INFRASTRUCTURE

A Standard Approach for Assessing the SPECTRUM MANAGEMENT NEEDS OF DEVELOPING COUNTRIES

Report

Telecommunication Development Sector

A standard approach for assessing the spectrum management needs of developing countries

These guidelines are intended to provide a standard approach for assessing national spectrum management development needs and may provide spectrum management assistance or a self-assessment exercise. This report was prepared by ITU expert Terence Jeacock, under the supervision of the ITU Telecommunication Development Bureau (BDT) Spectrum Management and Broadcasting Division and with the co-operation of the ITU Radiocommunication Bureau (BR).

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1 Introduction

The radio frequency spectrum, a limited and valuable resource, is used for all forms of wireless communication, including mobile telephony, radio and television broadcast, broadband links, aeronautical and maritime navigation, and satellite command, control and communications. The radio frequency spectrum (referred to simply as spectrum in these guidelines) is used to support a wide variety of commercial and public sector uses. Because the spectrum cannot support all of these uses simultaneously to an unlimited extent, its use must be managed or coordinated to prevent signal interference.

The growth in telecommunications services and radio technologies has led to an ever increasing demand for the use of spectrum among competing business, public sector and other users. Some established uses, such as broadcasting, microwave links, aeronautical and maritime radar, satellites, etc. continue to utilize significant amounts of spectrum. On top of this, society's growing appetite for mobile communications has led to a massive increase in demand for mobile radio-based applications. This growth, against the background of maintained demand elsewhere, is placing increasing pressure on the regulatory system to manage rapidly rising and shifting demand.

The task of strategic spectrum planning is becoming increasingly complicated. It must take account of the complex interaction between technical developments, market forces and social trends. It must also reflect international developments, as radio waves do not stop at national frontiers and most major radio services are now developed for a global, or at least a regional market.

Thus, the efficient and effective management of the spectrum, while crucial to making the most of the opportunities that the spectrum resource represents, grows more complex. Improved data handling capabilities and engineering analysis methods are key elements to accommodating the number and variety of users seeking access to the spectrum resource. If the spectrum resource is to be used efficiently and effectively, the sharing of the available spectrum has to be coordinated among users in accordance with national regulations within national boundaries and in accordance with the Radio Regulations (RR) of the International Telecommunication Union (ITU) for international use. The ability of each nation to take full advantage of the spectrum resource depends heavily on spectrum managers facilitating the implementation of radio systems, and ensuring their compatible operation. Furthermore, the imbalance between the demand for radio frequencies and the availability of spectrum keeps growing, especially in urban areas.

While the international framework for the utilization of the radio frequency spectrum is set out in the ITU Radio Regulations, there is considerable flexibility for the establishment of national policies within this framework. There are many options for organising national spectrum management as each country must develop its own system to meet its political and legislative regime and regional situation.

Although it would be difficult to develop a single standard model for spectrum management, a set of general requirements can be identified that are necessary to follow the framework of the ITU Radio Regulations.

The following sections identify and describe each of these general requirements and provide an overview of opportunities for improvement by examining typical situations where problems can arise. In addition, new methods of managing spectrum are taken into account. The annexes contain tables of detailed spectrum management activities and their assessment considerations.

These guidelines are intended to provide a standard approach for assessing national spectrum management development needs. They may be used by ITU in advance of a mission to provide spectrum management assistance to a developing country or as a self-assessment exercise by an administration.

2 Country background

2.1 Relevance for national spectrum management

A summary of a country's political, economic, geographical and topographical background can be useful in understanding its spectrum management development and requirements.

2.1.1 Political

The "political" element provides an indication of organizational and legal structure; policies for liberalization and market approach. Regional administrative centres may require spectrum management on a regional basis. Different ethnic regions are likely to have regional broadcasting requirements.

2.1.2 Economic

Economic factors provide information on the role of radiocommunications in supporting major sources of Gross Domestic Product (GDP).

2.1.3 Demographic

Distribution of population, main cities and towns indicate areas of (future) high spectrum demand. Large, sparsely populated, rural areas indicate requirement for radio links to support infrastructure development and/or backhauling.

2.1.4 Geographic

Geographical information indicates country size and radio coverage requirements; coastal areas indicate maritime requirements; number of neighbouring countries indicates cross-border frequency co-ordination requirements.

2.1.5 Topographic, geomorphologic

Mountainous regions, flat plains, deserts, large inland water areas, large forests or jungle areas etc. will have different influences on radio use, planning and requirements. For example, countries located in heavy rain zones may have difficulties in deployment and operation of satellite and microwave links at higher frequencies due to significant signal attenuation in the rain.

2.2 Assessment procedure[1]

Most of the information can be collected from on-line sources prior to the mission to build an initial outline of the country's environment for which spectrum management has to be designed to meet radiocommunication needs. These initial views may be discussed and refined (by the administration itself or by the expert with the host administration during the mission). In particular, it should be determined how far the host administration takes into account these important factors.

3 Legal framework for spectrum management

3.1 Relevance for national spectrum management

It is essential to establish a clear legal basis to manage spectrum use, to provide a national policy for use of the spectrum and to specify regulations for radio applications. Also, the legislation should specify the organisation(s) responsible for managing the spectrum and define its duties, roles and extent of its authority. In addition, the legislation should establish procedures and processes that are fair and transparent. The intention is to provide legal certainty to spectrum stakeholders and investors.

[1] An assessment look-up table is given in Annex 4.1.

These general objectives of spectrum management do not vary from country to country. Spectrum management must serve the national interest, promote the country's economic and social development and ensure safety of life. However there is significant variation in the legal approaches to meeting those objectives. Globalization has not brought with it a model for spectrum management, which remains marked by national factors such as the country's geography, society, radiocommunication history and economic maturity.

One of the main differences is in the legislative approach. In some countries, spectrum management and radiocommunication are included in the same legislation that regulates telecommunications network and services. In some other countries, radiocommunications and general telecommunications have individual legislation with, for example, a separate "Radiocommunications Act" to cover all aspects of radiocommunications. Whichever approach is used, the same key elements of spectrum management should be included.

The primary legislation, which is necessary to establish the legal basis for the essential elements, should also empower the administration to make regulations (as secondary legislation) to manage quickly and efficiently new or changing routine regulatory requirements that need legal enforcement. These may be in the form of regulatory codes or statutory instruments that can be approved without requiring the full constitutional law-making process.

3.2 Assessment procedure[2]

A detailed analysis should be made of the main and any secondary legislation governing radiocommunications. Some preparatory analysis can be made if a copy can be obtained in advance of the mission from the administration directly or from its website. In any case, it is preferable to have it in electronic format.

3.3 Opportunities for improvement

It would be a very lengthy and challenging task to make changes to the primary legislation even if implementation or failure to implement the legislation were to be discovered. In such cases, it would be helpful to identify clearly any problems and propose a suitable "road map" with a timetable to implement corrective measures.

4 Organisational structure of spectrum management

4.1 Relevance for national spectrum management

The Telecommunications or Radiocommunications Act should identify and establish the administration, the legal entity with overall responsibility for national spectrum management and interface with ITU. The administration could be a government ministry or one of its departments, a state institution or an independent regulator (see previous section). Other government agencies may have delegated responsibilities for managing their own services in nationally allocated bands (band managers). Telecommunications operators, e.g. of public fixed and mobile services, may have licenses that permit them to manage the bands assigned in their licences. These types of devolved spectrum management arrangements:

- should define clearly the responsibilities (and limitations) of the band managers. For example, the administration must retain the formal responsibility to provide a single point of international representation at ITU and in bi-lateral frequency negotiations; there should be arrangements for a periodic independent review of the band managers' efficiency in the use of the assigned bands.

[2] An assessment look-up table which contains a recommended list of good practice reference points is given in Annex 4.2.

- reduce the resources required by the administration, as the responsibility of routine frequency assignment will be transferred to the band managers. However, the administration will have additional responsibilities such as co-ordinating between band managers or other spectrum users, especially if frequencies are shared or adjacent band interference occurs.

