

**APT REPORT ON**

**SATRC ACTION PLANS FOR THE DEVELOPMENT OF SPECTRUM MANAGEMENT INFRASTRUCTURE, PROCEDURE AND TOOLS**

**Edition: October 2023**

**The 24th Meeting of South Asian Telecommunication Regulators’ Council (SATRC-24)**

**3 – 5 October 2023**

**Dhaka, Bangladesh**

***(Source: SATRC-24/OUT-09)***

**No. SAPVIII-REP-09**

**Adopted by**

**24th Meeting of South Asian Telecommunication Regulators’ Council (SATRC-24)**

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**EXECUTIVE SUMMERY**

With the rapid development of telecommunication industry all over the world, the radio-based technology advancement plays a key role in dramatic changes in telecommunication market and accordingly the demand for the radio frequency spectrum has ever been increasing. Though a large number of radio-based technologies are evolving and being introduced to the market, the amount of radio frequency spectrum available for the allocation and assignment to cater the demand is limited and finite. In general, these technologies fall under different service categories such as national defense, public safety, broadcasting, business and industrial communications, aeronautical and maritime radiocommunications, navigation, and personal communications. Radiocommunication links, as opposed to telecommunications, are necessary in a dynamic or mobile environment, where wireline telecommunication may not be available, or where telecommunications have been disrupted, such as in emergency or natural disaster situations. Radiocommunication systems may operate from satellites or from terrestrial platforms.

The recent GSMA report on the Mobile Economy 2023, indicates that 5.4 billion unique mobile subscriptions are registered in mobile networks worldwide in the year 2022 and it is expected to grow 6.3 billion by the year 2030. This report also indicates that 4.4 billion mobile internet users are registered in the year 2022 and it is predicted to reach 5.5 billion in the year 2030.

This report shows us how the demand for wireless services is increasing and the wireless applications have become a part of everyday life. Therefore, the implementation of spectrum management processes in proper regulatory framework is important at national and international levels.

The use of computers in the spectrum management process has become crucial for most administrations that are faced with the ever-increasing use of radio frequencies. Several aspects of this process, such as frequency coordination, administrative procedures (registration and issuing of licenses) and notifications of assignments to the International Telecommunication Union (ITU) according to the Radio Regulations, are crucial in the establishment of a computer automated process. The first aspect to be considered is the establishment of a national body and associated regulations.

Considering the requirements and the importance of the computer aided spectrum management and spectrum monitoring systems, many telecommunication regulatory bodies use such systems for the efficient and effective use of scarce radio frequency spectrum. Almost all developed countries use automated spectrum management and monitoring systems whereas some developing countries are struggling to purchase such systems due to the high cost incurred with the initial purchase as well as the maintenance. Depending on the geographic and demographic size, some smaller countries are able to manage the spectrum management processes manually without investing money for the purchasing of specific systems. Therefore, the decision on whether we need the computer aided system for spectrum management or not is the crucial factor to gain the benefits to the country. The lack of know-how and experience on spectrum management systems is the main challenge in most of the developing countries.

Considering these challenges in use of proper spectrum management and monitoring system for south Asian countries, the South Asian Regulators’ Council (SATRC) proposed the work item on “Action plan for the development of spectrum management infrastructure, procedure, and tools” to study and to publish a report for the benefit of SATRC countries.

**CHAPTER 01 - SPECTRUM MANAGEMENT INFRASTRUCTURE**

**Introduction:**

With the telecommunication reforms at the beginning of 1990s all over the world, many countries had established independent telecommunication regulators to initiate liberalization of telecommunication market in their respective countries. Some of the countries formed a single regulatory body to regulate all telecommunication activities whereas some of the countries instituted more than one regulatory body with different regulatory responsibilities. The diversity of telecom reregulation is common in SATRC countries as well. Afghanistan, Sri Lanka, Nepal, Bhutan, Bangladesh, and Maldives have established a single telecommunication regulator to regulate entire telecommunication market whereas in India, Pakistan, and Iran there is a regulator, however, certain functions are managed by government itself.

In telecommunication regulation, spectrum management is an important and vital role of the regulator for the development of telecommunication industry in respective countries. In order to manage the radio frequency spectrum in an efficient and effective way, the regulator should properly build the spectrum management infrastructure within the overall regulatory infrastructure. The following are the important spectrum management infrastructure to be established and maintained by a spectrum regulator.

* Legal Framework (Law, Policy, and Regulation)
* Regulatory Framework
* Organizational Structure and Staff
* Spectrum Management Facilities
* Spectrum Monitoring Facilities
* Enforcement Framework
* Training

**Legal Framework (Law, Policy, and Regulation):**

The field of telecommunications [law](http://communication.iresearchnet.com/communication-and-law/), policy, and regulation is a subset of the larger fields of governance and regulation in general, and the regulation of media and communications in society in particular. Telecommunications law and policy generally concern the ownership and control of and access to large-scale electronic networks that connect people and businesses. These networks may be fixed (primarily involving the use of fiber and wires) or mobile (primarily involving the use of radio frequency spectrum), but such terminology is increasingly becoming antiquated as new technologies create products and services that are more difficult to define.

Telecommunications law and policy generally involve the application of state power through public regulation to secure three objectives: (1) the promotion of competition in the provision of telecommunications services to end users; (2) ensuring that those services are widely available to all sectors of the public, including the poor and those living in rural areas; and (3) aiding citizens and consumers through the often complex choices associated with telecommunications networks in the face of technological change.

Globally, the Telecom Regulators are functioning independently with autonomy of its operation. Accordingly, the telecommunications regulation prioritizes a set of governance values that are (1) reject state ownership and monopolies, and (2) promote competition and consumer choice. These values have been adopted by most national and regional policy organizations, the end-user community, and the telecommunications providers themselves. Further, organizations such as the World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD) have placed reform and better regulation of the telecommunications sector near the heart of their missions. These values are so ingrained in this industry sector that it is now difficult to imagine a nation deciding to nationalize its telecommunications sector or otherwise limit competition in some manner.

The management of radio-frequency spectrum by society is a function usually delegated to telecommunications regulators by policymakers. Working in conjunction with frequency allocation plans agreed on an international and often regional level, telecommunications regulators make decisions about (1) the service and technical rules associated with particular frequency bands, and (2) the terms and conditions under which that spectrum is licensed to individual users. Because radio-frequency spectrum is often made available on an exclusive-use basis to end-users, there is often competing demand for the limited number of licenses that governments make available. One method of resolving that demand is to auction the radio spectrum license to the highest bidder. Radio spectrum auctions have proved to be an attractive license assignment mechanism for two reasons. First, the auctions have sometimes turned into significant revenue raisers for the government involved, raising the internal political profile of the telecommunications regulator. Second, and perhaps more important, auctions have demonstrated themselves to be efficient assignment mechanisms because they tend to result in the spectrum license being awarded to the person who values it most highly.

**International Experiences on Legal Framework:**

**France:**

For telecommunications: the Post and Electronic Communications Code codifies the sector’s legislative and regulatory texts, including:

* the telecommunications law of 26 July 1996, which lays the legal foundation for the creation of ART (Autorité de Régulation des Télécommunications) and ANFR (The National Frequency Agency);
* the implementing legislation on the organization and functioning of ANFR and ART.

For broadcasting:

* The law on freedom of communication of 30 September 1986 as modified and completed by further laws, the last one in August 2000.

Both legislations have been modified by the Law of 21 June 2004, relating to confidence in digital economy, and the Law of 9 July 2004, relating to electronic communications and audiovisual communication services, which implements, in particular, the elements of the European Framework Directive.

**United Kingdom:**

* The Wireless Telegraphy Act (1949) in principle requires all radio stations and apparatus to be authorized by means of a licence or otherwise. In practice many uses of radio no longer require individual licences as more and more classes of radio equipment come under the scope of deregulation provisions (class licences, general licences, exemptions, etc.). The Act was amended in 1998 to allow auctions to be introduced as a more efficient way of regulating spectrum use.
* The Communications Act 2003 transfers the government’s licensing powers under the Wireless Telegraphy Act (including the provisions for auctions and granting Radio Spectrum Access rights) to Ofcom (the Regulator). These are now exercised within the European Union Directive 2002/21/EC on electronic communication networks and services, under which Ofcom is required to promote competition, in particular, in relation to the provision and making available of services and facilities that are provided or made available in association with the provision of networks or electronic communications services. In this way, auctions are to be used as the preferred means to assign spectrum; granting of trading rights will help develop the market for spectrum trading; and restrictions on use of individual spectrum bands are made as light as possible.

Ofcom also performs a key role in coordinating spectrum use at the European level through the Radio Spectrum Committee (RSC) and the Radio Spectrum Policy Group **United States:**

* (RSPG) by virtue of powers devolved by DTI through ministerial directions to Ofcom pursuant to the Communications Act 2003.

**United States:**

* The 1934 Communications Act is the basic law governing wire line communications and radiocommunications within the United States and between the United States and other countries.
* OBRA (Omnibus Budget Reconciliation Act), voted by Congress in 1993, authorizes FCC to auction spectrum.

**Entities** involved in national spectrum organization:

* Congress.
* The National Telecommunication and Information Administration (NTIA), in particular its Office of Spectrum Management (OSM) and its Inter department Radio Advisor Committee (IRAC).
* The Federal Communications Commission (FCC).

**New Zealand:**

The 1989 Radiocommunications Act provides the overall regime for spectrum management in New Zealand.Spectrum is managed in one of two distinct frameworks, either an administrative framework or a property rights framework. The administrative framework (termed radio licences) is operated solely by the Ministry and typically has annual licences which are renewed on payment of an administrative fee. The property rights framework allows for a management right to be created over a specific frequency range, which can be either held by the Ministry or allocated commercially to private interests. The holder of the management right can issue licences (termed spectrum licences) as they deem appropriate. Management rights and spectrum licences have legal certainty, are fully tradable, and are established for periods of up to 20 years. When the spectrum is managed by the Ministry, licences are typically allocated by auction. Entry into markets such as broadcasting, and some telecommunications services is only limited by acquisition of the necessary spectrum licences. The Act is accompanied by the Radiocommunications Regulations, which details the administrative framework, provides for control of non-radio “interfering equipment” and sets the fees payable to the government. Associated legislation is the Telecommunications Act, the Broadcasting Act and the Commerce Act.

**Cameroon:**

* The Federal Law 67/LF/20 of 12 June 1967 regulating private radio electricity and fixing the charges corresponding thereto.
* The Law No. 98/14 of 14 July 1998 which created the TRB and the IFMB, and its implementing instruments signed by the Head of State and the Decree N°98/197 of 8 September 1998) on the organization and functioning of the TRB.
* The decrees on the rules governing the authorization to operate telecommunications networks (Decree N°2001/830/PM of 19 September 2001) and on the rules governing the granting of authorizations to provide telecommunications services (Decree N°2001/831/PM of 19 September 2001).
* The Law No. 90/52 of 19 December on the freedom of social communication and the Decree N°96/260 of 19 October 1996 and Decree N°2000/158 of 3 April 2000 which all define the powers of the Ministry of Communication with regard to spectrum management.

**Republic of Korea:**

* The 1961 Radio Wave Act establishes the regulatory framework for efficient use of radio frequency spectrum and is supported by its Presidential Decree and KCC Notifications.
* The 1983 Telecommunication Basic Act provides basic guidance on telecommunications and is supported by its Presidential Decree and KCC Notifications.
* The 2000 Broadcasting Act regulates the licensing of Broadcasting Service Provider and Program Providers and is supported by its Presidential Decree.

**Regulatory Framework:**

The telecommunication sector, including radiocommunications, is organized internationally within the framework of the International Telecommunication Union (ITU), which provides the basic framework for the global coordination and management of the radio-frequency spectrum. In between ITU and the national administrations, two other kinds of organizations, regional organizations and specialized international organizations, are also involved in spectrum management, at either regional or global level. At the regional level, organizations have been founded that bring together administrations, in some cases associating industry or radiocommunication operators. Their aim is to establish common positions in preparation for ITU decisions, to harmonize national frequency allocations within the relatively flexible framework set by ITU so as to facilitate the coordinated introduction of new services, and to harmonize the standards and procedures for certification of equipment with a view to its free circulation and use in the countries concerned. This is the case in particular for the European Conference of Postal and Telecommunications Administrations (CEPT), and to a lesser extent for the Inter-American Telecommunication Commission (CITEL), the Asia-Pacific Telecommunity (APT) and the Arab Council of Ministers for Telecommunication and Information, which in pursuing these objectives intend to promote the emergence of regional markets and hence to accelerate the development of radiocommunication services.

At the global and regional levels, specialized international organizations also exist in sectors of activity that use radiocommunications and are therefore dependent on spectrum availability: civil aviation, the maritime sector, meteorology, broadcasting, radio amateurs, radio astronomy and research.

**International principles governing spectrum use:**

The radio-frequency spectrum is a non-depletable but limited natural resource available in all countries and in outer space. Since any transmitting radio station may cause harmful interference to spectrum uses on Earth or in space, the spectrum is a common resource of mankind that requires rational management by a treaty level agreement among all countries. In that spirit, ITU has been drawing up legal instruments for over a century, so that spectrum use is based on the following fundamental principles set forth in the ITU Constitution (CS):

a) “while fully recognizing the sovereign right of each State to regulate its telecommunication...”, “... to avoid harmful interference between the radio stations of different countries”;

b) “… to improve the use made of the radio-frequency spectrum for radiocommunication services and of the geostationary-satellite and other satellite orbits”;

c) to “facilitate the worldwide standardization of telecommunications, with a satisfactory quality of service”, and “... to harmonize the development of telecommunication facilities, ... with a view to full advantage being taken of their possibilities”;

d) to “foster international cooperation and solidarity ...”

