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| **The 17th Meeting of the South Asian Telecommunication Regulators’ Council (SATRC-17)**  |  |
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**SATRC REPORT ON**

**SPECTRUM RE-FARMING IN SATRC COUNTRIES**

**Prepared by**

**SATRC Working Group Spectrum**

**Adopted by**

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**EXECUTIVE SUMMARY:**

The main purpose of spectrum management is to facilitate the access to people or group of people to deploy telecommunication technologies in right time without harmful interference and ensuring the effective and efficient usage or spectrum.

With the introduction of cellular technology in the first generation public mobile networks, radio-communication has moved from a technology used for a limited number of services and people to a mass market technology. This development has brought about a lot of innovation, research and development into the field, resulting in an endless stream of technological advances. Together with technology developments, the standardisation activities also took off, giving yet another boost for development of mass applications.

As such technological changes are difficult to predict by themselves, particularly predicting the time scales for commercial deployment of the emerging technologies. This places particularly high pressure on spectrum management, because a priori spectrum availability is usually demanded and seen as a necessary guarantee for investing into the development of new technologies. At the same time, the advance freeing of spectrum may lead to inefficiency if the new technology arrives later or does not arrives at all. This once again reinforces the need for inherent flexibility of future spectrum management decisions.

One of the biggest challenges facing spectrum regulators is the reallocation of spectrum. When frequencies have been used for one purpose, perhaps for decades, it is often difficult to reallocate these frequencies for a different use. Sometimes it may happen that the international table of frequency allocations has changed and therefore national table of frequency allocations might be realigned to be consistent with it. Alternately, a radio service may not have developed as expected, while the spectrum available for another service operating in a nearby frequency band is insufficient to keep up with growing demand. Sometimes, new technologies become available which is more spectrum efficient, allowing spectrum to be freed up either for the same use in that band or other uses. Sometimes in order to improve existing services or introduce new services, it may be necessary to move existing users of the radio spectrum to more modern technologies or new frequency bands.

In view of these challenges spectrum refarming sometimes becomes essential for proper management and efficient usages of spectrum. Spectrum re-farming is a key process in spectrum management to reallocate frequency bands for more efficient technologies with higher throughput. This is essential to cater the market demands with the development in wireless applications throughout the world.

A number of administrations in SATRC region have opted for refarming of spectrum by formulating methods and guidelines for the same. This report studies and addresses the methods and the guidelines on Spectrum Re-farming in SATRC Countries. This topic is one of the five work items assigned to the “Working Group on Spectrum” under the SATRC Action Plan Phase V. This work item is proposed by the Working Group on Spectrum to the 14th SATRC Council Meeting in Paro, Bhutan considering the importance of Spectrum Re- farming which is a very essential tool in Spectrum Management.

The report contains ten sections and feedback received from SATRC countries onthe questionnaire prepared to study this topic. Section 1 of the report briefly introduces the topic; Spectrum Re-farming and why the spectrum re-farming is essential for Spectrum Management all over the world. It also mentions the usefulness of this report as a guideline for all SATRC countries to practice in their countries while releasing frequency bands for new services.

Spectrum Re-farming is necessary because of the changes in the use of the radio equipment with the innovation of new technologies. This is described in Section 2 of this report. The changes in the use of radio equipment depends on various factors and some of the main factors are described in this section.

In Section 3 of the report, the requirement of spectrum re-farming is discussed because the timely identification of the spectrum re-farming is very important to introduce new technologies at the right time to get full benefits to the society at large. The adverse effects due to the delay in the implementation of spectrum re-farming are also addressed in this section.

The regulatory context in relation to the spectrum re-farming is extensively described in Section 4. This section mainly focuses on national, regional and international regulatory issues which should be seriously considered by all the administrations during the implementation of spectrum re-farming.

In section 5 of this report, the estimation of feasibility of spectrum re-farming is discussed. The feasibility of the spectrum re-farming is estimated considering the advantages compared with the existing and new services and the removal cost. The economic advantages and social benefits are also considered in the feasibility estimation.

The re-farming cost is a deciding factor in spectrum re-farming. This cost includes the administrative cost and the compensation cost for existing users. The section 7 discusses the methods of the estimation of the re-farming cost.

The Section 8 includes the re-farming experience in India, Pakistan and Sri Lanka. The policies and recommendations in relation to the spectrum re-farming in respective countries are discussed in this section. Some spectrum re-farming cases are also briefly included in order to share experiences among SATRC countries.

Overcoming the challenges faced in spectrum re-farming is very important for the successful implementation of spectrum re-farming. Identification of possible challenges well in advance, is an advantage to overcome the obstacles faced in the process of implementation. The information in this section will be more useful for all SATRC countries to overcome these challenges.

The responses received for the questionnaire circulated among SATRC countries, are annexed to this report for information. This information may be useful for all administrations in SATRC region for spectrum re-farming.

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1. **INTRODUCTION**

One of the biggest challenges facing spectrum regulators is the reallocation of spectrum. When frequencies have been used for one purpose, perhaps for decades, it is often difficult to reallocate these frequencies for a different use. The need for reallocation often known as re-farming can arise in several ways. It may be that the international table of frequency allocations has changed and the national table of frequency allocations must be realigned to be consistent with it. Alternately, a radio service may not have developed as expected, while the spectrum available for another service operating in a nearby frequency band is insufficient to keep up with growing demand. Sometimes, new technologies become available which is more spectrum efficient, allowing spectrum to be freed up either for the same use in that band or other uses. Whatever the reason, there will be times when spectrum users will have to make changes to their operations. The central issues that arise are then who decides, and who will pay for the costs incurred by these users in transitioning to new frequencies.

To improve existing services or introduce new services, it may be necessary to move existing users of the radio spectrum to more modern technologies or new frequency bands. This movement of existing spectrum users, or as it is otherwise known, spectrum Re-farming (Redeployment), needs to be planned. Spectrum re-farming should be included in the administration’s national spectrum strategy together with the mechanism identified to assist implementation of re-farming. It should be considered equally with all other options, i.e. sharing, removing restrictions, etc.

Spectrum re-farming is not necessarily a simple task and an administration may face a number of difficulties that can complicate, delay and even disrupt the process. The administration is encouraged to use spectrum monitoring data to supplement other data when considering re-farming. The level of difficulty experienced and options of implementations available may subsequently influence an administration’s approach to spectrum re-farming.

This Report aims to provide deeper insight into the theory and practices of spectrum re-farming and as such is expected to be used by administrations in SATRC countries as a source of guidance on this subject. While the report is intended as guidance on the application of spectrum re-farming, it is however realized that the implementation of re-farming processes remains a strictly national issue. As such their use depends fully on the legal bases and regulatory practices in the area of spectrum management in a particular country.

The report gives information and guidelines for administrations to consider now and in the future. It also gives an overview of the current developments and experience within the SATRC countries in the area of re-farming. The information was gathered through the questionnaire circulated among the member countries. The responses received for the questionnaire are attached in Annexure I in this report.

1. **CHANGES IN THE USE OF RADIO EQUIPMENT**

Spectrum Re- farming is required with the introduction of new technologies together with modern radio equipment. The radio equipment has been developed to cater high throughput to support high speed communication networks. The changes in radio equipment have to be made due to several reasons.

* 1. **Nature and pace of changes**

As already briefly mentioned in the introduction, the use of radio spectrum is ever changing. However recent changes in the radio-communication sector have become more complex, dynamic and harder to foresee.

For a long time remaining a closed area of carefully planned professional applications and corporate users (such as military, governments, utility companies, etc.), the world of radio-communication first received a serious public boost during the 1980-ies, when the first generation of public mobile telephony networks was introduced. Since then radio-communication has become a highly visible part of the telecommunications industry, quickly gaining subscribers, attracting significant investments and pushing applications and technology forward. Given the wide acceptance and high interest from broad user groups, the mobile technology quickly advanced, producing lightweight user terminals and further widening applications to a broad range of digital services.

Generally over the last four decade the radio-communication mass-market became a vibrant and dynamic marketplace, where new applications are leading to demand for yet other new applications and this is expected to continue to be so in the long term. All these changes also incur additional demand for spectrum, and it becomes clear that recognition of the driving factors behind those changes and developing the ability to prepare for them are important steps in developing a spectrum re-farming strategy.

* 1. **Institutional and legal changes**

One of the most important factors driving the recent and future changes in radio-communication market is the institutional and legal background. Originally the radio-communications were managed within the framework of the state-owned telecommunications monopolies, which often were also the main operator of quite limited public radio-communication services at the time. The changes in the use of radio at that time were carefully projected and centrally managed. This has significantly changed by liberalisation of radio-communication markets, which was completed in most countries by the end of 1990-ies. This resulted in the appearance of many private radio-communication operators and booming growth of public radio-communication services.

Following the initial experience of liberalised radio-communication markets many countries have totally revised their telecommunications legislature and often adopted new telecommunications and radio-communication laws in the mid1990-ies. This was usually aimed to ensure the efficient functioning of a liberalised market and the establishment of a new regulatory structure with independent National Regulatory Authorities in the centre of telecommunications management.

* 1. **Technical changes**

With the introduction of cellular technology in the first generation public mobile networks, radio-communication has moved from a technology used for a limited number of services and people to a mass market technology. This development has brought about a lot of innovation, research and development into the field, resulting in an endless stream of technological advances.

