communications;
- Creating a commercially viable and sustainable satellite based communication industry in Myanmar; and,
- Building a selective position as provisioning in regional and multi-regional markets.

Ministry proposes the establishment of a comprehensive satellite policy guiding the provision of services in Myanmar. A consultation on this subject can be expected in due course.

In response to the evolving market for broadband data services that has developed to support growing demand by business, government and the general public, PTD will permit the provisioning of its own satellite services. The process has been initiated by releasing a RFP through the lease of multiple satellite transponders in the C-band and Ku-band.

The following services are envisioned, as a minimum in the short to medium term:

a) Commercial VSAT services;

b) Broadcast services;

c) Trunking services/cellular backhaul

Discussions have been initiated which are expected to lead to a policy framework for the services envisioned. The policy framework would also layout the criteria for the orderly provision of satellite services via domestic, regional and global satellite systems in Myanmar and the regulatory licensing process to be used to award authorizations.

Myanmar plans to lease satellite capacity to offer domestic satellite services, with plans to pursue the process to secure their position for the provision of a domestic satellite service; however, a policy framework has yet to be developed.

15.Aeronautical

Aeronautical frequencies bands are allocated internationally within the ITU and support the domestic and international communications of Aeronautical services.

The International Civil Aviation Organization (ICAO) in cooperation with Member States and industry groups to reach consensus on international civil aviation Standards and Recommended Practices. They plan and coordinate the use of radiofrequency assignments.

15.1. Demand

Bands are internationally prescribed. As broadcasting sectors grow, consideration needs to be given to possible radio frequency interference, particularly from CATV, FM radio broadcasting and aeronautical obstructions from radio antenna structures.

15.2. Current Assignments

Under the MOT the Department of Civil Aviation (DCA) is responsible for:

- Air Traffic Services
- Communication and Radio Navigation Facilities
- Licensing of pilots and aircraft maintenance engineers and flight checks
- Construction, maintenance and management of airports
- Airworthiness Control
- Issue of permits and licences to domestic and international airlines
- Conclusion of bilateral air agreements
- Relations with ICAO and other international organizations
- Training of civil aviation personnel

Aeronautical Frequencies are currently prescribed in Spectrum Rules Annex F – Frequencies related to Aeronautical Mobile are provided based on ITU RR.

15.3. Going forward

No specific initiatives concerning release of new spectrum for aeronautical services is planned.

16.Maritime

16.1. Demand

The maritime mobile service includes those bands used for communications between ship stations as well as with coast stations to coordinate the safe movement of shipping traffic. Users in this band include: the naval branch of the armed forces ensuring the safety and security of coastal waters; Commercial fisheries comprising coastal or inshore fisheries, and offshore or deep-sea fisheries; Commercial shipping; and other domestic and international shipping traffic.

In Myanmar, the Department of Marine Administration is responsible for the following tasks:

1. Maritime Legislation
2. Maritime Incident, Accident Investigation and Arbitration
3. Maritime Safety
4. Maritime Environmental Protection
5. Maritime Security
6. Port State Control Implementation
7. Flag State Control Implementation
8. Coastal State Control Implementation
9. Conducting International Ships and Port Facilities Security Code
10. Ship Survey
11. Ship Registration
12. Conducting the Maritime Education and Training
13. Seafarers Certification and Verification
14. Myanmar Seafarers Registration
15. Controlling Myanmar Seafarers Recruitment and Placement Services Companies
16. Conducting the Myanmar Seafarers Services
17. Conducting the Myanmar Seafarers Affairs
18. Conducting Coastal and Inland Water Vessel Business Licensing
19. Focal Department for International Maritime Organization
20. Focal Department for ASEAN Maritime Affairs
21. Focal Department for ASIAN Coast Guard Agency

16.2. Current Assignments

ITU related reference:

International Telecommunication Union - Radio Regulations

- Article 5, Chapter VII (Articles 30 to 34) and Chapter IX (Articles 46 to 58); and
- Appendices 15, 17, 18, and 25.

Maritime bands include a broad range of frequencies including VLF Very-low Frequency (3-30 kHz), LF Low-frequency (30-300 kHz), MF Medium-frequency (300-3000 kHz), HF High-frequency (3-30 MHz), VHF Very-high Frequency (30-300 MHz), UHF Ultra-High Frequency (300-3000 MHz) and SHF Super Ultra-High Frequency (3-30 GHz).

