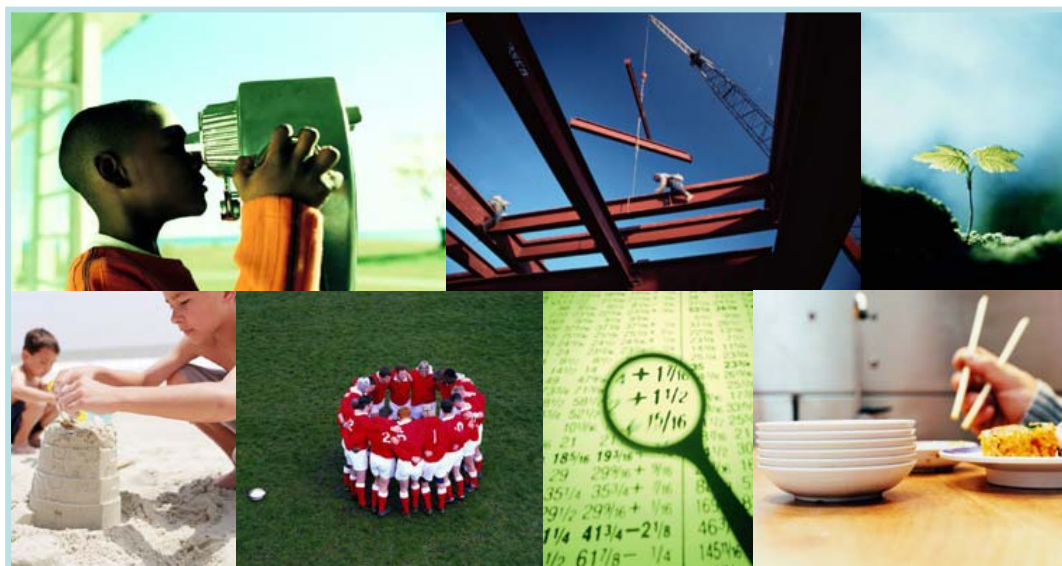


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Spectrum Allocation and Management Guidelines for the National
Telecommunications Commission of Thailand

Revised Spectrum Master Plan

Lot n°6 – CRIS 2006/125292

TABLE OF CONTENTS

1	Introduction	5
1.1	Background	5
1.2	Vision and Mission	6
1.3	Supporting Objectives	6
1.4	General Policies	7
1.5	Scope of this Document	8
2	Frequency Allocation	8
2.1	Description	8
2.2	Background	9
2.3	International Best Practise	9
2.4	Objectives	9
2.5	Policies	10
3	Frequency Assignment	11
3.1	Description	11
3.2	Background	12
3.3	International Best Practise	12
3.4	Objectives	13
3.5	Policies	13
4	Monitoring, Enforcement and Control	14
4.1	Description	14
4.2	Background	15
4.3	International Best Practise	16
4.4	Objectives	16
4.5	Policies	17
5	Radiocommunications Licensing	18
5.1	Description	18
5.2	Background	18
5.3	International Best Practise	19
5.4	Objectives	19
5.5	Policies	20
6	Spectrum Pricing	20
6.1	Description	20
6.2	Background	20
6.3	International Best Practise	22
6.4	Objectives	23
6.5	Policies	24
7	Spectrum Engineering	25
7.1	Description	25
7.2	Background	25
7.3	International Best Practise	25
7.4	Objectives	26
7.5	Policies	26
8	International	27

8.1	Description	27
8.2	Background	28
8.3	International Best Practise	29
8.4	Objectives	29
8.5	Policies	30
9	Radio Equipment Type Approval	30
9.1	Description	30
9.2	Background	30
9.3	International Best Practise	31
9.4	Objectives	31
9.5	Policies	31
10	Training and Development	32
10.1	Description	32
10.2	Background	32
10.3	International Best Practise	32
10.4	Objectives	33
10.5	Policies	34

ABBREVIATIONS AND ACRONYMS

APT	Asia Pacific Telecommunity
DBBD	Department and Directing Board for Broadcast Division (Prime Minister's Public Relations)
DF	Direction Finding
EC	European Commission
EU	European Union
ICAO	International Civil Aviation Organisation
ICNIRP	The International Commission on Non-Ionizing Radiation Protection
IMO	International Maritime Organization
ITU	International Telecommunications Union
JC	Joint NBC-NTC Commission
MOTC	Ministry of Transport and Communications
NBC	National Broadcasting Commission
NFAP	National Frequency Allocation Plan
NRPC	National Radio Policy Committee
NTC	National Telecommunications Commission
NTFA	National Table of Frequency Allocations
PPDR	Public Protection and Disaster Relief
PTD	Post and Telegraph Department of the MOTC
RR	(ITU) Radio Regulations
SMO	Spectrum Management Organisation
SOLAS	Safety of Life at Sea
TRMC	Telecommunications Regulation Master Class
UN	United Nations
WTO	World Trade Organization

1 Introduction

Spectrum Management is a generic term incorporating frequency management (planning and allocation), individual licensing and assignment of frequencies, national and international co-ordination of frequencies, international representation, administration including the setting of regulations as well as cost recovery charges and spectrum fees for licences, enforcement and control of regulations, spectrum engineering and the setting of standards for radio transmitting equipment, and spectrum monitoring.

1.1 Background

A Royal proclamation formally established the National Telecommunications Commission (NTC) on 1 October 2004. The NTC is an independent state telecommunications regulator, which fully accords with the requirements of Section 40 of the 1997 Constitution of Thailand, now superseded by the 2006 Interim Constitution.

Section 40 of the 1997 Constitution of Thailand stated:

“Transmission frequencies for radio or television broadcasting and radio telecommunication are national communication resources for public interest.

There shall be an independent regulatory body having the duty to distribute the frequencies under paragraph one and supervise radio or television broadcasting and telecommunication businesses as provided by law.

In carrying out the act under paragraph two, regard shall be given to utmost public benefit at national and local levels in education, culture, state security, and other public interests including fair and free competition.”

The provision above clearly shows that the intention of the 1997 Constitution was to reform the philosophy of spectrum management, its objectives, responsible bodies and the way the spectrum should be managed.

Legal instruments define NTC's duties and responsibilities, which are to regulate all telecommunication services in Thailand through the formulation of a Master Plan for Telecommunications Services and Frequency Plan. Additional duties include the setting of criteria and categories of telecommunication services, permitting and regulating the use of spectrum for telecommunication services, and the granting of licences to telecommunications operators.

A Joint Commission comprising Commissioners from both the National Broadcasting Commission (NBC) and NTC is foreseen in the *Act on the Organisations to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services* of 2000. The Joint Commission's principal task is to prepare the Master Plan for Spectrum Management and the National Table of Frequency Allocations (NTFA). The NTFA is a key element for the Telecommunications Master Plan as well as the Broadcasting Master Plan.

In the absence of the NBC and consequentially the Joint Commission as well, NTC has taken on the role of preparing the Spectrum Master Plan, National Table of Frequency Allocations (NTFA) and associated frequency plans for telecommunications services.

1.2 Vision and Mission

The Telecommunications Master Plan provides the following overall vision:

Monitoring and supervising telecommunication industry to meet international recognised standard. Modernisation and standardisation of telecommunication industry based on reasonable price meeting changing situations.

In order to maximise the efficient and effective use of the radio frequency spectrum by all sectors of society, the NTC has adopted the following mission for its spectrum management role:

The NTC will create a predictable environment for the current and future use of radio spectrum in Thailand, which is in the public interest.