**Organizational Structure and Staff of National Regulator:**

The national radiocommunication law should delegate the authority and responsibility to manage spectrum use to one or more government bodies. Though a single authority may be ideal, the realities and the level of resources available may dictate other approaches. In most cases, an administration may favor the appointment of a single department, or agency to manage all radiocommunication use. This approach has the benefit of simplifying the decision-making process and establishing policies that impact all users. The decision authority optimizes its role by accommodating as many user requirements as possible. A single authority may decrease a part of its workload and increase its effectiveness, if justified, by delegating authority to other groups.

National telecommunication law may further stipulate who is representing the national interests in the framework of international activities (for example, the spectrum management authority may perform this role). If spectrum use within the country is managed by several authorities, national representation in international negotiations may become complicated. It is recommended therefore that a single agency or ministry be given the overall authority for coordination of spectrum use and for managing the spectrum internationally.

The independence of the spectrum management authority is crucial in making decisions in the national interest. When the spectrum management authority is limiting spectrum users to a consultative role, there will be less opportunity for biased decisions. However, the participation of users in the decision-making process can help to build confidence that is very important to effective implementation of national objectives.

**Structure of Spectrum Management Unit:**

There are a number of ways to determine the size of the professional staff relative to the functional requirements. The staff size should be based on the functional requirements, and these could be based on the current value of the telecommunication structure in the country, the number of new licenses required, or the number of current and projected frequencies. The simplest to use and understand is related to the number of frequencies required. Table 1 describes typical ranges of frequency assignments for each of the three spectrum management systems. Although it is not possible to accurately define the various categories, this table may assist countries in planning a functional spectrum management system.

***Table 01- Typical Range of Frequency Assignments for Different Size Structures***

|  |  |  |  |
| --- | --- | --- | --- |
| **Spectrum Management System** | **Typical Rage of Actions, Licenses or Frequency Assignments** | **Estimated Range of Professional Staff Size** | **Comments** |
| Small | 100 to 10,000 | 5 to 10 |  |
| Medium | 10,000 to 100,000 | 10 to 50 |  |
| Large | Above 100,000 | Above 50 | Typically, a developed country with greater than 100,000 frequency assignments |

**Small Spectrum Management Unit:**

Figure 01 below shows the typical organization structure of a small spectrum management unit.

*Figure 01 - Small spectrum management organization of professional staff*

**Medium Spectrum Management Unit:**

Figure 02 below shows the typical organization structure of a medium spectrum management unit.

***Figure 02 - Medium spectrum management organization of professional staff***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **Spectrum** M**anager** |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **Frequency assignment chief** |  | **Spectrum engineering chief** |  | **Spectrum planning chief** |  | **Administrative and****economic support** |
|  |  |  |  |  |  |  |  |  |  |  |
| **Application processing – 2**-Data entry**Technical examination – 2**-Allocated band-Data fields**Frequency assignment – 2**-Interference criteria**Licensing – 1**-PTT review-Enter approved assignment**Frequency coordination – 1**-National-International**Spectrum fees – 1**-Fee table-Number of transmitters**Data records - 1**-All systems |  | **Engineering studies – 2**-Spectrum efficiency-Adequate allocations**Standards/type approval – 2**-Minimize interference**Frequency measurements – 2**-Clear frequencies**Interference measurements – 2**-Determine interference**Frequency complaints – 1**-Record complaint-Eliminate complaint**Interference tracking - 1**-Record of problem |  | **Frequency allocations – 2**-Present and future requirements**Planning and regulatory – 2**-Develop procedures**Liaison and consultation - 2**---Information to SM clients**Frequency plans – 2**-Detailed use plans**Procedures for management****- 1**-Detailed frequency process**National and International****coordination - 1**-Procedures-Software programs |  | **Spectrum Department Budget – 2**-Review budget status-Annual budget preparation**Economic/billing report – 2**-Review and develop reports**IS/IT support.**-Fix simple PC problems -**2**-Update FMS parameters **-2****Legal affairs guidance - 2**Update FMS parameters |
|  |  |  |  |  |  |  |

**Large Spectrum Management Unit:**

A large spectrum management organization should again follow the functions described above in Medium Spectrum Management Unit. Typical professional staff numbers greater than 100, and the number of total frequency assignments is greater than 100 000. The system requires an advanced spectrum management computer system that keeps records for all services and provides engineering analysis support for all frequency ranges and systems. The structure could be organized like those previously described, it could be organized by radio service, or it could be organized in a matrix structure by the basic function that applies to all services. Other organizational structures are also possible.

**Spectrum Management Facilities:**

Administrations which are falling under medium and large categories of spectrum management units, have been managing spectrum resources by using computer aided systems. These systems may manually operate or semi-automated or fully automated system depending on the requirement and economic situation of the country. The computer systems used for spectrum management contain hardware and software facilities depending on the requirements. Software solutions may include the following application and engineering modules but not limited to.

* Invoicing and licensing
* Land Mobile Planning tool
* Microwave Links Planning tool
* Electro Magnetic Compatibility ((EMC) Test tool
* Broadcasting Planning tool

**Spectrum Monitoring Facilities:**

Spectrum monitoring serves as the eyes and ears of the spectrum management process and helps spectrum managers to plan and use frequencies, avoid incompatible usage, and identify sources of harmful interference.

In today’s industrial environment, the use of wireless devices and systems is proliferating at a rate beyond the user’s ability to understand, monitor, and control effectively. Many systems operate in unregulated frequency bands and have never been subjected to testing to assess how their performance might be affected by other systems that share the spectrum. Modern industrial facilities can have hundreds or even thousands of wireless devices. It is no longer practical or cost effective to attempt to troubleshoot issues with wireless systems by having someone “walk around” with a portable spectrum analyzer and a handheld directional antenna trying to determine the source of an interfering signal. Manual techniques can only be effective if the signal can readily be distinguished from the overall radio frequency (RF) environment. In addition, this method requires a skilled operator. It is clear that yesterday's spectrum monitoring methods are not up to the task of today's spectrum management challenges, which requires a different paradigm.

This new more proactive paradigm makes the distinction between spectrum monitoring and active spectrum management. Monitoring is an open loop process where tools and methods are used to determine what is there at any given instant in time, to make sense of it, and possibly undertake further investigation such as the previously described manual signal hunt. Management, by contrast, is an active process where a desired state, in this case use of the spectrum, is known and a closed loop system is in place to compare the current state with the desired state and then take specific focused action to return the system to the desired state. This is precisely the challenge facing spectrum use and problem resolution today. A system is needed that provides automated tools to compare the spectrum with what is expected, to identify signals that should not be there and thus could be interference sources, to verify that they are in fact interference sources so limited resources are not spent locating emitters that in fact are not causing problems, and then to locate true sources of interference so they can be mitigated.

**Enforcement Framework:**

Effective management of the spectrum depends on the spectrum manager’s ability to have effective tools for the enforcement of relevant regulations. Spectrum managers should be granted the authority to enforce spectrum use regulations and set appropriate penalties. For instance, the enforcement staff or other spectrum managers may be granted the authority to, when they identify a source of harmful interference, either require that it be turned off or confiscate the equipment under appropriate legal mechanisms. However, the limits of that authority must be specified.

**Training:**

An automated spectrum management system is a large and potentially complex information system, which includes a large database of applications and licenses, frequency allocations, geographic information, and other data. Training in such a system is an essential element of any administration’s spectrum management activities, to prepare staff for their duties. With the rapid evolution of radiocommunication systems, training must be a continuous, on-going process. Spectrum management staff requires a broad knowledge of topics related to the radio-frequency spectrum and radio services. Equipment and computer software is often highly specialized and not used outside the administration. Thus, it is necessary to prepare specific training programs and use qualified instructors. Training courses need to be tailored to the staff to be trained; different categories of staff require different training courses. These training courses can be composed of standard modules or units, each covering specific topics within spectrum management. Training courses can be divided into three broad categories:

* Basic training (training of new staff)
* On-the-job training
* Professional development training.

**CHAPTER 02 – SPECTRUM MANAGEMENT PROCEDURE**

**Introduction:**

With the rapid development in wireless technologies for various applications all over the world, the demand for radio frequency spectrum has been increasing tremendously. The regulators or administrations face numerous challenges to cater to the ever-increasing demand for radio frequencies. As the demand of the radio frequency spectrum is very much higher than the supply in many applications like IMT, administrations have to follow a more transparent and market based competitive spectrum assignment mechanism to assign radio frequencies for such applications. As a result of high demand, the administrations or respective countries are able to collect considerably high revenue in terms of frequency licensing fee by assigning radio frequency spectrum.

Facilitating more radio frequency spectrum for high demand applications cannot be initiated at national level as it needs global and regional harmonization and therefore, it should be met at regional and international level for the spectrum harmonization to avoid interferences. National requirements of radio frequency spectrum are discussed in regional organizations such as the APT and the regional organizations make recommendation to ITU for its approvals and to include to the Article 5 of the Radio Regulation. Allocation of the new radio frequency spectrum will be taken into account with the following objectives.

* Optimize spectrum use in accordance with international best practice.
* Support and promote innovation and encourage competition.
* Promote the economic and societal benefits from use of spectrum.
* To ensure that full advantage can be taken of international market and technology developments by ensuring the timely availability of the requisite radio spectrum.

**Stages Involved in Assigning Radio Frequency Spectrum:**

Spectrum scarcity is not an absolute value, since: “The cause of its scarcity is to be found not only in institutional mechanisms, but also in a growing demand for uses resulting from technical progress. This demand comes up against the fact that there is an increasingly narrow bottleneck in the availability of the resource as well as in the allocation and access mechanisms”. The same source identifies the following key factors that contribute to the scarcity of frequencies and increased spectrum access costs:

* The deregulation and liberalization of electronic communication markets
* The privatization and "merchandising" of the public domain
* Awareness of the value of the radio spectrum
* Worldwide competition between multinational operators.

Spectrum management has thus to respond proactively to these trends, in three broad areas:

* Planning current and future use of the spectrum
* Management, which includes issuing authorizations and licenses (as well as ensuring compatibility of uses and equipment)
* Monitoring and controlling spectrum use.

These areas call for the implementation of regulatory processes, which are defined in the ITU Radio Regulations (RR).

1. **Allocation (of a frequency band):**

Entry in the national table of frequency allocations of a given frequency band for the purpose of its use by one or more specific services. Spectrum can be allocated on an exclusive basis (allocated to a single service) or a shared basis (shared by more than one service), and on a primary or secondary basis.

1. **Allotment (of a radio frequency or radio-frequency channel):**

Entry of a designated frequency or channel in a plan for use by a specific service under specified conditions. The allocation is made by a competent conference, such as the World Radiocommunication Conference (WRC) convened by the International Telecommunication Union (ITU).

1. **Assignment (of a frequency or a radio-frequency channel):**

Authorization given by a national regulatory authority for a given entity (e.g. a mobile telecommunication service operator or provider) to use a designated frequency or channel under specified conditions.

**General Principles of Radio-Frequency Spectrum Management**:

Traditionally public authorities have often allocated frequencies for specific applications, and then assigned parts of the spectrum to entities responsible for using them for specific purposes based on the “first come, first served” principle. This approach is fast, practical and less costly, but has its limits in today’s environment. For this reason, modern spectrum management is geared towards optimizing the value of the radio frequency spectrum. Such optimization is now becoming both necessary and sought after by public authorities for several reasons:

* to encourage an effective use of this resource, which is not produced, is limited, and is in some cases scarce;
* the frequency spectrum has become an important means to develop countries' telecommunications;
* the budgetary income generated by the spectrum can contribute to countries' economic development;
* income from frequencies must contribute to improving the means used for spectrum management (monitoring, spectrum management information system, …) and make it possible to fund refarming operations.

This optimization involves maximizing the attainment of three objectives: economic efficiency, technical efficiency, and social benefit. This is not an easy task, since these three objectives often conflict, obliging the regulator to decide on trade-offs.

**Economic Efficiency:**

From the perspective of economic efficiency, spectrum management seeks to maximize the added value of use of the services produced by the available spectrum. All frequencies, on account of their technical characteristics, can be used for more than one service. This is reflected in national tables of frequency allocations and databases of spectrum users, where a frequency band may be segmented by sub-band, area, and time. For example, the 700 MHz band in Latin America can be used equally by broadcasting services and by mobile services (pursuant to the ITU Radio Regulations and the provisions of other regional bodies such as the Regional Telecommunication Technical Committee for Central America – COMTELCA). Accordingly, the principle of economic efficiency holds that a frequency band must be allocated to the communication service that generates greatest economic value.

**Technical Efficiency:**

From the perspective of technical efficiency, given that the spectrum is a scarce resource, the objective to be pursued through frequency management is maximum utilization. At the same time, one of the reasons why the spectrum has to be managed is interference. Interference occurs when residual transmissions on neighboring frequencies cause degradation in the quality of communication. By setting conditions of use and specified technologies, the principle of technical efficiency serves to keep interference down to acceptable levels.

**Social Benefits:**

The third objective to be pursued is maximizing social benefit. Recognizing that telecommunications are a service for the public good, effective spectrum management enables service providers to access the spectrum in an environment of healthy competition. This idea can be illustrated by means of an example from the mobile telecommunication industry. Radio-frequency spectrum management allows multiple mobile operators to gain sufficient access to the resource to offer services on a competitive basis, as a result of which the end-user will benefit with wider coverage, lower prices and innovative products. Another aspect of the social objectives to be maximized is better access to telecommunication services that have a high socio-economic impact, such as mobile broadband.

In many instances, these three spectrum management objectives (economic efficiency, technical efficiency and social benefit) may conflict. For example, a spectrum assignment scheme may achieve optimum technical efficiency but does not necessarily represent the best economic value. This is the case of assigning spectrum under a generic license or through free access as against competitive licensing (auctions, beauty contests, bidding, etc.). Economic research has shown that, while assigning frequencies by auction can maximize economic efficiency of the spectrum (in the short term), setting aside some frequencies for open access generates a greater economic surplus.