Together with technology developments, the standardisation activities also took off, giving yet another boost for development of mass applications.

Technology changes are difficult to predict by themselves, but it seems even more difficult to predict the time scales for commercial deployment of the emerging technologies. This places particularly high pressure on spectrum management, because a priori spectrum availability is usually demanded and seen as a necessary guarantee for investing into the development of new technologies. At the same time, the advance freeing of spectrum may lead to inefficiency if the new technology arrives later or does not arrives at all. This once again reinforces the need for inherent flexibility of future spectrum management decisions.

The concept of Software Defined Radio aims at fully re-configurable radio equipment, which could be adjusted to operate in a different frequency band, with different parameters, with different network technology by a simple adjustment of their internal operating software, either in a service shop or just automatically by receiving instructions over the network. Once developed, such devices could alleviate many of today’s spectrum management (and in particular spectrum re-farming decision-making) considerations, linked to the currently very limited flexibility of operating radio equipment.

* 1. **Market issues**

As already explained in the previous sections, during the last decades radio-communications have been developing in a liberalised environment of a market-based economy. This resulted in the influence of market-driven considerations and tendencies on the daily practice of the radio-communication sector.

So today most developments in the field of radio technologies and services are driven by the demand from end users and industry itself. And since radio-communications became an integral part of peoples’ daily lives, the demand is increasingly difficult to predict, as it is very much inter-linked with many other societal developments. Therefore the radio technology now attempts to follow any changes in the user base structure and their behavioural patterns. That is why manufacturers are constantly striving to adapt by observing trends in interests in particular applications (increased SMS use, web browsing, transmission of music files, multimedia) as well as issues of pure fashion (size and design of the terminals, which impacts their radio parameters as well).

Radio-communication has also become a strong macroeconomic force in the national economies. Therefore any changes facing the industry, e.g. withdrawal of a particular radio-communication service due to re-farming, may be either eased or hardened by such related macroeconomic issues as employment, capital interest rates, industry growth, etc.

* 1. **Convergence**

Convergence in the broader sense means the fusion of different telecommunications and information technologies in order to provide the end customer with the broadest possible range of services and applications, often accessible from one terminal. An example is the combination of public calling capabilities (telecommunications) with the reception of video and audio programmes (broadcasting) and remote computing (information technology), all manageable from a single (so-called multimedia) terminal.

From the technology standpoint convergence means that the range of traditional service-tailored connections (e.g. telephone line, broadcasting channel, computer access in the above example) should be replaced by a transparent bit stream of flexibly adaptable bandwidth. While the modern telecommunication networks already realise such transparent transmission of bit streams between the network termination points, most highly divergent radio access technologies are ill-suited for the provision of such transparent and flexibly re-configurable bit streams between an end user and a network termination point.

Traditionally, radio spectrum was allocated to particular services (e.g. broadcasting, mobile, fixed, etc.) and the radio networks developed within those allocations were subsequently tailored for specific use (e.g. one-way wideband broadcasting networks, two-way narrowband mobile networks, fixed connections with strictly defined bit stream parameters, etc.). The current pattern of spectrum use still reflects those parameters (channel width, duplexing set-ups, etc.) of the particular networks/applications. Therefore convergence is now likely to demand from spectrum managers two major efforts: to review the principles of allocating spectrum to particular services and to re-arrange the existing spectrum use by adapting it to provisioning of transparent application-independent connectivity.

1. **IDENTIFICATION OF THE REQUIREMENT FOR SPECTRUM**

 **RE-FARMING**

Before starting the process of spectrum re-farming, it is very important to identify the real requirement of the application. As the re-farming is a time consuming and costly process, the administration should estimate the net advantage of the final outcome of redeployment plan. In the process of re-farming, it is necessary to move existing users of the radio spectrum to new technologies or new frequency bands. This requirement to move existing users of the spectrum can arise for a number of reasons, for example:

a) a spectrum allocation may have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems;

b) an allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share;

c) a decision by a World Radio-communication Conference (WRC) to allocate a currently-occupied frequency band to a different service on a regional or global basis.

If, as in the case of b) above, the spectrum allocation is not being used efficiently, there may be a requirement to re-engineer the band to improve spectral efficiency and this can include the following options:

– increasing the level of spectrum sharing;

– reducing the channel bandwidth to increase the number of channels;

– changing to more efficient modulation techniques that permit greater sharing;

– reducing the frequency reuse distance.

Any of the above options may provide the requirement for starting a spectrum re-farming process in order to change existing users’ current equipment and/or their frequency assignment, even though any change in frequency may be limited to the same frequency band. In some cases, the spectrum sharing criteria between services on a co-primary basis is detailed but the national requirements may be to assign these frequencies to one of the radio service and may require the redeployment of other radio services from the same band.

If an administration can move existing users to unused spectrum, then the spectrum re-farming process may not be difficult. However, resistance amongst radio users to changes in the type of equipment used, or to changes in frequency allocation, limits an administration’s flexibility to make spectrum available for new users and services. In addition, in some countries, increasing spectrum congestion can make the identification and use of alternative frequency bands time-consuming and difficult. Delays in the introduction of new services are undesirable, as they can make a proposed solution obsolete before it is implemented and, in the case of a proposed change affecting one or more frequency bands, a delay with one service may impact on several other bands and services.

These delays, as studies have shown, are capable of causing a significant loss to a country’s economy. If a solution is not achieved, this may lead in the long term to impairment in spectrum use and a reduction in radio-communication development. Hence, it is important that once an administration has decided to use spectrum re-farming, any unnecessary delays in the process are avoided.

The extent to which an administration will need to use spectrum re-farming will depend on the size of the demand for spectrum and the level of spectrum congestion within the administration. For those administrations where the level of demand for spectrum has given rise to spectrum congestion and there is little usable spectrum available, the need for an effective spectrum re-farming policy is self-evident. However, there are benefits in identifying a suitable spectrum re-farming mechanism. Benefits can apply even to countries where spectrum congestion is not a problem, as the necessity to make spectrum available to take advantage of new services is an issue that faces all administrations, e.g. providing spectrum to take advantage of the global growth in mobile services.

1. **REGULATORY CONTEXT**
	1. **National Regulations in SATRC Countries**

It is clearly identified that re-farming and spectrum trading remain essentially a matter of national choice, which should result in the adoption of the appropriate national regulations. The national regulations should therefore provide a legal basis for re-farming measures. It appears that most of SATRC countries do not allow spectrum trading as a policy.

With the liberalization of telecommunication market, most of countries have adopted modern telecommunications and radio-communication laws, allowing for spectrum re-farming tasks either through specific provisions in the law, or through a general remit to ensure efficient use of spectrum.

It may be concluded that re-farming is normally carried out nationally, based on the laws and regulations set out in a particular country. However it should be also noted that spectrum re-farming and trading, as spectrum management tools have a much wider international implication.

National rules about re-farming and spectrum trading should take into account the international context dealing with spectrum use and management.

* 1. **International Telecommunication Union (ITU)**

The agreements binding the Member States within the framework of ITU lay the foundation for spectrum management world-wide. ITU international agreements recognise that utilisation of the radio frequency spectrum is a matter of State sovereignty. However, in order to be efficient the use must be regulated and therefore this sovereignty should be given a framework. The basic global instruments by virtue of which States undertake to respect common rules for sharing and using the spectrum constitute this framework. The goal being efficient utilisation of spectrum and equitable access.

The ITU instruments, at least those that are relevant to spectrum management, are the Constitution (CS), the Convention (CV) and, most important, the Radio Regulations (RR). These instruments are only binding the States and are therefore not directly applicable to individuals, operators or others, concerned by spectrum utilisation. Compliance with those instruments therefore presupposes that each State will take the measures required (legislation, regulations, clauses in licences and authorisations) to extend those obligations to other spectrum users (operators, administrations, individuals, etc.).

The ITU has recognised the importance of re-farming as one of spectrum management tools through the adoption of study question ITU-R Q. 216/1 ”Spectrum redeployment as a method of national spectrum management”. Another ITU-R question, which is closely relevant to the subject, is ITU-R Q. 206/1”Strategies for economic approaches to national spectrum management and their financing”.

* 1. **Regional Harmonisation**

The regional harmonization of the radio frequency spectrum is very essential for the “Good Practice” of Spectrum Management in each country. The Asia-Pacific Telecommunity (APT) was founded on the joint initiatives of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the International Telecommunication Union (ITU).

The main objective of the APT is that the development of regional cooperation in areas of common interest, including radio-communications and standards development. APT has been developing harmonisation measures in the area of novel approaches to spectrum management, such as application of economic measures. It is recommended that re-farming process is a national issue but that redeployment of spectrum has also bilateral and multilateral aspects. Therefore, all administrations need to support regional harmonization of radio spectrum while considering re-farming in their respective countries.

Considering the importance of bilateral and multilateral coordination in south Asian region, the SATRC was formed under the APT. Each countries in SATRC region need to closely coordinate with other countries to efficient and effective use of radio spectrum in the region. This mechanism will help to bring the telecommunication sector in this region to the forefront in the world.