4.2 Procedure for assessment[3]

The assessor's main objective is to provide a clear description of the organisational structure of spectrum management, in particular to determine whether there is more than one organisation responsible for spectrum management. The administration should be identified and a description should be provided of its functional structure together with staff numbers and responsibilities. The legal relationship with other main spectrum users (government ministries, agencies or operators) should be described, especially if they have delegated powers for spectrum management. The effectiveness of the co-ordination arrangements between an administration and other main spectrum users is examined in section 13.

Interview a representative sample of the main spectrum stakeholders, especially if they are separate band managers, to obtain their views on how well the system works; the efficiency of their planning methods; and effectiveness of the administration's procedures for co-ordination and consultation in national spectrum planning. This includes the opportunities for consultation and participation in the administration's activities in regional spectrum management harmonization in particular preparations for ITU world radiocommunication conferences (WRCs).

4.3 Opportunities for improvement

The most likely areas where improvements can be made will be in defining clearly the delegated responsibilities of the band managers and in implementing or strengthening co-ordination procedures between the various agencies. In addition, bench-marking may be done against similar economies and best practices of other countries, which may be found in ITU-R Reports SM.2012 and SM.2093 and the National Spectrum Management Handbook, may be applied in organizational structures while remaining within the national mandate/legal framework.

5 Current spectrum allocation, usage, and future trends

5.1 Relevance for national spectrum management

An examination of national spectrum allocations and use can provide a measure of the effectiveness of spectrum management planning policies. The first item of interest is the amount of spectrum allocated to government and non-government services and the rationale for the division. It is also useful to see the sub-division of spectrum for various non-government applications. In addition to spectrum allocation information, there should be a measure of the actual use (i.e. working assignments) of allocations, and to identify systems, services or bands that have congestion or other difficulties.

5.2 Procedure for Assessment[4]

The key document to obtain is the National Table of Frequency Allocations for detailed examination for accuracy and how well it has been implemented. It should be in accordance with the ITU Radio Regulations with a rational division of the spectrum to government and major non-government use. Channelling arrangements should be used for the fixed and mobile bands in use. Licensing records and statistics should be made available to assess the level of use of the bands.

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[3] An assessment look-up table is given in Annex 4.3.

[4] An assessment look-up table is given in Annex 4.4.

5.3 Opportunities for improvement

If a National Table of Frequency Allocations is not available then the first priority is to train the spectrum management staff in the procedures necessary to develop one and how to maintain it.

6 Spectrum and apparatus licensing processes/mechanisms

6.1 Relevance for national spectrum management

Article 18 of the ITU Radio Regulations requires that: "No transmitting station may be established or operated by a private person or by any enterprise without a licence issued in an appropriate form and in conformity with the provisions of these Regulations by or on behalf of the government of the country to which the station in question is subject…"

The administration must therefore have some form of licensing process to meet this requirement. In practice, there is considerable flexibility for administrations to operate their licensing procedures. Individual licensing is usually required for those stations that operate "internationally" such as aeronautical and maritime mobile (especially where operator qualification is required) and for those transmitters which require individual frequency planning (e.g. interference analysis). Whereas personal transmitters operating under the control of public mobile telephone networks designed to meet international standards are usually subject to some form of general licensing regime such that individual licences are unnecessary. Similarly, various short range devices, including computer terminals in wireless local area networks, operate under a general "licence exempt" basis, provided that the equipment conforms to an accepted standard. This is necessary to facilitate the free movement of people owning such equipment between countries.

The administration may have a different licensing regime for government agencies or major operators, especially in the case where such agencies or operators have delegated authority to self-manage their allotted spectrum. ITU Constitution Article 45 requires each Member State to ensure that stations established and operated by its operating agencies do not to cause harmful interference to the radio services or communications of other Member States or of recognized operating agencies which operate in accordance with the provisions of the ITU Radio Regulations. Although, under Article 48, Member States retain their entire freedom with regard to National Defence Services, they must, in general, comply with the statutory provisions relative to giving assistance in case of distress; prevention of harmful interference and the provisions for the types of emission and the frequencies to be used.

6.2 Procedure for assessment[5]

The assessment report should describe the licensing arrangements for different types of use. If spectrum management has been delegated to other organisations determine how they authorise use in the bands managed.

6.3 Opportunities for improvement

The objective should be to simplify the licensing processes for operators while ensuring certain quality of service for the end users. For example, licensing of services/systems is preferred rather than licensing of individual equipment. Opportunities for licence exemption should be explored, especially for low power short range devices. Applicability of new licence regimes, for example Licenced Shared Access, could be assessed for certain bands and services. Statistics should be kept of numbers of licence types and the typical time taken to process different licence types. It should be possible to publish processing target time so that licensees know how long they will have to wait for a licence.

[5] An assessment look-up table is given in Annex 4.5.

7 Financing of spectrum management – spectrum pricing mechanisms

7.1 Relevance for national spectrum management

This can be considered in two parts: firstly, how the costs of spectrum management functions are met, and secondly, how market approaches are being applied to spectrum management.

7.1.1 Spectrum management financing

Spectrum users benefit from the planning, management and monitoring of the spectrum that are carried out by the state or by other organizations delegated by the state. It is therefore reasonable and lawful for the state or spectrum management organizations to require users to pay *administrative fees* (known also as *frequency management fees* or *service fees)* to cover all costs arising out of spectrum planning, management and monitoring activities *(cost recovery).*

The establishment of spectrum fees and administrative fees must be carried out with due respect for the rules of transparency, objectivity, proportionality and non-discrimination. It is particularly important that the rules governing the establishment of fees are simple, readily understandable by all concerned and relatively stable over time in order to provide spectrum occupants with the necessary visibility and legal security.

7.1.2 Application of market approaches to spectrum management

The application of market approaches is a detailed and complex subject dealt with in many ITU texts and elsewhere, so only the briefest explanation is given here. However, increasingly, there are reasons that mechanisms for calculating spectrum fees may be different to simple cost recovery for the spectrum management service. For example, fees may be designed to: promote spectrum efficiency; when spectrum demand exceeds supply; determine the most cost beneficial spectrum use, encourage innovation and adoption of newer technologies, finance research and public consultation activities. An administration's spectrum management maturity may be gauged by the degree to which market approaches have been adopted and the methods chosen.

7.2 Procedure for assessment[6]

The assessor should expect to see a well-defined financial strategy for meeting the total costs of managing the spectrum. The spectrum management authority, as a government department or an independent agency should be required to publish its annual operational budget. This should be well-balanced and costs fairly distributed between licence groups, with those requiring the most spectrum management resources paying higher fees accordingly.

7.3 Opportunities for improvement

The objective should be to provide a simplified fee structure and collection mechanism as this goes hand-in-hand with a simplified licensing scheme. As well as being able to easily choose a licence "product" that meets their needs, licensees should be able to see easily how much it will cost, both for any initial fee and the annual renewal fees.

[6] An assessment look-up table is given in Annex 4.6.

8 Spectrum quality control, interference management and enforcement

8.1 Relevance for national spectrum management

In order to guarantee that spectrum use conforms to existing regulations and the authorizations granted, there should be some form of spectrum monitoring capability:

- to measure spectrum occupancy (to evaluate effectiveness of spectrum planning and identify geographical areas and bands having congestion);
- to verify administrative (licensing) database records;
- to check technical compliance;
- for interference resolution;
- to trace unlicensed/illegal use.

Spectrum monitoring systems may be fixed, mobile, transportable or a combination. In view of the considerable cost of monitoring equipment and the need for highly trained operators, an administration may need to prioritise its monitoring requirements to obtain the most effective type of system for the budget available. For example, a fixed monitoring station can provide an HF monitoring capability over a wide area but (because of propagation limitations) only 50-100 km for VHF and UHF. If the administration's priority is VHF and UHF, a mobile or transportable system would offer much greater flexibility as the equipment can be moved easily to different areas of interest. A mobile system is very flexible, especially for tracing interference or illegal use. A transportable system is ideal for urban occupancy measurements and can be operated, on a temporary basis, safely and securely in a suitable government building, using the local power supply. Results may be returned to base by disk or preferably by internet.[7]

In addition to monitoring, the national regulations must contain measures/enforcements, usually in the form of financial penalties, intended to deter interference caused by unauthorized use or use that does not conform to the allocation, assignment or authorization.