**Radio-Frequency Spectrum Assignment Models:**

As mentioned above, radio-frequency spectrum management is guided by three alternative assignment models:

* Command and control model: This involves granting usage licenses within a primary market, organized on the basis of administrative assignments.
* Market-oriented model: This includes holding auctions, secondary markets and sharing models.
* Common-use model: This assumes full liberalization (subject to the principles of no interference) in the use of spectrum.

Many countries’ regulatory frameworks and spectrum management models employ a mix of these models, seeking the most effective combination of approaches to suit specific bands and each country’s particular situation.

**Auctions:**

In the early days of wireless communications (primarily maritime), as there were so few spectrum users, the risk of interference was minimal, with the result that use of the spectrum was completely free and unlicensed. The proliferation of radio stations in the 1920s prompted the US Congress to set up a telecommunication regulator empowered to grant licenses for the exclusive use of bands of spectrum. Under this model, called command and control, the US telecommunication regulator assigned frequency bands through hearings coordinated by an administrative judge in which possible alternative assignments were put forward. The protection of spectrum property rights is irrevocable, guaranteeing the right to utilize the spectrum for a specified period and under specified conditions, so that it can be assigned as efficiently as possible. Thus, setting the price of spectrum by means of an auction will guarantee more effective assignment of its use than the command-and-control model. In a frequency band auction, the highest bidder is granted a license to transmit and receive signals in the band acquired. This license is protected by operating rights. This method has since spread to most countries of the world, partly because it gives governments the possibility to generate significant revenues. Before the 1990s, the majority of countries assigned spectrum bands for the mobile telecommunication service according to the command-and-control principle, based on so-called “beauty contests”. In this method, entities interested in obtaining a license are assessed in terms of their coverage plans and technology. Thus, the regulator assigns the frequency band to the candidate that puts forward the most attractive cellular network deployment plan from the point of view of technological progress and territorial coverage. During the 1990s, the auction model took hold in most countries of the world, partly because it gave governments the opportunity to generate significant revenues. Auctions provide an effective reply to two questions: Who to assign to? and How much to charge? Auctions are an assignment mechanism that leads to transactions (assignment of resources and setting of prices) based on comparison of offers from those participating in the process. Generally, the auction process rules are announced in advance, and the prices paid are set by the participants according to their commercial strategy and capabilities. The advantage of auctions resides in the fact that market prices for spectrum rationalize the availability of supply. Moreover, the winner is the bidder with the best business plan, rather than the company which gets lucky or whose presentation makes the best impression on the adjudicator. Last but not least, the government, as the seller, collects maximum income. It is important to point out, however, that auctions may not always be the most suitable assignment mechanism for the following reasons:

* Not all bands can be auctioned: e.g. frequencies allocated to aeronautical, maritime, etc. services do not fit into this “market forces” model
* Limited technical requirements
* Auction does not necessarily achieve the highest social value from the spectrum on offer
* A poorly qualified candidate may win the license
* A successful candidate may overbid in relation to the intrinsic value of the auctioned spectrum, even to the point of invalidating its business plan (the so-called “winner’s curse”)
* Uncertainty regarding demand, tariffs, etc.
* Possibility of collusion between bidders, resulting in a price which is lower than the intrinsic value.

Table 02 summarizes the advantages and disadvantages of the auction model, which may serve as a guide to determining in which cases to use auctions and how to conduct them.

***Table 02: Advantages and Disadvantage of Auction Models***

|  |  |
| --- | --- |
| Advantages | Disadvantages |
| * Relative maximization of revenue for the government
* Optimization of spectrum (economic efficiency)
* Opening up to competition
* Relative speed of process
 | * Limited technical requirements
* Does not necessarily achieve the highest social value
* A poorly qualified candidate may win the licence
* Successful candidate may overbid (the so called "Winner's curse"): uncertainty regarding demand, tariffs, etc.
* Possibility of collusion during the bidding
 |

According to ITU, ten types of auction may be identified, namely:

(1) open auction (public bids)/closed auction (sealed bids);

(2) single-round/multiple-round auction;

(3) single-object/multi-object auction;

(4) sequential/simultaneous open auction;

(5) English (ascending) auction;

(6) Dutch (descending) auction;

(7) single-round/sealed-bid/first-price auction;

(8) single-round/sealed-bid/second-price auction;

(9) simultaneous/multiple-round/ascending auction; and, finally,

(10) clock auction.

**The Concept of Secondary Market:**

In markets that have matured to a greater level of flexibility and the implementation of secondary markets, regulatory mechanisms have been introduced with the aim of cutting down on the administrative restrictions on licensing, allowing licenses to be subdivided and recombined in new configurations. In 2010, according to ITU, 11 countries possessed a secondary frequency market, and 12 were planning to implement a secondary market in the future. Among the most well-known examples, we may mention the standard training units (STUs) in Australia, management rights in New Zealand and partial leasing and sub-leasing possibilities in the United States. At the European level, there are a number of directives: Directive 2009/140/EC of the European Parliament and the Council, of 25 November 2009, amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorization of electronic communications networks and services. France and the United Kingdom are reference cases for the rapid incorporation of these directives in their national law. The option of temporarily surrendering spectrum usage rights for a period of time could come to be more important than the option of selling spectrum, as a way of channeling into a secondary market the supply of spectrum which is being underused in the short term. Since we are typically dealing with long-term licenses that have been granted through competitive mechanisms, the license-holder is unlikely to want to relinquish the license, or even part of it, but with the incentive of a rent may be willing to surrender temporary or shared use. With respect to secondary markets, in some countries, licenses can be transferred without any significant restrictions, subject to some degree of power of veto on the part of the regulator for technical or exceptional reasons. In such cases, the national competition authority often intervenes to eliminate restrictions on license-holding by foreigners. This avoids problems of excessive concentration of frequencies, which leads to a deterioration in services or a less healthy business climate. Flexibility of use, together with the possibility of reconfiguring licenses, are strong factors in fostering supply and demand for underused spectrum in secondary markets. Experience appears to support the argument that the more flexible the service, technology and configuration (of bands, geographical areas, periods of use, etc.), the greater the opportunity for third parties to offer services and ultimately the more effective the development of a secondary spectrum market. Some countries allow trading and transfer of licenses among operators against financial consideration, generally subject to the technical and economic endorsement of the respective regulator. The secondary market may also entail certain disadvantages, such as the fact that the resale of frequencies will require administrative provisions, which are not covered in the original regulatory framework. Besides this, there is room for distortion of competition insofar as the prices obtained on the public market through auctions are different from those arising from the secondary market.

**CHAPTER 03 - SPECTRUM MANAGEMENT TOOLS:**

**Introduction:**

The radio frequency spectrum is a finite resource used by many civil and military applications. To ensure proper and fair use, the spectrum is heavily regulated and frequency bands are allocated to specific users. The key to successful spectrum management is effective spectrum monitoring; monitoring who is using the spectrum, where and when they are using it and what they are using it for. Any breach of conditions can then be quickly spotted, and the spectrum utilized effectively.

The use of computers in the spectrum management process has become crucial for most administrations that are faced with the ever-increasing use of radio frequencies. Several aspects of this process, such as frequency coordination, administrative procedures (registration and issuing of licenses) and notifications of assignments to the International Telecommunication Union (ITU) according to the Radio Regulations, are crucial in the establishment of a computer automated process. The first aspect to be considered is the establishment of a national body and associated regulations.

Considering the requirements and the importance of the computer aided spectrum management and spectrum monitoring systems, many telecom regulatory bodies use such systems for the efficient and effective use of scarce radio frequency spectrum. Almost all developed countries use automated spectrum management and monitoring systems whereas some developing countries are struggling to purchase such systems due to high cost incurred with the initial purchase as well as the maintenance fees. Depending on the geographic and demographic size, some small countries are able to manage the spectrum management processes manually without the investment for the purchasing of specific systems. Therefore, the decision on whether we need the computer aided system for spectrum management or not is the crucial factor to gain the benefits to the country. The lack of know-how and experience on spectrum management systems is the main challenge in most of the developing countries.

**Requirement of Spectrum Management Tools:**

The requirements of Spectrum Management and Monitoring tools vary at national, regional and international level. The administrations which fall within medium or large spectrum management organizational structure need to have semi or fully automated spectrum management and monitoring tools to manage scarce radio frequency spectrum more efficiently and effectively.

**Spectrum Management Tools:**

Achieving effective radio frequency spectrum utilization, its use must be coordinated and regulated through both national regulations and the Radio Regulations of the International Telecommunication Union (ITU). The capability of each country to take full advantage of the spectrum resource depends heavily on spectrum management activities that facilitate the implementation of radio systems and ensure minimum interference. For this purpose, administrations should, as appropriate, make use of computerized spectrum management systems.

Though the effectiveness of a spectrum management system cannot easily be defined, it is, in general, related to how well the system meets the national needs and how well it is able to safeguard the interests of the public in the accommodation of radio users. National spectrum management consists of the structures, procedures, and regulations whereby an administration controls the use of the radio spectrum within its geographical boundaries.

Effective management of the spectrum depends on the spectrum manager’s ability to have effectual tools for the enforcement of relevant regulations.

**National objectives related to the spectrum:**

The national objectives related to the spectrum may include the following;

* to make available efficient nationwide and worldwide telecommunications services for personal and business use;
* to foster innovation in the development of infrastructures and provision of radiocommunication services;
* to serve national interests, including security and defence;
* to safeguard life and property;
* to support crime prevention and law enforcement;
* to support national and international systems for transportation;
* to foster conservation of natural resources;
* to provide for dissemination of educational, general, and public interest information and entertainment;
* to promote scientific research, resource development, and exploration;
* to promote the dissemination of the cultural heritage and protection of the national and regional folklore; and
* to promote the reduction of the digital divide.

In order to meet these objectives, the spectrum management system must provide an orderly method for allocating and assigning frequency bands, authorizing and recording frequency assignments and establishing regulations and standards. A policy statement or regulation can specify technical factors, establish licensing criteria, and set priorities that will be used to determine who will be authorized to access a frequency band, and for what purpose it will be used. While policy statements also can be a link between the government agenda and spectrum managers, stability of radiocommunication policies is essential for investments. The government may delegate to the spectrum management organization the authority to establish spectrum policy and regulations. The government may alternately choose to have that organization be led by political appointees, delegating to the spectrum manager only the authority to develop means of implementation and to carry out decisions.

The processes developed to nationally allocate spectrum, assign frequencies to licensees, and monitor compliance with license terms are essential tools for implementing national goals and objectives.

**Spectrum Management Functional Responsibilities and Requirements:**

The basic national spectrum management responsibilities and requirements (functions) are:

* Spectrum management planning and regulations;
* Spectrum management financing, including fees;
* Allocation and allotment of frequency bands;
* Frequency assignment and licensing (including non-license allocations);
* National liaison and consultation;
* International and regional cooperation including frequency coordination and notification;
* Standards, specifications, and equipment authorization;
* Spectrum monitoring;
* Spectrum enforcement;
* Spectrum management support functions including;
	+ administrative and legal;
	+ computer automation;
	+ spectrum engineering;
	+ training.

The spectrum management agency (a self-sustained agency or a part of a national agency) may be structured in different ways according to the law, background, customs, and telecommunication resources of the country concerned. It should encompass all the functions listed above, some of which may be combined or further divided, depending on the size of the organization. The spectrum management organization should publish details about its organization and operational procedures, so that they may be effectively understood by spectrum users.

**Computer-Aided Techniques for Spectrum Management:**

The use of computers in the spectrum management process has become crucial for most administrations that are faced with the ever-increasing use of radio frequencies. Several aspects of this process, such as frequency coordination, administrative procedures (registration and issuing of licenses) and notifications of assignments to the ITU according to the Radio Regulations, are crucial in the establishment of a computer-automated process.

For any automated spectrum management system to be successful, several areas need to be addressed and clearly articulated by the administration proposing such a project. The areas that should be considered and the questions that should be answered include:

* Existence of a regulatory infrastructure for spectrum management. This means that a spectrum management authority and its supporting units are in place and effectively operating. These include, but are not limited to, legislation, regulations and operational policies and procedures.
* Definition of scope and project objectives for applying a computer-aided spectrum management system. Why is automation being considered? Have new directives been issued requiring that resources be redirected to other functions within the administration's mandate? Is automation seen as a tool for coping with an increasing workload? What portions of processes or tasks within each spectrum management unit are to be considered for automation? Are some manual processes better left untouched?
* Determination of available internal and external resource allocations. An assessment must be made as to what financial and human resources will be required and dedicated to the project. Also, will it be necessary to obtain special funding authority?
* How is the system to be developed or implemented, by in-house resources, by contract, by purchasing available software, or by a combination of these? Does the administration possess the necessary regulatory and technical experts, or will it require assistance?
* What limits or boundaries, if any, are to be imposed in automation development? Will the magnitude of the project dictate its development over many phases or years?
* Development of work plans and schedules showing project phases, tasks and status reporting milestones. The use of any graphical illustrations, such as Gantt charts, for the work plan and scheduling should be considered.
* Definition of user specifications. The needs and requirements of the end users must be clearly defined to ensure their proper translation to detailed design specifications. The scope of the spectrum management functions that should be automated and the extent to which each will be automated must be clearly defined. Any contract to be awarded must contain a clear and comprehensive statement of work.
* Identification of operational requirements. Each task or activity contains its own operational requirements that must be easily interpreted into a sequence of steps such as flow charts or pseudo codes.
* Establishment of functional and technical specifications. These specifications chart out the development of the system and are the basis of the detailed design.
* Availability of organizational and procedural documentation of existing systems and operations. System developers will need access to this documentation as they will invariably need to become themselves quasi-regulatory/technical experts before the translation of existing operations and procedures can begin.
* If contractors are to be considered, their performance history must be examined. Does the contractor have the requisite skilled or experienced system developers to see the project through to completion and implementation? Previously delivered contracts should be reviewed to determine or assess any related experience that can be applied to the proposed contract.