1.3 Supporting Objectives

Subject to the establishment of the NBC and Joint Commission defined in the *Act on the Organisations to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services* of 2000, the NTC has assumed the following overall objectives to fulfil the vision and mission defined in 1.2 above:

- Facilitate policy making with regard to the strategic planning of the radio spectrum in Thailand taking into consideration amongst other things, cultural, defence, economic, education, emergency, free and fair competition, freedom of expression, health, national security, public interest, safety, scientific, social and technical aspects of governmental policies as well as the various interests of radio spectrum users, with the aim of optimising the use of radio spectrum and of avoiding harmful interference;
- Guide the development of the Broadcasting Master Plan and the Telecommunications Master Plan as well as the master plans for other sectors requiring access to significant portions of the radio frequency spectrum;
- Establish a National Radio Policy Committee (NRPC) to facilitate policy making and strategic planning of the overall radio spectrum;
- Ensure the effective implementation of radio spectrum policy in Thailand to ensure the availability and efficient use of radio spectrum;
- Ensure the timely provision of information concerning the allocation, availability and use of radio spectrum in Thailand;

- Ensure the effective representation of national interests in international negotiations where radio spectrum use affects Thailand's policies and strategic direction.

1.4 General Policies

In order to meet the objective of improving overall policy making and strategic planning of the radio spectrum in respect of convergence arising from the digitisation of broadcasting and telecommunications services, as well as the blurring of boundaries between radiocommunication services especially the broadcasting, fixed and mobile services:

1. The NTC shall establish a National Radio Policy Committee (NRPC), which shall address spectrum management issues of strategic national importance and resolve any disputes between one or more NRPC members in relation to spectrum management matters;
2. The NRPC shall comprise the Commissioners as well as representatives of government departments and semi-state bodies having a strategic interest in the radio spectrum;
3. The NRPC shall establish their meeting schedule, rules of procedure and method of working;
4. The NRPC may permit representation from non NRPC members at specified NRPC and/or (ad-hoc) working group meetings or a series of meetings on a case by case basis;
5. The NRPC shall establish specialised working groups and ad-hoc groups as appropriate where matters involving a number of NRPC members may be addressed. For example but not limited to:
 - a. NFAT Revision and Maintenance Group (NRMG) dealing with proposals for modification and the periodic revision of the NFAT,
 - b. National Frequency Register Maintenance Group (NFRG) dealing with the agreement of assignments in shared bands as well as any proposals for access to bands managed by another NRPC member or changes to block allocations etc;
 - c. National Site Clearance Group (NSCG) to approve the use of assignments at particular geographical locations, which do not conform to specified technical parameters, e.g. exceed power limits or maximum antenna height ;
6. The NRPC may also provide the framework for the national preparation of Thai proposals and briefs for meetings of international bodies addressing spectrum management issues;
7. The NTC shall provide the secretariat and technical support for the NRPC.

1.5 Scope of this Document

In preparing this document, the Consultant has been minded to produce a series of objectives and policies that would, together, form the basis for a total spectrum management master plan. However, the scope of work defined in the contract between the Consultant and the NTC wishes for the Consultant to specifically address matters of spectrum assignment, allocation, licensing and pricing. As such, we have included additional sections in this master plan to ensure that the deliverable is complete but these sections are for example only and NTC is advised that it should consider and develop these example sections further in order to finalise the master plan.

The sections of this document which are within its scope of work of this project and thus those which the Consultant will work with NTC to finalise are:

- Frequency Allocation
- Frequency Assignment
- Monitoring, Enforcement and Control
- Radiocommunications Licensing
- Spectrum Pricing
- Spectrum Engineering
- International

The sections of this document which have been provided by the Consultant in order to provide a complete picture of what the final spectrum master plan should look like but which are outside the scope of this project and which NTC will need to finalise are:

- Radio Equipment Type Approval
- Training and Development

Given the pre-existence of the Telecommunications Master Plan, this Spectrum Master Plan has been structured to have a similar look and feel. In this way, there is consistency between the various Master Plan documents produced by NTC.

This document represents both the final spectrum master plan in addition to explanatory text which describes the background and international best practise which lead to the objectives and policies proposed. We envisage the spectrum master plan being composed of the introductory section of this report (section 1) plus the remaining sections without the background and international best practise sub-sections, as these sub-sections serve only to describe the situation. Those sections which will not form part of the final Spectrum Master Plan have been greyed-out in this version of the document so as to clearly indicate their status.

2 Frequency Allocation

2.1 Description

Allocation (of a frequency band) means an entry in the NTFA of a given frequency

band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions.

Allocations in the NTFA are based *inter alia* on international and regional service designations by the International Telecommunication Union (ITU) and the Asia Pacific Telecommunity (APT).

2.2 Background

As well as burgeoning telecommunications and broadcasting sectors, in common with many countries, Thailand has a significant governmental sector which uses and demands significant amounts of prime radio spectrum.

In Thailand the National Table of Frequency Allocations (NTFA) does not identify major band utilisations, nor does it identify bands used for governmental applications or specify which portions of which bands are actually used for the intended purpose.

2.3 International Best Practise

Assessing current and future demand requires a forward-looking assessment by a national regulator of those markets which form the major spectrum users. In order to develop a perception of what is required to avoid spectrum congestion and shortages in the future, which will hold back growth and slow down innovation, it is important to hold meetings with key sector players and stakeholders in order to collect sufficient information to analyse the situation and formulate a strategy for the future.

Consultative processes, often involving a 'spectrum review' have been performed on a national or regional bases. Such techniques facilitate transparency and help provide potential users, importers and manufacturers with a predictable spectrum allocation usage regime.

National frequency allocation tables are generally based on Article 5 of the ITU Radio Regulations (RR), although minor national variations may sometimes occur and Thailand is no exception. However, national tables usually further clarify the user (or users) to whom the bands are allocated. Thus, they comprise the frequency bands of the RR and identify specific sub-band use where there are several users of a given service. The published versions of these tables are almost always only summary outlines stating whether the user is a Government Department or public user. Specific assignments used by the Armed Forces are virtually never mentioned although reference is often made to non-civil or governmental use with some indication of the overall application e.g. tactical mobile, weapon systems radar, professional mobile radio, private point to point links etc.

2.4 Objectives

The NTC should, in consultation with other concerned government departments ensure that adequate spectrum is available to:

- Satisfy the requirements contained in international obligations and treaties,
- Provide for competitive telecommunication infrastructures through free and fair processes,

- Encourage regional and local involvement in determining frequency allocations,
- Provide spectrum for rural telecommunications with a particular emphasis on the provision of spectrum for telecommunications services for educational (including art and culture) and other public interest (including health and emergency) purposes,
- Introduce future generations of public and private mobile technologies,
- Satisfy the spectrum requirements for internationally provided radionavigation services e.g. Galileo and GPS,
- Facilitate the rollout of broadband telecommunications networks,
- Ensure the timely introduction of digitised broadcasting networks,
- Facilitate regionally and globally harmonised frequencies for the PPDR (Public Protection and Disaster Relief) system, in order to help rescue and emergency teams communicate with each other,
- Meet the needs of civil aviation, and the maritime industry,
- Satisfy the spectrum requirements of NRPC members including those responsible for national security and defence,
- Stimulate technological innovation and competitiveness in a technology neutral fashion,
- Introduce new spectrum management techniques, where appropriate e.g. spectrum commons and spectrum property rights etc,
- Support economic growth and create employment.
- Support the introduction of more spectrally efficient technologies.

2.5 Policies

1. The NTC shall be the lead body in Thailand with respect to developing national spectrum plans, the Thai National Table of Frequency Allocations (NTFA) and shall provide a Chairman for the NRPC.
2. NTFA shall reflect international obligations and national policy on the use of the radio spectrum (in support of the broader objectives for the telecommunications sector).