Interference can cause serious financial loss to radio users, therefore resolution is a very important service that administrations are expected to provide to licensed users as part of the licensing process (and therefore financed from licence fees). The administration should make available a single point of contact for reporting and following up licensees' interference complaints or other type of complaints from public (e.g. people complaining of bad TV reception).

8.2 Procedure for assessment[8]

If the administration has a monitoring facility, the assessor should take the opportunity to see the facility and interview the staff. Of interest for the report is the type and amount of monitoring undertaken, the experience of the staff and how monitoring is integrated into general spectrum management activities.

8.3 Opportunities for improvement

Monitoring is often neglected and overlooked as an aid to spectrum management because of the equipment cost and requirement for trained operators. Depending on the capabilities of any existing equipment, it might be possible to propose some useful monitoring programmes. However, it may be necessary to recommend a separate study by a monitoring expert to define the most appropriate and cost-effective system. Otherwise, as an interim measure, it would be most useful to help the administration define its monitoring priorities to assist development of licensing.

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[7] Further information may be found in the latest version of the ITU-R Handbook on Spectrum Monitoring and in ITU-R Recommendations and reports.

[8] An assessment look-up table is given in Annex 4.7.

9 Spectrum management databases and computer assisted assignment

9.1 Relevance for national spectrum management

Record keeping of administrative and technical data is an essential requirement of spectrum management. The data may be stored on paper-based system but computerized systems are more efficient. Whichever format is chosen, the key elements are: accuracy; sufficiency; security and control; data entry validation; ability to search and analyse; ability to interface with other systems (especially national monitoring). It may be important to harmonize, to the extent possible, the list and format of data elements in national databases with Appendix 4 of the RR and formats of ITU/BR data processing systems.

The extent to which computer support facilities are used by the spectrum management authority depends on the resources, priorities, and particular requirements of the country concerned. In addition to the main functions of providing an electronic database for licensing records and complex engineering analysis, computer support may include the development, provision, and maintenance of support facilities for nearly all spectrum management activities, including record keeping, forecasting and financial management related to licensing. Further information can be obtained from the ITU Handbook on Computer Aided Techniques. In addition, the ITU Spectrum Management System for Developing Countries (SMS4DC) provides practical examples of an actual implementation of a computerised SM system in accordance with ITU-R SM.1370 (see Annex 1 for references).

9.2 Procedure for assessment[9]

The assessment should identify all databases used in the country; in particular the database used by the administration/regulator but also those used by delegated agencies and operators.

9.3 Opportunities for improvement

The examination of the existing databases is most likely to reveal inadequate data, inaccurate data and inadequate data entry validation procedures. There can be very little improvement in spectrum management until these problems are resolved. Validation and correction of even a small database can be a lengthy process. Existing databases are unlikely to have all the data fields necessary for spectrum management procedures to be recommended elsewhere in the report, for example ITU frequency co-ordination and notification. Desk instructions for the procedures will have to be written and staff will need to be trained to understand the purpose of these additional data and where to obtain it. New application forms will need to be designed to request additional data from applicants. A particular source of database error is inaccurate information on the location of transmitter sites (geographical latitude and longitude). Many sites are used by several transmitters, sharing the infrastructure, site access, site security, electrical power, telecommunications lines or microwave backhaul links etc. It is therefore useful for the spectrum manager to establish a site (or antenna tower) register/database, with the geographical location accurately measured (GPS etc.). Spectrum management engineers can compare new requests to use the site with the register information. Other potential uses for the register are to enable a rapid assessment of transmitter intermodulation interference; monitoring campaigns could include site inspections to ensure licence compliance and good site engineering practice.

[9] An assessment look-up table is given in Annex 4.8.

10 Application of spectrum engineering in spectrum management

10.1 Relevance for national spectrum management

Spectrum engineering is one of the key elements of spectrum management. It is the application of engineering practice and principles to ensure that spectrum plans are designed to make effective and efficient use of the spectrum and maximise the number of different radio systems that are able to operate as intended in any given frequency band.

The results of spectrum engineering analyses are used as technical input to spectrum planning in two ways, either to plan the spectrum to enable systems with defined technical and operational characteristics to operate as intended, or to determine the technical and operational characteristics necessary to enable systems to work in a specified frequency plan. Spectrum engineering must also take into account design and equipment costs to ensure the economic viability of engineering solutions to spectrum management problems.

Therefore, spectrum engineering is required to deal with a wide range of frequency allocation and assignment situations, for example, to develop technical recommendations to support ITU world radiocommunication conference (WRC) decisions or in routine frequency assignment to estimate service areas, co-channel interference, inter-modulation etc.

Some spectrum engineering problems can, of course, be solved using “pen and paper” technology. However, the increasingly complex problems resulting from the introduction of new technology and mass-market radio devices require the application of computers for “number crunching” and to enable graphical interfaces to provide a better visual understanding of the different interactions between multiple systems. Also, computerisation enables greater application of probabilistic methods to avoid unnecessary or wasteful safety margins calculated by worse-case analysis.

10.2 Procedure for assessment[10]

The assessor should determine the spectrum engineering analysis procedures used and tools available, at least for the fixed, mobile and broadcasting services.

10.3 Opportunities for improvement

This will depend on the current level of spectrum engineering used in the administration but is likely to be minimal if there has been no computer available with spectrum engineering tools. If the administration plans to introduce, for example, the ITU Spectrum Management System for Developing Countries (SMS4DC), then an extensive training course for staff will be required to demonstrate the spectrum management tools and principles incorporated into this software. In addition, various spectrum planning criteria will need to be developed and agreed to enable staff to interpret the results and take decisions.

11 Radio equipment standardization, type approval and related certification

11.1 Relevance for national spectrum management

Article 3 of the ITU Radio Regulations concerns the requirements associated with the technical characteristics of stations with the objective to avoid interference. Appendices 2 and 3, respectively, of the ITU Radio Regulations give maximum values for frequency tolerance and spurious emissions and other technical standards. Administrations have the responsibility to ensure that equipment authorised for use

[10] An assessment look-up table is given in Annex 4.9.

in their territory conforms to these Regulations. This is achieved through the use of documents which specify the minimum performance requirements for radio transmitters and receivers (or other equipment) and the associated procedures to ensure conformity with these requirements. These documents are commonly referred to as "equipment standards". Standards can be developed by national, regional or international organisations such as ITU.

Many administrations have technical and operational regulations and requirements for radiocommunication systems. A great number of international compatibility and operational standards already exist within ITU and the International Special Committee on Radio Interference (CISPR). ITU is the recognized body for approving recommendations with respect to standards. It operates in partnership with many standards development organisations (SDO), global core standards (GCS) proponents and transposing organizations. The organisations contributed in developing global core standards within relevant ITU-R Recommendations are ARIB, ATIS, CCSA, ETSI, TTA, TTC, 3GPP, IEEE, WiMAX Forum and etc. It is recommended to have a regulatory mechanism to recognize those proven, effective standards, which are produced and adopted by international or regional standardization bodies can be adopted, as national standards.

In accordance with requirements of the World Trade Organization, many countries have established mutual recognition agreements (MRAs) among themselves. These agreements generally assume a comparable level of technical development and compatible conformity assessment approach. These agreements establish conditions for mutual acceptance of certificates, marks of conformity, and test reports issued by the conformity assessment bodies of either party to a bi-lateral agreement.

The majority of radiocommunication equipment manufacturers will supply equipment certified and marked for compliance with internationally recognised standards. In this context it is recommended to have a regulatory scheme to recognize such equipment.

11.2 Procedure for assessment[11]

The assessor should determine what procedures are in place to ensure radiocommunication equipment is compliant to an appropriate technical standard.