1. **ESTIMATION OF FEASIBILITY OF RE- FARMING**

The estimation of the feasibility of the re-farming project is the key role in modern spectrum management practice. The community as a whole must derive sufficient benefit from a re-farming of radio-frequency bands to merit the granting of authorization. This benefit is reflected, in economic terms, through a maximization of the community surplus. In other words, one must reach an equilibrium point such that no other use of the spectrum can improve the community surplus, according to the Pareto optimality criterion.

In seeking this equilibrium point, it is useful to compare the preferences (utilities) of the various players involved. Their utility functions are expressed in terms of private value and social value for the community. Private value corresponds to the profits they can derive from the use of the frequency bands, whereas the social value corresponds to the importance of the service to society at large. The calculation of private value is fairly simple, whereas quantifying the social value is relatively complex. It is possible to call on the notion of “opportunity” in trying to evaluate the social value of the service. In other words, by calculating what the absence of the service would cost the community.

As regards the process of spectrum re-farming, it is necessary to compare the utilities in terms of private value and social value of the agent being asked to relinquish the frequency bands and of the incoming agent.

Let *Uoutgoer* and *Uincomer* denote the respective utilities (comprising the private and social values) of the operator leaving the spectrum and the operator who replaces him. Let *Cremoval* denote the spectrum re-farming cost for the outgoer:

if *Uincomer*>*Uoutgoer*+*Cremoval*then the removal is socially and economically optimal;

if *Uincomer*<*Uoutgoer* then the removal is not socially and economically optimal; and

if *Uoutgoer*<*Uincomer*<*Uoutgoer*+*Cremoval* then a choice has to be made.

* 1. **The cost of redeployment**

It is assumed that, as the result of spectrum re-farming, the user of a frequency band is obliged to relinquish the band and to pursue his activity in a different frequency band or to use a non-radio solution where this is possible. For this user, the obligation to leave the frequency band may induce an additional cost that he would not have incurred in the absence of this obligation. In what follows, this additional cost will be known as the “redeployment cost”.

In the telecommunication sector in particular, the resale value of the equipment involved in the move is in most cases unknown. Investments made in these networks are often so-called “sunk costs” for the users. This means that if the activity ceases the users cannot recoup their investments. Calculation of the residual value makes it possible to determine the theoretical value of this equipment when it cannot be resold. It is useful to distinguish the residual book value and the residual economic value. For this reason, two methods are envisaged and presented below for the calculation of the redeployment cost:

− calculation using residual book value;

− calculation using residual economic value.

* 1. **Calculation of the redeployment cost using the residual book value**

The book value method is applied in particular when the outgoer keeps normal accounts. Moreover, in the case of commercial activity, this method takes into account the tax advantages that the outgoer has enjoyed relating to the depreciation of his equipment.

* + 1. **Evaluation of the cost incurred by the user on leaving the frequency band**
			1. **Move to another part of the spectrum or exit from the spectrum**

It must first be determined whether the outgoing user is obliged to use radio frequencies if he is to pursue his activity. If this is the case (as, for example, for an operator of mobile services), the outgoing user is moved to another frequency band and the cost, *Cd*, of this move to another part of the spectrum is evaluated. If this is not the case (as for example, for an organism owning fixed radio links), the two following hypotheses must be envisaged:

− the user is moved to a different frequency band and the cost *Cd* is evaluated;

− the user gives up the use of frequencies in favour of an alternative wire-based system and an evaluation is made of the cost, *Cs*, corresponding to the exit from the radio spectrum.

The choice between these two hypotheses, taking only the economic criterion, leads to adopting the least cost of the two.

Let *Ci* be the cost incurred by the user on leaving the frequency band. *Ci* is equal either to *Cd* if the user is obliged to occupy a different frequency band, or to the smaller of *Cd* and *Cs* if the user has the possibility of adopting a wire-based solution.

* + 1. **The residual book value, *Vcr***

This method makes allowance for the age of the outgoing user’s equipment, taking the residual book value *Vcr* of this equipment. The usual definition of the residual book value of an item of equipment is obtained as follows:

 *Vcr* purchase price of the equipment ready for use minus depreciation

*Vcr* represents the value of the fraction of equipment remaining to be depreciated. If at this stage in the depreciation, its owner can no longer use the equipment, the latter, according to accounting theory, would incur a loss equal to *Vcr*.

* + 1. **Renewal costs**

Because of technological evolution and the ageing of equipment, the occupier of a frequency band is called upon to renew his equipment even in the absence of any change of band. Let *Cr* be this cost of renewal of equipment, with identical properties and the same frequency band. *Cr* in this case represents the cost this occupant would incur even in the absence of any spectrum redeployment.

* + 1. **Calculation of the redeployment cost**

Take the user of a frequency band whose present equipment has a residual book value *Vcr* and who has to evacuate this band by reason of redeployment. Leaving the band means that he has to spend a sum equal to *Ci* (see 5.2.1.1) in order to be able to pursue his activities. The fact of evacuating theband will probably mean that it is impossible for him to use his present equipment, hence causing a loss equal to *Vcr* (see 5.2.2). If he were to stay in the band, he would have to spend a sum equal to *Cr* (see 5.2.3). We therefore have the following relationship:

 Redeployment cost  additional cost for the user obliged to leave the frequency band
 *Ci**Vcr* – *Cr*

Remarks:

− if the calculation results in a negative redeployment cost, this means that the user has an interest in leaving of his own accord the frequency band he currently occupies;

− calculating the redeployment cost of a frequency band requires, in each case, an expertappraisal to establish the actual costs of the existing network and the new network.

The results of the calculation are highly sensitive to the level of depreciation and the architecture of the existing network.

* 1. **Calculation of the redeployment cost using residual economic value**

The economic approach makes it possible, among other things, to leave aside the following two aspects:

− the fact that the actual service life of the equipment may be different from the life used for accounting purposes(determined on the basis of depreciation periods);

− the possibility that the outgoing user does not apply a depreciation regime.

* + 1. **Analysis of the value of networks**

Once the incomer has recognized his interest in using radio waves to provide his service and when it is established that the value to the incomer is greater than the value to the outgoer plus the cost of moving (in other words *Uincomer**Uoutgoer**Cremoval*), the outgoer has five options:

*Option 1*: *The outgoer ceases activity*: the outgoer provides a service whose value to society is small, whose technology is obsolete or which no longer has any justification; all these are cases in which it is preferable that the outgoer cease his activity.

*Option 2*: *Sharing frequency bands for a single service*: the existing operator uses frequencies but in an inefficient manner or is unable to justify the quantity at his disposal; in this case, he could, without technical handicap, agree to another operator being installed to provide the same service.

*Option 3*: *Sharing frequency bands between different services*: the incomer may exploit the host frequency band without the existing operator having to move and the latter can also continue exploiting the spectrum without interference from the incomer. This is the solution of sharing frequency bands for the provision of different uses.

*Option 4*: *The outgoer moves his activity to another host frequency band*: the incomer has the exclusive use of the whole frequency band and the existing operator must move his activity to another frequency band.

*Option 5*:*The outgoer moves his activity to a totally different platform*: the incomer wishes to benefit from the exclusive use of the whole frequency band and the existing operator must move his activity. On examination, it turns out that the development cost of the activity of the outgoer on other frequency bands is higher than the development cost of the same activity on a wire-based support (cable, optical fibre, etc.). It is preferable, for an unchanged service, that the outgoer evacuate the frequency bands and move to an alternative platform.

Each of these cases can be tackled by an economic study of the different investment options.

1. **METHODS OF RE-FARMING**

Spectrum re-farming can be used in a number of different ways. Voluntary spectrum redeployment and regulatory spectrum redeployment are the two methods used all over the world.

* 1. **Voluntary Spectrum Redeployment**

This method of spectrum redeployment represents the case when an administration decides to implement spectrum redeployment and to use methods to encourage an existing spectrum user to voluntarily decide to return the frequencies used to the spectrum manager for re-assignment. This process tends to occur when an existing user recognizes the benefits they are gaining from using the spectrum are less than the costs of continuing to use it. This method may not be suitable if the spectrum needs to be recovered quickly, as it is likely to take time. Typically voluntary spectrum redeployment occurs when there may be more than one increase in licence fees or for an increase in licence fees to coincide with the existing equipment needing to be serviced or replaced, or a new technology appearing that provides a better service than the existing equipment, e.g. for taxi drivers, the greater range provided by cellular telephones compared to mobile radio.

The stimulus for an administration deciding to implement voluntary spectrum redeployment may arise for many reasons, including the monitoring of statistics on the use of a frequency band, e.g. if the number of users in a frequency band are decreasing nationally, or possibly regionally, or if there is a rapid turnover of users in the band. Such changes in the number of users may indicate that the existing service is either no longer desirable or there are problems of operation with that particular service. Noting that spectrum users may vacate a frequency band for a large number of reasons and that in some frequency bands there may be only a limited number of users (either due to a large operating bandwidth or individual users having access to multiple frequency assignments in the band), the decision by a single user to leave a band may create an opportunity for the administration to consider future usage. If a frequency band became vacant, without any action by the administration, good spectrum management practice should mean the automatic reconsideration of the frequency band’s usage.