3. The NTC shall, in consultation with NRPC members, ensure that adequate spectrum is available for new technological developments in such a way as to remain, as far as practicable, technologically neutral.
4. The NTC shall actively encourage the participation of regional and local bodies in determining national frequency allocations.
5. NTC shall, when requested, give favourable consideration to delegating the detailed management of frequencies used exclusively for defence and national security applications [as defined in the NTFA] to the sponsoring Government Department; NTC shall however retain overall management control of the spectrum and be responsible for the overall efficiency of the radio frequency spectrum.
6. NTC shall respond to requests for advice and assistance on governmental spectrum management issues initiated by the sponsoring Government Department.
7. The NTC shall ensure that adequate spectrum provision is made to support emergency services and designated telecommunications services in the case of a national emergency, or in the case of natural and man-made disasters.
8. NTC shall implement an appropriate re-farming or spectrum transfer method for circumstances where there is a justified requirement to transfer the use of a frequency band to another use e.g. from civil to defence or vice versa, or from one civil user to another.
9. The NTC has a general policy of maximising access and optimising the efficient use of the spectrum; it shall therefore look favourably on systems that seek to employ low power, minimise interference to other users, do not require additional protection from other users or which offer the potential for wealth transfer between citizens.

Comment [DC1]: A decision on whether to provide more information in the NTFA is required by the NTC.

3 Frequency Assignment

3.1 Description

Assignment (of a radio frequency or radio frequency channel¹) means authorisation given by the NTC (or other NRPC member with delegated responsibility) in the form of a frequency assignment pursuant to the radiocommunications licence issued to a particular licensee, for a radio station to use a radio frequency or radio frequency channel under specified conditions. An assignment specifies the precise frequencies assigned to a particular licensee in technical detail.

Comment [DC2]: This assumes that only NRPC members will be entrusted to manage assignments under delegated authority from NTC. It also assumes a NRPC will be implemented. A text change would be required if this is not the case.

¹ In international terminology (ITU) a designated frequency channel in an agreed *a-priori* Plan is considered to be an allotment. When that channel within the Plan is assigned to a user it is converted to a frequency assignment

The assignment of frequencies and channels may also be incorporated in licensing processes which are treated elsewhere in the Spectrum Master Plan. For example a frequency(s) or channel(s) may be associated with a market based award of a licence. Once the process has been completed frequencies will be assigned to the user. A class licence may authorise the general use of particular equipment using specified assigned frequencies and operating conditions. Similarly some equipment or applications utilising assigned frequencies or frequencies within an allocated band under specified conditions may be the subject of a general licence or be exempted from licensing altogether.

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3.2 Background

Frequency Plans in the form of channel arrangements have been developed by NTC's Telecommunications Technology and Engineering Bureau for bands allocated to the fixed and mobile services, which are designated for telecommunications or private (professional) applications. These are then provided to the two licensing bureaus in order that detailed assignments can be made when an application is made for a licence which requires spectrum.

A typical task encompasses the three following steps:

1. Frequency (channel) identification
2. Frequency (channel) nomination (or allotment)
3. Technical authorisation

Assignments are evaluated technically using software provided by Loxley IT and recorded in a central assignment database. This database also contains details of governmental assignments to facilitate co-ordination and interference resolution. It is anticipated that a National Spectrum Management System will be implemented in the near future which will be fully integrated with the monitoring, licensing and enforcement functions.

3.3 International Best Practise

The formalities concerned with the identification of suitable frequency(s) and the issuing of a specific authorisation to a user entitling them to operate radiocommunication stations (i.e. use the radio spectrum) at a specified frequency(s) and location(s), and (usually) should be in accordance with clearly defined conditions. These conditions may be contained in specified documentation or the conditions may be specified in the licence for example the maximum power and maximum height of antenna. This is an important task for any administration and will be conducted with the knowledge that the radio frequency spectrum is a finite natural resource. Frequencies will therefore be assigned in an efficient and effective manner. A state of the art national spectrum management system using internationally recognised propagation criteria embedded in assignment software as well as a terrain data base and other administrative data bases.

Frequency assignment activities are ongoing and may take many forms, from the identification of a single frequency in response to a licence application, to the identification of a large number of frequencies for a large radio-based network such as a national telemetry or broadcasting system. Most activity is request driven, as new users apply for licences, though in the case of re-farming it may be the national regulator which determines an appropriate set of alternative assignments prior to instigating migration.

3.4 Objectives

The NTC in establishing an effective assignment regime when an individual spectrum licence and associated frequency(s) assignment(s) is required should:

- Utilise the optimum frequency assignment and planning tools available;
- Ensure that assignment staff understand the various techniques and methods employed in frequency assignment and when they should be used;
- Seek to reduce the incidence of harmful interference occurring between licensed radiocommunication stations;
- Maximise the efficient planning of radiocommunication stations ;
- Ensure that all assignment (and licensing) records are accurate;
- In co-operation with NRPC members seek to ensure the accuracy of assignment records, where delegated responsibility has been ceded by the NTC for the detailed planning of specific frequency allocations;
- Develop quality criteria to support the frequency assignment in a timely manner in support of the overall licensing process,
- Make all frequency assignment rules and guidelines publicly available to aid transparency in decision making,
- Consider the feasibility of placing information on specific categories of frequency assignments in the public domain by means of the Internet.

Comment [DC3]: This has been modified to include defence assignments. However security considerations may not make this practicable. If so the original word should be used and appropriate safeguards taken to ensure that all bodies with delegated management responsibility shall keep accurate records.

3.5 Policies

1. The process of assigning frequencies shall be open, transparent and non discriminatory for all users. It shall encourage efficient spectrum use and support the promotion of competition in the telecommunications sector.
2. The formalities concerned with the identification of suitable frequency(s) and the issuing of a specific licence or authorisation and associated frequency assignment to a user entitling them to operate radiocommunication stations

(i.e. use the radio spectrum) at a specified frequency(s) and (usually) shall be in accordance with the NTFA and clearly defined licensing conditions.

3. Such conditions will be contained in clearly specified documentation or will be specified in the licence.
4. NTC shall ensure that optimum state of the art tools and methods are employed, as appropriate in the frequency assignment process.
5. NTC shall convene regular reviews under the auspices of the NRPC to ensure that frequency assignment methods employed by organisations, with delegated responsibility for detailed planning, maintain the objective of maximising spectrum usage whilst minimising harmful interference to other spectrum users.
6. Frequency assignments shall be revoked if the NTC determines that it is in the national interest to reorganise frequency allocations in the NTFA. In such cases the NTC may offer replacement frequency assignments.
7. All licences for stations or networks to which frequencies have been assigned may be withdrawn, subject to a decision of the NTC, if the radio frequency spectrum provided is not used within a specified period.

4 Monitoring, Enforcement and Control

4.1 Description

Spectrum users are required to comply with licence requirements and technical rules and regulations. Without effective regulations and enforcement procedures, the integrity of the spectrum management process can be compromised. The regulator needs an appropriate framework and process for responding to and managing complaints and for settling disputes. Consideration needs to be given to penalties, remedies, enforcement and other dispute resolution mechanisms.

Furthermore the radio spectrum is a scarce resource and should be managed in the overall public interest. The licensing process involves administrative charges to cover NTC's spectrum management costs as well as spectrum fees where demand for frequencies (potentially) exceeds the available spectrum, are levied on users by a variety of means. Unlicensed use of spectrum therefore involves a revenue loss to NTC and is therefore not in the public interest.