As part of their ongoing spectrum allocation activities, the PTD have identified the bands allocated for use by stations in the Maritime Mobile Service frequency bands indicated in the Spectrum Rules – Annex E. Bands are conformance with ITU allocated bands, Appendices S 17 and S 18. These are the most commonly used bands HF and VHF. Spectrum Rules - Annex B incorporates the Distress and Safety frequencies for non- Global Maritime Distress and Safety (GMDSS) and GMDSS.

While it is anticipated that there will be a continued increase in maritime traffic and a related increase in communications technologies deployed, at the time of writing of this document, the Department of Marine Administration had not expressed the need for more frequencies to Ministry/PTD,

16.3. Going forward

Action Planned by Ministry/PTD:

No specific initiatives concerning release of new spectrum is planned.

17.WRC – 15

As per WRC-15, agenda Item 1.1,

- To consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 (WRC-12)**

Appendix B includes the Agenda items for WRC-15.

Appendix A: List of telecommunications services Licensees in Myanmar

The following link provides the latest information on licensees (operators) in the telecommunications services in Myanmar.

Website Link: http://www.mcit.gov.mm/sites/default/files/Licence%20Issued%20List(6.5.15).pdf

Appendix B: WRC-15 Agenda Items

WRC-15 Agenda Item	Title
1	On the basis of proposals from administrations, taking account of the results of WRC-12 and the Report of the Conference Preparatory Meeting, and with due regard to the requirements of existing and future services in the bands under consideration, to consider and take appropriate action in respect of the following items:
1.1	To consider additional spectrum allocations to the mobile service on a primary basis and identification of additional frequency bands for International Mobile Telecommunications (IMT) and related regulatory provisions, to facilitate the development of terrestrial mobile broadband applications, in accordance with Resolution **233 (WRC-12)**;
1.2	To examine the results of ITU-R studies, in accordance with Resolution **232 (WRC-12)**, on the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, service in Region 1 and take the appropriate measures;
1.3	To review and revise Resolution **646 (Rev.WRC-12)** for broadband public protection and disaster relief (PPDR), in accordance with Resolution **648 (WRC-12)**;
1.4	To consider possible new allocation to the amateur service on a secondary basis within the band 5 250-5 450 kHz in accordance with Resolution **649 (WRC-12)**;
1.5	To consider the use of frequency bands allocated to the fixed-satellite service not subject to Appendices **30**, **30A** and **30B** for the control and non-payload communications of unmanned aircraft systems (UAS) in non-segregated airspaces, in accordance with Resolution **153 (WRC-12)**;
1.6	To consider possible additional primary allocations:
1.6.1	To the fixed-satellite service (Earth-to-space and space-to-Earth) of 250 MHz in the range between 10 GHz and 17 GHz in Region 1;
1.6.2	To the fixed-satellite service (Earth-to-space) of 250 MHz in Region 2 and 300 MHz in Region 3 within the range 13-17 GHz;
	And review the regulatory provisions on the current allocations to the fixed-satellite service within each range, taking into account the results of ITU-R studies, in accordance with Resolutions**151 (WRC-12)** and **152 (WRC-12)**, respectively;
1.7	To review the use of the band 5 091-5 150 MHz by the fixed-satellite service (Earth-to-space) (limited to feeder links of the non-geostationary mobile-satellite systems in the mobile-satellite service) in accordance with Resolution **114 (Rev.WRC-12)**;
1.8	To review the provisions relating to earth stations located on board vessels (ESVs), based on studies conducted in accordance with Resolution **909 (WRC-12)**;
1.9	To consider, in accordance with Resolution **758 (WRC-12)**:
1.9.1	Possible new allocations to the fixed-satellite service in the frequency bands 7 150-7 250 MHz (space-to-Earth) and 8 400-8 500 MHz (Earth-to-space), subject to appropriate sharing conditions;
1.9.2	The possibility of allocating the bands 7 375-7 750 MHz and 8 025-8 400 MHz to the maritime-mobile satellite service and additional regulatory measures, depending on the results of appropriate studies;
1.10	To consider spectrum requirements and possible additional spectrum allocations for the mobile-satellite service in the Earth-to-space and space-to-Earth directions, including the satellite component for broadband applications, including International Mobile Telecommunications (IMT), within the