The items listed above are for the guidance of an administration in considering the decisions on the establishment, design, development and implementation of a computerized spectrum management system.

**Spectrum Monitoring Tools:**

In the present context of spectrum management, the theoretical spectrum planning is not sufficient anymore. Understanding of the actual use of the spectrum is needed before making decisions on frequency assignments or allotments.

Monitoring supports the overall spectrum management process in general, including frequency assignment and spectrum planning functions, by practical measurements of channel and band usage so that channel availability statistics may be derived, and the effectiveness of spectrum use can be assessed. With this data, spectrum planning can be verified by comparison between the theoretical planning and actual use. The result of this comparison can be used to adjust planning. Utilization of the spectrum occurs 24 h/day, 7 days/week, every week of the year, whether locally, regionally, or globally. Likewise, spectrum monitoring should also be available 24 h/day.

Spectrum monitoring comprises:

* monitoring of emissions for compliance with frequency assignment conditions (technical and operational characteristics of the signals);
* frequency band observations and frequency channel occupancy measurements providing information about the actual usage of the spectrum;
* assistance in the investigation of radio interference on a local, regional and global scale;
* detection, localization and identification of illegal transmitters;
* identification and measurement of interfering signals.

This information may be used to trigger subsequent enforcement activities, e.g. the on-site inspection of a radio station.

Monitoring information is necessary because the spectrum is not always used as intended. This may be due to the complexity of the equipment, interaction with other equipment, a malfunction of equipment, or deliberate misuse. These problems have been further exacerbated due to the proliferation of terrestrial and satellite radio systems and the introduction of unintentional radiators, such as computers, which may cause local interference.

**Integration of spectrum monitoring and spectrum management systems:**

Administrations which perform both spectrum management and spectrum monitoring should consider using an integrated, automated system with a common relational database which provides the following functionalities:

* Remote access to system resources
* Automatic violation detection
* Frequency assignment and licensing
* Tools to support spectrum engineering
* Automated measurement of signal parameters
* Automated occupancy measurements coupled with optional geo-location measurements
* Scheduling of measurements for immediate or future execution

When considering the procurement of an integrated system, an evaluation has to be made of which of these functions are necessary and how much integration is appropriate for an administration. There is no doubt that the monitoring and enforcement service must have access to the license database, and that spectrum managers can use certain information provided by the monitoring service.

**Types of Monitoring Stations:**

The following three types of monitoring station are defined:

* fixed monitoring stations;
* mobile monitoring stations;
* transportable monitoring stations.

**Fixed Monitoring Stations:**

Fixed monitoring stations are the central element of a monitoring system. In their coverage area, they generally allow all measurements to be carried out, without limitations such as insufficient working space, inadequate possibilities to set up antennas and limited power supply.

There are two approaches for determining the location of a fixed monitoring station. It can be established either at a place where a minimum of interference from man-made noise and radio emissions is expected, or in highly populated regions where many emissions, including low-power emissions, can be received. The first approach is particularly suitable for HF monitoring stations because they are very sensitive to interference, and propagation conditions allow them to be located far from transmitter sites. For VHF/UHF monitoring stations the second option will be chosen as the propagation conditions do not permit such stations to be located far from transmitters. However, great care must be taken not to overload the receivers with strong signals, e.g. from broadcasting transmitters, and to create intermodulation products. In practice, different requirements will make it necessary to find a compromise.

The main drawback of fixed, manned monitoring stations is the very fact that they are fixed and that, for financial reasons, they cannot be established in sufficient numbers. Therefore, such stations are frequently complemented by remote controlled monitoring stations, which may be equipped with measuring receivers and/or direction finders, depending on their purpose. Advanced equipment not only allows stations to be operated by a remote operator, but also allows measurement programmes to be carried out automatically, with results being transmitted to the manned monitoring station at a later time or an alarm going off when certain limits are exceeded.

Figure 03 presents sketches of configuration for remote fixed stations, either with a larger container space that allows temporary local operation or without this space, allowing only remote-controlled operation.

Figure 03

Fixed Monitoring Stations Diagrams, (a) Larger site with shelter for local operation
(b) Smaller site with all equipment attached to the tower.



Such fixed stations have the following main characteristics:

– remote controlled;

– neither a building nor large shelter is required next to the mast;

– reduced power consumption for a whole fixed station.

**Mobile Monitoring Stations:**

Mobile monitoring stations have the function to carry out all those monitoring operations where the low power of the transmitters, the high directivity of the antennas and the particular propagation characteristics make it impossible for measurements to be made by fixed stations.

The design of mobile monitoring stations varies considerably according to their purpose, scope and operating conditions. The complexity of the equipment and its proper operation together with the problems of weight and power consumption usually necessitate a specially equipped vehicle capable of rapid movement. In some cases, the mobile unit must carry additional portable equipment for making specialized measurements in locations that are not readily accessible by the vehicle.

The vehicle types of mobile monitoring stations are classified into three types, as described on the following items:

***Type* 1:**

These vehicles are passenger cars (or estate wagons) used to carry passengers, equipment and antennas. The antenna array used for DF and monitoring is mounted in an unobtrusive roof-top carrier mounted directly to the luggage rack on the roof of the car. The monitoring and DF equipment is mounted in the luggage area at the rear of the car, and the operator can be seated anywhere in the passenger area of the car and control the equipment from his laptop. This type of station can operate while in motion or stationery. The measurement results are stored on the hard drive or flash memory of the laptop and can be downloaded to the fixed station database when the car returns to its home station at the end of the measurement session. Alternatively, with a communications connection the data can be transferred directly to the central station. Typically, the monitoring station can be operated locally, but it can also be remotely controlled by the central station.

A printer can also be provided inside the car. Almost any passenger car or estate wagon can be used as a Type 1 vehicle, especially if it is factory equipped with a roof rack. Because they look like ordinary passenger cars and do not attract attention, these types of mobile stations are especially useful when searching for illegal transmitters.

***Type* 2:**

These are heavy duty 4 x 4 utility vehicles to be used on difficult road conditions where neither Type 1 nor Type 3 vehicles can go (desert areas, mountains, etc.). They contain equipment capable of both monitoring and direction finding while in motion or stationery. These vehicles are equipped with a telescopic mast compatible with the difficult road conditions the vehicle is used for and the compactness of the equipment compartment. A typical mast can then extend the antenna used for monitoring and DF up to approximately 6 m above ground level. The operator can be seated anywhere in the passenger area of the vehicle and can control the equipment from a laptop. With the mast down, this type of station can operate while in motion or stationary. During normal operation, the electrical power is provided by the high current alternator mounted on the engine of the vehicle, and environmental control is provided by the on-board vehicle air conditioner and heater. There is generally not enough room for permanently mounting an auxiliary electrical generator inside the vehicle. However, these types of vehicles can be equipped with an external generator mounted on a special purpose platform at the rear of the vehicle. This vehicle type is the standard vehicle for rural and mountain area operations where access would be difficult for passenger cars or large vans.

***Type* 3:**

These are heavy-duty utility vans. They are intended for universal use and are therefore equipped with the same type of monitoring and direction-finding equipment as the Type 2 vehicles, including a mast which can be raised up to approximately 10 m above ground level. An optional mast can be added to raise additional monitoring antennas if needed. When the mast is not raised, the Type 3 vehicles can operate while in motion as a homing station. In addition, the auxiliary generator is built into the vehicle and properly shielded from noise and electromagnetic interference. Type 3 vehicles use alternating current (a.c.) power, either from the on-board generator or from the mains when the vehicle is stationary. This vehicle can easily accommodate one passenger in the front and 2 or 3 operators in the back. This vehicle type is the standard vehicle of the monitoring service, primarily used for investigating interference. It may also accommodate transportable/portable equipment to perform monitoring and direction-finding tasks equipment to be used outside the vehicle to reach an area inaccessible to vehicles.

Other vehicle types, of course, may be used. Examples include trucks, equipped with a shelter that provides space for more monitoring positions.

Figure 04

Examples of mobile monitoring stations



**Transportable Monitoring Stations:**

Transportable monitoring stations combine some of the features and advantages of fixed stations with some of the features and advantages of mobile stations. They can have larger aperture antennas that are generally available to fixed stations and they can offer larger operator work areas than are available in mobile stations, yet they can be redeployed to different locations as needed by the monitoring service.

The equipment for transportable stations is typically installed inside of an equipment shelter. Shelters may be small, allowing space for just equipment that may be remotely controlled, or may be larger, allowing workspace for one or several operators. VHF/UHF antennas for transportable stations may be installed on a transportable mast so they may be elevated several meters above the ground.

Transportable stations may include HF DF capability, using transportable antennas that are deployed on an adjacent field. These antennas allow the transportable system to provide high aperture and therefore highly accurate DF results. The antennas can then be removed when it is desired to move the transportable station.

A transportable station may be placed in a particular location, such as on the ground or on the roof of a building, for an extended period of time, and then may be moved to another location as required by the needs of the monitoring service. Such a station does not need a dedicated vehicle as does a mobile monitoring station; a vehicle or other means of transportation is only needed when it is desired to move the transportable station from one location to another.

Typically, this type of monitoring station can be operated locally but also remote controlled by the central station. Via communication connection the measurement data can be transferred directly to the central station.

**National Frequency Allocation Table (NFAT):**

The NFAT is based on current and expected spectrum requirements in the country for the foreseeable future. It is expected that the NFAT will be used as a source document by importers, manufacturers, and users of radiocommunications equipment as well as by foreign administrations and regional telecommunication organizations. Frequency allocations are not static and will change from time to time as new radio systems are introduced and old ones phased out. Changes in spectrum utilization will also occur at the international level or as a consequence of national decisions made to meet specific national requirements. The NFAT will therefore be reviewed and updated periodically in consultation with its stakeholders. It will also be reviewed and revised immediately after an International Telecommunication Union (ITU) World Radiocommunication Conference (WRC) or subsequent to any regional frequency harmonization initiative. The activities of other United Nations specialized agencies are also relevant, in particular the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Since radio frequencies do not respect national borders, it is also necessary to take account of spectrum usage in neighboring countries.

**Regional Requirements:**

The objective of Asia Pacific Telecommunity (APT) shall be to foster the development of telecommunication services and information infrastructure throughout the region with a particular focus on the expansion thereof in less developed areas.

Among the objectives of APT, the development of regional corporations in areas of common interest, including radio communication and standard development, is an important task for the development of telecommunication sector in the region. In this process, the sharing of information among regional countries is vital requirement for all the countries.

**Notification to AFIS:**

APT Frequency Information System (AFIS) is a web-based portal for sharing frequency information of APT member administrations. AFIS is to illustrate the extent of frequency harmonization within Asia-Pacific region, and it allows user to quickly search and compare spectrum information of a member of APT administration. The purpose of AFIS is to share the information of Spectrum usage of APT members and to allow members and users to compare spectrum usage data of several administrations. AFIS allows APT members to develop and maintain a smart Spectrum Information Management System for the Asia-Pacific region.

AFIS has five main information categories as mentioned below.

* Allocations: ITU Radio Regulations terms
* Applications: Radio communications systems or equipment types to which the bands have been designated. There are three layers of applications list available.
* Radio Interfaces: Requirements for the use of radio equipment. 14 parameters for each Radio Interface.
* Right of use information: In the case of spectrum trade, who is using the band.
* Documents: Any related information.

Information in AFIS belonged to each administration is fully controlled by the respective administration. There are different ways of uploading and maintaining the data submitted to AFIS.

* Manual insertion/update
* Downloading a data file and modifying the file
* Using a software utility to extract data from a national database.
* Database maintenance tool with fully integrated AFIS-XML support and a GUI for easy incorporation of changes.

**Working Methodology of AFIS:**

Each APT member administrations will have individual account for working on AFIS. The administration has to nominate a point of contact. Upon request of the administration, APT secretariat will provide a username and a password to each contact point. After the first login, contact point can change the password and can take complete control of the account. The contact person of an administration will be fully responsible for data upload and editing the frequency information of the particular administration. The APT secretariat will not be able to access the data after the contact point changes the password and APT secretariat will also not be responsible to the data provided in the AFIS.

The data which would be made available in AFIS will be fully secured and can only be altered by the contact point. Data can be inserted directly in AFIS interface or through an XML file in appropriate format. The data files are ready for export/import by the authorized contact points. Once data is inserted in AFIS, it can be reused by administrations for their information system or other purposes.

AFIS is a potential tool that can assist members to become Smart Regulator/ Administrator for managing frequency spectrum. The availability of data in AFIS would eventually help the user of frequency spectrum in respective country. AFIS can also compare data for a series of administrations and it gives the opportunity to members to share their information with other administrations. Eventually, it would help to gain a harmonized approach to use frequency bands for particular applications. Hence, AFIS would contribute to the regional harmonization of usage of frequency spectrum. AFIS would also contribute to the underdeveloped/developing nations for the development of electronic version of their National Table of Frequency Allocation (NTFA) and a comprehensive information system for the work of Frequency Management.

**International Requirements:**

**ITU Notifications (The BR International Frequency Information Circular (BRIFIC) For Space and Terrestrial Services):**

ITU has developed BRIFIC system for the notification of Terrestrial and Satellite services separately.

**Terrestrial Service:**

The Terrestrial Services Department (TSD) of ITU carries out technical and regulatory functions and provides assistance to administrations in the domain of international management of the RF spectrum, as specified in the Radio Regulations and various Regional Agreements, concerning terrestrial services (broadcasting, fixed, maritime mobile, aeronautical mobile, etc.).

It processes notifications of frequency assignments, maintains the Master Register and Plans concerning terrestrial services and publishes their updates at regular intervals.