Monitoring can be used to obtain detailed information on the technical and operational characteristics of radio systems. Measurements will typically include frequency, power and the spectrum mask of a transmitter.

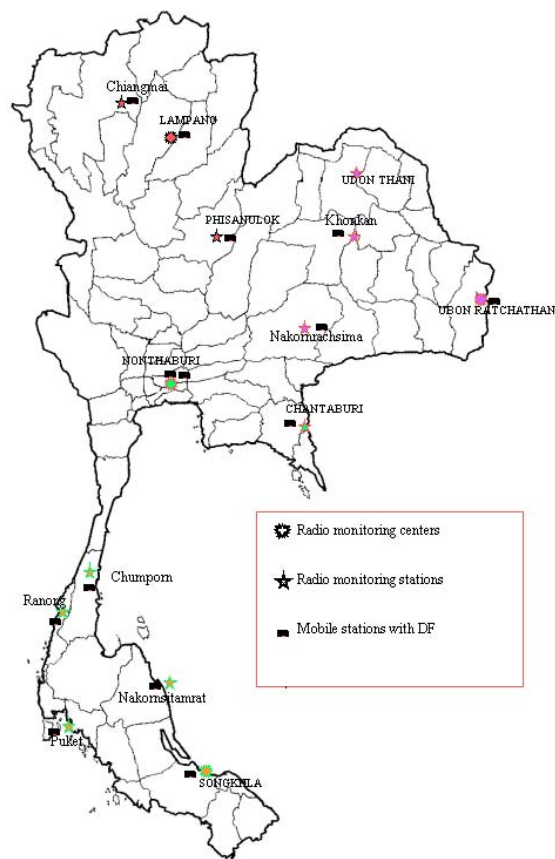
In the course of conducting exercises to resolve interference problems, the spectrum manager may be required to enter user premises and inspect radio equipment to determine compliance with licence conditions and technical standards.

An important aspect of fulfilling these tasks is the requirement under law and regulation to establish the powers, authorities, duties and obligations of the spectrum manager/inspector and protection of rights for the public under circumstances where inspection of property is necessary.

4.2 Background

The Thai radio monitoring service was established 1977, beginning with 1 station there are now 4 main stations or centres and 10 sub-stations providing coverage throughout Thailand (76 provinces). At present, all of these stations are staffed. There are an additional 14 mobile stations, based at the various main and remote stations. The stations in a region are not only responsible for monitoring, but also for radiocommunication licensing, and enforcement. Most of the stations are manually controlled, with the exception of some of the frequency occupancy measurements which can be conducted automatically.

The illustration below shows the extent of the existing monitoring network in Thailand, which forms NTC's Radio Frequency Monitoring Bureau.



NTC has recognised that the current staffed nature of the monitoring stations is not the most efficient method of conducting monitoring and is planning to reduce the

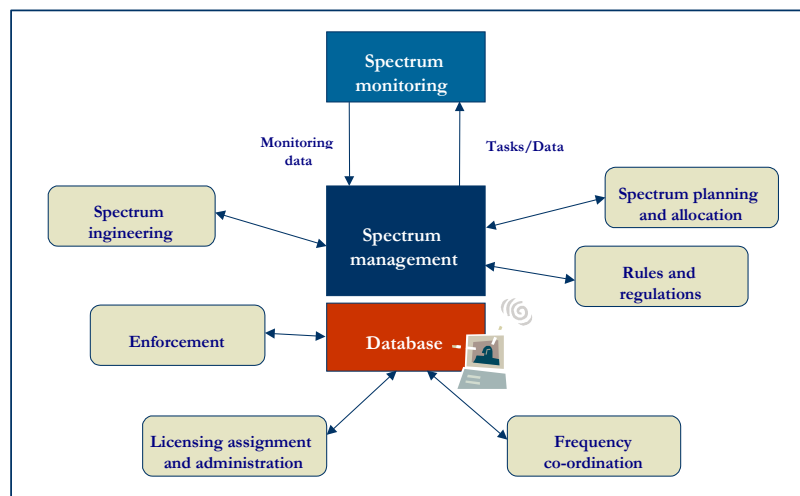
burden by making 5 of the existing 14 stations fully automatic (and hence unstaffed).

Although there is a Telecommunications Enforcement Bureau in the Competition Promotion Department, this Bureau only deals with the unauthorised provision of commercial telecommunications services. For infringements concerning the use of spectrum the situation is investigated by the Radio Frequency Monitoring Bureau. However broadcasting infringements are only investigated if harmful interference is being experienced by other authorised radiocommunications services. NTC can apply to a Court for permission to enter premises to collect evidence, where an offence is believed to be occurring. When it appears that any person has violated the Act or there is reasonable cause to suspect him of so doing an authorised officer of the NTC shall have the authority to arrest that person and collect any admissible evidence required to pursue a prosecution.

Comment [DC4]: Act of 2000 or 1959?

4.3 International Best Practise

The ITU's recommended model for a complete spectrum management environment should provide the framework for the new system for the new NSMS. It should provide for the integration of the monitoring and database functions. It is important, in terms of best practice that the information on assignments licensed can feed into the monitoring process and data from monitoring activity can feed back to the assignment and allocation process. A clear strategy for spectrum monitoring and understanding of how it supports the spectrum management process is therefore necessary.



Elements of spectrum management. Source: ITU

Concerning enforcement the key issue is that penalties in regulations and law must be sufficiently onerous to discourage infringements of licensing conditions, as well as the unauthorised establishment and use of radiocommunications stations. In addition the regulator must have sufficient powers and resources to collect evidence that will sustain a successful prosecution in a court of law.

4.4 Objectives

Spectrum monitoring activities are conducted by NTC to support the process of spectrum management. Objectives include:

- Determine planned and actual frequency usage and frequency occupancy to improve spectrum efficiency;
- Identify possible cases of unauthorised spectrum usage for subsequent investigation;
- Assist in providing acceptable coverage of public services;
- Assess availability of spectrum for future uses;
- Ensure compliance with spectrum management regulations;
- Maximise the benefit of the limited spectrum resource to society;
- Resolution of interference problems, particularly to safety-of-life services for existing and potential spectrum users;
- Provide monitoring data to support ITU activities.

4.5 Policies

Monitoring

1. Fixed and mobile monitoring equipment shall be utilised by the NTC to ensure radiocommunications equipment and/or stations licensed for use in Thailand meet the requisite standards required to maximise the use of the spectrum.
2. The NTC shall investigate, as appropriate, interference to licensed radiocommunications systems (especially those of a safety related nature), arising from other radiocommunication systems, from unintentional radiators or from active electrical and electronic apparatus, equipment and networks.
3. Cases of interference shall be resolved quickly (particularly in the case of interference to services which are critical to the safety of life).
4. A planned series of monitoring campaigns to identify band occupancy and unlicensed usage shall be developed and instigated by NTC in conjunction with the NRPC in order to support spectrum allocation and assignment activities.
5. The NTC shall participate in international monitoring activities.

Comment [DC5]: We hope this section adequately meets the need of Comment 33 in the response table.

Enforcement

6. The NTC shall take action against any unauthorised use of the radio spectrum with a view to collecting admissible evidence for any subsequent prosecution.

Control

7. NTC shall have the capability to ensure that equipment deployed in the field meets appropriate standards and is installed and operated in accordance with the specified licence conditions.
8. The NTC shall have the capability to ensure that Licensees' radiocommunications stations are within the limits specified by the guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)² and that such stations comply with any radiation emission standards adopted and published from time to time by ICNIRP.

Comment [DC6]: NTC has the authority in Law. It may not have the means.

Comment [DC7]: NTC has the authority in Law. It may not have the means.