When this spectrum redeployment method is to be used as part of an identified administrative policy then it may need to be linked to a charging mechanism, e.g. licence fees. To provide the greatest flexibility the charging mechanism also needs to be flexible. Hence this spectrum redeployment method may be suitable for charging mechanisms like spectrum pricing, where the cost of the licence can be linked to a wide variety of factors, e.g. coverage area, extent of sharing, bandwidth, and hours of operation.

* 1. **Regulatory Spectrum Redeployment**

Regulatory spectrum redeployment is the approach most associated with an administrative policy to redeploy spectrum. This method basically consists of the administration either terminating the licence or refusing to renew the licence. Early notification/publicity of the administration’s plans for the frequency band is essential to ensure that those affected will have the maximum time to plan alternative arrangements. There are three main categories under this redeployment method.

* Spectrum redeployment at the expiration of the current licence
* Spectrum redeployment at the end of the equipment’s lifetime or before the expiration of the licence
* Redeployment of spectrum in licence-exempt bands
	+ 1. **Spectrum Redeployment at the Expiration of the Current Licence**

This approach currently appears to be the most common way of achieving spectrum redeployment. The difficulty faced by the administration in applying the policy will depend on the length of the licence term and the speed with which the administration wishes to recover the frequency band. If the period of the licence is short (e.g. one or two years) or the administration knows sufficiently far in advance that it requires this spectrum, then recovering the spectrum may not be a problem. However, if the administration wants to recover the spectrum quickly, it may face claims for compensation depending on the terms and conditions of the licence, if:

– the existing licence period is long (e.g. 10-15 years); or

– the licensee has purchased radio equipment based on an understanding that, even though the licence period is short, the licence will be renewed automatically.

* + 1. **Spectrum redeployment at the end of the equipment’s lifetime or before the expiration of the licence**

This approach requires that the administration announce its intentions to redeploy the spectrum sufficiently far in advance of the date on which they propose to reclaim the frequency band. To minimize difficulties, the administration could wait until the end of the equipment’s lifetime. However, the lifetime of equipment differs from service to service and for some systems, such as military equipment, updating technologies are used which further prolong the lifetime of equipment. For cases where the operational lifetime of the equipment is unacceptable, compared to the period the administration has set to recover the spectrum, it may be necessary for the administration to agree with the users a fixed lifetime for the equipment or impose a cut-off date; potentially giving rise to claims for compensation.

* + 1. **Redeployment of spectrum in licence-exempt bands**

By definition there are no records of users and their application of services used in licence-exempt bands. It would be impossible to contact all users to notify them of redeployment bands, and this prevents the band from being emptied of incumbent users.

Considerations for new assignments or allocations of licence-exempt bands should take account of the legacy from assigning licence-exempt services if the bands are later to be the subject of redeployment plans.

Most users of licence-exempt devices for short-range radio-communication devices (SRD) (refer to Report ITU-R SM.2153) are reluctant to pay any costs caused by spectrum policy change. However, it is difficult to establish the spectrum policy plan in the licence-exempt bands because of life time of the products, which is between 3 and 10 years on the average depending on the product type.

In the case of redeployment of licence-exempt bands, the administrations may review the potential infringement of people’s property rights because most licence-exempt users are unspecified. In order to judge the property infringement for existing users, it needs to consider the relationship between the government authority and the property loss.

1. **RE-FARMING COST**

As describe earlier, the re-farming process is costly and time consuming task. The administrative cost and the compensation cost for existing frequency user to vacate or move to different bands are the main cost components involving this process. The administration can lose revenue from licence fees if the period allowed to move existing users out of a particular frequency band is too long. It is the existing users who initially incur the cost of implementing spectrum redeployment, as they will need to purchase new equipment in addition to the new licence fee. The level of costs incurred by users will depend on the amount of equipment used, how much time they have had to amortize its costs and how much of their existing equipment they can reuse. Taking three typical examples can provide an indication of the range of costs, and while the costs may be associated with regulatory redeployment they could equally apply to voluntary redeployment:

* 1. **Migration to frequency bands within the tuning range of the equipment used**

This option assumes that all the equipment associated with spectrum redeployment process can be re-tuned. In this case, the costs may be limited to those associated with the re-tuning and testing of the equipment. If the costs of operating in the new frequency band were lower (e.g. a lower licence fee), the cost of re-tuning would be offset by the reduced operating costs. This approach is reasonably simple and therefore suitable for short-term implementation.

* 1. **Migration into other frequency bands outside the tuning range of the equipment used**

This option is potentially more technically and economically difficult to implement. For some services it may be impossible to move to other bands, e.g. science services using physically specific frequencies. For other services it may require a general change of the radio infrastructure, which could be costly. However, it should not be assumed that the costs are always high. If redeployment is part of a move to a new technology that is already available (e.g. a taxi company moving from two-way radio to a cellular phone) the cost to the end user may be low, providing they have had time to amortize the cost of their original equipment. In addition, the increased flexibility and performance could over a short period of time outweigh the costs. Depending on the extent of the operator’s infrastructure, migration to a higher frequency band may require a long transition period, due to the consequences of shorter propagation paths, e.g. re-designed infrastructure, acquisition of new transmission sites and equipment; this does not necessarily fit with the general desire for rapid changes in the telecommunication environment.

It should be noted that the consequences of migration to a lower frequency band can also lead to a longer transition period, because a greater propagation range may require international coordination.

* 1. **Migration to achieve greater spectral efficiency**

This option would almost certainly require the purchase of some new equipment (e.g. a move from equipment with a 12.5 kHz bandwidth to a 6.25 kHz bandwidth). However, it is unlikely that this option would require any change in the transmission/reception infrastructure (i.e. antennas and masts) and so again the costs would be limited. If the costs of operating in the new frequency band are lower (e.g. a lower licence fee), then the costs of new equipment would be offset by the reduced operating costs.

1. **RE-FARMING EXPERIENCES IN SATRC COUNTRIES**

This section of the report addresses re-farming experiences in some countries in SATRC region.

* 1. **RE-FARMING EXPERIENCE IN INDIA**

**8.1.1 Telecom Regulatory Authority of India (TRAI):**

The Telecom Regulatory Authority of India (TRAI) was, established with effect from 20th February 1997 by an Act of Parliament, called the Telecom Regulatory Authority of India Act, 1997, to regulate telecom services, including fixation/revision of tariffs for telecom services which were earlier vested in the Central Government.

**8.1.2 Spectrum Re-farming in India:**

Spectrum in 800, 900 and 1800 MHz bands has been refarmed by the Department of Telecom (DoT) based on following recommendations of TRAI:

* TRAI’s recommendations on ‘Spectrum Management and Licensing Framework’ dated 11th May 2010.
* TRAI’s recommendations on ‘Auction of Spectrum’ dated 23rd April 2012.
* TRAI’s response to DoT’s letter dated 25th October 2012 seeking clarifications on the prescribed limit for spectrum, retention of spectrum on renewal of licences and refarming of spectrum

The following approach was adopted for the refarming of spectrum:

1. Following policy decisions were taken in 2012:
* Spectrum is delinked from the licence.
* All the future access spectrum assignment will be through auctions.
* Use of spectrum acquired through auctions will be liberalised.
1. Licences were given for a period of 20 years. As the licence agreement is binding on both licensee as well as the licensor; it was thought that the spectrum assigned cannot be refarmed mid-way. Therefore, when the licences would come up for renewal that would be the most appropriate time for refarming the spectrum.
2. The licensees, which were awarded Cellular Mobile Telecom Service (CMTS) Licences in 1994 and 95, were mostly having spectrum in the 900 MHz band. When these licences, came up for renewal, following options were explored for the assignment of spectrum held by these licensees:
	1. full refarming of the 900 MHz band where incumbent operator was permitted to retain any spectrum in that frequency,
	2. partial refarming where an incumbent operator was permitted to retain 2.5 MHz in the 900 MHz band;
	3. partial refarming where an incumbent operator was permitted to retain 5 MHz of spectrum.

Pros and Cons of each of the above approaches are given below:

|  |  |  |  |
| --- | --- | --- | --- |
| Option No. | Quantum of 900 MHz spectrum permitted to be retained on renewal of license | Pros | Cons |
|  | 0 MHz(i.e refarm entirely) | 1. Gives equal opportunity to all TSPs to bid
2. Both holders and non-holders have to bid on an equal footing, so optimize price realization
 | 1. Incumbents infrastructure could become redundant if they fail in the auction
2. Incumbents would need to make substantial additional investment on towers and equipment if they fail in the auction
3. Till (new) auction winners have infrastructure in place, there could be adverse impact on:

(a) Rural Coverage(b) Quality of urban coverage |
|  | 2.5 MHz (refarm balance) | 1. Allows some retention, significantly moderates adverse impact on rural, urban areas
2. Ensures that both holders and non-holders bid, so still optimizes price realization
3. Gives adequate opportunity to all TSPs
 | 1. May not be optimal technically, but can be optimized if some spectrum is also held in 1800 MHz band
2. Cannot be used to deploy LTE etc. unless 5 MHz is available / acquired in 900 MHz band
 |
|  | 5.0 MHz (refarm balance) | 1. Avoids any redundancy of existing infrastructure
2. Avoids any temporary adverse impact on existing services
3. Enables deployment of 4G / LTE technologies by TSPs on liberalization
 | 1. No incentive for incumbents to bid – adverse impact on price realization
2. No equal opportunity for non-holders to win 900 MHz spectrum in auction
3. Perpetuates current holding pattern of 900 MHz spectrum with only 0 or 1 block of 5 MHz available for non-holders of 900 MHz spectrum
 |

After due deliberation, it was decided that the entire spectrum should be refarmed and incumbents should not be allowed to retain any spectrum. Accordingly, entire spectrum held by them in 900/1800/800 MHz bands was put to auction and the incumbent licensees were required to take part in the auction to regain it.