It applies to various administrative regulations dealing with allocation of international means of identification (call sign series, MIDs) and with safety of life. To this end, it processes submissions for various service documents (List of coast stations, List of ship stations, etc.), publishes their updates and maintains their on-line versions.​

**Submission of Notices for Terrestrial Services:**

Submission of frequency assignment/allotment notices for terrestrial services to the BR for the update of the Master International Frequency Register (MIFR) and/or for the modification of Plans shall be made via the secured web interface WISFAT (Web Interface for Submission of Frequency Assignments/allotments for Terrestrial Services).

As stipulated in [BR Circular-letter CR/297 dated 20 January 2009](https://www.itu.int/md/R00-CR-CIR-0297/en), only notices received via WISFAT, are considered as official submissions.

Access to this interface is restricted to registered notifiers, therefore administrations shall appoint notifier(s) for their administration and inform the BR by sending an official e-mail to “brmail@itu.int” giving the ITU username, name, position and official e-mail address.

Before submitting notices via WISFAT, administrations are strongly recommended to validate their submissions using the [e​Validation​](https://www.itu.int/ITU-R/eTerrestrial/eValidation) tool​. The incomplete notices will be returned to the notifying administration.

In addition, administrations are encouraged when submitting many files on the same day, to compress their files into one single file by using for example WinZip or WinRaR.​​

**Master Register / BR IFIC:**

The BR International Frequency Information Circular (Terrestrial Services) (BR IFIC) is a service document that contains information on the frequency assignments/allotments submitted by Administrations to the Radiocommunication Bureau. It is published in DVD-ROM format, published once every two weeks. The Preface describes the contents and the layout of the BR IFIC.

The BR IFIC (Terrestrial services) contains:

* [t​he Master International Frequency Register (MIFR) (including all the frequencies prescribed for common use)​;](https://www.itu.int/en/ITU-R/terrestrial/brific/BRIFIC/Preface/PREFACE_EN.pdf#page=9)
* [the frequency assignment/allotment Plans for Terrestrial services;](https://www.itu.int/en/ITU-R/terrestrial/brific/BRIFIC/Preface/PREFACE_EN.pdf#page=10)
* notices under treatment in accordance with Article 11 for updating of the Master Register;
* notices under treatment pursuant to regional agreements for updating of the Plans;
* [the Special sections associated with Terrestrial services;](https://www.itu.int/en/ITU-R/terrestrial/brific/BRIFIC/Preface/PREFACE_EN.pdf#page=6)
* the TerRaQ program for querying the published information;
* the TerRaNotices program for the creation and validation of electronic notices;
* the Preface to the BR IFIC

**Maritime databases- Maritime mobile Access and Retrieval System) (MARS):**

The main objective of the ITU MARS (Maritime mobile Access and Retrieval System) webpage is to provide users with the means to access and retrieve operational information registered in the ITU maritime database. This information has been notified to the Radiocommunication Bureau, by Administrations of the Member States of the ITU.

**Global Administration Data System (GLAD):**

GLAD (Global Administration Data System) is an online data retrieval-system and a central repository of ITU-R common information concerning administrations and geographical areas.

GLAD is an online data retrieval-system and a central repository of ITU-R common information concerning administrations and geographical areas as well as means of identification, such as call signs, maritime identification digits and other identificators.

**e Terrestrial:**

eTerrestrial is an online portal for terrestrial services. It contains several tools, which are complementary to the TerRaSys tools provided in the BR IFIC (Terrestrial services). These tools are to facilitate the application of the procedures in the Radio Regulations and regional agreements by providing online access to BR databases and serv​ices.

ITU Members shall cooperate in order to continue the development of the IMS in accordance with [ITU-R Resolution 23-3 (2015)](https://www.itu.int/pub/R-RES-R.23-3-2015) "Extension of the International Monitoring System to a worldwide scale".

**Space Services:**

BR IFIC Space Services is a service publication published every two weeks by the Radiocommunication Bureau in accordance with provision Nos. 20.1-20.6 and No. 20.15 of the Radio Regulations. It contains information on the frequency assignments to space stations, Earth stations or radioastronomy stations submitted by administrations to the Radiocommunication Bureau for recording in the Master International Frequency Register, as well as those that are submitted under the relevant provisions of the Radio Regulations or that are subject to the Appendices 30, 30A and 30B Plans. The information published corresponds to the recorded assignments as well as the notifications still being processed. The SRS database formerly sold separately is now available only in this DVD-ROM. The BR IFIC (Terrestrial Services) DVD is published at the same time. For additional technical support and information: http://www.itu.int/ITU-R/go/space-brific/en.

Each Administration and each paying subscriber has been invited to assign one (1) designated user, per DVD subscription, for free online access. Otherwise, online access is available for separate purchases. See the current Publication Notice for information on annual subscriptions.

**International Monitoring:**

The Telecommunication Standardization Bureau (TSB) of ITU provides access to:

* ​spectrum monitoring information submitted by administrations (Regular Monitoring Programme) ;
* modifications to the latest edition of the List of International monitoring stations (List VIII) ;
* reports of the monitoring programmes in the 405.9-406.2 MHz band.

Article 16 of the Radio Regulations (RR) contains the provisions related to the International Monitoring System (IMS). The IMS comprises monitoring stations and centralizing offices voluntarily designated by administrations.

Provision No. 3.14 of the RR stipulates that: “to ensure compliance with these Regulations, administrations shall arrange for frequent checks to be made of the emissions of stations under their jurisdiction. For this purpose, they shall use the means indicated in Article 16, if required…”.

**CHAPTER 04 – EXPERIENCE IN SATRC COUNTRIES**

**Introduction:**

Under the action plan phase VIII, it was considered that connectivity is an important pillar for achieving the objective of digital transformation of the economy and the society. Spectrum is a key resource for delivering connectivity. Improving the policies, regulations and measures for spectrum are must do activities for SATRC Members. Development of spectrum management infrastructure, procedure and tools plays an important role in this aspect. The objective of this work item is to study and recommend a harmonized action plan for SATRC Members for institutional development of spectrum management infrastructure, procedure and tools.

In order to gather information related to this work item, a questioner was prepared and circulated among the SATRC member countries. The questioner is as follows.

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| A picture containing text, clipart  Description automatically generated | ASIA-PACIFIC TELECOMMUNITY | Document No: |
| **The Meeting of the SATRC Working Group on Spectrum** | **SAPVIII-SPEC1/ OUT-05** |
| 21 – 23 June 2022, New Delhi, India | 28 June 2022 |

Working Group on Spectrum

**QUESTIONNAIRE ON WORK ITEM**

**DEVELOPMENT OF SPECTRUM MANAGEMENT INFRASTRUCTURE, PROCEDURE AND TOOLS**

**Question 1:**

Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.

**Question 2:**

What are the fundamental principles on which the Spectrum Management Policy is made?

**Question 3:**

What is your Spectrum Assignment Procedure?

**Question 4:**

How often you update the Spectrum Assignment Procedure to meet the present/future requirement?

**Question 5:**

What are the infrastructures used for the Spectrum Management activities?

5.1: Details of Hardware Infrastructure

5.2: Details of Software Tools

**Question 6:**

Is your spectrum management infrastructure system partially/fully automated? What are the main functions?

**Question 7:**

Details of Spectrum Management Infrastructure System

7.1: When did you purchase/develop the Spectrum Management Infrastructure System?

7.2: How often do you upgrade the system?

7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?

7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?

7.5: What are the drawbacks in the Spectrum Management Infrastructure System?

**Question 8:**

How did you facilitate funds for the initial cost and maintenance cost?

**Question 9:**

Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?

**Spectrum Assignment Policies and Procedures in SATRC Countries:**

In the process of spectrum assignments in SATRC countries, it was noticed that some countries have a specific spectrum assignment policy, whereas in some countries, policies are under consideration and others do not have such specific policy.

The following table summarizes the details of spectrum assignment policies in SATRC counties.

|  |
| --- |
| **Spectrum Management Policies and Procedures in SATRC Countries:** |
| Afghanistan | In Afghanistan, they have a spectrum assignment policy, but they are working on the existence policies to update to fulfill the future requirements. The Afghanistan Telecom Regulatory Authority (ATRA) was made the Radio Frequency Policy on the base of ITU Recommendations, NFAT, Afghanistan Spectrum Regulations, Telecom Laws and Principles to provide followings.1. Equal access to radio communication services;
2. Harmonized utilization of radio spectrum and efficient use;
3. Extension of radio services to rural arears;
4. Radio Spectrum for future technologies.

ATRA has been using two types of spectrum assignment approaches.1. Administrative procedure
2. Market based approach (Auction)

ATRA plans to update the spectrum assignment procedure according to new technologies and consider the economic aspects of spectrum in future. |
| Bangladesh | In Bangladesh, the Bangladesh Telecommunication Regulatory Commission (BTRC) has National Frequency Allocation Plan (NFAP), where the guidelines for spectrum assignment is included.There is no specific spectrum management policy in Bangladesh, but they have National Frequency Allocation Table which has been prepared in consultation with international, regional organizations and relevant stake holders (ie. ITU, APT and SATRC). Spectrum assignment guideline/instruction has been framed considering the following basic principles:1. Efficient utilization of spectrum;
2. Quality of service;
3. Scope of revenue;
4. Utility of all users;
5. Network cost;
6. Social welfare.

BTRC assigns spectrum for IMT through competitive auctions as well as administrative process. For other services, the requests for spectrum are placed before the Spectrum Management Committee (SMC) for recommendations. The Commission approves the spectrum assignments based on the recommendations of the SMC. Their spectrum assignment procedure is updated as and when necessary. |
| Bhutan | In Bhutan, the Bhutan Information Communication and Media Authority (BICMA) does not have specific spectrum policy, but they have Information Communication and Media Act 2018 which covers the whole process of ICT and communication related developments and policies. BICMA also has the National Radio Rules and Regulations 2021 (NRRR 2021) and the National Frequency Allocation Plan 2021 which governs the whole process of spectrum assignment, management, and monitoring.BICMA assigns spectrum through administrative process. Two telecom operators are assigned the required spectrum equally based on their proposals and needs. NRRR 2021 allows the auction, but they have never assigned spectrum based on the auction methodology. The spectrum assignment procedure will be revised based on the requirements (approximately once in 2 to 4 years) |
| India | In India, the National Frequency Allocation Plan (NFAP) is the policy document for Spectrum Allocation. NFAP was prepared based on Radio Regulation of ITU-R and national priorities and it was further modified in consultation with stakeholders.India assigns spectrum through administrative process as well as through auctions and their spectrum assignment procedure is reviewed and revised depending on the need. |
| Iran | In Iran, the law of wireless communications as the main principles was approved in 1966 in the Islamic parliament. Then, in 1977, its executive regulations were approved. This law has been enforced in the country until now and all the regulations related to radio communications are approved under the mentioned law.The most important principles in the law are:* Licensing and authorizations,
* Spectrum user rights,
* Supervision,
* Determining radio network parameters,
* Revenues and fees,
* Technical standards.

Under spectrum assignment procedure, the Communication Regulatory Authority of Iran (CRA) issues licenses according to table of national frequency allocations and Spectrum Planning in each radio communication services, as well as national regulations, where license holders must use standard equipment. After the license is issued, the license holders are periodically visited to comply with the license parameters as follows:* To ensure spectrum utilization consistency with conditions of granted radio licensees;
* To discover and to stop illegal and unlawful operation of radio communication stations;
* To resolve national and international interference complains;
* To investigate and proof qualification of licensees as well as given license;
* To conduct spectrum monitoring missions requested by different divisions of spectrum management authority;
* To measure spectrum occupancy, noise floor, propagation parameters and any other requested activities related to the physical activities in field;
* To confiscate and enforce radio equipment in operation without having an approved standard or a certificate.

According to the market conditions and market needs that are continuously monitored, and based on the resulting changes, the Spectrum Assignment Procedure may change. |
| Nepal | The Nepal Telecommunication Authority (NTA) has Telecommunication Service’s Radio Spectrum (Distribution and Price) Policy, 2069, as well as the first amended version, 2073. (<https://nta.gov.np/en/spectrum>) The fundamental principles of spectrum policy include but not limited to technology neutrality, spectrum auctions, prohibition on sharing/ Trading/ Leasing of spectrum, secure and efficient spectrum usage, spectrum refarming, adoption of best practices in spectrum management, and spectrum capping.The NTA assigns spectrum through administrative processes in response to licensees’ demand and the cellular spectrum is assigned through auction methodology as well. The spectrum assignment policy is amended typically every three to four years. |
| Pakistan | In Pakistan, the statutory mandate of spectrum management is assigned to the Frequency Allocation Board (FAB) through Pakistan Telecommunication (Re-organization) Act, 1996 (as amended in 2006). In accordance with the ibid Act, the Federal Government approved De-Regulation policy for the Telecommunication Sector 2003, and Mobile Cellular Policy 2004. With these two, the government approved policies provided basic guiding principles and frameworks to FAB for efficient spectrum management. Afterwards, through promulgation of Telecom Policy 2015, spectrum management principles were suitably addressed therein. Based on the said principles enumerated in Telecom Policy 2015, Pakistan Rolling Spectrum Strategy was published in 2020.Allocation and assignment of spectrum to maximize social and economic benefits derived from the use of this scarce resource. Recognizing that spectrum is a valuable public resource belonging to the State and must be used in public interest, the overriding spectrum policy goals in Pakistan are to:* Use spectrum in an efficient and flexible manner;
* Maximize social and economic benefits;
* Promote stability and transparency;
* Support the emergence of future telecommunications services.