11.3 Opportunities for improvement

The objective should be to simplify the procedures for obtaining and importing properly certified equipment so that prospective users can establish a radio system to improve the efficiency of their businesses with the minimum of bureaucracy and delay. There should be ready acceptance of equipment certified by recognised standards organisations. The responsibility for installing properly certified equipment should be with applicant and dealer. Compliance enforcement should be a post-licensing exercise with suitable penalties for use of non-compliant equipment. Thought should be given to licensing dealers and installation engineers, or perhaps encouraging establishment of a self-regulating trade association.

12 Participation in international spectrum planning and co-ordination activities

12.1 Relevance for national spectrum management

Radiocommunications have a significance that goes beyond the borders of each nation. Navigation equipment is standardized to allow movement throughout the world. Satellite system transmissions facilitate worldwide communications. Radio wave propagation is unhindered by political boundaries.

[11] An assessment look-up table is given in Annex 4-10.

Communications system manufacturers produce equipment for many markets, and the more the markets encourage commonality the simpler and less expensive the production process will be. National spectrum management takes place within the framework established by all the international commitments made by states globally, regionally or bilaterally. It is therefore vital that those commitments be properly reflected in national legislation and regulations. For these reasons, the national spectrum manager's ability to participate in international fora becomes significant. International activities include those within ITU, those within regional telecommunications organisations, other international bodies, and bilateral discussions between neighbouring countries concerned with the ITU Radio Regulations. Those involved in national spectrum organization in each country should be highly encouraged to be involved in and provide input to the reflection and discussions held at international level with a view to developing the global or regional regulatory and legal framework. If they are not involved, national spectrum concerns may not be reflected at international level, with potentially serious economic consequences for the country.

12.2 Procedure for assessment

An assessment look-up table is given in Annex 4.11.

12.3 Opportunities for improvement

Participation in international spectrum management activities is often given a low priority because of the expense of sending delegates and the absence of key staff from normal duty when attending international meetings can cause disruption of business for small administrations. It is usually more effective to send those staff directly involved and experienced in the subject rather than sending only the most senior officers. As explained above, decisions taken internationally can have a major impact, so at the very least, the administration should be participating through electronic means (email and internet) as these facilities are provided by ITU (study groups) and regional telecommunications organisations. The administration should be encouraged to use the Radiocommunication Bureau International Frequency Information Circulars (BR IFIC) on a regular basis to check notifications of frequency assignments proposed by neighbouring countries to assess if coordination is required. The administration should also be submitting its own notifications to the BR. The administration should be encouraged to send relevant staff to attend ITU world or regional radiocommunication seminars for training on notification and coordination procedures and other spectrum management activities.

If the country has several borders, bi- or multi-lateral border co-ordination activities will become increasingly important to resolve problems, especially for broadcasting and public mobile telecommunications systems. To minimise cross border interference and to optimise the spectrum use in border areas international coordination agreements are in place. One of these agreements is the "Harmonised Calculation Method (HCM)", which is agreement among 17 European administrations on the co-ordination of frequencies between 29.7 MHz and 43.5 GHz for the fixed service and the land mobile service. GHz. In addition, neighbouring countries are often developing channelling plans for some services in border areas, e.g. for cellular communication networks, to facilitate coordination. Relevant information on this approach could be found in materials of some regional organizations. One example would be ECC Recommendation (08)02 on frequency planning and frequency coordination for GSM / UMTS / LTE / WiMAX Land Mobile systems operating within the 900 and 1800 MHz.

13 Participation of stakeholders in the spectrum management process

13.1 Relevance for national spectrum management

Spectrum stakeholders are the government and non-government spectrum users that depend on radiocommunications to function efficiently. Consultation with these stakeholders is essential in virtually every aspect of spectrum management, including the development of national legislation and regulations, spectrum policies, technical standards, etc.

The type and extent of consultation will depend on government policy and how the institutional authority for spectrum management has been organised. For detailed and regular consultation, it is usual to establish working groups or committees with membership drawn from relevant government departments and other agencies. It also usual practice to include: major non-government spectrum stakeholders (e.g. service providers, telecom industry, broadcasting organisations). While it is seldom practical to consult with each individual spectrum user, effective consultations can take place by also allowing associations or bodies representing groups of users to contribute.

For less regular but major changes in spectrum management policies or related issues, it is important that the spectrum regulator's proposals be made public. In some countries, this is, in any event, required under broader national legislation governing all regulatory activities, perhaps by a requirement for setting out proposals in an official or widely-distributed publication (official gazette or journal or on an official website). Sometimes, several options may be presented for public comment. It may also be helpful to allow for exchanges between interested parties. Often, meetings are held between the spectrum regulator and relevant stakeholders and, increasingly, the Internet has become the standard tool for publicising consultations and collecting responses. Regardless of the means for obtaining input, minimal guidelines allowing interested parties to contribute gainfully should be set, such as allowing for a given period of time, with a deadline by which comments must be submitted. In all consultations, transparency and fairness are paramount. Unless otherwise requested, responses to consultations should be published. Finally, the administration's decisions should be published, with a report showing the reasoning to support the decisions based on the responses to the consultation.

13.2 Procedure for assessment[12]

The assessor should examine and describe the procedures in place for consultation with spectrum stakeholders.

13.3 Opportunities for improvement

The main objective is to ensure basic consultation arrangements are in place. For major spectrum use decisions and development of spectrum strategy, there should be a high level "spectrum co-ordination and strategy committee" with representation from government spectrum users, national telecommunications operators and broadcasters. Smaller stakeholders could be encouraged to form associations and appointed representatives (e.g. equipment suppliers and maintainers). Notification and consultation with individual users could be arranged through the administration web-site (see section 15).

14 Collaboration with academic and research institutions and industry

14.1 Relevance for national spectrum management

Collaboration with academic and research institutions and industry on research projects to improve spectrum management and efficient utilisation can offer several mutual benefits. For an administration with limited staff and resources, it is advantageous to make use of an external source of academic knowledge and facilities. In return, academic institutions and students may be provided with the challenge of real spectrum management issues. It may also be a method of interesting and attracting a future generation of engineers and related professions into careers in spectrum management.

[12] An assessment look-up table is given in Annex 4.12.

14.2 Procedure for assessment[13]

The assessor should report any relevant collaboration with institutions of higher learning and industry. It would also be useful to determine if any institutions of higher learning are providing courses and training relevant to telecommunications engineering (for example did the administration staff receive their engineering training in the country or elsewhere).

14.3 Opportunities for improvement

Most administrations in developing countries would benefit from external expert assistance in preparing strategies and policies for spectrum management. However, the opportunities for collaboration will depend largely on the national availability of suitable institutions of higher learning that provide telecommunications engineering training/research facilities and the level of industry involvement in telecommunications development. *The Spectrum Management Training Programme is a new programme being developed under the auspices of the ITU Academy. It comprises of a set of high level training materials in all areas of Spectrum Management and covers a full range of topics, which were developed by experts drawn from within and outside ITU.* The development of this programme is being coordinated by the Human Capacity Building division within the Projects Support and Knowledge Management department of the ITU's Telecommunications Development Bureau (BDT), in close collaboration with BDT's focal point for the Spectrum Management and Radiocommunication Bureau (BR), subject matter experts, academia representatives and other stakeholders.

15 Public information: websites; eLicensing

15.1 Relevance for national spectrum management

Radiocommunications and telecommunications are rapidly developing industries. If they are to play their full role in the economic and social development of a country then all those involved (users, potential users, operators, equipment suppliers etc.) need to be able to access quickly and easily information about spectrum use, availability, licensing processes and types, regulations and fees. They also need to know about changes to regulations as soon as possible and be given the opportunity to participate in the consultative process.

Traditionally, such information would be made available through the official government gazette or journal (and in some countries this may still be a legal requirement). However, increasingly information distribution is through the internet and the administration will provide a web-site for the purpose.