Following the above approach, about 50% of the spectrum assigned in 800/900/1800 MHz band is a liberalised spectrum at on date.

The licensees who are holding the non-libarealised spectrum have been given a option to refarm their spectrum for the liberalised use by paying the auctioned determined period pro-rated of the remaining validity period of the licence validity.

* 1. **RE-FARMING EXPERIENCE IN PAKISTAN**
		1. **Pakistan Telecommunication Authority (PTA):**

Pakistan Telecommunication Authority (PTA) is government agency responsible for the establishment, operation and maintenance of telecommunications in Pakistan.

The Pakistan Telecommunication Ordinance 1994, established the primary regulatory framework for the telecommunication industry including the establishment of an authority. Thereafter, Telecommunication (Re-Organization) Act no XVII was promulgated in 1996 that aimed to reorganize the telecom sector of Pakistan. Under Telecom Reorganization Act 1996, Pakistan Telecommunication Authority (PTA) was established in 1996 to regulate the establishment, operation and maintenance of telecommunication systems, and the provision of telecom services.

* + 1. **Frequency Allocation Board (FAB):**

Frequency Allocation Board was established under Section 42 of the Pakistan Telecommunication (Re-organization) ACT 1996 to take over functions of the then Pakistan Wireless Board.

FAB analyzes and assigns the portions of Radio Spectrum to intended wireless users in the country. It safeguards and monitors the national spectrum to ensure its optimum utilization across Pakistan. It also performs necessary international coordination and agreements with other administrations in relation to various satellite and terrestrial based communication networks whereby fulfilling national obligations as contained in international treaties of the ITU, etc,. It also performs monitoring of national spectrum for the detection of un-authorized wireless stations and users.  It also provides site clearance of all wireless installations in the country.

* + 1. **Spectrum Re-Farming in Pakistan:**

“*The Telecommunications Policy 2015*” published by the Ministry of Information Technology Government of Pakistan,is aimed to facilitate the attainment of an all-embracing national agenda and to transform Pakistan into an economically vibrant, knowledge-based, middle-income country by 2025.

This document indicates their policy on Spectrum Management including Spectrum Harmonization, Spectrum Strategy, Release of Spectrum, Spectrum Re-farming, Analogue UHF TV spectrum and MMDS spectrum, Spectrum Assignment, Spectrum for digital microwave communication, Continuing spectrum rights and obligations, Relinquished spectrum rights, License renewal where the license includes spectrum assignments, Introduction of Administrative Incentive Pricing (AIP) for microwave spectrum assignments, Unlicensed access, Test and development licenses, Spectrum trading, Spectrum sharing, Mergers and acquisitions and Interference protection.

Spectrum will be re-farmed where its current use is not in the best social and economic interests of Pakistan, it is underutilized, used inefficiently or its use is inconsistent with international allocations. The re-farming will ensure the reassignment of frequencies to uses with greater social and commercial benefits than are attainable from the prevailing assignment of those frequencies. Spectrum to be re-farmed will be identified in the rolling spectrum strategy. The requirement of spectrum in the context of national security will be given due consideration as per operational requirements of defense sector.

Pakistan Telecommunication Authority/ Pakistan Electronic Media Authority (PTA/PEMRA) in consultation with FAB will propose a re-farming framework to be approved by the Federal Government (MoIT).

The Spectrum Re-farming Framework will be based on international best practices and market demand scenario. The framework will be a combination of administrative, financial and technical measures aimed at moving incumbent users and hence their equipment out from their spectrum assignments in a particular band either partially or completely so that the band may be allocated to other uses. It will also provide a process for estimating the compensation required, where applicable, through a well-structured criteria.

Federal Government (MoIT), in consultation with PTA/PEMRA and FAB will decide to re-farm any spectrum and such decision will be effected through a policy directive.

Upon decision by the Federal Government (MoIT) for re-farming of a particular band, a Spectrum Re-farming Committee comprising of MoIT, FAB, PTA/PEMRA and incumbent users will:

a) Estimate the value of the re-farmed spectrum using the valuation method to be adopted;

b) Estimate the compensation cost of re-farming (for government users only); and

c) Determine timeline for Re-farming.

The government users who are required to vacate spectrum identified for re-farming, may receive compensation for relocating to new spectrum. FAB will assist these spectrum users throughout their transition to a new spectrum band. Funds for compensation may be raised from fees collected from the issuance of licenses that incorporate spectrum assignments in the re-farmed band.

On re-farming, compensation costs will be recovered from the license fees paid through the regulatory authority that collects the fees. PTA will create Spectrum Re-farming Fund (SRF) and allocate an amount, to be determined by the Re-farming Committee, from the fees it collects for this fund. Payment of compensation to the government users from whom the spectrum is re-farmed, if required, will be made as approved by the Committee on the basis of predefined criteria for the purpose.

* 1. **RE-FARMING EXPERIENCE IN SRI LANKA**
		1. **Telecommunications Regulatory Commission of Sri Lanka (TRCSL):**

The Telecommunications Regulatory Commission of Sri Lanka (TRCSL) was established under the Sri Lanka Telecommunication (Amendment) Act No.27 of 1996 as the national regulator for telecommunications and managing spectrum in Sri Lanka.

* + 1. **Spectrum Re-farming in Sri Lanka:**

There is a need to estimate the amount of spectrum needed for various services as mobile networks evolved from GSM (2G) through 3G and on to the LTE (4G).

TRCSL identifies new technologies to be introduced based on market survey and social benefits to the society at large from new service and decides the frequency band/s to be used considering the international and regional harmonization of the radio frequency spectrum.

In the process of spectrum re-farming, a Spectrum Re-farming Committee (SRC) will be formed to study and make recommendations to the Commission on suitable re-farming approach to be followed. The SRC will analyze the feasibility of the re-farming by considering the existing users in the band and the advantages of new service compared to the existing one. Then the committee will make their recommendations to the Commission on the following:

* Necessity of introducing of new technology
* Social and economic benefits of new service
* Conducting Public and Stakeholder’s consultation if necessary
* Suitable frequency bands to be used for new service
* Impact on the existing services and users in the band
* Proposals on alternative technologies or/and alternative frequency band for existing services
* Cost of compensation for replacement radio equipment of existing users
* Method of compensation
* Time line for re-farming process
* Frequency assignment mechanism for new services

The public and stakeholder consultation will be launched to get public and stakeholder opinion on introduction of new service if necessary. The TRCSL encourages all interested parties, particularly the end-users of which, to comment on the public consultation documents.

A suitable compensation mechanism will be introduced for the replacement of radio equipment or to change the technology. The TRCSL has given compensations only for government organizations, defense forces and the Police as a policy decision in previous re-farming cases.

* + - 1. **Re-farming of 3GPP Bands 7 and Band 38:**

The fixed and mobile operators have extensive infrastructure in place and have been evolving their services further. The TRCSL is in the process of allocating spectrum in 2.5GHz band to them through auctioning or other spectrum acquisition mechanisms to enable them to provide enhanced services leading to high speed packet access, allowing high data throughputs.

The LTE technology was deployed in Sri Lanka in 2013 in both 1.8GHz and 2.3 GHz frequency bands. Full band of 2.3GHz is completely utilized by fixed LTE services and a part of 1.8GHz band is utilized by mobile LTE services. In 1.8GHz frequency band, some operators deploy their LTE service coexistence with 2G services. Some operators made requests to use 900MHz and 1.8GHz frequency band for 3G and LTE services coexistence with presently available 2G service.

The 900MHz frequency band has some attractive properties; when a mobile operator seeks to meet coverage targets as fewer base station sites are needed. Sri Lanka being an urban-rural country, therefore, all mobile operators would like to deploy 3G and 4G services in 900MHz frequency band. This advantage diminishes when operating in urban areas and lager spectrum would be needed in the future, creating a demand for 1800MHz and 2300MHz spectrum bands. Re-farming will, therefore, impact on the network deployment, postulate various mixes of block size and band, and to calculate operator’s return on investment in each case as network deployment costs change in line with site count.

Considering the huge demand for data traffic, TRCSL has decided to re-farm 3GPP band 7 and band 38 to allocate for LTE service. These bands are currently assigned to long hop microwave links and need to be shifted to other suitable bands. The present and future allocation of these bands are depicted in figure 01 below.