The procedure for spectrum assignment has been clearly listed in Pakistan Telecommunication (Re-organization) Act, 1996 (as amended in 2006). Application for spectrum assignment has to be submitted to the Pakistan Telecommunication Authority (PTA). The PTA refers to the said application to the FAB. Afterwards, FAB makes assignment to the user in accordance with Pakistan Table of Frequency Allocations through clearance from its members. Accordingly, the license(s) are issued by the PTA.Spectrum assignment procedures are regularly reviewed and updated by the FAB in order to properly manage present/ future spectrum demands of spectrum users/ licensees. |
| Sri Lanka | In Sri Lanka, a proper frequency management policy is being prepared and is planned to published in near future. Presently, spectrum management is done accordance with the Sri Lanka Telecommunications Act No. 25 of 1991 as amended Act No. 27 of 1996.The spectrum management policy addresses the following.* Allocate Spectrum to highest value use or users
* Enable and Encourage Spectrum to move to its highest value use
* Use the lease cost and lease restrictive approach to achieving Policy Objectives
* Promote both Certainty and Flexibility
* Managing interferences by looking for a larger Spectrum utilization efficiently and effectively
* Spectrum Allocation and Assignment process is in transparent manner.

In Sri Lanka, the spectrum assignment procedure addresses the followings.* Process of assigning frequencies is open, transparent and non -discriminatory for all users;
* Issue frequency assignments in a timely manner and in accordance with published assignment criteria, in support of the overall licensing process;
* Frequency assignments will be made for all users is in accordance with the National Frequency Allocation Table (NFAT);
* Simple administrative processes is employed for the assignment of frequencies where demand for use of spectrum does not exceed supply. The frequencies will be assigned to the users on a first-come first-served basis;
* Scarce and highly valued spectrum where demand exceeds supply will be assigned to the users through market-based spectrum management techniques such as auctions or competitive bidding or spectrum trading.
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**Spectrum Management Infrastructure and Tools in SATRC Countries:**

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| **Spectrum Management Infrastructure and Tools in SATRC Countries:** |
| Afghanistan | The ATRA uses the SMS4DC spectrum management tool developed by ITU for their spectrum management activities with desktop application database. They purchased SMS4DC in 2014 with an initial cost of USD 2,500 which amount was provided by ITU.The ATRA mentioned that SMS4DC is complex, not user friendly, not automated infrastructure, very heavy to load, and very difficult to enter the spectrum management data. They also mentioned that they are not even using it.ATRA has its own budget, financial and procurement department for purchasing and maintenance of spectrum management infrastructure and tools. They do not have skill and dedicated staff to run and operate the spectrum management system. |
| Bangladesh | In Bangladesh, the infrastructure used for the Spectrum Management activities includes Automated Spectrum Management System (ASMS) and Spectrum Monitoring System. Spectrum Monitoring System includes Fixed Monitoring Stations (FMS), Mobile Monitoring Stations (MMS), Portable Monitoring Station and Handheld Monitoring Stations.07 Fixed Monitoring Stations (FMS), 05 Mobile Monitoring Stations (MMS), 01 Portable Monitoring Station and 12 Handheld Monitoring Stations are used in the Monitoring System. Among the Fixed Monitoring Stations (FMS), the central station is located in the capital city and the other stations are located in different major cities across the country.ASMS, Scorpio and RAMDA software are being used for spectrum monitoring activities.Spectrum Management Infrastructure system in Bangladesh is partially automated. Main functions are as follows:* planning of unused spectrum;
* monitor & detect unauthorized usage of spectrum;
* identify sources of harmful interference;
* monitor spectrum occupancy, etc.

The first Spectrum Management Infrastructure System was procured in 2009. Later the system was upgraded, and a newer system was incorporated.The challenges that they have faced during the implementation/maintenance of the Spectrum Management Infrastructure System are as follows:* Lack of adequate qualified staffs.
* ASMS, being an off-the-shelf product, does not fully fulfill their requirement.
* Spectrum monitoring equipment are costly in nature. Hence limited number of monitoring stations were established throughout the country considering the budget constraint issue.
* Technologies evolve very swiftly. Keeping pace with this advancement and upgrading the system becomes a challenge sometimes due to budget constraint.

BTRC has purchased 04 different types of equipment from 03 different vendors. Initial investment cost varied from 800,000 USD to 4,000,000 USD approximately depending on the system. Whereas annual maintenance cost varied from 150,000 to 200,000 USD approximately depending on the system. These costs are facilitated by the revenue budget.The staff engaged in spectrum monitoring activities are reasonably expert. However, there is a lot of room for improvement. |
| Bhutan | In Bhutan, they have a Spectrum Analyzer and one fixed monitoring station for monitoring activities, and theymaintain the spectrum assignment details in manual excel sheets at the moment since they do not have the automated spectrum management software tools. They are planning to make it fully automated in future. |
| India | In India, the National Spectrum Monitoring System consisting of 21 Nos. of Fixed-cum- mobile H/V/UHF monitoring units covering the frequency band 9 kHz – 3000 MHz and Fixed H/V/UHF monitoring facilities at four International Monitoring Stations at Delhi, Mumbai, Kolkata & Chennai.Automated Spectrum Management Software was provided by LS Telecom. The Spectrum Management Infrastructure is presently partially automated. There is no interconnectivity between the Monitoring and the software part.The National Radio Spectrum Management and Monitoring System (NRSMMS) was procured in 2002. All the components of the project were commissioned in 2008. The main drawback in NRSMMS was that all the equipment and software was proprietary and could not be tailored to their requirements and the maintenance contract was not satisfactory.The project was funded partially by the World Bank under the Telecommunication Sector Reform Project and partially funded by Government of India.During the initial commencement of the project, training was provided to staﬀ. There are adequately qualiﬁed staﬀ for the operation of the Spectrum Management Infrastructure. |
| Iran | In Iran, since spectrum management has different dimensions. Necessary infrastructures have been prepared for each dimension, which includes the following:* Holding continuous meetings with the ICT department,
* Conversation portal;
* ITU models propagation;
* Table of national frequency allocations;
* A large number of radio monitoring equipment have been installed in the country, which are checking the spectrum situation;
* Software such as: Web Base services, SMS4DC, MATLAB, [Visual Studio](https://www.bing.com/ck/a?!&&p=28ccbbddd40ff36fJmltdHM9MTY2MzYzMjAwMCZpZ3VpZD0zOWIyYWEyYy0zNzc2LTZhYTEtMDNhOS1hNTZmMzY3ZjZiOGEmaW5zaWQ9NTE2Nw&ptn=3&hsh=3&fclid=39b2aa2c-3776-6aa1-03a9-a56f367f6b8a&u=a1aHR0cHM6Ly92aXN1YWxzdHVkaW8ubWljcm9zb2Z0LmNvbS92cy8&ntb=1) and etc.

Spectrum management infrastructure is partially automated, in fact every infrastructure section as standalone is automated and result information is shared between other sections manually.Since 2001, CRA has been updating these systems every year if needed.Some of challenges what have faced usually are: * Funding relative cost,
* Specialized human for operation the infrastructures,
* Approach of Maintenance (repairs),

Cost of spectrum management and monitoring infrastructure and tools depends on what infrastructures are targeted. However, this cost is between 5 to 10 million dollars (USD). As for maintenance cost, it is almost 1 million USD per year. This cost is estimated annually in the national budget.The CRA is holding training and workshops throughout the year for the employees continually, so that their information and expertise is update. |
| Nepal | In Nepal, Fixed Stations, Mobile Monitoring Stations, Spectrum Analyzers, Spectrum Monitoring Receivers, EMR Tool, and Mobile Benchmarking Tool are used spectrum monitoring and measurements.SMS4DC (Spectrum Management System for Developing Countries), NTA’s Frequency Management Module of Office Automation System, NTA’s GIS based Telecommunications Infrastructure MIS, NTA’s Frequency Module of Online Tracking and Monitoring System (OMTS), and APT Frequency Information System software are used for spectrum management and monitoring activities. These systems were gradually purchased since 2007. The main challenges of these systems are as follows:* Timely update of the systems,
* integration of different systems,
* human resources.
* tool does not support all frequency bands and are not up to date.

The expenses for spectrum management and monitoring are covered by the Authority and the Ministry. |
| Pakistan | The FAB is using the spectrum monitoring system of Rhode & Schwartz (R&S) and spectrum management system of LS Telecom.Spectrum management infrastructure is partially automated. Currently, a project is being carried out to fully automate the process of spectrum management and monitoring. The spectrum management infrastructure was initially procured in early 2000. Some parts of the spectrum management infrastructure are upgraded from time to time depending upon the advancement in technology.Earlier, there were very few known spectrum management system developers across the globe. Similarly, the interfaces were also propriety. Therefore, there were issues of interoperability and very high associated prices for the system. However, now slowly and gradually more and more developers are developing spectrum management tools and the interfaces are also being standardized.The total cost of the initial project was approximately 25 million USD. The maintenance cost of the system varies from time to time depending upon the utilization or tasks.Reliable and good spectrum management infrastructure system is very costly, and affordability is the main drawback/issue for the developing or least developing countries.In Pakistan, the spectrum management infrastructure is funded through collection of Annual Spectrum Administration Fees (ASAF) by PTA from spectrum users. |
| **Sri Lanka:** | In year 2000, TRCSL purchased Frequency Management and Monitoring System (FMMS) from LS Telcom and Rhode & Swartz, Germany respectively with a total cost of USD 5 Million.This system consists of a fully automated spectrum management system with several software tools and fully automated spectrum monitoring system with “Argus” software tools.In 2015, TRCSL purchased monitoring equipment and Mobile Surveillance Vehicle for GEW, South Africa.The hardware in spectrum management system are Servers, Client Computers, Switches, Modems, and Firewalls and in monitoring system are Monitoring Receivers, Direction Finders, Monitoring and Direction-Finding antennas, and Mobile Surveillance VehiclesSoftware used in Spectrum Management System are as follows:* SpectraPlus – For Invoicing and licensing
* ChirPlus\_BC- For Broadcasting
* ChirPlus\_FX- For Fixed link
* Monitor\_Plus- For Analyzing

Software used for Spectrum Monitoring are as follows:* Argus – For Monitoring and Analyzing
* SkyMon- For Monitoring

The main functions of FMMS are;* Issuing Invoices for frequency licenses
* Generating frequency licenses
* Generating renewal notices
* Simulation of Broadcasting systems
* Simulation of Fixed Links
* Analyzing technical details of transmitters
* Spectrum Monitoring
* Report generation

Spectrum Management System is upgrading continuously with maintenance agreement with the supplier.The following challenges were faced when they implement/maintain the Spectrum Management Infrastructure System.* High initial cost in terms of foreign currency
* High repair and maintenance cost
* No facilities within the country for necessary repair and therefore repairs take conservable time.
* Lack of skilled staff
* Lack of spare parts

The funds for purchasing and maintenance were provided by the assistance from the World Bank and TRCSL’s owned funds.The lack of experience and adequate staff is the major issue for the effective utilization of infrastructure. |

**CHAPTER 05 – PROPOSALS AND RECOMMENDATIONS**

1. For effective and efficient utilization of radio frequency spectrum, it is important to establish the spectrum management units according to the volume of work to be performed in the following areas.
	1. Documents to be issued/updated/amended (Legislative, Policy, Recommendations, Reports, Certificates etc.)
	2. Licenses to be issued annually.
	3. Frequency assignments to be made annually.
	4. Services offered to the general public.
	5. Radio frequency applications depending on the location and the territory of the country (Maritime, Satellite).

The size of the spectrum management unit may fall under small or medium or large as described in Chapter 01 of this report.

1. For spectrum management activities, a suitable spectrum management tool should be used by the telecom regulators of member countries, especially those who have spectrum management units that fall under medium and large categories depending on their budgetary capabilities. Use of fully automated spectrum management systems are recommended for easiness and accuracy.
2. For spectrum monitoring activities, the monitoring equipment should be used depending on the requirement of the country. That equipment may be portable, mobile, transportable or fixed. The use of an automated spectrum monitoring system is necessary to achieve the best outcome through efficient and effective monitoring by identifying the real use of radio spectrum, mitigating interferences, and identifying illegal transmissions.
3. SATRC members are encouraged to enter the frequency information to AFIS and MIFR as early as possible and to use frequency information in AFIS for the regional harmonization of spectrum and for border coordination activities. SATRC members are able to receive necessary training on the AFIS system provided by APT.
4. SATRC members should make the arrangement to notify frequency assignments and transmitter details to the BRIFIC system of ITU. This will help for international harmonization of spectrum use and for the ITU intervention to the interference resolution with neighboring countries.
5. Arranging training programs for the staff in order to build the human resource within the organization. It is very important and essential to face the regulatory challenges with the introduction of new technologies. These training programs are in the range of organizational, national and international levels.
6. Timely formulation of policies, recommendations and rules is needed for maintaining proper regulatory framework including spectrum management processes and spectrum monitoring activities.
7. It is recommended to use common infrastructure and tools by SATRC countries for spectrum management and spectrum monitoring in order to purchase with affordable price and it is very important to share the experience among the member countries.