Ideally, licensees or potential licensees should be able to conduct licensing procedures on-line.

15.2 Procedure for assessment[14]

The assessor should report on the facilities and information available through the administration web-site.

15.3 Opportunities for improvement

Depending on the facilities already available, the assessor should recommend the basic information is made available: the National Table of Frequency Allocations, information on licensing procedures, licence types, licence fees, proposed changes of spectrum use, equipment import/approval/certification procedures, contact details for the relevant spectrum management departments. Relevant application forms should be available for electronic download.

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[13] An assessment look-up table is given in Annex 4.13.

[14] An assessment look-up table is given in Annex 4.14.

Annex 1: References

List of Reference Material

ITU-R Study Group 1 (SG1) (www.itu.int/en/ITU-R/study-groups/rsg1/Pages/default.aspx) is directly involved in spectrum management (principles and techniques, general principles of sharing, spectrum monitoring, long-term strategies for spectrum utilization, economic approaches to national spectrum management, automated techniques and assistance to developing countries in cooperation with the Telecommunication Development Sector). However, certain recommendations from other study groups will provide valuable information in building spectrum management capability e.g. recommendations on channelling arrangements for fixed services.

ITU-R Recommendations (Spectrum management and monitoring)

Recommendations relevant to sections 4, 5:

SM.1265 National alternative allocation methods

SM.1603 Spectrum redeployment as a method of national spectrum management

SM.1896 Frequency ranges for global or regional harmonization of short-range devices (SRDs)

Recommendations relevant to section 7:

SM.1050 Tasks of a monitoring service

SM.1139 International monitoring system

SM.1392 Essential requirements for a spectrum monitoring system for developing countries

SM.1447 Monitoring of the radio coverage of land mobile networks to verify compliance with a given licence

SM.1880 Spectrum occupancy measurement

Recommendations relevant to sections 8, 9:

SM.1370 Design guidelines for developing automated spectrum management systems

SM.1537 Automation and integration of spectrum monitoring systems with automated spectrum management

ITU-R handbooks and reports

List of ITU Handbooks (see esp. SG01) and download links: www.itu.int/pub/R-HDB

ITU-R Study Group 1 reports on spectrum management issues

Report relevant to sections 4, 7:

SM.2012: Economic aspects of spectrum management

Report relevant to section 5:

SM.2015: Methods for determining national long-term strategies for spectrum utilization

SM.2153: Technical and operating parameters and spectrum requirements for short-range devices

SM.2255: Technical characteristics, standards and frequency bands of operation for radio-frequency identification (RFID) and potential harmonization opportunities

Report relevant to sections 4, 6:

SM.2093: Guidance on the regulatory framework for national spectrum management

Other ITU references

ITU Radio Regulations

www.itu.int/pub/R-REG-RR/en

ITU International Monitoring System (Reports)

www.itu.int/en/ITU-R/terrestrial/monitoring/Pages/default.aspx

ITU BR Fixed and Mobile Services Department (especially frequency plans)

www.itu.int/en/ITU-R/terrestrial/fmd/Pages/default.aspx

ITU BR Space Services Department

www.itu.int/en/ITU-R/space/Pages/default.aspx

ITU-BDT Spectrum Management System for Developing Countries (SMS4DC) v4.1

www.itu.int/pub/D-STG-SPEC-2014-V4.1

ITU Spectrum Management Training Programme

http://academy.itu.int

ITU ICT Regulation Toolkit Module 5: Radio Spectrum Management

www.ictregulationtoolkit.org/5

ITU World and Regional Radiocommunication Seminars

www.itu.int/en/ITU-R/seminars/Pages/default.aspx

Other reference material

Radio Spectrum Management 2nd Edition (Withers)
Publisher: The Institution of Electrical Engineers
ISBN: 0 85296 770 5

Essentials of Modern Spectrum Management (Cave, Doyle, Webb).
Publisher: Cambridge University Press
ISBN: 978-0-521-20849-9
Agreement on the co-ordination of frequencies between 29.7 MHz and 43.5 GHz for the fixed service and the land mobile service (HCM Agreement)
www.hcm-agreement.eu/

Annex 2: Glossary of abbreviations and terms

A more detailed database of terms and definitions can be found out at:
www.itu.int/online/termite/index.html

A/A	Air-to-Air
ACAS	Airborne Collision Avoidance System
AES	Aircraft Earth Station
A/G/A	Air-Ground-Air
AIS	Universal Shipborne Automatic Identification System
AVI	Automatic Vehicle Identification for Railways
BFWA	Broadband Fixed Wireless Access
BR IFIC	Radiocommunication Bureau International Frequency Information Circular
BWA	Broadband Wireless Access
CEPT	European Conference of Postal and Telecommunications Administrations
CGC	Complementary Ground Component
CT1	Cordless Telephone 1
CT2	Cordless Telephone 2
DECT	Digital European Cordless Telecommunications
DME	Distance Measuring Equipment
DMO	Direct Mode Operation
DSC	Digital Selective Calling
DSRR	Digital Short Range Radio
DVB-H	Digital Video Broadcasting – Handheld
EC	European Community
ECC	Electronic Communications Committee
ECC/DEC	ECC Decision
ECC/REC	ECC Recommendation
EDR	Unified Digital Radiocommunication System
EEC	European Economic Community
EFIS	ERO Frequency Information System
e.i.r.p.	Equivalent Isotropically Radiated Power
EN	European Standard
epfd	Equivalent power flux-density
EPIRB	Emergency Position-Indicating Radiobeacon
ERC	European Radiocommunications Committee
ERC/DEC	ERC Decision
ERC/REC	ERC Recommendation

ERMES	European Radio Messaging System
ERO	European Radiocommunications Office
ETCS	European Train Control System
FM	Frequency Modulation
GBSAR	Ground Based Synthetic Aperture Radar
GMDSS	Global Maritime Distress and Safety System
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communications
GSM 1800	GSM in the 1800 MHz band
GSM-R	GSM-Railway
HAPS	High Altitude Platform Station
HDFSS	High-density applications in the fixed-satellite service
HF	High Frequency
ICAO	International Civil Aviation Organization
ICAO Annex 10	Annex 10 to the Convention on International Civil Aviation (Aeronautical Telecommunications)
ILS	Instrument Landing System
ILS LOC	Localizer Element of ILS
IMO	International Maritime Organization
IMT-2000	International Mobile Telecommunications-2000
ISM	Industrial, Scientific and Medical
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
LF	Low Frequency
Loran	Long range air navigation system
LTE	Long Term Evolution
MBS	Mobile Broadband System
MCA	Mobile Communication on Aircraft
MF	Medium Frequency
MLS	Microwave Landing System
MSI	Maritime Safety Information
MVDS	Multipoint Video Distribution System
MWS	Multimedia Wireless System
NATO	North Atlantic Treaty Organisation
NAVTEX	Automated direct-printing telegraph system for navigational and meteorological warnings and urgent information to ship

NDB	Non-Directional Radio Beacon
NGSO	Non-Geostationary Orbit
NJFA	NATO Joint Civil/Military Frequency Agreement
NTFA	National Table of Frequency Allocations
(OR)	Off-route
PAMR	Public Access Mobile Radio
PMR	Professional/Private Mobile Radio
PMR 446	Professional Mobile Radio 446
PR 27	Personal Radio 27
PSTN	Public Switched Telecommunication Network
(R)	Route
Rev.WRC-03	Revised by WRC-03
Rev.WRC-2000	Revised by WRC-2000
Rev.WRC-95	Revised by WRC-95
Rev.WRC-97	Revised by WRC-97
RFID	Radio Frequency Identification
RLAN	Radio Local Area Network
ROES	Receive Only Earth Station
RR	Radio Regulations
RTTT	Road Transport & Traffic Telematics
SART	Search and Rescue Transponder
S-DAB	Satellite Digital Audio Broadcasting
SI	System International of Units
SIT	Satellite Interactive Terminal
SIT	Shipborne Interrogator-Transponder
SNG	Satellite News Gathering
S-PCS	Satellite Personal Communications Services/Systems
SRD	Short Range Device
SSB	Single-Sideband
SSR	Secondary Surveillance Radar
SUT	Satellite User Terminal
TACAN	Tactical Air Navigation System
T-DAB	Terrestrial Digital Audio Broadcasting
TLPR	Tank Level Probing Radar
TV	Television
TVOR	Terminal VOR
UHF	Ultra High Frequency

