PAKISTAN TELECOMMUNICATION AUTHORITY

Paper on Spectrum Trading and Recommendations for PTA

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Table of Contents

Executive Summary

The core spectrum management objectives include promotion of technological innovation. This is a real challenge because spectrum is a scarce resource. In order to tackle this challenge, various technical and regulatory tools are used all over to the world by the regulators. One of such tools is spectrum trading defined above.

Spectrum trading is the transfer of full or partial rights and associated obligations to use spectrum. One of the standard definitions[1] of spectrum trading is:
"Spectrum trading, or the transfer of spectrum usage rights, denotes to a mechanism whereby rights of use are transferred from one user to another for a certain price. In contrast to a system in which spectrum is returned and then re-assigned, the trading approach is characterized by the fact:

- The transfer of the right to use the spectrum in question is initiated voluntarily by the present user.
- The sum paid by the new owner of the spectrum usage right is retained, either in full or in part, by the previous owner."

This paper aims at:

a. Exploring the regulatory framework of spectrum trading.
b. Explore the legislative and required policy framework to support spectrum trading.
c. Devise the recommendations on spectrum trading for making it part of the paper on "Spectrum Management Recommendations" which would be sent to GoP as an input to Spectrum Policy project and implementation of radio frequency management reforms in Pakistan.

We will discuss case studies of Office of Communication (Ofcom) which is UK's communication regulator and Radio Spectrum Policy Group (RSPG) which assists European Commission in the development of radio spectrum policy. In the end we will conclude and suggest recommendations.

[1] The Regulatory Environment For Future Mobile Multimedia Services, ITU Document MMS/04, 6 June 2006 by Mainz http://www.itu.int/osg/spu/ni/multimobile/papers/MMS_flexiblespectrumstudy_060606.pdf

1. Introduction

1.1 Background

Spectrum is a scarce resource. According to ITU report[2]:
"While the recent growth in demand for mobile telecommunication services has driven a large portion of spectrum demand, the growing popularity of entirely new applications such as the Global Positioning System (GPS), which was originally developed for defense purposes, as well as radio tracking applications such as the use of Radio Frequency Identification (RFID) tags have also placed a greater burden on spectrum resources."

Spectrum trading would enable the license transfer to the user who value it the most thus providing maximum **benefit to the economy**. On economic gain, it is may be noted[3]:
"Primarily, economic efficiency could be more easily achieved by exposing licensees to the opportunity cost of their spectrum. If the value a licensee places on the spectrum is lower than that placed on it by another party, the reassignment of the spectrum to the other party would result in a gain in economic efficiency."

1.2 General Purpose of Spectrum Trading

The idea behind introducing spectrum trading is to minimize anticompetitive **spectrum hoarding** and allow flexible use of spectrum optimally and efficiently. Spectrum hoarding or spectrum holding is the accumulation of spectrum for future use. Unnecessary storage of bandwidths (spectrum) introduces monopoly in the market and leads to anti-competitive behaviors. Spectrum trading will be effective to minimize spectrum hoarding/holding. According to ITU[4]:

"The practice of hoarding spectrum refers to companies that hold unused spectrum which they have no intention of actively using in future. There are two motives for spectrum hoarding:

- Unused spectrum may held for speculative reasons in order to sell it for a profit at a later date.
- Spectrum may be hoarded in order to prevent others from using it. This may be motivated by anti-competitive considerations."

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[2] Workshop on Radio spectrum Management For a Converging World, February 2004, You can find more on International Herald Tribune, "Toward a Network of Things", Oct 15, 2003 at www.iht.com/articles/113815.html.
[3] Workshop on Radio spectrum Management For a Converging World, February 2004, ITU Document RSM/07
[4] The Regulatory Environment For Future Mobile Multimedia Services, ITU Document MMS/04, 6 June 2006 by Mainz

Spectrum is a **scarce resource** and it should be utilized efficiently. Spectrum is a valuable asset needed to offer multi-services including cellular telephony. The demand for bandwidth (spectrum) is increasing with the introduction of new technologies and subscriber growth. According to ITU:
"Spectrum trading contributes to a more efficient use of frequencies"[5]

Spectrum trading and spectrum liberalization go hand in hand. Spectrum liberalization is the change in conditions to use the license. Spectrum liberalization would be a necessary step for spectrum trading allowing more than one user to share the spectrum. Spectrum trading will increase flexibility in the use of spectrum. Spectrum trading if combined with spectrum liberalisation would give the users flexibility in terms of spectrum usage.

Spectrum trading will allow more users to access spectrum by dynamically accessing the spectrum (Dynamic Spectrum Access). Dynamic spectrum access allows two users to operate, and access and share spectrum on timely basis. Spectrum trading will open the door for Dynamic Spectrum Access.
"Today's wireless networks are characterized by a fixed spectrum assignment policy. However, a large portion of the assigned spectrum is used sporadically and geographical variations in the utilization of assigned spectrum ranges from15% to 85% with a high variance in time. The limited available spectrum and the inefficiency in the spectrum usage necessitate a new communication paradigm to exploit the existing wireless spectrum opportunistically. This new networking paradigm is referred to as NeXt Generation (xG) Networks as well as Dynamic Spectrum Access (DSA) and cognitive radio networks."[6]

[5] The Regulatory Environment For Future Mobile Multimedia Services, ITU Document MMS/04, 6 June 2006 by Mainz
http://www.itu.int/osg/spu/ni/multimobile/papers/MMS_flexiblespectrumstudy_060606.pdf
[6] NeXt generation/dynamic spectrum access/cognitive radio wireless networks: A survey, Available online at www.sciencedirect.com , 17 May 2006

2. Introduction of Spectrum Trading

2.1 What is Spectrum Trading?

Spectrum trading is the trading of rights and associated obligations to use spectrum. "Secondary trading of spectrum permits the purchaser to change spectrum while maintaining the right to use – "property rights"."[7]
Spectrum trading will provide an incentive to the licensees to lease or sale the part of spectrum which is not in their use thus allowing the spectrum to be used more efficiently.