WRC-15 Agenda Item	Title
	frequency range from 22 GHz to 26 GHz, in accordance with Resolution **234 (WRC-12)**;
1.11	To consider a primary allocation for the Earth exploration-satellite service (Earth-to-space) in the 7-8 GHz range, in accordance with Resolution **650 (WRC-12)**;
1.12	To consider an extension of the current worldwide allocation to the Earth exploration-satellite (active) service in the frequency band 9 300-9 900 MHz by up to 600 MHz within the frequency bands 8 700-9 300 MHz and/or 9 900-10 500 MHz, in accordance with Resolution **651 (WRC-12)**;
1.13	To review No. **5.268** with a view to examining the possibility for increasing the 5 km distance limitation and allowing space research service (space-to-space) use for proximity operations by space vehicles communicating with an orbiting manned space vehicle, in accordance with Resolution **652 (WRC-12)**;
1.14	To consider the feasibility of achieving a continuous reference time-scale, whether by the modification of coordinated universal time (UTC) or some other method, and take appropriate action, in accordance with Resolution **653 (WRC-12)**;
1.15	To consider spectrum demands for on-board communication stations in the maritime mobile service in accordance with Resolution **358 (WRC-12)**;
1.16	To consider regulatory provisions and spectrum allocations to enable possible new Automatic Identification System (AIS) technology applications and possible new applications to improve maritime radiocommunication in accordance with Resolution **360 (WRC-12)**;
1.17	To consider possible spectrum requirements and regulatory actions, including appropriate aeronautical allocations, to support wireless avionics intra-communications (WAIC), in accordance with Resolution **423 (WRC-12)**;
1.18	To consider a primary allocation to the radiolocation service for automotive applications in the 77.5-78.0 GHz frequency band in accordance with Resolution **654 (WRC-12)**;
2	To examine the revised ITU-R Recommendations incorporated by reference in the Radio Regulations communicated by the Radiocommunication Assembly, in accordance with Resolution **28 (Rev.WRC-03)**, and to decide whether or not to update the corresponding references in the Radio Regulations, in accordance with the principles contained in Annex 1 to Resolution **27 (Rev.WRC-12)**;
3	To consider such consequential changes and amendments to the Radio Regulations as may be necessitated by the decisions of the Conference;
4	In accordance with Resolution **95 (Rev.WRC-07)**, to review the resolutions and recommendations of previous conferences with a view to their possible revision, replacement or abrogation;
5	To review, and take appropriate action on, the Report from the Radiocommunication Assembly submitted in accordance with Nos. 135 and 136 of the Convention;
6	To identify those items requiring urgent action by the Radiocommunication Study Groups in preparation for the next world radiocommunication conference;
7	To consider possible changes, and other options, in response to Resolution 86 (Rev. Marrakesh, 2002) of the Plenipotentiary Conference, an advance publication, coordination, notification and recording procedures for frequency assignments pertaining to satellite networks, in accordance with Resolution **86 (Rev.WRC-07)** to facilitate rational, efficient, and economical use of radio frequencies and any associated orbits, including the geostationary-satellite orbit;
8	To consider and take appropriate action on requests from administrations to delete their country footnotes or to have their country name deleted from footnotes, if no longer required, taking into account Resolution **26 (Rev.WRC-07)**;

WRC-15 Agenda Item	Title
9	To consider and approve the Report of the Director of the Radiocommunication Bureau, in accordance with Article 7 of the Convention:
9.1	On the activities of the Radiocommunication Sector since WRC-12;
9.1.1	Protection of the systems operating in the mobile-satellite service in the band 406-406.1 MHz
9.1.2	Studies on possible reduction of the coordination arc and technical criteria used in application of No. 9.41 in respect of coordination under No. 9.7
9.1.3	Use of satellite orbital positions and associated frequency spectrum to deliver international public telecommunication services in developing countries
9.1.4	Updating and rearrangement of the Radio Regulations
9.1.5	Consideration of technical and regulatory actions in order to support existing and future operation of fixed satellite service earth stations within the band 3 400-4 200 MHz, as an aid to the safe operation of aircraft and reliable distribution of meteorological information in some countries in Region 1
9.1.6	Studies towards review of the definitions of fixed service, fixed station and mobile station
9.1.7	Spectrum management guidelines for emergency and disaster relief radiocommunication
9.1.8	Regulatory aspects for nano- and picosatellites
9.2	On any difficulties or inconsistencies encountered in the application of the Radio Regulations; and
9.3	On action in response to Resolution **80 (Rev.WRC-07)**;
10	To recommend to the Council items for inclusion in the agenda for the next WRC, and to give its views on the preliminary agenda for the subsequent conference and on possible agenda items for future conferences, in accordance with Article 7 of the Convention.

Source: ITU-R Preparatory Studies for WRC-15, available at: http://www.itu.int/net/ITU-R/index.asp?category=study-groups&rlink=rcpm-wrc-15-studies&lang=en#{C4B1254B-0A2F-4AED-9668-3D91F9613047}