UIC	International Union of Railways
UMTS	Universal Mobile Telecommunications System
UNO	United Nations Organization
UTC	Coordinated Universal Time
UWB	Ultra-Wideband
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range
VSAT	Very Small Aperture Terminal
WARC	World Administrative Radio Conference
WARC-92	World Administrative Radio Conference for Dealing with Frequency Allocations in Certain Parts of the Spectrum, Malaga-Torremolinos, 1992
WAS	Wireless Access Systems
WiBro	Wireless Broadband
WiMAX	Worldwide Interoperability for Microwave Access
WRC	World Radiocommunication Conference
WRC-15	World Radiocommunication Conference, Geneva, 2015
WRC-12	World Radiocommunication Conference, Geneva, 2012
WRC-07	World Radiocommunication Conference, Geneva,2007
WRC-03	World Radiocommunication Conference, Geneva, 2003
WRC-2000	World Radiocommunication Conference, Istanbul, 2000
WRC-95	World Radiocommunication Conference, Geneva, 1995
WRC-97	World Radiocommunication Conference, Geneva, 1997

Annex 3: Template for assessment report

Executive summary: Observations and lessons learned

1 Introduction

2 Country background

3 Legal framework for spectrum management

4 Organisational structure of spectrum management

5 Current spectrum allocation, usage, and future trends

6 Spectrum and apparatus licensing processes/mechanisms

7 Financing of spectrum management and spectrum pricing mechanisms

8 Spectrum quality control, interference management and enforcement

9 Spectrum management databases and computer assisted assignment

10 Application of spectrum engineering in spectrum management and assignment

11 Radio equipment standardization, type approval and related certification

12 Participation in international spectrum planning and co-ordination activities

13 Participation of stakeholders in the spectrum management process

14 Collaboration with academic and research institutions and industry

15 Public information; websites; eLicensing

Annexes

1 References

2 List of Tables and Figures

3 Daily log of interviews held with [administration] staff and other organisations

Separate appendices

1 [Extracts from] National Radiocommunication Law

2 [Extracts from] National Table of Frequency Allocations

3 etc….

Annex 4: Assessment tables

A4.1 Country background

A4.2 Legal framework for spectrum management

A4.3 Organisational structure of spectrum management

A4.4 Current spectrum allocation, usage and future trends

A4.5 Spectrum and apparatus assignment/licensing processes/mechanisms

A4.6 Financing of spectrum management and spectrum pricing mechanisms

A4.7 Spectrum quality control, interference management and enforcement

A4.8 Spectrum management databases and computer assisted assignment

A4.9 Application of spectrum engineering in spectrum management and assignment

A4.10 Radio equipment standardization, type approval and related certification

A4.11 Participation in international spectrum planning and co-ordination activities

A4.12 Participation of stakeholders in the spectrum management process

A4.13 Collaboration with academic and research institutions and industry

A4.14 Public information; websites; licensing

Annex 4.1: Country background

Feature	Points to check and report
Political	Is the country ITU member? Is the country a member of any regional telecommunications organisation? Does the country have autonomous regions? How are these governed? Are there different ethnic regions (especially with different languages)? If there are regional government offices is there a requirement for regional spectrum management? Determine the policies for liberalisation, including any planned changes. Is there a monopoly telecom operator? If not, how is competition organised?
Economic	What are the major sources of GDP? What is their dependency on radiocommunications?
Demographic	How is the population distributed? How many main population centres (i.e. cities)? Are there large, sparsely populated, rural areas? What is the extent of radiocommunication service provision?
Geographic	In which ITU region is the country? What is the overall size of the country (square km)? If there are coastal areas, how large? How many neighbouring countries are there? Are any major population centres close to a border?
Topographic Geomorphologic	Determine if there any mountainous regions, flat plains, deserts, large inland water areas, large forests or jungle areas. How do these affect the need for communications?
Telecom infrastructure	Are wired backbone networks are largely available? In all regions? Is their capacity is sufficient to serve as backhauls for radio networks? What is the portion of fibre-optic? What is Internet penetration rate?

Annex 4.2: Legal framework for spectrum management

Legal issues in the Radiocommunications Law	Points to check and report
Rights or duties of the government	Does the government have the right to regulate the use of the spectrum as a national "good" (i.e. resource or asset)?
Identification of the administration	Is the organisation identified (e.g. the Spectrum Management Authority (SMA)) with the authority to manage the spectrum, including allocation and assignment of frequencies and the geostationary orbit in accordance with the ITU Radio Regulations?
Enforcement of the law	Does the SMA have the authority to enforce the radiocommunications law and impose penalties through the courts?
Issue of secondary legislation or regulations	Does the SMA have the authority to issue secondary legislation (e.g. legal regulations) for spectrum management?
Licences and fees	Does the SMA have the authority to issue licences and to charge fees (spectrum fees and administrative fees)?
National Table of Frequency Allocations	Does the SMA have the duty to prepare a National Table of Frequency Allocations?
Consultative procedures	Does the SMA have a duty to consult before making major policy decisions on spectrum use and issuing new secondary legislation?
Monitoring for spectrum quality control, spectrum management, research.	Does the SMA have the right to monitor emissions for the purposes of managing the spectrum and spectrum quality control?
Technical Specifications for users' radio equipment.	Does the SMA have the right to set technical requirements for equipment and spectrum usage parameters to achieve efficient use of the spectrum?
International and bi-lateral negotiations for spectrum management issues	Does the SMA have the right to conduct international negotiations globally and bi-laterally on spectrum management issues to ensure frequency coordination and interference avoidance?
Research into spectrum efficiency	Does the SMA have the right to undertake research to improve spectrum efficiency; either by itself or by contracting consultants and research organisations?
Creating the opportunities (spectrum refarming and economic incentives) to improve spectrum efficiency by introduction of new technology	Are the necessary legal mechanisms available for spectrum re-farming: such as change of frequency allocation, compensation for damages, incentives for the current users to return unwanted spectrum to the SMAs?

Annex 4.3: Organisational structure of spectrum management

Organisational feature	Points to check and report
Type of administration	Is the administration a government department or an independent agency?
Delegated authority for spectrum management	Does the administration have sole authority for managing the national spectrum or is there delegation to additional organisations for specific spectrum use?
Other delegated spectrum management authorities	If authority has been delegated, provide a list of organisations and determine the extent of the authority. In particular note differences in scope of authority between government and non-government organisations.
High level consultative committee/ procedure with other government spectrum users	Is there some form of high level committee or procedure with representatives of other government spectrum users to reach agreement on spectrum use and develop strategy?
Consultative procedure with other major spectrum stakeholders	To what extent are non-government spectrum users invited to participate in major spectrum choices and development of strategy? What is the mechanism for such participation?
Staff employed	How many staff is involved in spectrum management? What is their distribution? By units? Regionally?

Annex 4.4: Current spectrum allocation, usage and future trends

Aspects of spectrum use	Points to check and report
National Table of Frequency Allocations and if exists, associated Table of Frequency Use	Has an NTFA and Table of Frequency Use for radio applications been developed? Are they separate or combined? What is the level of detail? How well has it been implemented?
Rational division of spectrum between major uses	How is spectrum divided between government and non-government use and how is spectrum provided for major uses such as aeronautical, maritime, public telecommunications, broadcasting?
Orderly use of frequency bands	Are channelling arrangements in use? Are "spectrum management parameters" of equipment specified (by applicable standards or other methods of specifying minimum performance requirements)?
Availability of statistical information on existing spectrum (actual) use.	Statistics should be available from assignment records. Information can be obtained from stakeholder interviews. Are there spectrum congestion problems (services, bands, areas)?
Strategic policies for future spectrum use	What plans are in place to deal with congestion or the introduction of new technology?
Availability and regular update of Spectrum Management Masterplan.	Is a Spectrum Management Masterplan available and when was it last updated?
Defence use	What is the portion of the spectrum used for defence applications? What are the bands?
Broadcasting (terrestrial and satellite)	?
Public mobile systems (cellular radio)	?
Point-to-point links (microwave networks)	?
HF radio	?
Licence exempted applications, etc.	