2.2 Benefits to the Country

As spectrum is a **scarce resource**, it should be managed in efficient manner to get maximum benefits. Secondary market is always helpful in the reallocation of resources between users. The aim of introducing spectrum trading is to achieve the highest usage value of the spectrum. It will maximize the benefit in terms of social usage, economic increase, and help towards the National Policy Goal to maximize the proliferation of spectrum.

"The economic value of the radio industry (excluding civil aviation, defence and other public sector use of radio) is some £20 billion per annum at 2000 prices"[8]

"The wireless telecommunications sector plays an important role in the Canadian economy, accounting for 25,000 jobs, over $9.5 billion in revenue, and a $4.1 billion investment in infrastructure. In recent years, the number of wireless subscribers has increased at a compound annual growth rate exceeding 17% to reach 14.9 million while revenue has grown at a rate of 14% to reach $9.5 billion. "[9]

Spectrum trading has direct effects on incumbent operators. New entrants to the market will not face any difficulty in acquiring spectrum. An example is the WiMAX operators in Pakistan. WiMAX operates in 2.5 GHz, 3.5 GHz and 5.8 GHz band. Out of these bands, in Pakistan only 3.5 GHz band has been allocated to WLL operators for WiMAX.

Spectrum is a vital input to many services. The demand for different services increases with the time. Example is ever increasing demand in mobile phones that they now became a necessity for everyday chores. Allocating spectrum for new services will bring innovation in services to the users.

[7] ITU document on Introduction of Spectrum Trading by Mclean Foster & Co. , Executive level training for regulators and policy makers , Dec 3,2006
[8] Review of Radio Spectrum Management for Department of Trade and Industry by Professor Cave Martin
[9] Spectrum Policy Framework for Canada, DGTP-001-07, June 2007

2.3 Spectrum Scarcity and Rise in Spectrum Demand

The demand for services changes with the passage of time and since different services are employed best in different frequency bands, it is often desirable to move to higher frequencies and refarm the spectrum. The alignment of spectrum and reallocation of frequencies is the biggest challenge facing by spectrum regulators. Spectrum trading would be helpful in the alignment of spectrum for better uses and achieve maximum benefit.

The demand of spectrum for public telecom service is increasing and to met the same the spectrum allocated historically for other services / activities be got vacated. The requirements of spectrum for public telecom services would be:

Demand Scenario	Spectrum Requirement (MHz)		
	2010	2015	2020
High Demand	840	1300	1720
Low Demand	760	1300	1280

Source: Migration Issues: Developing Countries- the Regulatory Issues[10]

3. Regulator's Role in Spectrum Management

Regulators are concerned with two forms of efficiency in managing spectrum:

- **Technical Efficiency**
  The objective of technical efficiency is to achieve maximum possible use of available spectrum within acceptable interference limits. It also aims to promote the development and introduction of spectrum-saving technologies.

- **Economic Efficiency**
  Economic efficiency, on the other hand, involves ensuring that spectrum is allocated and assigned to uses that derive the highest economic value from it. Economic efficiency is easy to achieve than technical efficiency.

Radio Spectrum Policy Group carried out a survey report on Role of the National Regulatory Authority in Spectrum Trading. There is general agreement that the **NRA's main role**[11] should be to:

[10] ITU Regional Workshop on IMT, 7-8 June 2010, Viresh Goel Deputy Advisor TRAI
[11] RSPG04-43 WG Secondary Trading – Summary of replies to public consultations

- Maintain in a transparent and non-discriminatory manner, detailed on-line registries recording the rights and obligations associated with each trade, and the corresponding assignments;
- Guarantee and police spectrum rights, investigate possible infractions and manage disputes between users by taking binding decisions on them;
- Establish levels of acceptable interference and ensure that these levels are not exceeded;
- Guarantee efficient and effective use of spectrum, in particular, prevent speculative hoarding, avoid fragmentation of spectrum, re-assign spectrum;
- Establish clear and detailed rules for secondary trading, with clearly defined rights and obligations for all parties involved;
- Monitor and control spectrum use, including assignments characteristics;
- Continue spectrum harmonisation on an international basis;
- Control and evaluate change of use, with prior publication of requests for such changes, appropriate technical studies and industry consultation;
- Ensure observance of competition rules, detect and prevent anti-competitive behaviour and control concentrations of market power;

The Management should make sure that transfer of license or rights and associated obligations in case of outright total transfer/outright partial transfer or concurrent total transfer/concurrent partial transfer should be transparent and fair.

The Management should make sure to avoid excessive spectrum fragmentation. The Management should define Minimum Contiguous Bandwidth that can be tradable should be defined to avoid spectrum fragmentation.

The Management should make sure that QoS is not decreased below a certain threshold while sharing bandwidths.

3.1 Administrative Rigidity

Administration's rigid behavior towards the usage of spectrum users leads to spectrum inefficient use. If the spectrum usage is minimum for one licence holder, the spectrum is being under-used. However the same licence holder can sale, lease or share the spectrum by changing the terms and conditions of that particular licence, hence called spectrum trading. The change in the terms and conditions of the licence is spectrum liberalisation.

As the demand for spectrum is increasing with the introduction of new services, frequency bands are becoming more congested especially the lower frequency bands. The spectrum should be aligned according to the services for the future use vacating the lower frequency bands for new services. The spectrum managers all

over the world are following the approaches towards frequency sharing by using methods such as inband sharing, licensing such as leasing and spectrum trading. They are also using the unlicensed spectrum combined with low power radios or advanced radio technologies including ultra-wideband.