5 Radiocommunications Licensing

5.1 Description

A radiocommunication licence is an authorisation granted under the law and regulations to allow access to and use of the radio spectrum to provide telecommunications services.

Licensing is typically an administrative function whereby licences are issued and renews and spectrum fees and charges collected. Different categories of radio users may be licensed in different ways, especially where there are different information requirements.

5.2 Background

At present, spectrum licensing in Thailand falls into two distinct categories: commercial and non-commercial. Each of these categories of user are managed by a different section within NTC.

The non-commercial category covers the following licence types:

- Marine and Aeronautical;
- Amateur;
- Defence and Government;
- Private Services;
- Equipment.

² The International Commission on Non-Ionizing Radiation Protection (ICNIRP) published guidelines on limits of exposure to static magnetic fields in 1994 and on limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz) in 1998. The guidelines advise basic restrictions to provide protection against the established adverse health effects of exposure. Reference levels are also given for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Compliance with the reference levels ensures compliance with the relevant basic restrictions, however the reference levels are not limits and if they are exceeded, it does not necessarily follow that the basic restrictions will also be exceeded.

All other licence types are covered by the commercial licensing section.

The licensing process is conducted by the competition promotion department for the two types of licensee. The Telecommunication Technology and Engineering Bureau provides the competition promotion department with a series of band-plans allocating and allotting spectrum to certain uses (such as fixed, mobile). Upon issuing a licence, the competition promotion department then uses its own technical tools to identify and assign a specific frequency.

Licensing of radio usage for commercial telecommunications users is not currently linked with their telecommunications licence. This is a particularly acute issue where the duration of the licence is concerned. At present the durations of telecommunications and radiocommunications licences can vary meaning that it is possible for a telecommunications licensee to be left without a radiocommunications licence and vice versa.

5.3 International Best Practise

Some authorization activities associated with spectrum management include licensing, examination, certification of radio operators, equipment, type approval, type acceptance and international notification and registration. In terms of licences, there are various types, including individual licences, system licences, class licences, general licences, etc. Some uses of spectrum are not licensed. It is important, however, to recognize that unlicensed does not necessarily mean unregulated since equipment may still need to meet certain technical standards.

Of particular importance given the expansion of mobile telecom services and liberalisation of telecom markets in developing and emerging economies, is the authorisation of spectrum in connection with licensing the provision of telecommunications services. It is necessary, for instance, to authorize cellular service providers to use the required spectrum as well as authorizing them to operate the cellular networks.

It is important that the regulatory process facilitates granting, at virtually the same time, authorisations to operate a telecommunication service and to use the required radio spectrum. There should be no delays or risks of inconsistent regulatory requirements as between the two types of authorisations. This is also the case for authorizing broadcasting undertakings. If two separate authorisations are issued, they should be issued simultaneously.

5.4 Objectives

The objectives of licensing are:

- To fulfil NTC's legal requirement in managing the radio spectrum;
- To document and record the administrative and technical details of all radio spectrum usage in Thailand in an uncomplicated and wherever feasible, standardised format;

- To enable access to the radio spectrum to as many applicants as possible taking into public interest and social welfare obligations;
- To simplify licensing processes and administrative intervention wherever possible;
- To ensure that access to the radio spectrum is provided in a timely and appropriate fashion.

5.5 Policies

1. NTC shall ensure that licensees comply with the specified conditions contained within their radiocommunication licence. Failure to comply with such conditions may result in the revocation or non-renewal of the said licence, or the imposition of fines or other penalties as the law allows.
2. NTC shall undertake a review of licensing and associated administrative processes in order to simplify procedures and expedite the delivery of licences to applicants. Furthermore, the means of collection and recording of data shall be reviewed and where possible harmonised throughout the organisation.
3. Individual licences authorising the establishment of radiocommunication stations will generally be for a specified fixed term, renewable on the anniversary of the date of issue. However if the licence is for the provision of a telecommunications service any radiocommunication station directly associated with the provision of that service shall be licensed for the same term as the associated telecommunication licence.
4. Class licences shall be implemented for specific categories of uses which are utilising non-exclusive spectrum (e.g. short range, low power devices) in accordance with technical regulations concerning frequency of operation and radiated output power.

6 Spectrum Pricing

6.1 Description

Spectrum pricing refers to the application of economic or market-based spectrum management techniques to set the appropriate radio licence fees in such a manner that the fees reflect the economic value of the spectrum. These techniques are used to encourage efficient use of the spectrum, to discourage spectrum hoarding and to encourage users to migrate to less congested frequency bands.

6.2 Background

There is currently no congestion in non-commercial radio spectrum in Thailand, so for these services the application of spectrum pricing techniques is not appropriate and spectrum charges based on cost-recovery mechanisms should be applied. However,

there are instances where there are many more organisations who would wish to gain access to certain frequency bands than there is spectrum available and as such pricing based on scarcity is a valid method of spectrum licensing.

At present, all spectrum licences (with the exception of defence and governmental users who do not pay any fees) are priced according to one of two formulas which are defined in the regulations (announcements) based on the 1955 law. One formula applies to public radio networks (e.g. cellular, paging) and private radio networks used by government agencies and state owned enterprises (such as the Electricity Generation Authority of Thailand). The other applies to private radio networks used by the private sector for non-commercial telecommunications services (such as corporate security). There are also equipment import, export and manufacture fees.

The first of these formulas is calculated as follows:

$$FF = (BW \times AC \times FC) + MC$$

Where:

FF is the Frequency Fee
 BW is the Bandwidth Occupied
 AC is the Application Constant
 FC is the Frequency Constant
 MC is the Minimum Charge

The second formula is as follows:

$$FF = (BW \times AC \times FC) (N_1 + 2N_2 + 4N_3)$$

Where:

FF is the Frequency Fee
 BW is the Bandwidth Occupied
 AC is the Application Constant
 FC is the Frequency Constant
 N₁ is the number of terminals with less than 5 Watts output power
 N₂ is the number of terminals with more than 5 Watts but less than 10 Watts output power and
 N₃ is the number of terminals with more than 10 Watts output power

The Application Constant, AC, takes one of two values depending on the type of application being 5 for public (commercial) services and 10 for private (non-commercial) services. The Frequency Constant, FC, varies across a range of frequency bands, effectively replicating a crude form of congestion pricing. The table below shows the values for the FC.

Frequency (MHz)	Frequency Constant
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0.01 – 1,000	10
1,000 – 3,000	5
3,000 – 10,000	0.5
10,000 – 20,000	0.05
20,000 and over	0.001

The Minimum Charge, MC, is based on the service type and is shown in the table below.

Service Type	Minimum Charge (Baht)
Paging	50,000
Radio Broadcasting	50,000
Television Broadcasting	100,000
MMDS	100,000

There is a strong initiative within NTC to encourage spectrum management techniques which are in the public interest. Indeed this goes beyond the entreatment of support for general interest obligations into the desire to enable wealth transfer through spectrum management techniques. It is in the field of spectrum pricing where such desires can be most effectively realised.

Until a reconciliation of the total cost of spectrum management in Thailand and existing spectrum licence revenues has been conducted, it is difficult to determine whether the existing spectrum charges are fair and representative. However, given the time since a review was last conducted it seems fair to suggest that they may not be. Further, the use of the number of terminals in determining the charges is difficult to enforce: if a user buys another 10 handsets after gaining a licence, who will check? Keeping check on so many users would be both costly and unnecessary and does not reflect their actual usage of the spectrum. A better analogy would be to use the area sterilised or the transmitter power, both of which should not change once a licence is issued.