Annex 4.5: Spectrum and apparatus licensing processes/mechanisms

Licensing activity	Points to check and report
Licensing system general	Is a licensing system in operation? What types of system require a licence? Is there a licence exemption arrangement or general licence for certain systems e.g. SRD, WiFi etc.?
Interface with users	Is the application procedure easy to understand and published? Is it clear which systems and equipment require a licence and what types of licence are available? Have the following been published: requirements for applicant eligibility; equipment technical requirements; telephone number for queries? Is there a system for queries to be dealt with promptly and by trained personnel? Is there FAQ?
Registration and verification of incoming applications	Are incoming applications filed (data-entry for computer systems) and given a unique registration number for process tracking and future reference? Are administrative details checked for eligibility and accuracy, technical details checked for accuracy (especially geographical coordinates of the station)?
Consideration/analysis of applications (administrative and technical)	Are all staff involved suitably qualified and trained and have desk instructions detailing the procedures to be followed for each licence type to ensure efficiency and a consistent approach?
Decision on application and staff level for final authorization[15]	Is decision making organised to be fast and efficient? Is the number of levels of decision making minimized – e.g. one for administration issues and one for technical issues?
Licence renewal, amendment, transfer, revocation	Are licences valid for a fixed period (usually not less than a year, or, e.g. 3-5 years for "small" private systems such as PM, 15 years for "large" systems such as PMLTS)? Does the licensing authority through renewals whether the licence is still required? If the licence is not renewed, is the spectrum re-licensed to another licensee? Is the licensee required to notify the authority of major changes to the licence (especially change of transmitter site)? Can a licence be transferred to a new owner of a system? Is the authority able to revoke the licence for non-payment of fees, major infringements of use or, with reasonable notice, to enable spectrum re-farming?
Automation of licensing procedure	Level of the automation of the licensing activities in order to establish fairness and divulge more human resources on planning

[15] Licences are issued on behalf of the government (e.g. secretary of state for the department responsible for spectrum management). It is usual practice for routine licences to be authorised (i.e. signed) by a suitably qualified and experienced officer at middle management level.

Annex 4.6: Financing of spectrum management and pricing mechanisms

Finance activity	Points to check and report
Financing of the administration	How is the administration financed? E.g. by government payment or from licence fees?
Fee setting mechanisms (Cost recovery administrative fees)	Are fees set only for cost recovery? If not, is surplus returned to treasury etc.?
Fee setting mechanisms (spectrum efficiency and congestion fees)	Are some fees set to encourage spectrum efficiency or to deal with spectrum congestion or shortage?
Fee setting mechanisms (Transparency)	Are fee setting mechanisms and formulae publicly available and ensured by regulations/legislation?
Fee setting mechanisms (Non-discriminatory, proportionate)	Are fee setting mechanisms and formulae easily understood by licensees? Are they non-discriminatory, proportionate etc?
Calculation of licence fee	Have licence fees and charges and methods for calculating fees for each licence type been made publicly available information?
Fee payments	Are there different options available for fee payments e.g.: cash, electronic fund transfer, etc.? Have safeguards against corruption been implemented?
Market approaches (types of approach used)	What types of market approach have been used? E.g. if there are competing cellular operators, were the licences awarded by auction?
Use of fees by SMA	Are regulatory arrangements and procedures in place to use the fees for: – cost recovery of spectrum management activities including spectrum planning; – spectrum licencing; – spectrum monitoring including resolving interference; – certification of radio equipment; – developing standards; – research; – training, international cooperation and coordination?

Annex 4.7: Spectrum quality control, interference management and enforcement

Aspect of spectrum quality control	Points to check and report
Spectrum quality control and the radiocommunication law	Does the law permit the administration to monitor for spectrum management purposes; allow illegal users or other infringements to be prosecuted and fined?
Funding of monitoring activities	How is monitoring funded? What is the budget?
Monitoring facilities available	What monitoring facilities are available (fixed, mobile, transportable, frequency bands covered etc.)?
Staff employed on monitoring duties	How many staff are employed on monitoring duties? What is the level of experience?
Types of monitoring activity	What is monitoring equipment used for; are there regular monitoring campaigns to target particular aspects (illegal use, occupancy etc.)?
Interference resolution	Is there statistical information on interference, illegal use, licence infringements? What is the complaints procedure?
Integration of monitoring and spectrum management systems	Do the monitoring and spectrum management systems have the facility to exchange data? For example can monitoring staff check results against licence records and can assignment engineers request up-to-date occupancy measurements?
Involvement in ITU International Monitoring System (IMS)	Are some radiomonitoring stations already included in IMS? Are there some plans to join ITU IMS?

Annex 4.8: Spectrum management databases and computer assisted assignment

Data	Points to check and report
Accuracy	Inaccurate data will seriously compromise effective spectrum management. The assessment should examine what methods have been used to check accuracy and, if possible, a representative sample of data should be checked as part of the assessment mission.
Sufficiency	The database should contain sufficient information fields to enable spectrum management. A list of the fields should be obtained and compared against the models in the ITU Handbook: Computer-aided Techniques for Spectrum Management (CAT)
Security and control	Access to records should be strictly controlled by password and details of the access automatically kept in a system log Adequate and regular data back-up facilities should be in place to enable data to be replaced in case the primary database is destroyed or damaged. There should preventative measure against computer-virus.
Data entry validation	In order to ensure database accuracy is maintained and suitable frequency assignments made, all data from application forms should be validated as it is entered into the database. Some automatic validation can be built into data-entry screens but some essential data (e.g. geographical location) may have to be checked manually
Ability to search and analyse	One of the main benefits of computerised database systems is the ability to sort and search data for statistical or engineering analysis. The assessment should examine the range of search facilities and the extent to which statistical analysis is used to enhance effective spectrum management
Ability to interface with other systems	Once the administration has an accurate database available, various ways to use the data to assist spectrum management will be discovered. It is important that the database structure design allows access and interface with other systems, in particular bi-directional access to the monitoring system would enable monitoring staff to quickly identify users in an area, while frequency assignment staff could access the monitoring database to obtain the latest channel occupancy data.
Spectrum management system	Is a spectrum management system in use? Is its structure and data elements harmonized with Appendix 4 to the ITU Radio Regulations and formats of ITU data processing systems?
Antenna Tower or site database	Does this exist? Is it planned?

Annex 4.9: Application of spectrum engineering in spectrum management and assignment

Engineering feature	Points to check and report
Application of spectrum engineering	Is spectrum engineering used in the spectrum management, planning and licensing processes? E.g. is the electromagnetic compatibility of proposed assignments verified with the existing frequency assignments? Is interference potential with incumbent users assessed during frequency planning for new services
Graphical User Interface	Map displays of transmitter sites; path profiles; coverage and interference areas; antenna polar diagrams
Automatic or semi-automatic search for best channel assignment	assessment of co-channel and adjacent channel interference to-from existing users; best channel identification
Use of various propagation models to assess service area coverage and interference range	What models are available? Is terrain data available (resolution in metres)
Assessment of interference in accordance with the procedures of Regional and World-Wide allotment plans	Does the administration assess interference in accordance with the relevant procedures?
Implementation of cross-border frequency sharing agreements	Does the administration assess interference in accordance with any cross-border sharing agreements?
Assessment of interference between point-to-point microwave links	Path-profiling; link budgets; interference between links; channel by channel assessment of interference – best channel identification
Other calculations	

Annex 4.10: Radio equipment standardization, type approval and related certification

Equipment certification	Points to check and report
Requirement for certification	Is there a requirement to use only certified or approved equipment?
Equipment standards	Are equipment standards developed by the administration or does the administration adopt standards produced by international or regional standardisation bodies?
Certification process	Does certification require equipment type-approval or submission of technical documents?
Mutual recognition	Does the administration accept conformance certificates issued by other countries?
Certification	What is the average time needed to obtain equipment certification?
Certification register	Is there a register of certified equipment or is individual certification required for each frequency application?
Import enforcement	Is there a check that imported equipment has the necessary certification?
In service enforcement	Are there regular checks that equipment in service have certificates?
Equipment suppliers	Is there an authorisation or register system for suppliers of equipment?
Type approval guidelines	Have the guidelines been developed if required? Have they been consulted publicly and more importantly with customs departments? Are they available within public domain?
Type approval or compliance testing	Are there facilities in the country for type approval or conformance testing? If so, is this a government or commercial facility?
List of certified equipment	Does this exist?