3.2 Trends in Spectrum Management Reforms

Advanced spectrum allocation strategies are based on Radio Resource Management, which is all about interference management and allocation techniques for multi-band operation.
New technologies used for improving Bandwidth Efficiency include:
• Bunched systems;
• Ultra-wideband (UWB);
• Adaptive modulation and coding (AMC);
• Flexible frequency sharing;

3.2.1 Bunched Systems

In pedestrian and indoor environments, there will be severe fluctuations in traffic demands, high user mobility and different traffic types. This highly complex environment will require advanced Radio Resource Management algorithms. It could be beneficial to have a central intelligent unit that can **maximize the resource utilization**. This capability is provided by bunched systems.
The advantage of using Bunched systems provides dynamic distribution of load, dynamic Radio Resource Management, and adaptive coverage control. Bunched systems are well suited to hotspot coverage like in case of WiFi and WiMAX.
Design issues of the radio access network (RAN) and the Radio Resource Management algorithm for the bunched systems must be considered before choosing bunched systems to achieve bandwidth efficiency.

3.2.2 Ultra-wideband (UWB)

The basic concept of UWB is to develop, transmit and receive an extremely short duration burst of RF energy. The transmitted waveforms are extremely broadband (typically some gigahertz).
Its advantage is that UWB systems provide the potential for **spectrum sharing** between services and more **efficient use** of spectrum.
However, it should be consider that no internationally agreed definition of UWB exists because the applications and uses to which this technology are very diverse and the devices have not been fully developed yet.

3.2.3 Adaptive modulation and coding (AMC)

Adaptive modulation and coding schemes adapt to channel variation by varying parameters such as modulation order and code rate based on channel status information (CSI).
The advantage of AMC schemes is that the amount of spectrum utilized is based on the actual channel conditions rather than worst case channel conditions.
However, it should be noted that delays in reporting the channel conditions reduces the reliability of the channel status indicator which may cause the system to select incorrect modulation levels and coding rate.

3.2.4 Flexible Frequency Sharing

Flexible frequency sharing is a method to optimize the use of spectrum resources is sharing of frequency carriers between different operators and users.
Its advantage is that spectrum resource is used more efficiently.
While implementing it, we must consider that the use of flexible spectrum sharing may have serious implications on the time required to scan the spectrum and locate a radio access technology (RAT) carrier after the terminal has been powered on.

4. Spectrum Trading Rights

Since spectrum trading is all about **trading of rights** so it is necessary to study what kind of rights are associated with spectrum trading. The generic framework is based upon

Spectrum Management Rights (SMR)

Spectrum Management Rights are the rights of owner over the segments/chunks of spectrum relating to frequency and geography. This can also be time limited. Spectrum Management Rights holder have the right to issue Spectrum Usage Rights that comply and are compatible with their SMR terms and conditions.

Spectrum Usage Rights (SUR)

Spectrum Usage Rights are the rights associated with the user to transmit and receive at a specific location or service area. Each SUR would be associated with its parent SMR.

The transferor and the transferee should be very clear about the following:

- **Band available** to the transferee to use.
- **Geographical area** in which the specific band can be used.
- **License time period** validity, the time till which the transferee can use the license rights and its associated obligations.
- **Services types** which the transferee can avail.
- **Interference threshold level** which should not be exceeded by the transferee during the holding of licence.

4.1 Spectrum Management Rights

The SMR owner's rights would include but not be limited to the following:

1. "Exclusive" management rights to use radio spectrum within specified range of (frequency, geography). The owner has powers to change rights for spectrum management reasons and this could include deployment of technologies such as Ultra Wideband, Bunched systems, Adaptive modulation and coding (AMC), Flexible frequency sharing.

2. The owner has right to introduce or modify SURs following a specified procedure. This would require to register SURs and to obtain the consent of the SUR holder in the case of modifications.

3. Right to operate up to an envelope of parameters (e.g. EIRP).

4. Right to negotiate changes to the SMR parameters with neighbours in geography or frequency subject to certification that changes will not cause harmful interference to other parties and site clearance is obtained where required;

5. The owner has the right to trade. No licensee will be forced to trade. Licensees will sale or lease spectrum by their own will.

6. The type of transfer will depend on the license holder.

- Transfer of all or only some parts of the rights and associated obligations of a license (full or partial transfer of rights)
- The old licensee can operate at the same time in parallel (concurrent holding) or sole holding. (Holding of a license)

4.2 Spectrum Usage Rights

When buyers acquire licences to use spectrum, perhaps through auction, they expect that they have bought certain rights. These rights are often expressed as both a right to transmit within certain guidelines, and a right to expect only low levels of interference from others. While the right to transmit is normally clearly defined, the expected level of interference is less so. Often, a licence states that the user can expect the spectrum to be free of 'harmful interference'.

Spectrum Usage Rights would give the owner

1. Rights to operate according to a set of defined transmission parameters and receive specified levels of interference protection

2. Right for their receiver characteristics to be taken into account when other's proposed change of use is assessed

3. Right to trade the SUR. This may require the approval of the SMR holder, depending on the terms and conditions written into the SUR. The extent to which an SMR holder might change the associated SURs will depend on the precise terms of the SURs.

5. Forms of Spectrum Trading

Different forms of spectrum trading that can take place are:

- ***Sale*** - Ownership of the usage right is transferred to another party.
- ***Buy-Back*** – A usage right is sold to another party with an agreement that the seller will buy back the usage right at a fixed point in the future.
- ***Leasing*** – The right to exploit the usage right is transferred to another party for a defined period of time but ownership, including the obligations this imposes, remains with the original rights holder.
- ***Mortgage*** – The usage right is used as collateral form for a loan, analogous to taking out a mortgage on an apartment or house.