6.3 International Best Practise

Under normal circumstances, radio licensees should only pay for a proportionate amount of the cost of the management of the radio spectrum based on the amount of spectrum which they consume (both in terms of bandwidth and coverage or space).

Economic and market-based spectrum management techniques should only be applied in situations where there is congestion (insufficient supply) or scarcity (excess demand) of spectrum and where there are no policy or practical obstacles to its implementation. Spectrum pricing is usually implemented in one of three generic forms (though there are significant differences between national implementations):

- **Administrative Incentive Pricing (often called Spectrum Pricing).** Fees are calculated (or more usually estimated) by the regulator which are set at a level that incentivises users to make effective use of the radio spectrum. For

existing licensees, this is the only method available to take account of congestion/scarcity.

For new licences (unless existing licenses are revoked), the following methods are also available:

- **Comparative Selection Processes (Beauty Parades).** Licenses are packaged and then offered for auction but the price (whether one-off or annual) of the licence is fixed by the regulator. Bidders must compete on criteria such as quality or speed of roll-out of their service. Adjudication of the final responses can be very subjective and a number of beauty parade based competitive spectrum auctions have ended up being disputed in the legal courts.
- **Drawing a Lottery:** Licensees names are drawn 'from a hat' such that each applicant has an equal chance of success. This is only applicable where all candidates have similar capabilities and qualifications but arguably does nothing to encourage an economically efficient outcome.
- **Spectrum Auctions.** Licences are packaged and then auctioned to the highest bidder. Such a mechanism is highly transparent and (in theory) yields the price for the spectrum that the market supports instead of one which has been estimated by the regulator.

One other spectrum management technique usually embraced under the market-based techniques is spectrum trading. Spectrum trading allows users to trade their frequency assignments subject to a number of pre-determined technical criteria which are covered in their licences. For trading to be established, it is absolutely essential that the licence database is as accurate as possible and that each trade is notified to the spectrum authority, otherwise a situation in which there is some uncertainty as to who is using which frequencies can easily and rapidly be exacerbated.

Many countries now consider it good practice to apply spectrum pricing to governmental services in order that governmental users become aware of the true value of the spectrum which they occupy and hold in reserve. It is of course necessary for the Government to adjust budgets to take account of the marginal value of spectrum already in use by their spectrum users. In turn Government budget holders would subsequently be able to choose whether to release spectrum and purchase other items necessary to fulfil their overall objectives.

6.4 Objectives

The objectives of spectrum pricing are:

- To encourage efficient use of the radio spectrum;
- To accelerate the migration of spectrum users from one band to another where re-farming is necessary;
- To reflect the socio-economic value of radio spectrum where such spectrum

- can be shown to be congested or scarce;
- To stimulate marginal welfare gain in the delivery of radiocommunication services;
- In the short-term to prepare for the trading of spectrum licences. In the long-term to introduce spectrum trading.

6.5 Policies

1. The price of a licence to utilise spectrum shall comprise two elements, an administrative charge and a spectrum usage fee. All spectrum users shall pay the appropriate spectrum charges and fees. The administrative charge is applicable to all radio users and shall recover the direct and indirect costs incurred by NTC in managing the radio spectrum. However the NTC may decide to reduce a charge based on cost recovery, for socio-economic reasons. The charge is based on the amount of spectrum used (both in terms of bandwidth and spatial factors) and the efficiency of its use and re-use. The spectrum fee, where applicable, shall reflect the scarcity the spectrum assigned.
2. Where a licensee requires the use of spectrum and the assignment of frequencies is unlikely to constrain the number of applicants for frequencies in that band or the efficiency of use of the band, then the spectrum shall be made available on a non-competitive (first come, first served) basis. Where there is likely to be a higher demand than there is spectrum available then a market-based spectrum management technique shall be employed unless there are over-riding public interest reasons not to. Market-based spectrum management techniques which NTC shall consider on a case-by-case basis shall include, but not be restricted to: comparative selection of licensees, lotteries, administrative incentive pricing (AIP) and auctions.
3. Spectrum fees payable to license a station of each category of radiocommunication service or user-group shall be prepared and published by NTC in accordance with the processes described in the Spectrum Management Guidelines.³ Spectrum fees shall be easily calculable; based on factors which NTC has the ability to measure and monitor; and shall be equitable and even-handed to all licensees.
4. In cases where spectrum pricing techniques are applied, prices shall be determined in such a way as to reflect the cost to society and the benefits the public will receive.
5. However NTC shall initiate a discussion and review of Governmental exemption of spectrum usage fees in the NRPC with a view to a possible future revision of the applicable legislation.
6. NTC shall undertake a programme of licence reconciliation for those licensees

³ Spectrum Management Guidelines will need to be prepared to support the Master Plan specifically for this section but for other sections also.

for whom it wishes to facilitate the introduction of spectrum trading. Such a programme shall ensure that the license database is as accurate as possible and comprise an administrative and technical campaign to confirm the identity and transmission parameters of each licensee.

7. NTC shall prepare new licence schedules for those licensees for which it wishes to facilitate the introduction of spectrum pricing.
8. Spectrum Trading shall be introduced as soon as practicable. To further this policy, NTC shall on a regular basis review whether the NTFA and the data it holds on licensees is sufficiently accurate to permit the commencement of spectrum trading between defined categories of licensees.

7 Spectrum Engineering

7.1 Description

Spectrum engineering includes the evaluation of information, capabilities and technology choices to support decisions affecting the allocation, allotment and assignment of radio spectrum. Identifying solutions to interference problems and technical compatibility among radio systems are key areas of focus.

A spectrum engineering function should develop technical guidelines, procedures and administrative instructions for radio spectrum usage as well as compatibility and sharing criteria for the efficient use of radio spectrum by various radiocommunications systems and services. It should also provide technical input to the licensing and pricing functions.

7.2 Background

NTC is in the process of implementing an integrated spectrum management and engineering suite from LS Telcom. The installation of this software suite will enhance and regularise the existing spectrum engineering capability and ensure that NTC will be in a position to deliver world-class services.

7.3 International Best Practise

Spectrum Engineering is the technical function which supports spectrum management providing analysis and investigation of radio spectrum matters. Typically such analysis and investigation covers interference and transmitter coverage matters but can also extend to co- and adjacent-channel technology sharing issues.

Spectrum Engineering in the 21st century is largely provided through sophisticated computer software which may link together with licensing, geographical, topographical and geomorphological databases in order to provide real-life as well as theoretical analyses.

Effective spectrum engineering is a key element in raising the technical efficiency of

spectrum allocations and assignments and thus maximising access to and usage of this vital resource. Spectrum engineering becomes especially important where there is a need to consider the implantation of new technologies, especially in bands where existing services are operating.

Spectrum Engineering also provides an important input to the development of frequency planning procedures and guidelines. In addition it also provides the foundation for the formulation of technical policy needed to support spectrum management.

7.4 Objectives

The objectives for spectrum engineering are:

- To facilitate the efficient allocation and assignment of frequency bands and frequencies;
- To provide technical guidance on how to minimise interference between radio users especially in adjacent bands, frequencies and orbital positions;
- To facilitate the compatibility of different radio standards utilising the same frequency band;
- To develop suitable and implementable spectrum masks for new and existing services;
- To produce technical guidelines concerning the use of the radio spectrum;
- To provide NTC with information with respect to future developments in radio technologies to ensure NTC takes account of forthcoming changes in spectrum usage and demand (such as convergence and digitalisation).