**Figure 01. Present and future allocation of 2.5GHz frequency band**



* + - 1. **Progress of re-farming in 2.5GHz frequency band:**
* The identification of the existing users, has already been done and the usage of equipment has also been furnished by respective users in this band.
* The alternative frequencies have been identified based on hop lengths and applications.
* The alternative frequencies have been conveyed to the user to prepare estimates for the cost of replacement of the existing equipment.
* Almost all the existing users have submitted their estimations for the replacement of existing equipment based on new frequency assignments. The total cost of replacement will be Sri Lankan Rupees Hundred and Fifty Million (USD 1.035 Million based on the exchange rate 1USD = 145LKR) approximately.
* Based on the above information, the Commission will be informed to get necessary approval of the Cabinet of Ministers to implement this re-farming process.
* The compensation will be given to the existing users to migrate to the alternative frequency bands and the deadline for the completion of migration will be announced. The period of migration will be maximum of one year.
* New assignment will be done through auctioning or other spectrum acquisition mechanisms with a future effective date which will specified based on the completion date of the migration.
* Normally the cost for the compensation will be recovered from the upfront fee or re-farming fee collected from successful bidders.

The operators will be required to co-ordinate spectrum use and the avoidance of interference with themselves and other users making use of adjacent frequencies. The Commission will intervene to resolve any disputes where parties are unable to reach an agreement on coordinating the use of spectrum.

1. **CHALLENGES IN SPECTRUM RE- FARMING**

The main challenge administrations faced in re-farming is the delay in approval or decision of the respective government or authority/ies concerned. The delay may cause the financial loss to the country as well as the disturbance of the social benefits to the society at large. The timely deployment of technology, is very essential to get full use of it otherwise the technology may be outdated or obsolete within short period of time sometime before the implementation. The demand for frequency band will be decreased with time and hence the administration will lose maximum value of the spectrum when the band is offered with the delay sometime no demand at all. Therefore, the administrations should give prompt attention to start the process of the approval of higher authorities well in advanced to avoid unnecessary delays.

The unavailability of necessary data with administrations, is very common problem in many developing countries including SATRC countries. The data may include frequency data, user data, equipment data etc. Lack of data availability is due to several reasons. The main reason is that most of the administrations were formed after the liberalization of telecommunication market in late 90-ies and they started the proper regulatory practices within few years after their establishment. Most of the countries have commissioned modern spectrum management systems to process the spectrum management data in more effective and efficient way. The beginning of the implementation of database management system, the previous data had to be entered in to the system manually with the data available mainly in document format and some counties having soft format. Therefore, the entering of previous data might cause erroneous result due to human errors and wrong information available. Some administrations do not have a proper database management system yet. In spectrum re-farming, absense of necessary data, affects estimating the cost for compensations for the existing users hence the assessment of the feasibility of new system is not an easy task.

The other main challenge administrations are facing is that the reluctance of vacation of band by the existing frequency users. There may be several reasons for this situation. The main reason is that the existing users are used to operate existing technologies for their applications for a long time and their staff is trained for particular technology(ies) and they are familiar with the existing equipment(s). In the process of compensation, the existing users may get financial assistance for purchase of new equipments but no compensation at all for training their staff . This kind of shortcomings should be avoided by introducing proper compensation mechanism with the effective stakeholder consultation.

The other reason for this is that the existing users are more powerful in politically or socially or their service is crucial like the Military, the Police, disaster management etc. To handle this kind of users the approval from higher authorities like the approval of the Cabinet of Ministers, is very essential.

Lack of funds for the compensation for existing users, are also a main challenge in spectrum re-farming. Sometimes, the administration needs to clear bands for the applications like disaster management or national security. In this kind of situations, the administration are not able to get the value of the spectrum (upfront fee) or annual spectrum fee from new users. Therefore, re-farming fund should be maintained to handle this kind of situations.

The nationwide radio frequency monitoring system also a very important factor for successful implementation of spectrum re-farming. The real frequency usage can only be investigated through proper monitoring process in the area concerned sometime it may be local or nationwide. For effective monitoring, the necessity of proper frequency monitoring system will arise. Most of the SATRC countries are having frequency monitoring systems but not distributed throughout the countries and need some improvements. The frequency monitoring is also needed to verification of the clearance of the frequency band after the vacation of existing users before the re-assignment.

Sometimes, the general law of the respective countries may disrupt the process of relocation of existing users in re-farming band. Therefore, the administrations should draw prompt attention on the legislation in their countries to avoid such kind of legal problems.

1. **CONCLUSION**

The main purpose of spectrum management is to facilitate the access to people or group of people to deploy telecommunication technologies in right time without harmful interference and ensuring the effective and efficient usage or spectrum. The spectrum re-farming is a key process in spectrum management to reallocate frequency bands for more efficient technologies with higher throughput. Therefore, the re-farming is essential to cater the market demands with the development in wireless applications throughout the world.

Even though, the re-farming of spectrum is a national issue of the respective country, a prompt attention should be drawn to the international and regional harmonization of the usage of frequency band during the process of re-farming.

The proper spectrum policies are the bases of the spectrum re-farming and the administrations should formulate or improve the policies to meet the present and future re-farming issues.

This report is mainly aimed on the guide line for the spectrum re-farming for SATRC countries and the responses to the questionnaire will help the administrations to share the experiences on re-farming in each countries.

1. **REFERENCES**

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|  |  |
| --- | --- |
| ***Annexure I*** |  |
|  |  |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from India**

**Questionnaire**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)

**In India, Spectrum Refarming refers to permitting liberalised use of spectrum. Spectrum in all the bands acquired through recent auctions is liberalized spectrum. Spectrum assigned earlier administratively in 800/900/1800 MHz band was non-liberalised spectrum.**

1. What is the re-farmed Frequency band?

**Spectrum in all the bands acquired through recent auctions is liberalized spectrum. Auctions have been held in 800/900/1800/2100 MHz Bands since 2012.**

1. What are the services in this band before the re-farming?

**800 MHz band – CDMA**

**900 MHz/1800 MHz band – GSM**

1. What is the new service deploy in this band?

**Some TSPs are using /planning to use spectrum in 900 MHz band for HSPA and 800/1800 MHz for LTE. Spectrum in 2100 and 2300 MHz band was assigned through auction and has been used for HSPA and TD-LTE respectively.**

1. What is the requirement of the Spectrum Re- Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. |  |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. |  |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. |  |
|  |
|  |
| d) | Others. Please specify. **To use the spectrum for newer and more spectral efficient technologies**.1. What is time taken to complete the Spectrum Re-Farming? Please select.
 |  |
|  |
|  |

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year |  |
|  |  |  |
| b) | 1-2 years |  |
|  |  |  |
| c) | 2-5 years |  |
|  |  |  |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

**Note: - Spectrum in 800/900/1800 MHz band was assigned administrative, as part of mobile licence, till 2006. This Spectrum was non-liberalised spectrum and its use was restricted to using GSM technology in 900/1800 MHz bands and CDMA in 800 MHz bands. On completion of 20 years period, these licences are expiring in batches. Spectrum getting vacated as a result of expiry of licences is being reassigned through auction in a liberalised form. At present, approx. 50% spectrum has been liberalised through this process. This process will take more than 10 years to refarm the entire spectrum in the 800/900/1800 MHz bands.**

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  |  |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  |  |
|  |
|  |  |  |  |
| c) | Other. Please specify.  |  |  |

**The following approach was adopted for the refarming of spectrum:**

1. **Following policy decisions were taken in 2012:**
* **Spectrum is delinked from the licence.**
* **All the future access spectrum assignment will be through auctions.**
* **Use of spectrum acquired through auctions will be liberalised.**
1. **Licences were given for a period of 20 years. As the licence agreement is binding on both licensee as well as the licensor; it was thought that the spectrum assigned cannot be refarmed mid-way. Therefore, when the licences would come up for renewal that would be the most appropriate time for refarming the spectrum.**
2. **The licensees, which were awarded Cellular Mobile Telecom Service (CMTS) Licences in 1994 and 95, were mostly having spectrum in the 900 MHz band. When these licences, came up for renewal, following options were explored for the assignment of spectrum held by these licensees:**
3. **full refarming of the 900 MHz band where incumbent operator was permitted to retain any spectrum in that frequency,**
4. **partial refarming where an incumbent operator was permitted to retain 2.5 MHz in the 900 MHz band;**
5. **partial refarming where an incumbent operator was permitted to retain 5 MHz of spectrum.**

**Pros and Cons of each of the above approaches are given below:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Option No.** | **Quantum of 900 MHz spectrum permitted to be retained on renewal of license** | **Pros** | **Cons** |
|  | **0 MHz****(i.e refarm entirely)** | 1. **Gives equal opportunity to all TSPs to bid**
2. **Both holders and non-holders have to bid on an equal footing, so optimize price realization**
 | 1. **Incumbents infrastructure could become redundant if they fail in the auction**
2. **Incumbents would need to make substantial additional investment on towers and equipment if they fail in the auction**
3. **Till (new) auction winners have infrastructure in place, there could be adverse impact on:**

**(a) Rural Coverage****(b) Quality of urban coverage** |
|  | **2.5 MHz (refarm balance)** | 1. **Allows some retention, significantly moderates adverse impact on rural, urban areas**
2. **Ensures that both holders and non-holders bid, so still optimizes price realization**
3. **Gives adequate opportunity to all TSPs**
 | 1. **May not be optimal technically, but can be optimized if some spectrum is also held in 1800 MHz band**
2. **Cannot be used to deploy LTE etc. unless 5 MHz is available / acquired in 900 MHz band**
 |
|  | **5.0 MHz (refarm balance)** | 1. **Avoids any redundancy of existing infrastructure**
2. **Avoids any temporary adverse impact on existing services**
3. **Enables deployment of 4G / LTE technologies by TSPs on liberalization**
 | 1. **No incentive for incumbents to bid – adverse impact on price realization**
2. **No equal opportunity for non-holders to win 900 MHz spectrum in auction**
3. **Perpetuates current holding pattern of 900 MHz spectrum with only 0 or 1 block of 5 MHz available for non-holders of 900 MHz spectrum**
 |