Every system that governs spectrum usage rights has at least three dimensions:

- The **spectrum band** which can be used
- The **geographical area** where the spectrum band can be used
- The **period of time** during which it can be used

6. Interference

6.1 Types of Interference

One of the main threats to spectrum trading is interference. The main types[12] of interference are:

• The **in-band interference from co-channel transmissions** across geographic boundaries (as shown in red)

• The **in-band interference from out-of-band emissions** falling across frequency boundaries (as shown in blue)

• The **out-of-band (adjacent channel) interference** (as shown in green) is determined by the in-band power of the transmitter and the out-of-band performance of the victim receiver.

• The **intermodulation products** and overload (as shown in purple) are to some extent controlled by the out-of-band limits applying to the transmitter. There are, however, situations where intermodulation products arise unexpectedly in a receiver or passively due to non-linear conductivity in metal. Other spurious emissions (e.g. harmonics / frequency conversion products) exist, both for transmitters and receivers.

[12] Final Report Executive Summary on Spectrum usage Rights published on 10th February 2006 by AEGIS spectrum engineering

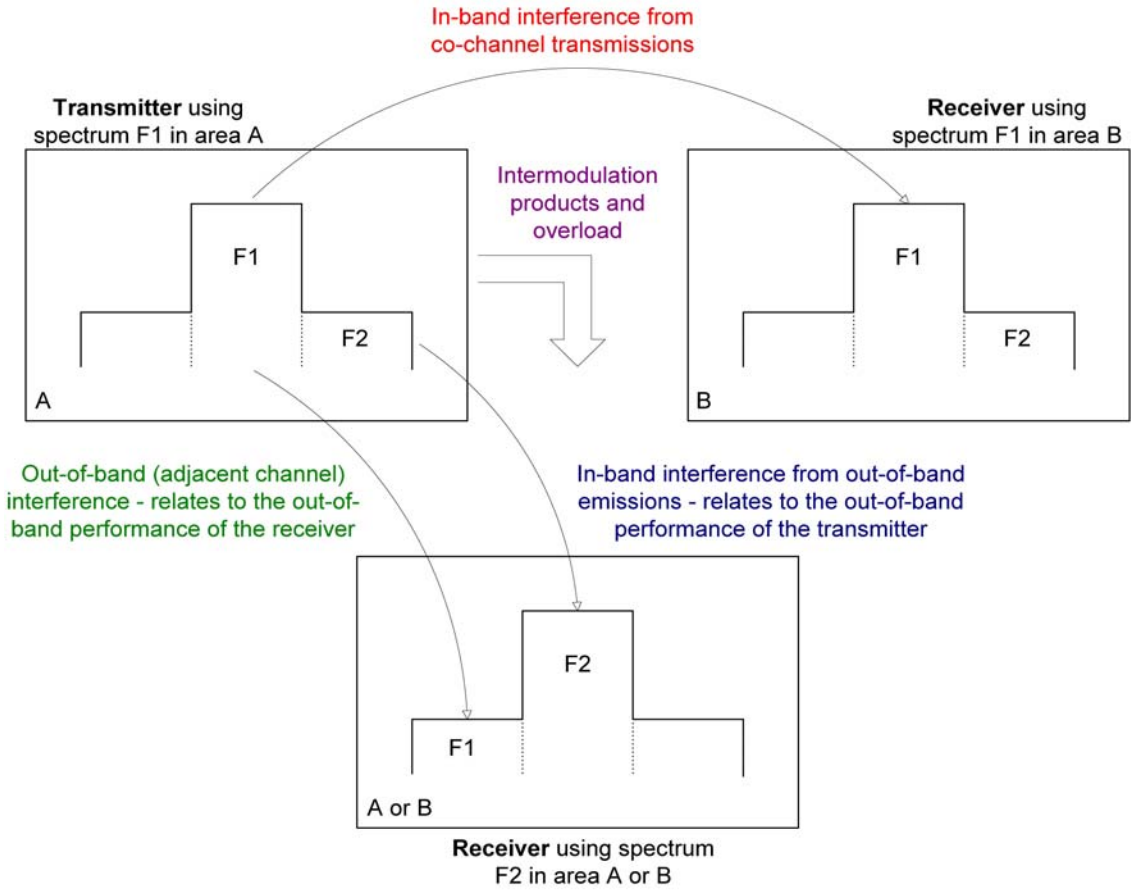


Figure 1: The interference environment

Figure showing different types of interferences[13]

The following table[14] provides a more detailed overview of the main elements that need to be defined in any regime governing rights of use.

Table 1: Elements of spectrum usage requiring definition

Element	Description
Nature of rights	Tradable spectrum access licences defined in terms of frequency, geography, emissions. Change of use within ITU allocation. Right to sign leasing agreements.
Type of licence	Possibility of partitioning assigned spectrum into tradable units, tradability of spectrum assigned to government bodies.
Method for transferring control	The Federal Network Agency decides on mechanism; parties apply for the Federal Network Agency approval of an intended trade; no restricted on transfer if new licensee agrees to meet all conditions within the original licence.
Transfer of control	Current spectrum use registered with the regulatory authority in a

[13] Final Report Executive Summary on Spectrum usage Rights published on 10th February 2006 by AEGIS spectrum engineering

[14] Source : Department of Trade and Industry, Review of Radio Spectrum Management (2002), p. 116, WIK Consult

	central database.
Aggregation/partitioning	Is this permitted or not? It may not be permissible if it is exclusively reserved for a specified public use (e.g. military use).
Duration	How long the spectrum may be used for, period during which trading is possible.
Technical parameters	Boundaries set for point at which negotiations between neighbours (for managing interference) are triggered.
Method of changing interference parameters	Framework for negotiations between spectrum users, role of regulatory authorities as referee.
Service/technology constraints	Change of use allowed within ITU allocation and European agreements.
Compliance with licence conditions	Ensuring that licensee and/or lessee complies with conditions and obligations.
Process for enforcing interference conditions	Licensees negotiate with each other. Regulator can take action if privately negotiated solutions breach interference norms and standards.