**REFERENCES**

1. [www.communication.iresearchnet.com](http://www.communication.iresearchnet.com)
2. ITU-R Handbook on National Spectrum Management **Edition of 2015**
3. Requirements for Spectrum Monitoring in Industrial Environments, Murat Aksu and Richard Candell Intelligent Systems Division Engineering Laboratory, November 2017
4. ITU-D Assignment and use of radio spectrum – POLICY GUIDELINES AND ECONOMICS ASSPECTS
5. ITU-R Handbook on Spectrum Monitoring Edition of 2011.
6. Report ITU-R SM.2093-2 (06/2015) – Guidance on the Regulatory Framework for National Spectrum Management
7. ITU Publication on ICT Infrastructure Business Planning Toolkit 2019
8. ITU Handbook on Computer – Aided Techniques for spectrum Management (CAT), Edition 2015
9. ITU-R Recommendation SM.1370-2 (08/2013) – Design Guidelines for Developing Automated Spectrum Management System
10. ITU-R Recommendation SM.1537-1 (08/2013) – Automation and Integration of Spectrum Monitoring System with Automated Spectrum Management.
11. ITU-R Report SM.2257-3 (06/2015) – Spectrum Management and Monitoring During Major Events

**Annex 01**

**Responses for the Questionnaire by Member Countries:**

**AFGHANISTAN:**

**Question 1:**

**Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.**

***Ans: Yes. We have spectrum management policy but we are working on the existence policies to update to fulfill the future requirements.***

**Question 2:**

**What are the fundamental principles on which the Spectrum Management Policy is made?**

***Ans: ATRA is making the Radio frequencies policy on the base of ITU Recommendations, Afghanistan Spectrum Regulations, Telecom law and Principles.***

***a: To provide equal access to Radio communication services.***

***b: Harmonized utilization of Radio spectrum and efficient use.***

***c: To extend the Radio communication services to the rural areas.***

***d: to provide spectrum for the future technologies.***

***e: To ensure the interference free radio communication services.***

**Question 3:**

**What is your Spectrum Assignment Procedure?**

***Ans: ATRA is using two types of spectrum assignment Approaches:***

***1: Administrative procedure for spectrum assignment.***

***2: Market based approach (Auction)***

**Question 4:**

**How often you update the Spectrum Assignment Procedure to meet the present/future requirement?**

***We have plan to update the spectrum assignment procedure according to the new technologies and consider the economic aspect of spectrum in the future and this will take time to complete.***

**Question 5:**

**What are the infrastructures used for the Spectrum Management activities?**

**5.1: Details of Hardware Infrastructure? *(Computer).***

**5.2: Details of Software Tools*? (SMS4DC Software and Desktop Application Database).***

**Question 6:**

**Is your spectrum management infrastructure system partially/fully automated? What are the main functions?**

***Ans: Our spectrum management infrastructure is manual and we don’t have automated spectrum management system.***

**Question 7:**

**Details of Spectrum Management Infrastructure System**

**7.1: When did you purchase/develop the Spectrum Management Infrastructure System?**

***Ans: In 2014.***

**7.2: How often do you upgrade the system?**

***Ans: Still we have the old system but we have plan to purchase new automated infrastructure for spectrum management.***

**7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?**

***Ans: No professional training and capacity building program which results to unprofessional and low capacity team*.**

**7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?**

***Ans: SMS4DC initial cost was 2500 Dollars which was provide by ITU*.**

**7.5: What are the drawbacks in the Spectrum Management Infrastructure System?**

***Ans: SMS4DC is complex and not user friendly and also not automated infrastructure and also very heavy to load and very difficult to enter the spectrum management data. To be mentioned, we are not even using it.***

**Question 8:**

**How did you facilitate funds for the initial cost and maintenance cost?**

***Ans: ATRA has its own budgen, financial and procurement department for purchasing and maintenance of spectrum management infrastructure.***

**Question 9:**

**Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?**

***Ans: No, staff is available but not able to run and operate the system*.**

**BANGLADESH:**

***Question 1:***

*Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.*

**Ans:** We have national frequency allocation plan (NFAP), where the guideline for spectrum assignation spectrum is described.

***Question 2:***

*What are the fundamental principles on which the Spectrum Management Policy is made?*

**Ans:** There is no Spectrum Management Policy in Bangladesh. However Bangladesh has a National frequency Allocation Table. The table has been prepared in consultation with international, regional organizations and relevant stack holder (ie. ITU, APT & SATRC). Spectrum assignment guideline/instruction has been framed considering the following basic principles:

1. efficient utilization of spectrum;
2. QoS’
3. Scope of revenue;
4. utility of all users;
5. network cost; and
6. social welfare.

***Question 3:***

*What is your Spectrum Assignment Procedure?*

**Ans:** For IMT, spectrum is assigned through competitive auction as well as administrative process.

For other services, the request for spectrum assignment is place before the Spectrum Management Committee (SMC) for recommendation. The Commission approves the spectrum assignment based on the recommendation of the SMC.

For unlicensed bands, spectrum is assigned through administrative process.

***Question 4:***

*How often you update the Spectrum Assignment Procedure to meet the present/future requirement?*

**Ans:** Spectrum assignment procedure is updated as and when necessary.

***Question 5:***

*What are the infrastructures used for the Spectrum Management activities?*

**Ans**: The infrastructure used for the Spectrum Management activities includes Automated Spectrum Management System (ASMS) and Spectrum Monitoring System. Spectrum Monitoring System includes Fixed Monitoring Stations (FMS), Mobile Monitoring Stations (MMS), Portable Monitoring Station and Handheld Monitoring Stations.

***5.1: Details of Hardware Infrastructure***

**Ans**: There are 07 Fixed Monitoring Stations (FMS), 05 Mobile Monitoring Stations (MMS), 01 Portable Monitoring Station and 12 Handheld Monitoring Stations. Among the Fixed Monitoring Stations (FMS), the central station is located in the capital city and the other stations are located in different major cities across the country.

***5.2: Details of Software Tools***

**Ans**: ASMS, Scorpio and RAMDA software are being used for spectrum monitoring activities.

***Question 6:***

*Is your spectrum management infrastructure system partially/fully automated? What are the main functions?*

**Ans:** Spectrum Management Infrastructure system in Bangladesh is partially automated. Main functions are as follows:

1. planning of unused spectrum;
2. monitor & detect unauthorized usage of spectrum;
3. identify sources of harmful interference;
4. monitor spectrum occupancy, etc.

***Question 7:***

*Details of Spectrum Management Infrastructure System*

***7.1: When did you purchase/develop the Spectrum Management Infrastructure System?***

**Ans**: The first Spectrum Management Infrastructure System was procured in 2009. Later the system has been upgraded and newer system has been incorporated.

***7.2: How often do you upgrade the system?***

**Ans**: It is upgraded as and when necessary.

***7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?***

**Ans**: The challenges that we have faced during the implementation/maintenance of the Spectrum Management Infrastructure System are as follows:

1. Lack of adequate qualified staffs.
2. ASMS, being an off-the-shelf product, does not fully fulfill our requirement.
3. Spectrum monitoring equipment are costly in nature. Hence limited number of monitoring stations were established throughout the country considering the budget constraint issue.
4. Technologies evolve very swiftly. Keeping pace with this advancement and upgrading the system becomes a challenge sometimes due to budget constraint.

***7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?***

**Ans**: There are 04 different types of equipment from 03 different vendors. Initial investment cost varied from 8,00,000 USD to 4,000,000 USD approximately depending on the system. Whereas, annual maintenance cost varied from 150,000 to 200,000 USD approximately depending on the system.

***7.5: What are the drawbacks in the Spectrum Management Infrastructure System?***

**Ans:** The following are the drawbacks:

1. Lack of adequate qualified staffs.
2. ASMS, being an off-the-shelf product, does not fully fulfill our requirement.
3. Existing system needs to be upgraded.

***Question 8:***

*How did you facilitate funds for the initial cost and maintenance cost?*

**Ans:** Revenue Budget.

***Question 9:***

*Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?*

**Ans:** Some people engaged in spectrum monitoring activities are reasonably expert. However, there are lot of rooms for improvement.

**BHUTAN:**

**Question 1:**

Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.

*Ans= As such we don't have specific spectrum policy in our country, but we do have Information Communications and Media Act 2018 which covers the whole process of ICT and communication related development and policies. And also we do have National Radio Rules and Regulations 2021( NRRR 2021) and National Radio Frequency Allocation Plan 2021 which governs the whole process of spectrum assignment, management and monitoring.*

**Question 2:**

What is your Spectrum Management Assignment Procedure?

*Ans= In our country Spectrum assignment is done through an administrative process, two operators are assigned the required spectrum equally based on their proposal and needs. The NRRR 2021 also allows the auction but we have never assigned spectrum based on the auction methodology until now.*

**Question 3:**

What is the basis on which the Spectrum Management Policy was developed?

*Ans= We don’t have Policy as such. But our National Radio Rules and Regulation and National Frequency Allocation Plans which governs the spectrum management process is based on the Information Communications and Media Act 2018.*

**Question 4:**

How often do you update the Spectrum Management Assignment Procedure to meet the

present/future requirement?

*Ans= We revised the Assignment procedures based on the requirement (approximately once in 2 to 4 years).*

**Question 5:**

What are the infrastructures used for the Spectrum Management activities?

5.1: Details of Hardware Infrastructure

*Ans= For monitoring, we have a Spectrum Analyser and one fixed monitoring station*.

5.2: Details of Software Tools

*Ans= We maintain the spectrum assignment details in manual excel sheets at the moment since we do not have the automated spectrum management software tools.*

**Question 6:**

Is your spectrum management infrastructure system fully automated? What are the main

functions?

*Ans= No. We are planning to make it fully automated in future*.

**Question 7:**

Details of Spectrum Management Infrastructure System

7.1: When did you purchase/develop the Spectrum Management Infrastructure System?

*Ans= Since we don't have a concrete Spectrum Management Infrastructure System at present. We do not have the management software tools.*

7.2: How often do you upgrade the system?

*Ans= No system as such.*

7.3: What are the challenges you have faced when you implement/maintain the Spectrum

Management Infrastructure System?

*Ans= NA*

7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average

maintenance cost per year?

*Ans= No spectrum management Infrastructure system.*

7.5: What are the drawbacks in the Spectrum Management Infrastructure System?

*Ans= NA*

**Question 8:**

How did you facilitate funds for the initial cost and maintenance cost?

*Ans= NA*

**Question 9:**

Do you have expertise and adequate qualified staff for the operation of the Spectrum

Management Infrastructure System?

*Ans= NA since we do not have the automated Spectrum Management Infrastructure System. We are planning to develop and accordingly the staff will be trained.*

**INDIA:**

**Question 1:** Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.

**Response:** The National Frequency Allocation Plan is a policy document for Spectrum Allocation in India

# Question 2: What are the fundamental principles on which the Spectrum Management Policy is made?

**Response:** Radio Regulations of ITU-R and national priorities are fundamental principles for National Frequency Allocation Plan. NFAP is further modified in consultation with stakeholders.

# **Question 3:** What is your Spectrum Assignment Procedure?

# Response: Through administrative assignment as well as auction

# **Question 4:** How often you update the Spectrum Assignment Procedure to meet the present/future requirement?

**Response:** Whenever a need is felt the Spectrum Assignment Procedures are reviewed and revised.

# Question 5: What are the infrastructures used for the Spectrum Management activities?

* 1. : **Details of Hardware Infrastructure**:

**Response:** National Spectrum Monitoring System consisting of 21 Nos. of Fixed-cum- mobile H/V/UHF monitoring units covering the frequency band 9 KHz – 3000 MHz and Fixed H/V/UHF monitoring facilities at four International Monitoring Stations at Delhi, Mumbai, Kolkata & Chennai.

* 1. : **Details of Software Tools**

**Response:** Automated Spectrum Management Software by LS Telecom

**Question 6:** Is your spectrum management infrastructure system partially/fully automated? What are the main functions?

**Response:** The Spectrum Management Infrastructure is presently partially automated. There is no interconnectivity between the Monitoring and the software part.

# Question 7: Details of Spectrum Management Infrastructure System

* 1. : When did you purchase/develop the Spectrum Management Infrastructure System?

**Response:** The National Radio Spectrum Management and Monitoring System was procured in 2002. All the components of the project were commissioned by 2008.

* 1. : How often do you upgrade the system?

**Response:** The system was not upgraded since then.

* 1. : What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?

**Response:** The Annual Maintenance and regular updates are not according to the latest ITU developments.

* 1. : What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?

**Response:** Total Contract Value for NRSMMS (excluding maintenance cost) was around INR 171.3 crores and Maintenance for 5 years was around INR 29 crores.

* 1. : What are the drawbacks in the Spectrum Management Infrastructure System?

**Response:** The main drawback was that all the equipment and software was proprietary and could not be tailored to our requirements. The Maintenance contract was not satisfactory.

# Question 8: How did you facilitate funds for the initial cost and maintenance cost?

**Response:** The project was funded partially by the World Bank under the Telecommunication Sector Reform Project and partially funded by Government of India.

# Question 9: Do you have expertise and adequate qualiﬁed staﬀ for the operation of the Spectrum Management Infrastructure System?

**Response:** During the initial commencement of the project training was provided to the staﬀ. There is adequate qualiﬁed staﬀ for the operation of the Spectrum Management Infrastructure.

**IRAN:**

**Question 1:**

Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.

**Answer:**

Yes, in our country, the law of using wireless communications as the main principles was approved in 1966 in the Islamic parliament. Then, in 1977, its executive regulations were approved.

This law has been enforced in the country until now and all the regulations relative radio communications approved in this regulatory are approved under the mentioned law.

**Question 2:**

What are the fundamental principles on which the Spectrum Management Policy is made?

**Answer:**

The most important principle in the law mention in answer Q.1 is:

* Licensing and authorizations,
* Spectrum user rights,
* Supervision,
* Determining radio network parameters,
* Revenues and fees,
* Technical standards.

**Question 3:**

What is your Spectrum Assignment Procedure?

**Answer:**

We issue licenses according to table of national frequency allocations and Spectrum Planning in each radio communication services, as well as national regulations, where license holders must use standard equipment. After the license is issued, the license holders are periodically visited to comply with the license parameters as follows:

* To ensure spectrum utilization consistency with conditions of granted radio licensees;
* To discover and to stop illegal and unlawful operation of radio communication stations;
* To resolve national and international interference complains;
* To investigate and proof qualification of licensees as well as given license;
* To conduct spectrum monitoring missions requested by different divisions of spectrum management authority;
* To measure spectrum occupancy, noise floor, propagation parameters and any other requested activities related to the physical activities in field;
* To confiscate and enforce radio equipment in operation without having an approved standard or a certificate.