**After due deliberation, it was decided that the entire spectrum should be refarmed and incumbents should not be allowed to retain any spectrum. Accordingly, entire spectrum held by them in 900/1800/800 MHz bands was put to auction and the incumbent licensees were required to take part in the auction to regain it.**

**Following the above approach, about 50% of the spectrum assigned in 800/900/1800 MHz band is a liberalised spectrum at on date.**

**The licensees who are holding the non-libarealised spectrum have been given a option to refarm their spectrum for the liberalised use by paying the auctioned determined period pro-rated of the remaining validity period of the licence validity.**

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license | **√** |
|  | (At the same, other licensees should have option to refarm also) |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. ……………………………………………………………………………….. |  |

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No | **√** |

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify.  |  |

**Not applicable, as refarming is done at the expiry of existing licensees**.

1. What is the total cost for the compensation?

**Not applicable, as refarming is done at the expiry of existing licensees**

1. How did you recover the compensation cost?

**Not applicable, as refarming is done at the expiry of existing licensees**

1. What are the technical benefits of this Spectrum Re-Farming?

**Spectrum can be used more efficiently and effectively.**

1. What are the economic benefits of this Spectrum Re-Farming?

**Telecom Service Providers are free to deploy any technology with certain interference related constraints. They can make its most optimal.**

1. What are the social benefits of this Spectrum Re- Farming?

**As the TSPs are free to use latest available technologies, subscribers will get the benefits of it.**

1. What are the prime constraints faced by the regulator and the industries while spectrum Re-farming?

**As entire spectrum held by incumbents is being put to auction at the expiry of licences , there are finite chances that incumbents may not regain spectrum, which give rise to following risk:**

1. **Incumbents infrastructure could become redundant.**
2. **Incumbents would need to make substantial additional investment on towers and equipment.**
3. **Till (new) auction winners have infrastructure in place, there could be adverse impact on:**

**(a) Rural Coverage**

**(b) Quality of urban coverage**

1. Is there any existence policy document/decisions/framework on spectrum Re-farming in your country? Please specify the name of the document and share its main content.

**No specific documents. However, following documents may be referred to:-**

1. **Notice Inviting Applications (NIA) of Nov 2012 (Auction of spectrum in 1800 MHz and 800 MHz bands), March 2013 (Auction of spectrum in 1800 MHz, 900 MHz and 800 MHz bands) and Feb 2014 (Auction of spectrum in 1800 MHz and 900 MHz bands)**

**Available at:** [**http://www.dot.gov.in/content/spectrum-management**](http://www.dot.gov.in/content/spectrum-management)

1. **TRAI’s recommendations on ‘Auction of Spectrum’ dated 23rd April 2012 and ‘Valuation and Reserve Price of Spectrum’ dated 9th September 2013**

**Available at http://**[**www.trai.gov.in**](http://www.trai.gov.in)

|  |  |
| --- | --- |
| ***Annexure II*** |  |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from Nepal**

**Questionnaire**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)

**CDMA Refarming**

1. What is the re-farmed Frequency band?

**1900 MHz Band**

1. What are the services in this band before the re-farming?

**CDMA**

1. What is the new service deploy in this band?

**GSM and WCDMA**

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. | √ |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. | √ |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. |  |
|  |
|  |
| d) | Others. Please specify. ……………………………………………………………………………………………………………………….. |  |
|  |
|  |

1. What is the requirement of the Spectrum Re- Farming? Please select.
2. What is time taken to complete the Spectrum Re-Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year |  |
|  |  |  |
| b) | 1-2 years |  |
|  |  |  |
| c) | 2-5 years | √ |
|  |  |  |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  | √ |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  | √ |
|  |
|  |  |  |  |
| c) | Other. Please specify. ………………………………………………………………………………….. |  |  |

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license |  |
|  |  |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license | √ |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. ……………………………………………………………………………….. |  |

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No | √ |

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify. ……………… |  |

1. What is the total cost for the compensation?

**Not Applicable**

1. How did you recover the compensation cost?

**Not Applicable**

1. What are the technical benefits of this Spectrum Re-Farming?

**Before Refarming only 2x45 MHz was allocated for GSM in 1800 MHz Band and only 2x20 MHz was allocated for CDMA in 1900 MHz Band. Refarming of 1900 MHz Band resulted to allocation of 2x75 MHz Bandwidth for GSM(2G) in 1800 MHz Band and 2x60 MHz Bandwidth for WCDMA(3G) in 2100 MHz Band.**

1. What are the economic benefits of this Spectrum Re-Farming?

**Wider spectrum band in 1800 MHz and 2100 MHz bands allowed for more spectrum assignments to more operators and the government is able to get more spectrum revenues.**

1. What are the social benefits of this Spectrum Re- Farming?

**GSM in 1800 MHz Band and WCDMA in 2100 MHz Band can be used in full potential.**

1. What are the prime constraints faced by the regulator and the industries while spectrum Re-farming?

**Time factor**

1. Is there any existence policy document/decisions/framework on spectrum Re-farming in your country? Please specify the name of the document and share its main content.

**Telecommunications Service Radio Frequency (Distribution and Pricing) Related Policy, 2012.**

Existing Frequency Band before refarming 1900 MHz Band

****

Cellular Mobile Frequency Band Plan after re-farming of 1900 MHz and 800 MHz

and 900 MHz Bands



|  |  |
| --- | --- |
| ***Annexure III*** |  |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from Sri Lanka**

**Questionnaire**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)

**Re-farming of 3.5GHz band for Wi-Max deployment**

1. What is the re-farmed Frequency band?
	* + 1. **GHz band**
2. What are the services in this band before the re-farming?

**Point-to-Point microwave links**

1. What is the new service deploy in this band?

**Wi-Max (IEEE 802.16d).**

1. What is the requirement of the Spectrum Re- Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. |  |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. | **√** |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. |  |
|  |
|  |
| d) | Others. Please specify.  |  |
|  |
|  |

1. What is time taken to complete the Spectrum Re-Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year |  |
|  |  |  |
| b) | 1-2 years |  |
|  |  |  |
| c) | 2-5 years | **√** |
|  |  |  |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  |  |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  |  |
|  |
|  |  |  |  |
| c) | Other. Please specify.  |  | **√** |

**The method of re-farming is a mixer or voluntary and regulatory re-farming approaches. The compensations have been given to the governmental organizations, the Military Forces and the Police. The replacement costs were calculated through government tender procedure. The private users have been given a grace period to migrate to new technologies or to new frequency bands.**

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license |  |
|  | (At the same, other licensees should have option to re-farm also) |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. ……………………………………………………………………………….. | **√** |

**Most of the users in the band, migrated during the valid licence periods and some of the have vacated the band at the end of the licence periods. Normally, the frequency licence are issued for one year period in Sri Lanka.**

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No |  |

**The compensations have been given only for the governmental organizations, the Military and the Police.**

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify.  | **√** |

**The cost of compensations has recovered by upfront fee (or re-farming fee) from new comer.**

1. What is the total cost for the compensation?

**Specific value is hard to find.**

1. How did you recover the compensation cost?

**The cost of compensations has recovered by upfront fee (or re-farming fee) from new comer.**

1. What are the technical benefits of this Spectrum Re-Farming?

**Spectrum was used data demand more efficiently and effectively.**

1. What are the economic benefits of this Spectrum Re-Farming?

**Wi-Max services have been given primarily for corporate data users and this was major boost of telecommunication facilities in various sectors in the business.**

1. What are the social benefits of this Spectrum Re- Farming?

**More social benefits in the fields like finance, education, medical, entertainment etc..**

1. What are the prime constraints faced by the regulator and the industries while spectrum Re-farming?
* **Existing users are reluctant to vacate the band**
* **Lack of accurate data on frequencies and equipment being used**
* **Alternative frequency allocations are not possible based on user’s requirement. E.g. unavailability of microwave frequencies for links with long hops.**
* **Lack of coordination of existing users**
* **Delay in making government decisions on re-farming including the adaption of technologies. E.g. Decision on digitalization of TV**
* **Lack of proper policies on Spectrum Management including Re-Farming**
* **Difficulty in deciding base price for upfront or re-farming cost**
* **No proper guideline for compensation procedure**
* **Difficulties in international coordination**
1. Is there any existence policy document/decisions/framework on spectrum Re-farming in your country? Please specify the name of the document and share its main content.

**No specific documents.**

|  |  |
| --- | --- |
| ***Annexure IV*** |  |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from Bangladesh (700MHz Band)**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)

700 MHz band

1. What is the re-farmed Frequency band?

700 MHz

1. What are the services in this band before the re-farming?

Spectrum was given to Internet Service Provider (ISP) before.

1. What is the new service deploy in this band?

Not yet deployed. But it has been identified for IMT. It is planned to release in near future.