7. Ofcom Case Study

7.1 Ofcom definition of Spectrum Trading

"Spectrum trading is the transfer of rights and associated obligations arising by virtue of a WT Act licence[15]. Associated obligations are those obligations that are necessarily and properly associated with a right, for example a limitation not to operate outside prescribed power levels."

7.2 Benefit to the country

According to a report [16]by Ofcom:
"Studies in the past have conservatively estimated that the use of radio spectrum adds around £24bn each year to the UK economy and that this value grows significantly year-on-year."

7.3 Forms of Trading

Ofcom published a register of licences-"spectrum registry" on the website for the users to find out what kinds of transfer are possible in which licence class. The licence holder would have many options to do the licence. It includes:

1. Selling all of the licence – for example, while closing the business
2. Selling part of the licence – for example, to sale out few frequencies or sale out any geographic area.
3. Lease the whole licence for a long period of time – for example, for the next 5 to 7 years.
4. Hiring the whole licence for recurring period of time – for example, allowing the transferee to access the spectrum dynamically.
5. Leasing or hiring out part of the licence concurrently holding the rights of other part of licence.
6. Buying or leasing or hiring another licence and combining it with own existing licence to increase the network or business – for example, to combine the new licence with existing one to expand the business to neighbouring town.

Trading may have different scenarios with respect to property rights and license[17].

(i) *Outright total transfer* : the transfer of all the rights and associated obligations under the license to a third party

(ii) *Outright partial transfer* : the transfer of some of the rights and associated obligations under the license to a third party

(iii) *Concurrent total transfer* : the transfer of all the rights and associated obligations under the license to a third party such that the transferor and the transferee concurrently hold the rights and associated obligations

[15] Granted under the Wireless Telegraphy Act 1949
[16] A Guide to the Spectrum Framework Review, Issued September 2005 by Ofcom
[17] A Statement on Spectrum Trading , Implementation in 2004 and Beyond, by Ofcom 6 August 2004

(iv) *Concurrent partial transfer* : the transfer of some of the rights and associated obligations under the license to a third party such that the transferor and the transferee concurrently hold the rights and associated obligations

7.3.1 Difference between Concurrent and Partial Transfer

A **Concurrent transfer** is the transfer of the rights and obligations under the licence such that the transferred rights and obligations become rights and obligations of the transferee while continuing to be rights and obligations of the person making the transfer; and
A **Partial transfer** is the transfer of only some rights and obligations under the licence. This will result in a licence being partitioned (divided) into two distinct licences. Partial transfers may be outright or concurrent.

7.3.2 Difference between Outright and Concurrent Transfer

In an outright transfer, the rights and associated obligations are fully transferred from one to another. The previous licensee does not possess any rights to use the spectrum afterwards.
In a concurrent transfer, the transferor and the transferee both have rights to use the spectrum in such a way that both do not interfere and degrade each other QoS. Ofcom thus provides flexibility in the use of license.

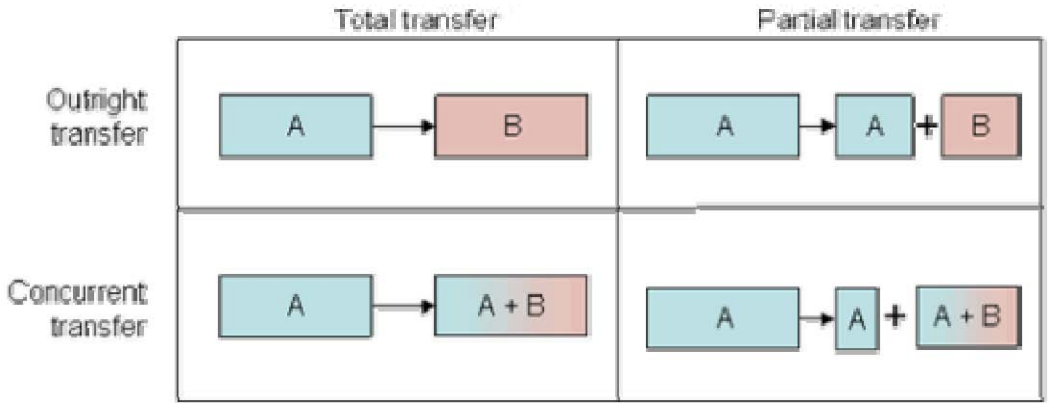


Figure 1 showing the trend of types of transfer in UK [18]

With an outright transfer, the rights and obligations of the person making the transfer become the rights and obligations of the transferee to the exclusion of the person making the transfer. After such a transfer, the original licensee (that traded the licence) no longer has any rights and/or obligations under the traded licence.

[18] A Statement on Spectrum Trading , Implementation in 2004 and Beyond, by Ofcom 6 August 2004

In contrast, with a concurrent transfer, the transferred rights and obligations become rights and obligations of the transferee while continuing, concurrently, to be rights and obligations of the person making the transfer. Such a transfer enables licensees to share rights to use spectrum. The number of concurrent licence holders is not limited in the regulations, and so joint holdings by three or more licensees might be possible. Where a licence is held concurrently by a number of licensees, the consent all those licensees to the transfer will be necessary to complete a subsequent trade. Additionally, under such a holding all licensees will be responsible for complying with licence obligations, including the obligation to pay the licence fee.

7.3.3 Total and partial transfers

Total transfers relate to the transfer of all rights and obligations held under a licence. In addition, Ofcom will introduce the possibility of two types of partial transfers, under which some of the rights and obligations under the licence will be transferred, to allow the **"splitting"** of a licence by frequency or geography.
Ofcom qualify only certain types of partial transfers for spectrum trading. These are:

- **Based on frequencies:** In the start, Ofcom allowed the transfer of rights and associated obligations of a range of frequencies for all licence classes other than Fixed Wireless Access licences operating in 3.6 GHz band.
- For example, this would give the opportunity that a licensee may transfer rights and obligations relating to a 5MHz frequency range within the overall range of frequencies authorised by his licence.