7.5 Policies

1. NCT shall have sufficient radio engineering expertise to deliver effective spectrum engineering solutions.
2. NCT shall ensure that it has the up-to-date spectrum engineering and other appropriate software tools and packages necessary to support an effective spectrum engineering capability.
3. NCT shall use the appropriate spectrum engineering tools and techniques to ensure the efficient and effective allocation and assignment of radio spectrum.
4. Radio interference shall be minimised through the judicious use of spectrum engineering.
5. No decisions regarding spectrum allocation and assignment shall be taken without reference to the guidelines and specifications produced by the spectrum engineering function, unless the spectrum engineering function has advised otherwise.
6. NTC shall conduct market studies and surveys and participate in or observe

meetings of international technology development and standardisation bodies. Details of these studies, surveys, meetings and conferences shall be documented and circulated amongst NTC staff in a timely fashion.

8 International

8.1 Description

Radio waves do not respect national borders and many uses of the radio frequency spectrum in Thailand may have an impact intentionally or unintentionally outside the country.

Thailand has a number of international obligations to satisfy in the spectrum management sector. The Constitution, Convention and Radio Regulations (including the Table of Frequency Allocations) of the International Telecommunication Union (ITU) are treaty based and will need to be respected in Thailand's policy and guidelines.

As well as the ITU, there are two other United Nations specialised agencies of importance. Annex 10 of the International Civil Aviation Organisation's (ICAO) Convention deals with aeronautical telecommunications, including spectrum issues on matters related to the safety and regularity of flight. Similarly the International Maritime Organization (IMO) in its Safety of Life at Sea (SOLAS) Convention prescribes certain mandatory radiocommunications carriage requirements for certain ships dependant on their sea area of operation.

The World Trade Organization (WTO) is also important in terms of market and competition issues in radiocommunications.

Thailand is an important member and hosts (in Bangkok) the Asia Pacific Telecommunity (APT), which is the ITU recognised regional telecommunications organisation for the Asia Pacific region.

The NTC will need to respect its international obligations, in order to secure the proper use of radiocommunications. This function is particularly important in the coordination of spectrum use in border areas. As a general rule it is necessary to initiate co-ordination if the station to be licensed is capable of causing interference to a neighbour or if Thailand requires protection of the service by neighbouring States. As with frequency assignment, much of the demand for coordination activity will be driven by new licence applications with those users requiring a single frequency generating less of a load than those with a network of transmitters to be licensed. There will also be a need to service incoming requests from neighbouring administrations. Regular bilateral meetings should be convened with the Spectrum Management Organisations (SMOs) of neighbouring countries to resolve identify and resolve current or potential future problems.

8.2 Background

NTC personnel participate in, or brief other Thai entities concerning all of the organisations mentioned in 8.1 above. In particular NTC will lead delegations to meetings of the ITU and APT as well as participate in any bilateral or multilateral co-ordination meetings.

In its revised offer of February 1997 Thailand undertook to introduce revised commitments in public local, long distance and international voice telecommunications services in 2006, conditional upon the passage of and consistent with the provisions in proposed new communications acts. Thailand also committed to introduce and apply certain regulatory principles, conditional upon the passage and entry into force of new telecommunications acts.

At the regional level Bangkok provides the seat for three important offices of international organisations. The regional telecommunications organisation (including spectrum management) is the Asia Pacific Telecommunity (APT). A number of regulatory initiatives are underway including a regional co-ordination agreement, a regional NTFA, an Asia Pacific solution for PPDR and regional proposals for ITU WRC-07. The second office is the Asia Pacific regional office of ICAO where it is likely that local difficulties with aeronautical frequency usage will be discussed. The third office is the regional office of the ITU to facilitate contact with ITU Members in the Asia Pacific Region and to provide technical and logistical support for activities of the ITU's Telecommunication Development Bureau

There are also bilateral contacts with neighbouring administrations. Thailand has land borders with Malaysia to the south, Myanmar to the west and Laos and Cambodia to the east. In addition for some services it may be required to effect co-ordination with Indonesia and Vietnam which have direct sea paths to Thailand. It is understood that a co-ordination agreement is already in place between Thailand and Cambodia. As mentioned previously APT are understood to be working on a regional solution to simplify cross border co-ordination difficulties. Where a bilateral agreement exists the Telecommunications Technology and Engineering Bureau enter into direct negotiations to agree a mutually acceptable solution. Where co-ordination is required with another neighbouring country the International Affairs Department is involved in the process.

Thailand has launched 5 communications satellites, the first on 7 December 1993 at an orbital position of 120 East. All are operated by the Shin Satellite Company. Next was Thaicom 2 in 1994 at 78.5 East. Thaicom 3 failed and was destroyed in 2006. Thaicom 4 and 5 are both located at 78.5 East, the latter was launched in May 2006. The satellites are used to provide Internet, broadcasting, especially Direct-to-Home (DTH) television as well as High Definition TV and other telecommunications services. Consequentially Thailand has been the notifying administration for Thaicom since 1993 and is required to monitor all ITU advance publications performed in accordance with Appendix 8 of the ITU Radio Regulations, to ensure that Thaicom will not be adversely affected by new satellite systems. It may also need to effect Appendix 7 co-ordination between earth stations and fixed point to point links using the same frequency band.

8.3 International Best Practise

The regulation of spectrum use on a global basis is a core responsibility of the International Telecommunication Union (ITU) and, in particular, its Radiocommunication Sector (ITU-R). The ITU is a specialized agency of the United Nations with its headquarters located in Geneva, Switzerland. The mission of the ITU-R sector is, *inter alia*, to ensure rational, equitable, efficient and economical use of the radio frequency spectrum by all radiocommunication services, including those using satellite orbits and to carry out studies and adopt recommendations on radiocommunication matters.

The ITU's Telecommunication Development Sector (ITU-D) has well-established programmes of activities. These programmes to facilitate telecommunication connectivity and access, foster policy development, assist in regulatory and network readiness, to expand human capacity through training programmes, to formulate financing strategies, and to e-enable enterprises in developing countries. These programmes are designed to address topics of interest to spectrum regulators.

It is important that all ITU members participate in these activities to ensure their views and positions are given a voice on the international stage. Much of the preparation for ITU activities is nowadays carried out in regional bodies. It is thus necessary that Asia Pacific administrations are active in the Asia Pacific Telecommunity.

In respect of bilateral and multi-lateral spectrum arrangements where the use of spectrum is harmonized across national borders it is necessary that regulators arrive at appropriate arrangements with their neighbours, not only to secure agreement on the implementation of transmitting stations but to protect receiving stations in neighbouring countries. It is therefore to every State's advantage to achieve these objectives but in addition to find means to achieve them in the most cost effective manner.

8.4 Objectives

- Subject to resource considerations, participate effectively in ITU activities concerning equipment standard, spectrum sharing studies and radio wave propagation,
- Develop proposals and prepare for ITU World Radio Conferences at the national (in co-operation with NRPC), regional (in APT) and global (ITU) levels,
- Participate effectively in other spectrum management related international activities, as appropriate, with neighbouring countries, at the regional level (e.g. in APT) and at the international level (e.g. in ICAO, IMO and WTO),
- Ensure that international obligations arising from the ITU Radio Regulations are effected e.g. co-ordination and notification of assignments and orbital positions, as appropriate.

8.5 Policies

1. The NTC shall develop Thailand's strategy for spectrum management matters in respect of foreign administrations, Regional bodies (e.g. Asia Pacific Telecommunity), International Civil Aviation Organization (ICAO) Asia Pacific Region, and International organisations (e.g. International Telecommunication Union (ITU), ICAO and International Maritime Organisation (IMO)).
2. NTC shall take a lead role in establishing appropriate delegations to participate in international forums addressing spectrum management activities.
3. In revising and maintaining the NTFA the NTC shall promote and support the harmonising of spectrum usage within the Region, thus maximising economies of scale and reducing equipment costs for users as well as reducing the likelihood of cross-border interference cases.
4. All frequency assignments (civil or governmental) capable of causing interference to, or requiring protection from, the stations of other administrations, shall be co-ordinated with the administration in question.
5. The NTC shall monitor the ITU advance publication process for space radiocommunication systems to identify at an early stage whether co-ordination should be effected with the notifying administration.