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. |  |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. |  |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. | X |
|  |
|  |
| d) | Others. Please specify. ……………………………………………………………………………………………………………………….. |  |
|  |
|  |

1. What is the requirement of the Spectrum Re- Farming? Please select.
2. What is time taken to complete the Spectrum Re-Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year |  |
|  |  |  |
| b) | 1-2 years |  |
|  |  |  |
| c) | 2-5 years | X |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  |  |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  | X |
|  |
|  |  |  |  |
| c) | Other. Please specify. ………………………………………………………………………………….. |  |  |

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license |  |
|  |  |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license | X |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. ……………………………………………………………………………….. |  |

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No | X |

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify. ……………… |  |

1. What is the total cost for the compensation?

N/A

1. How did you recover the compensation cost?

N/A

1. What are the technical benefits of this Spectrum Re-Farming?

Updated technology can be used by this Re-Farming.

1. What are the economic benefits of this Spectrum Re-Farming?

Previously it was assigned without any acquisition fee. By deploying network in this band, the industry can earn as well as during release of this band as IMT Govt. can earn revenue.

1. What are the social benefits of this Spectrum Re- Farming?

The social benefit from this band will be more coverage with greater throughput can be experienced by the users. Rural connectivity will be easier. As the deployment cost required in this band will be less to cover more, customer will enjoy better service in affordable price.

|  |  |
| --- | --- |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from Bangladesh (2300MHz Band)**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)

2300 MHz band

1. What is the re-farmed Frequency band?

2300 MHz

1. What are the services in this band before the re-farming?

Spectrum was given to Internet Service Provider (ISP) before.

1. What is the new service deploy in this band?

Broadband Wireless Access (BWA) service.

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. |  |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. | X |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. |  |
|  |
|  |
| d) | Others. Please specify. ……………………………………………………………………………………………………………………….. |  |
|  |
|  |

1. What is the requirement of the Spectrum Re- Farming? Please select.
2. What is time taken to complete the Spectrum Re-Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year |  |
|  |  |  |
| b) | 1-2 years | X |
|  |  |  |
| c) | 2-5 years |  |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  |  |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  | X |
|  |
|  |  |  |  |
| c) | Other. Please specify. ………………………………………………………………………………….. |  |  |

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license |  |
|  |  |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license | X |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. ……………………………………………………………………………….. |  |

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No | X |

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify. ……………… |  |

1. What is the total cost for the compensation?

N/A

1. How did you recover the compensation cost?

N/A

1. What are the technical benefits of this Spectrum Re-Farming?

Updated technology can be used by this Re-Farming.

1. What are the economic benefits of this Spectrum Re-Farming?

Previously it was assigned without any acquisition fee. By deploying network in this band, the industry can earn as well as during release of this band as IMT Govt. can earn revenue.

1. What are the social benefits of this Spectrum Re- Farming?

The social benefit from this band will be more coverage with greater throughput can be experienced by the users. Rural connectivity will be easier. As the deployment cost required in this band will be less to cover more, customer will enjoy better service in affordable price.

|  |  |
| --- | --- |
| ***Annexure V*** |  |
| APTlogogreen3 | ASIA-PACIFIC TELECOMMUNITY |
| **Meeting of the SATRC Working Group on Spectrum** |  |

**SPEC-02: Spectrum Re-Farming in SATRC Countries-Response from Bhutan**

**Questionnaire**

1. Name/Title of the Spectrum Re- Farming case in your country. (If there are more than one cases, please use separate questionnaire forms)
2. **In Bhutan, at the moment, the Spectrum Re-farming is not carried out under direct compulsion by the regulator. It is done through the voluntary application of the operators.**

**When the applicable frequency bands are free or the already in use frequencies can be deployed for better technology and services, the operators either applies to migrate their existing service from one frequency band to another free frequency band or intends to deploy new technology or services in the already in use frequency bands.**

**Title: 1800MHz Refarming**

1. What is the re-farmed Frequency band?

**Ans: 1800MHz band**

1. What are the services in this band before the re-farming?

**Ans: GSM**

1. What is the new service deployed in this band?

**Ans: 4G LTE**

1. What is the requirement of the Spectrum Re- Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | A spectrum allocation have been in operation for a considerable period of time and currently no longer matches the demands of users, or the capabilities of modern systems. |  |
|  |
|  |
|  |  |  |
| b) | An allocation within a specific range of frequencies is required for a new radio service and these frequencies are occupied by services with whom the new service cannot share. | **X** |
|  |
|  |
|  |
| c) | A decision by a WRC to allocate a currently occupied frequency band to different service on a regional of global basis. |  |
|  |
|  |
| d) | Others. Please specify. **Ans: The operator was assigned with 2x20MHz frequency in 1800MHz for GSM. Since the operator felt that the 2x10MHz was sufficient for its GSM operation, it decided to deploy the remaining 2x10MHz along with an additional 2x10MHz (additional assignment by regulator) for the 4G LTE services.****As the frequency band was suitable for 4G LTE, the operator decided to refarm its assigned frequencies in deploying 4G LTE.** | **X** |
|  |
|  |

1. What is time taken to complete the Spectrum Re-Farming? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Less than 01 year | **X** |
|  |  |  |
| b) | 1-2 years |  |
|  |  |  |
| c) | 2-5 years |  |
|  |  |  |
|  |  |  |
| d) | 5-10 years |  |
|  |  |  |
| e) | More than 10 years |  |

**Note: - The spectrum refarming case for the above mentioned case is straight forward. The operators submitted the application to the regulator to use the half of already assigned frequencies in 1800MHz to the operators to be deployed for 4G LTE with an additional 2x10MHz frequency assignment in 1800MHz by the regulators.**

**The operator had previously deployed 2x20MHz frequency band in 1800MHz for GSM. Now they have refarmed 2x10MHz from already assigned for 4G LTE. They have also applied for additional 2x10MHz in 1800MHz which was later assigned to the operator. Therefore, it took less than one year for the operator for deploying 4G LTE services in 1800MHz.**

1. What is method/methods applied for the Spectrum Re- Farming? Please select.

|  |  |  |  |
| --- | --- | --- | --- |
| a) | Voluntary Spectrum Re- Farming (Ehen the administration decides to implement Spectrum Re-Farming and to use the methods to encourage the existing spectrum user/users to voluntarily decide to return the frequencies used or re-farming.)  |  | **X** |
|  |
|  |
|  |  |  |  |
| b) | Regulatory Spectrum Re-Farming (This is the approach most associated with an administrative policy to redeploy spectrum) |  |  |
|  |
|  |  |  |  |
| c) | Other. Please specify.  |  |  |

1. If the Method of the Spectrum Re-Farming in the item 4, is the Regulatory Spectrum Re-Farming, what is the more appropriate description for your Spectrum Re-Farming Case? Please select.

|  |  |  |
| --- | --- | --- |
| a) | Spectrum Re-Farming at the expiration of the current license |  |
|  | (At the same, other licensees should have option to refarm also) |  |
| b) | Spectrum Re-Farming at the end of equipment’s lifetime and before the expiration of the license |  |
|  |
|  |  |  |
| c) | Spectrum Re-Farming at the end of equipment’s lifetime and after the expiration of the license |  |
|  |
|  |  |  |
| d) | Spectrum Re-Farming during the equipment’s lifetime and before the expiration of the license | **X** |
|  |
|  |  |  |
| e) | Spectrum Re-Farming in license exempt band  |  |
|  |  |  |
| f) | Others. Please specify. …………………………………… |  |

1. Has the compensation been given to the existing uses in the band for the migration to the other band?

|  |  |  |
| --- | --- | --- |
| a) | Yes |  |
|  |  |  |
| b) | No | **X** |

1. If yes, who did pay the compensation? Please select.

|  |  |  |
| --- | --- | --- |
| a) | New user (Incomer) |  |
|  |  |  |
| b) | Administration/ Government |  |
|  |  |  |
| c) | By Re-Farming fund |  |
|  |  |  |
| d) | Others. Please specify.  |  |

1. What is the total cost for the compensation?

**Ans: Not applicable**

1. How did you recover the compensation cost?

**Ans: Not applicable**

1. What are the technical benefits of this Spectrum Re-Farming?

**Ans: The Mobile operators provide the required service more effectively and efficiently. The assigned spectrum is more spectrally efficient, can render more coverage with more penetration.**

1. What are the economic benefits of this Spectrum Re-Farming?

**Ans: When the frequency is optimally used with cost efficient technology and equipments which further reduces the interference related constraints, the economic benefits are definitely derived.**

1. What are the social benefits of this Spectrum Re- Farming?

**Ans: With the efficient technology and good quality of services provided, the subscribers get the benefits. The good and uninterrupted service to the users definitely brings the social benefits to the community.**

1. What are the prime constraints faced by the regulator and the industries while spectrum Re-farming?

**Ans: since, the decision to deploy 4 G LTE services in 1800 MHz was of the operators, the operators did not face much difficulty in this spectrum re-farming except the need to procure few more equipments.**

**On the regulators side, it was also not of much difficulty except the certain administrative procedures.**

1. Is there any existence policy document/decisions/framework on spectrum Re-farming in your country? Please specify the name of the document and share its main content.

**Ans: No specific documents. However, we refer to the National radio Rules**