- **Based on geography:** Ofcom permits the transfer of the rights and associated obligations relating to a geographical area for Fixed Wireless Access licences operating in the 3.4 GHz and Broadband Fixed Wireless Access licences in the 28 GHz band.
- For example, a licensee may transfer rights and obligations relating to Scotland where a licence permits rights to transmit across the UK.

- **Transfers which are limited in time**

In the time limited transfer, the transferor and the transferee hold the rights and obligations for a defined "transfer period". The transfer can take place in two ways discussed below.

The transferor will hold the rights and associated obligations:

- For the period leading up to the transfer period
- For the periods after the transfer period

Such a transfer would be beneficial for organizations as it will not require the retransfer at the end of "transfer period". After the completion of "transfer period"

the rights and associated obligations would be automatically transferred to the transferor. Thus there would be no risk of retransfer failing by virtue of the operation of law rather than by the exercise of contractual rights.

The transfer can also take place in recurring transmission periods. For example, a licensee may wish to transfer the right of use between the hours of 8am and 5am only.

Table 2: Showing the permissible partial transfers under license classes[19]

Type of partitioning	**Licence Class**
Partitioning by frequency	Business Radio Technically Assigned Business Radio Area Fixed Services Point to Point Fixed Links Broadband Fixed Wireless Access (BFWA) 28 GHz (FWA) Spectrum Access 3.5 GHz Spectrum Access1785 MHz NI Award Spectrum Access 412-414 MHz Spectrum Access 1452-1492 MHz
Partitioning by geography	Business Radio Technically Assigned (partial trades of individual assignments may be traded) Business Radio Area (geographical segmentation possible down to a minimum trading unit 50 km grid square). Fixed Services Point to Point Fixed Links (partial Transfer of individual links under a licence) Broadband Fixed Wireless Access 28 GHz (BFWA) Spectrum Access 3.5GHz Spectrum Access1785 MHz NI Award Spectrum Access 412-414 MHz Spectrum Access 1452-1492 MHz
Partitioning not permitted	Business Radio Light Licences comprising of: • Simple UK • Simple Site • Suppliers Concurrent Spectrum Access (1781.7-1785/1876.7-1880 MHz) Fixed Wireless Access 3.6 GHz (FWA)

[19] A Statement on Spectrum Trading , Implementation in 2004 and Beyond, by Ofcom 6 August 2004

7.4 Legislative Framework

Ofcom documented the legal framework of spectrum trading defining the rights under a wireless telegraphy licence, possible transfers that can be made with the consent of Ofcom. Given below is a part of the legislative framework[20] of spectrum trading.

"(1) OFCOM may by regulations authorise the transfer to another person by—

(a) the holder of a wireless telegraphy licence, or

(b) the holder of a grant of recognised spectrum access, of rights and obligations arising by virtue of such a licence or grant.

(2) The transfers that may be authorised by regulations under this section are—

(a) such transfers of all or any of the rights and obligations under a licence or grant as have the effect that the rights and obligations of the person making the transfer **become rights and obligations of the transferee** to the exclusion of the person making the transfer;

(b) such transfers of all or any those rights and obligations as have the effect that the transferred rights and obligations become rights and obligations of the transferee while continuing, **concurrently**, to be rights and obligations of the person making the transfer; and

(c) transfers falling within either of the preceding paragraphs under which the rights and obligations that are acquired by the transferee take effect—

(i) if they are rights and obligations under a wireless telegraphy licence, as rights and obligations under a grant of recognised spectrum access; and

(ii) if they are rights and obligations under such a grant, as rights and obligations under a wireless telegraphy licence.

(3) Regulations authorising the transfer of rights and obligations under a wireless telegraphy licence or grant of recognised spectrum access may—

(a) authorise a partial transfer to be made by reference to such factors and apportionments, and to have effect in relation to such matters and periods, as may be described in the regulations, or as may be determined in accordance with them;

(b) by reference to such factors (including the terms and conditions of the licence or grant in question) as may be specified in or determined in accordance with the regulations, restrict the circumstances in which, the extent to which and the manner in which a transfer may be made;

(c) require the approval or consent of OFCOM for the making of a transfer;

(d) provide for a transfer to be effected by the surrender of a licence or grant of recognised spectrum access and the grant or making of a new one in respect of the transfer;

[20] Communication Act 2003

(e) confer power on OFCOM to direct that a transfer must not be made, or is to be made only after compliance with such conditions as OFCOM may impose in accordance with the regulations;
(f) authorise OFCOM to require the payment to them of such sums as maybe determined by or in accordance with the regulations in respect of determinations made by OFCOM for the purposes of the regulations or in respect of an approval or consent given for those purposes;
(g) make provision for the giving of security (whether by the giving of deposits or otherwise) in respect of sums payable in pursuance of any regulations under this section;
(h) make provision as to the circumstances in which security given under such regulations is to be returned or may be retained;
(i) impose requirements as to the procedure to be followed for the making of a transfer and, in particular, as to the notification about a transfer that must be given to OFCOM, or must be published, both in advance of its being made and afterwards;
(j) impose requirements as to the records to be kept in connection with any transfer, and as to the persons to whom such records are to be made available;
(k) set out the matters to be taken into account in the making of determinations under regulations under this section.

(4) The transfer of rights and obligations under a wireless telegraphy licence or grant of recognised spectrum access shall be void except to the extent that it is made—
(a) in accordance with regulations under this section; or
(b) in accordance with a provision specified in subsection (5).