Annex 4.11: Participation in international spectrum planning and co-ordination activities

International activity	Points to check and report
ITU activities (Conferences, meetings, seminars, workshops)	Does the administration participate in ITU activities? Which ITU Sectors? How many staff participate and at what level?
Regional (radiocommunications) organisation activities (Conferences, meetings, seminars, workshops)	Does the administration participate in Regional activities?
ITU co-ordination and notification	Does the administration use the ITU procedures for co-ordination and notification including BR-IFIC?
Cross-border frequency co-ordination with neighbouring countries	Does the administration have any bi- or multi-lateral co-ordination arrangements with neighbouring countries?
Guidelines for nominating suitable staff to the relevant event	Have the guidelines been developed, and fairly implemented?

Annex 4.12: Participation of stakeholders in the spectrum management process

Participation activity	Points to check and report
Policy and strategy	Are proposed changes to policy and development of strategy discussed between government spectrum stakeholders? Are changes publicised and other stakeholders given the opportunity though public consultation?
Preparation for ITU activities	Is a national committee established to prepare briefs and positions, especially for world radio conferences? Are non-government spectrum stakeholders invited to participate?
Preparation for regional organisation activities	Is a national committee established to prepare briefs and positions, especially regional preparations for world radio conferences? Are non-government spectrum stakeholders invited to participate?
Frequency bands: use or changes of use	Is there a public consultation mechanism?
Methods for national allocation process	Is there a public consultation mechanism?

Annex 4.13: Collaboration with academic and research institutions and industry

Collaboration activity	Points to check and report
Higher learning	Does the administration collaborate with institutions of higher learning (Universities, academies etc.)?
Industry	Does the administration collaborate with industry?
Examples	Provide examples collaboration activities and benefits achieved
Secondment	Is there a programme of exchange (secondment) of staff between the administration, Institutes and Industry to share or widen experience, provide training etc.?
SMTP	Have they heard about it? Have they already participated?

Annex 4.14: Public information; websites; e-Licensing

Information activity	Points to check and report
Administration web-site	Does the administration have a web-site?
Legislation	Can the radiocommunication legislation be viewed?
National Table of Frequency Allocations	Is the National Table of Frequency Allocations available?
Schedule of applications and frequencies	Is there a schedule of services and applications and available frequencies?
Schedule of fees and charges	Is there a schedule of fees and charges?
Schedule of equipment regulations	Is there a schedule of equipment regulations for each service/application/frequency
Licence application forms	Are licence application forms available?
e-Licensing	Is there any form of e-licensing available (e.g. submission of applications electronically)?
Announcement of proposed policy changes	Are proposed changes of policy, regulation frequency use etc. publicised?
Announcement of consultations	Are consultations on frequency use published? Can responses to consultations be submitted electronically?
Announcement of spectrum auctions	Is a public notice issued for spectrum auctions

Annex 5: Extract from the Handbook on National Spectrum Management: Best practices for national spectrum management

Introduction

With due regard to the ITU Constitution and Convention, this Annex addresses: Best Practices for national spectrum management activities (Annex 3 of National Spectrum Management Handbook 2014). International practices are not included. However, some of the Best Practices contained below are intended to interface with, or transition to international practices, e.g., those relating either to collaboration with colleagues in other countries, or to coordination, such as that which would occur at a bilateral or multilateral consultation preceding a World Radiocommunication Conference, or at an international satellite coordination meeting. These practices are further intended to harmonize global spectrum management policies, to the extent practicable, by harmonizing practices among national administrations.

Practices

1) Establishing and maintaining a national spectrum management organization, either independent or part of the telecommunication regulatory authority responsible for managing the radio spectrum in the public interest.

2) Promoting transparent, fair, economically efficient, and effective spectrum management policies, i.e., regulating the efficient and adequate use of the spectrum, taking into due account the need to avoid harmful interference and the possibility of imposing technical restrictions in order to safeguard the public interest.

3) Making public, wherever practicable, national frequency allocation plans and frequency assignment data to encourage openness, and to facilitate development of new radio systems, i.e., carrying out public consultations on proposed changes to national frequency allocation plans and on spectrum management decisions likely to affect service providers, to allow interested parties to participate in the decision-making process.

4) Maintaining a stable decision-making process that permits consideration of the public interest in managing the radio frequency spectrum, i.e., providing legal certainty by having fair and transparent processes for granting licenses for the use of spectrum, using competitive mechanisms, when necessary.

5) Providing in the national process, in special cases where adequately justified, for exceptions or waivers to spectrum management decisions.

6) Having a process for reconsideration of spectrum management decisions.

7) Minimizing unnecessary regulations.

8) Encouraging radiocommunication policies that lead to flexible spectrum use, to the extent practicable, so as to allow for the evolution of services16 and technologies using clearly-defined methods, i.e., (a) eliminating regulatory barriers and allocating frequencies in a manner to facilitate entry into the market of new competitors, (b) encouraging efficiency in the use of spectrum by reducing or removing unnecessary restrictions on spectrum use, thereby encouraging competition and bringing benefits to consumers, and (c) promoting innovation and the introduction of new radio applications and technologies.

9) Assuring open and fair competition in the marketplaces for equipment and services, and removing any barriers that arise to open and fair competition.

[16] Whenever the term “services” is used in this Handbook, it means applications and recognized radiocommunication services.

10) Harmonizing, as far as practicable, effective domestic and international spectrum policies, including of radio-frequency use and, for space services, for any associated orbital position in the geostationary-satellite orbit or of any associated characteristics of satellites in other orbits.

11) Working in collaboration with regional and other international colleagues to develop coordinated regulatory practices, i.e., working in collaboration with regulatory authorities of other regions and countries to avoid harmful interference.

12) Removing any regulatory barriers to free circulation and global roaming of mobile terminals and similar radiocommunication equipment.

13) Using internationally recommended data formats and data elements for exchange of data and coordination purposes, e.g., as in the ITU Radio Regulations Appendix 4, and in the ITU Radiocommunication Data Dictionary (Recommendation ITU-R SM.1413).

14) Using "milestone" management steps and phases to monitor and control lengthy radiocommunication system implementation.

15) Adopting decisions that are technologically neutral and which allow for evolution to new radio applications.

16) Facilitating timely introduction of appropriate new applications and technology while protecting existing services from harmful interference including, when appropriate, the provision of a mechanism to allow compensation for systems that must redeploy for new spectrum needs.

17) Considering effective policies to mitigate harm to users of existing services when reallocating spectrum.

18) Where spectrum is scarce, promoting spectrum sharing using available techniques (frequency, temporal, spatial, modulation coding, processing, etc.), including using interference mitigation techniques and economic incentives, to the extent practicable.

19) Using enforcement mechanisms, as appropriate, i.e., applying sanctions for non-compliance with obligations and for inefficient use of radio frequency spectrum under relevant appeal processes.

20) Utilizing regional and international standards whenever possible, and where appropriate, reflecting them in national standards.

21) Relying to the extent possible on industry standards including those that are included in ITU Recommendations, in lieu of national regulations.

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