**Question 4:**

How often you update the Spectrum Assignment Procedure to meet the present/future requirement?

**Answer:**

According to the market conditions and market needs that are continuously monitored, and based on the resulting changes, the Spectrum Assignment Procedure may change.

**Question 5:**

What are the infrastructures used for the Spectrum Management activities?

5.1: Details of Hardware Infrastructure

5.2: Details of Software Tools

**Answer:**

Since spectrum management has different dimensions, necessary infrastructures have been prepared for each dimension, which includes the following:

* Holding continuous meetings with the ICT department,
* Conversation portal;
* ITU models propagation;
* Table of national frequency allocations;
* A large number of radio monitoring equipment have been installed in the country, which are checking the spectrum situation;
* Software such as: Web Base services, SMS4DC, MATLAB, [Visual Studio](https://www.bing.com/ck/a?!&&p=28ccbbddd40ff36fJmltdHM9MTY2MzYzMjAwMCZpZ3VpZD0zOWIyYWEyYy0zNzc2LTZhYTEtMDNhOS1hNTZmMzY3ZjZiOGEmaW5zaWQ9NTE2Nw&ptn=3&hsh=3&fclid=39b2aa2c-3776-6aa1-03a9-a56f367f6b8a&u=a1aHR0cHM6Ly92aXN1YWxzdHVkaW8ubWljcm9zb2Z0LmNvbS92cy8&ntb=1) and etc.

**Question 6:**

Is your spectrum management infrastructure system partially/fully automated? What are the main functions?

**Answer:**

Spectrum management infrastructure is partially automated, in fact every infrastructure section as standalone is automated and result information is shared between other sections manually.

**Question 7:**

Details of Spectrum Management Infrastructure System

7.1: When did you purchase/develop the Spectrum Management Infrastructure System?

**Answer**:

 Since 2001, we have been updating these systems every year if needed.

7.2: How often do you upgrade the system?

**Answer**:

It depends on the market conditions and the emergence of new technologies.

7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?

**Answer:**

Some of challenges what have faced usually are:

* Funding relative cost,
* Specialized human for operation the infrastructures,
* Approach of Maintenance (repairs),
* Etc.

7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?

**Answer:**

It depends on what infrastructures are targeted. However, this cost is between 5 to 10 million dollars USD. About maintenance cost, it is almost 1 million dollars USD per year

7.5: What are the drawbacks in the Spectrum Management Infrastructure System?

**Answer:**

The most important subject is finding cost for buying or maintaining the systems.

**Question 8:**

How did you facilitate funds for the initial cost and maintenance cost?

**Answer:**

This cost is estimated annually in the national budget.

**Question 9:**

Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?

**Answer:**

 Yes. We have, however, we are holding training and workshop throughout year for the employees continually, so that, their information and expertise is update.

**NEPAL:**

**Question 1:**

**Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.**

**R: Yes, we have Telecommunication Service's Radio Spectrum (Distribution and Price) Policy, 2069, as well as the First Amendment version, 2073. (Link For Details: https://nta.gov.np/en/spectrum )**

**Question 2:**

**What are the fundamental principles on which the Spectrum Management Policy is made?**

**R: The fundamental principles of spectrum policy include but not limited to Technology Neutrality, Spectrum Auctions, prohibition on Sharing/Trading/Leasing of Spectrum, Secure and Efficient Spectrum Usage, Spectrum Refarming, Adoption of Best Spectrum Practices, and Spectrum Capping.**

**Question 3:**

**What is your Spectrum Assignment Procedure?**

**R: Spectrum used to assign through administrative processes in response to licensee’s demand. The licensee now receives cellular spectrum through a spectrum auction. Except for cellular, other spectrum is assigned in an administrative manner.**

**Question 4:**

**How often you update the Spectrum Assignment Procedure to meet the present/future requirement?**

**R: The assignment and allocation procedure are guided by the Policy specified in Question 1. The Policy is amended typically every three to four years.**

**Question 5:**

**What are the infrastructures used for the Spectrum Management activities?**

**5.1: Details of Hardware Infrastructure**

**R: Fixed Stations, Mobile Monitoring Stations, Spectrum Analyzer, Spectrum Monitoring Receiver, EMR Tool, Mobile Benchmarking Tool.**

**5.2: Details of Software Tools**

**R: SMS4DC (Spectrum Management System for Developing Countries), NTA’s Frequency Management Module of Office Automation System, NTA’s GIS based Telecommunications Infrastructure MIS, NTA’s Frequency Module of Online Tracking and Monitoring System (OMTS), APT Frequency Information System.**

**Question 6:**

**Is your spectrum management infrastructure system partially/fully automated? What are the main functions?**

**R: Partially automated.**

**NTA’s Frequency Management Module of Office Automation System: Frequency Database Management and Frequency Fee Calculation, Facilitation of Spectrum Assignment and Management and Report Generation.**

**NTA’s GIS based Telecommunications Infrastructure MIS: GIS based database of the coverage, infrastructures such as towers.**

**NTA’s Frequency Module of Online Tracking and Monitoring System (OMTS): Spectrum monitoring and report generation.**

**Question 7:**

**Details of Spectrum Management Infrastructure System**

**7.1: When did you purchase/develop the Spectrum Management Infrastructure System?**

**R: Since 2007 AD.**

**7.2: How often do you upgrade the system?**

**R: As and when required.**

**7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?**

**R: Timely update of the system, integration of different systems, and human resources.**

**7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?**

**R: N/A**

**7.5: What are the drawbacks in the Spectrum Management Infrastructure System?**

**R: The tool does not support all frequency bands and are not up to date.**

**Question 8:**

**How did you facilitate funds for the initial cost and maintenance cost?**

**R: The expenses are covered the Authority and Ministry.**

**Question 9:**

**Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?**

**R: Lack of adequate human resources.**

**PAKISTAN:**

**Question 1:**

**Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.**

**In Pakistan the statuary mandate of spectrum management is assigned to FAB through Pakistan Telecommunication (Re-organization) Act, 1996 (as amended in 2006). In accordance with the ibid Act, the Federal Government had approved De-Regulation Policy for the Telecommunication Sector 2003, and Mobile Cellular Policy 2004. These two government approved policies provided basic guiding principles and frameworks to FAB for efficient spectrum management. Afterwards, through promulgation of Telecom Policy 2015, spectrum management principles were suitably addressed therein. Based on the said principles enumerated in Telecom Policy 2015, Pakistan Rolling Spectrum Strategy was published in 2020.**

**Question 2:**

**What are the fundamental principles on which the Spectrum Management Policy is made?**

**Allocation and assignment of spectrum to maximize social and economic benefits derived from the use of this scarce resource. Recognizing that spectrum is a valuable public resource belonging to the State and must be used in public interest, the overriding spectrum policy goals in Pakistan are to:**

**Use spectrum in an efficient and flexible manner;**

**Maximize social and economic benefits;**

**Promote stability and transparency;**

**Support the emergence of future telecommunications services.**

**Question 3:**

**What is your Spectrum Assignment Procedure?**

**The procedure for spectrum assignment has been clearly listed in Pakistan Telecommunication (Re-organization) Act, 1996 (as amended in 2006). Application for spectrum assignment has to be submitted to PTA. PTA refers the said application to FAB. Afterwards, FAB makes assignment to the user in accordance with Pakistan Table of Frequency Allocations through clearance from its Members. Accordingly, the license(s) are issued by PTA.**

**Question 4:**

**How often you update the Spectrum Assignment Procedure to meet the present/future requirement?**

**Spectrum assignment procedures are regularly reviewed and updated by the Board in order to properly manage present/ future spectrum demands of spectrum users/ licensees.**

**Question 5:**

**What are the infrastructures used for the Spectrum Management activities?**

**5.1: Details of Hardware Infrastructure**

**FAB is using spectrum monitoring system of R&S**

**5.2: Details of Software Tools**

**FAB is using spectrum management Tools of LS Telcom**

**Question 6:**

**Is your spectrum management infrastructure system partially/fully automated? What are the main functions?**

**Spectrum management infrastructure is partially automated. Currently, project is being carried out to fully automate process of the spectrum management and monitoring.**

**Question 7:**

**Details of Spectrum Management Infrastructure System**

**7.1: When did you purchase/develop the Spectrum Management Infrastructure System?**

**The spectrum management infrastructure was initially procure in early 2000.**

**7.2: How often do you upgrade the system?**

**Parts of the spectrum management infrastructure are upgraded from time to time depending upon the advancement in technology.**

**7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?**

**Earlier, there were very few known spectrum management system developers across the globe. Similarly, the interfaces were also propriety. Therefore, there were issues of interoperability and very high associated prices for the system. However, now slowly and gradually more and more developers are developing the spectrum management tools and the interfaces are also being standardized.**

**7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?**

**The total cost of the initial project was approximately 25 Million USD. The maintenance cost of the system varies from time to time depending upon the utilization or tasks.**

**7.5: What are the drawbacks in the Spectrum Management Infrastructure System?**

**Reliable and good spectrum management infrastructure system is very costly and affordability is the main drawback/issue for the developing or least developing countries.**

**Question 8:**

**How did you facilitate funds for the initial cost and maintenance cost?**

**In Pakistan, the spectrum management infrastructure is funded through collection of Annual Spectrum Administration Fees (ASAF) by PTA from spectrum users.**

**Question 9:**

**Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?**

**Yes.**

**SRI LANKA:**

**Question 1:**

**Do you have a Spectrum Management Policy in your country? If so, please mention the reference to the document.**

**Answer: No. It is under consideration.**

**Question 2:**

**What are the fundamental principles on which the Spectrum Management Policy is made?**

**Answer:**

**• Allocate Spectrum to highest value use or users**

**• Enable and Encourage Spectrum to move to its highest value use**

**• Use the lease cost and lease restrictive approach to achieving Policy Objectives**

**• Promote both Certainty and Flexibility**

**• Managing interferences by looking for a larger Spectrum utilization efficiently and effectively**

**• Spectrum Allocation and Assignment process is in transparent manner**

**Question 3:**

**What is your Spectrum Assignment Procedure?**

**Answer:**

**• Process of assigning frequencies is open, transparent and non -discriminatory for all users;**

**• Issue frequency assignments in a timely manner and in accordance with published assignment criteria, in support of the overall licensing process;**

**• Frequency assignments will be made for all users is in accordance with the National Frequency Allocation Table(NFAT);**

**• Simple administrative processes is employed for the assignment of frequencies where demand for use of spectrum does not exceed supply. The frequencies will be assigned to the users on a first-come first-served basis;**

**• Scarce and highly valued spectrum where demand exceeds supply will be assigned to the users through market-based spectrum management techniques such as auctions or competitive bidding or spectrum trading.**

**Frequency Assignments - Telecommunications Regulatory Commission of Sri Lanka (trc.gov.lk)**

**Question 4:**

**How often you update the Spectrum Assignment Procedure to meet the present/future requirement?**

**Answer: Not yet decided**

**Question 5:**

**What are the infrastructures used for the Spectrum Management activities?**

**Answer: In year 2000, TRCSL purchased Frequency Management and Monitoring System (FMMS) from LS Telcom and Rhode & Swartz, Germany with a total cost of USD 5 Million.**

**This system consists of fully automated spectrum management system with several software tools and fully automated spectrum monitoring system with Argus software tools.**

**In 2015, TRCSL purchased monitoring equipment and Mobile Surveillance Vehicle for GEW, South Africa.**

**5.1: Details of Hardware Infrastructure**

**Answer:**

**Spectrum Management System:**

**Servers, Client Computers, Switches, Modems, Firewalls**

**Monitoring System:**

**Monitoring Receivers, Direction Finders, Monitoring and Direction-Finding antennas, Mobile Surveillance Vehicles**

**5.2: Details of Software Tools**

**Answer:**

**Spectrum Management System:**

**SpectraPlus – For Invoicing and licensing**

**ChirPlus\_BC- For Broadcasting**

**ChirPlus\_FX- For Fixed link**

**Monitor\_Plus- For Analyzing**

**Spectrum Monitoring:**

**Argus – For Monitoring and Analyzing**

**SkyMon- For Monitoring**

**Question 6:**

**Is your spectrum management infrastructure system partially/fully automated? What are the main functions?**

**Answer: Fully Automated**

**Functions:**

**• Issuing Invoices for frequency licenses**

**• Generating frequency licenses**

**• Generating renewal notices**

**• Simulation of Broadcasting systems**

**• Simulation of Fixed Links**

**• Analyzing technical details of transmitters**

**• Spectrum Monitoring**

**• Report generation**

**Question 7:**

**Details of Spectrum Management Infrastructure System**

**7.1: When did you purchase/develop the Spectrum Management Infrastructure System?**

**Answer: In year 2000 and 2015**

**7.2: How often do you upgrade the system?**

**Answer: Spectrum Management System is upgrading continuously with maintenance agreement.**

**7.3: What are the challenges you have faced when you implement/maintain the Spectrum Management Infrastructure System?**

**Answer:**

**• High initial cost in terms of foreign currency**

**• High repair and maintenance cost**

**• No facilities within country for necessary repair and therefore repairs take conservable time**

**• Lack of skilled staff**

**7.4: What is the initial cost of the Spectrum Management Infrastructure System and the average maintenance cost per year?**

**Answer: In 2000, TRCSL spent USD 5 Millon for Spectrum Management Infrastructure.**

**7.5: What are the drawbacks in the Spectrum Management Infrastructure System?**

**Answer:**

**• High initial and maintenance cost**

**• Repairs take considerable time**

**• Lack of spare parts**

**Question 8:**

**How did you facilitate funds for the initial cost and maintenance cost?**

**Answer: Assistance from World Bank and TRCSL’s owned funds**

**Question 9:**

**Do you have expertise and adequate qualified staff for the operation of the Spectrum Management Infrastructure System?**

**Answer: The lack of experience and adequate staff is the major issue for the effective utilization of infrastructure.**