(5) That provision is a provision which—
(a) is contained in a wireless telegraphy licence granted before the commencement of this section or in the first or any subsequent renewal after the commencement of this section of a licence so granted; and
(b) allows the holder of the licence to confer the benefit of the licence on another in respect of any station or apparatus to which the licence relates.

(6) A transfer shall also be void if it is made in contravention of a direction given by OFCOM in exercise of a power conferred by regulations under this section.

(7) Section 403 applies to the power of OFCOM to make regulations under this section."

Section 403[21] is stated under.
"403 Regulations and orders made by OFCOM

[21] Communication Act 2003

(1) This section applies to any power of OFCOM to make regulations or to make an order or scheme if that power is one to which this section is expressly applied.

(2) The powers to which this section applies shall be exercisable by statutory instrument, and the Statutory Instruments Act 1946 (c. 36) is to apply in relation to those powers as if OFCOM were a Minister of the Crown.

(3) Where an instrument made under a power to which this section applies falls to be laid before Parliament, OFCOM must, immediately after it is made, send it to the Secretary of State for laying by him.

(4) Before making any regulations or order under a power to which this section applies, OFCOM must—

(a) give a notice of their proposal to do so to such persons representative of the persons appearing to OFCOM to be likely to be affected by the implementation of the proposal as OFCOM think fit;

(b) publish notice of their proposal in such manner as they consider appropriate for bringing it to the attention of the persons who, in their opinion, are likely to be affected by it and are not given notice by virtue of paragraph (a); and

(c) consider any representations that are made to OFCOM, before the time specified in the notice.

(5) A notice for the purposes of subsection (4) must—

(a) state that OFCOM propose to make the regulations or order in question;

(b) set out the general effect of the regulations or order;

(c) specify an address from which a copy of the proposed regulations or order may be obtained; and

(d) specify a time before which any representations with respect to the proposal must be made to OFCOM.

(6) The time specified for the purposes of subsection (5)(d) must be no earlier than the end of the period of one month beginning with the day after the latest day on which the notice is given or published for the purposes of subsection (4).

(7) Every power of OFCOM to which this section applies includes power—

(a) to make different provision for different cases (including different provision in respect of different areas);

(b) to make provision subject to such exemptions and exceptions as OFCOM think fit; and

(c) to make such incidental, supplemental, consequential and transitional provision as OFCOM think fit.

(8) The Documentary Evidence Act 1868 (c. 37) (proof of orders and regulations etc.) shall have effect as if—

(a) OFCOM were included in the first column of the Schedule to that Act;

(b) OFCOM and persons authorised to act on their behalf were mentioned in the second column of that Schedule."

7.4.1 Circumstances of revocation

1. Ofcom believes under the following conditions, it may revoke tradable WT Act licences.

- If the transferee is unable to pay the licence fee on time.
- If the transferee delays to pay the licence fee.
- If the transferor consents to take back the licence.
- If the licensee is failed to comply with any requirement of the Trading Regulations.

2. Ofcom may revoke or change licence terms any time if it appears to be necessary for the national security.

3. Ofcom possess the rights to close down all or part of the network if appeared that harmful interference is occurring.

7.4.2 Circumstances under which transfer should not be made

1. A transfer can not be made where the licence holder or any of the concurrent licence holders does not consent to the trade.

2. A transfer can not be made where the transferee does not consent to the trade.

3. A transfer can not be made if the transferor had failed to pay the licence charges dues to Wireless Telegraphy because in such a case the licence would be owing to Ofcom.

4. A transfer can not be made if the licence holder has to pay installment to Ofcom.

5. A trade can not take place without the consent of Ofcom.

7.5 Conclusion

From UK case study, we concluded that UK aimed to make spectrum regulation as flexible as possible. They implemented their policy in such a way that it can satisfy the needs of the end users while ensuring the optimum use of spectrum.

Ofcom aimed to put minimum restrictions where necessary in terms of:

- Harmonization
- Competition problems
- Interference issues

Ofcom's policy for spectrum trading is not rigid. It gives the licence holders the flexibility to temporary transfer the spectrum usage rights however a final date for temporary transfer should be determined before the trade.

6. RSPG Case Study

6.1 RSPG Introduction

The Radio Spectrum Policy Group is a high-level advisory group assisting the Commission in the development of radio spectrum policy in the Community. Its members are representatives of Member States and the Commission.

The Radio Spectrum Policy Group (RSPG) was established under Commission Decision 2002/622/EC as one of the actions following the adoption of the Radio Spectrum Decision 676/2002/EC.

The Group contributes to the development of a radio spectrum policy in the Community that takes into account not only technical parameters but also economic, political, cultural, strategic, health and social considerations, as well as the various potentially conflicting needs of radio spectrum users with a view to ensuring that a fair, non-discriminatory and proportionate balance is achieved.

The RSPG adopts opinions, which are meant to assist and advise the Commission on radio spectrum policy issues, on coordination of policy approaches and, where appropriate, on harmonised conditions with regard to the availability and efficient use of radio spectrum necessary for the establishment and functioning of the internal market.