Comment [DC8]: This policy also includes the co-ordination of space stations.

9 Radio Equipment Type Approval

9.1 Description

Type approval of radio and telecommunications terminal equipment is a key part of the regulatory process: Type approval of radio equipment provides a key input to the establishment of an environment free of harmful interference. Standardisation is increasingly being carried out by international organisations and if appropriate a standard can be referenced in the national regulatory database or NFAP. Test results from other countries may, subject to review, also be accepted as the basis for demonstration of compliance with the adopted standards.

9.2 Background

NTC operates a very pragmatic type approval system. It requires all radio equipment to be type approved and, for each licence application, it requires the submission of a certification document for the equipment to be used. The certification document can be from any certification body approved by the EU or by certain other neighbouring countries. As such, equipment which is certified for use in most major markets will be accepted for use in Thailand.

9.3 International Best Practise

Radiocommunication equipment (often referred to as radio apparatus) must be authorised for use even if the use of the specific equipment does not require a licence. Ensuring that equipment meets certain technical standards reduces the possibility of harmful interference.

In most administrations, any (consumer) telecommunications equipment plus any equipment which uses the radio spectrum should be type approved such that its transmission (and reception) characteristics are known in order that planning and sharing between services can be calculated based on a series of known parameters. In addition, type approval usually requires equipment to be electrically and mechanically safe. In addition EMC considerations may require any electrical/electronic apparatus/equipment capable of causing unintentional interference, which inhibits the normal operation of a radiocommunication or telecommunication network to be type approved.

9.4 Objectives

Objectives for type approval are:

- To maximise the use of the radio spectrum through assuring the technical specification of any equipment used;
- To ensure that radiocommunication equipment does not cause harm to the general public or staff using it;
- To guarantee that the electromagnetic disturbance generated does not exceed the level above which radiocommunication or other equipment cannot operate as intended;
- To ensure that radiocommunication equipment has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use;
- To ensure that all radiocommunication equipment for sale in the Thai market-place conform to the applicable standards;
- To ensure standards are maintained without the need for the assessment of every item of radio equipment entering the country;
- To support an appropriate level of equipment regulation that maintains the need for radio spectrum compatibility whilst allowing equipment to be procured from world-wide markets and thereby delivering economies of scale and wealth benefits to Thai citizens.

9.5 Policies

1. In order to facilitate competition in the supply of telecommunications equipment and to stimulate the availability of a wide variety of equipment at affordable prices, the type approval scheme shall not place unnecessary burdens on manufacturers and suppliers prior to permitting access to the market. The process will be open, transparent and non discriminatory and support the promotion of competition in the telecommunication sector.
2. NTC has exclusive competence in matters relating to type approval. NTC shall

determine from which other bodies or classes of body it will accept evidence of compliance with the requirements for type approval.

3. All telecommunication apparatus which is an intentional transmitter of radio waves shall be subject to type approval regime.
4. [An Electromagnetic Compatibility (EMC) policy shall be developed by the NTC in co-operation with other concerned government departments to minimise problems of immunity and interference occurring to radiocommunications systems from non radio, active electrical and electronic apparatus, equipment and networks.]

10 Training and Development

10.1 Description

The telecommunications industry is rapidly changing and it is critical that any spectrum administration is both cognisant of, and competent in, the disciplines which underpin these technological developments. It is also important to ensure that staff, whether technical, administrative or managerial, are fully aware of developments in the market where transformational concepts such as convergence mean that the outlook changes rapidly and significantly.

Universities and other educational institutions provide graduates with a good, broad education in electronics, economics or other related fields but few, if any, provide specific training on spectrum management. As such, it is important to regularly update staff knowledge through training and attendance to fora and conferences.

A strong training and development programme are therefore essential prerequisites of a strong spectrum management function.

10.2 Background

NTC encourages its staff to partake in training where such is available to them. Further, sufficient funds are allowed for within the annual budget to allow for some training and development of key staff. There is clearly a need to balance the demand for budget for training and development against the requirement for finances for the day-to-day operation of NTC and getting the balance correct can be difficult. The more highly trained the workforce, the greater the need for them to continue to develop to remain at the top of their fields. Nevertheless, there is always scope to enhance the training provided across the board to all staff of an administration as there is little to be lost from having better trained staff.

10.3 International Best Practise

It is generally recommended that spectrum regulation staff should be conversant with the following subject areas:

Subject	Topics to be covered	Notes
Radio Propagation	<ul style="list-style-type: none"> Radio frequencies and their characteristics 	It is possible that training on these, relatively technical and theoretical areas may be available from sources within Thailand (such as the technical universities)
Radio Technologies	<ul style="list-style-type: none"> Propagation mechanisms Antenna characteristics Modulation schemes (AM, FM, PM, OFDM, CDMA) Access techniques (TDD, FDD, Space Diversity) 	
Rules and Regulations	<ul style="list-style-type: none"> The ITU Radio Regulations National legislation and regulations 	
Radio Licensing	<ul style="list-style-type: none"> Licensing and renewal Operator certification 	
Spectrum Engineering	<ul style="list-style-type: none"> Coverage planning Interference assessment Sharing criteria 	
Spectrum Planning and Frequency Assignment	<ul style="list-style-type: none"> Frequency and band planning Frequency allocation and assignment 	
International Co-ordination	<ul style="list-style-type: none"> Negotiation procedures 	
Monitoring and Enforcement	<ul style="list-style-type: none"> Monitoring principles and practices Interpreting monitoring results in the 'real-world' Developing monitoring plans and schedules Equipment usage Using monitoring to support spectrum management Enforcement 	Such training is often provided as part of the procurement of spectrum monitoring and management equipment
Market Surveillance	<ul style="list-style-type: none"> Undertaking market surveillance Mitigation and actions 	
Type Approval	<ul style="list-style-type: none"> Equipment type approval methods Implementation of a suitable regime Impact on spectrum management 	
Policy Development	<ul style="list-style-type: none"> Framework for policy development International and National factors Guidelines and principles 	This training may not be appropriate or necessary for all levels of staff, only those dealing with policy and planning.

10.4 Objectives

Bearing in mind that NTC recognises that, as an institution dealing with many issues at the forefront of technology, it has a special responsibility to encourage and support learning for all employees, the objectives for training and development are:

- To ensure NTC staff are fully appraised of technological developments in the field of radiocommunications;
- To enable more informed decisions on spectrum management matters;
- To make NTC a 'centre of excellence' for spectrum management in Thailand.

10.5 Policies

1. NTC shall provide sufficient training and development opportunities to its staff to ensure that the implementation of its spectrum management functions can be effectively conducted.
2. NTC shall provide induction training for all new staff, to help them understand how the function of their job relates to the NTC's role within the industry and how it relates to the NTC's business. Induction training must also ensure an understanding of individual responsibilities in the workplace.
3. NTC shall provide and support development and training for those at or near the beginning of their working lives, to enable them to gain suitable technical or professional qualifications and/or experience on which to base their subsequent career development.
4. NTC shall provide and support further development and training when required to maintain and enhance the standards of performance over a period of time.
5. NTC shall appoint a Training Officer to oversee implementation of the training policy and shall allocate specific funds to allow statutory training to be undertaken. Other training funds will be considered alongside other demands on the NTC budget.