6.2 Benefit to the country

The total volume of services which depend on radio spectrum availability is estimated to be worth at least €200 billion annually in Europe.[22]

6.3 Forms of Trading

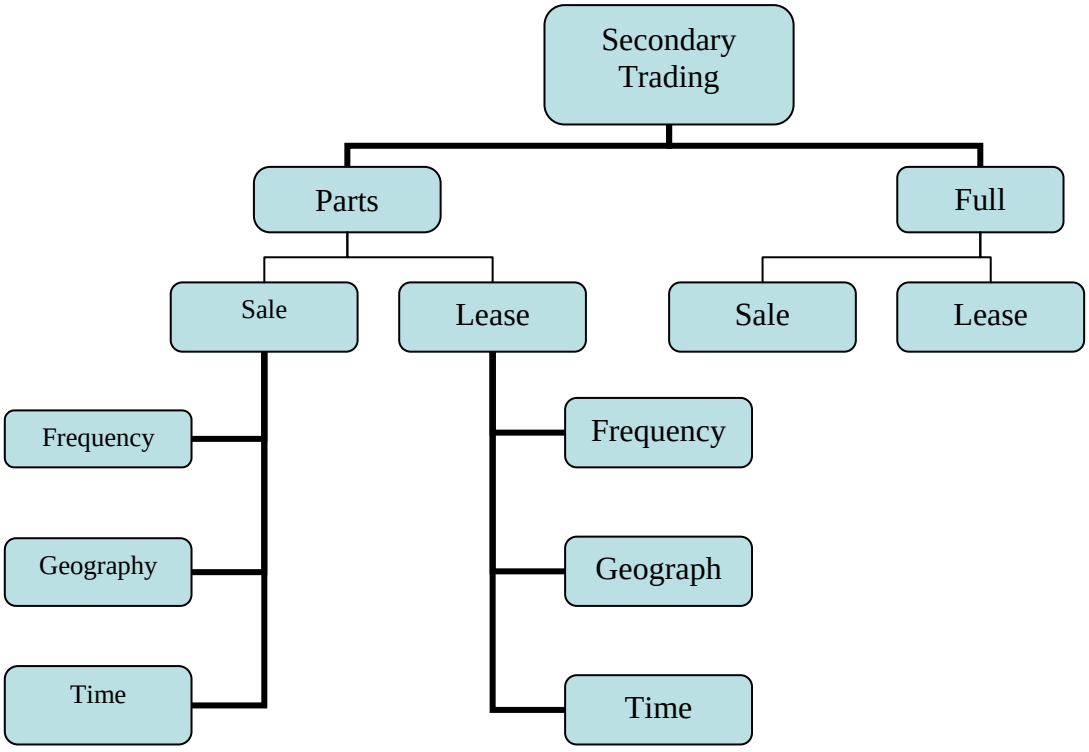
In Europe, spectrum is divided into bands and channels of varying size and bandwidth for planning purposes. In general, lower frequency bands have smaller bandwidth capacity than higher frequency bands. This means that higher frequency bands can carry more information. In contrast, lower frequency bands have longer

[22] http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/index_en.htm

range. Particular services require different frequency ranges depending on the characteristics of that frequency band.

The regime is based on three parameters (a) partial or full, (b) lease or sale, and (c) on the basis of frequency, geography or time. Following scenarios are possible in this regime.

(i) *Fully sale* : Permanent transfer of whole spectrum
(ii) *Partially sale* : Permanent partial transfer of only some parts of spectrum
(iii) *Partially Lease on the basis of Frequency* : Temporary partial transfer on the basis of frequency
(iv) *Partially Lease on the basis of Geography* : Temporary partial transfer on the basis of geography
(v) *Partially Lease on the basis of Time* : : Temporary partial transfer on the basis of time
(vi) *Partially Sale on the basis of Frequency* : Permanent partial transfer on the basis of frequency
(vii) *Partially Sale on the basis of Geography* : Permanent partial transfer on the basis of geography
(viii) *Partially Sale on the basis of Time* : Permanent partial transfer on timely basis



Flow chart showing different scenarios of spectrum trading

6.4 The Role of the NRA in controlling trading

There is general agreement that the NRA's main role[23] should be (listed in the order of occurrence in the replies) to:

- Maintain in a transparent and non-discriminatory manner, detailed on-line registries recording the rights and obligations associated with each trade, and the corresponding assignments;
- Guarantee and police spectrum rights, investigate possible infractions and manage disputes between users by taking binding decisions on them;
- **Establish levels of acceptable interference and ensure that these levels are not exceeded;**
- **Guarantee efficient and effective use of spectrum, in particular, prevent speculative hoarding, avoid fragmentation of spectrum, re-assign spectrum;**
- Establish clear and detailed rules for secondary trading, with clearly defined rights and obligations for all parties involved;
- Monitor and control spectrum use, including assignments characteristics;
- Continue spectrum harmonisation on an international basis;
- Control and evaluate change of use, with prior publication of requests for such changes, appropriate technical studies and industry consultation;
- **Ensure observance of competition rules, detect and prevent anti-competitive behaviour and control concentrations of market power;**

7. Pakistan's Current Scenario

7.1 Need for Spectrum Policy

Most of the developed countries like USA, Canada, Germany, New Zealand, UK, Australia have Spectrum Policy to make sure that Spectrum Management should be done in a very efficient way to get maximum economic and usage benefit of this national asset. There is a need of Spectrum Policy to manage and plan spectrum allocations for future use.

[23] RSPG04-43 WG Secondary Trading-Summary of replies to public consultation

7.2 Recommendations

- Spectrum Trading (ST) is a multi-variable regulatory instrument which needs to used carefully/selectively. Secondary markets in spectrum help to promote efficient use of spectrum. They offer opportunities for trading. A detailed research is required to **explore these markets** and **selectively/phase wise** introduce the ST through **policy/legal provisions.** Detailed **regulations** would need to be put in place. This is incentive based system without which the incumbents would always be reluctant to surrender the unused/under-utilized spectrum.

- Selective approach is helpful in **monitoring & mitigating the costs of ST**, some of which are:
    - Low spectrum trading activity which is due to
        - Uncertainty of scarcity and value of spectrum available in secondary markets.
    - Anti-competitive conduct
    - Spectrum Fragmentations leading to in-efficient use of spectrum.
    - High transaction costs.
    - Interference level getting increased.

- There is need to identify licensees desiring to trade. Regulatory awareness will be useful in this regard.

- In order to gauge the spectrum utilization and hence the scope for trading in Pakistan, PTA and FAB need to jointly examine the spectrum assignments for all the major RBS licensees.