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Radio Spectrum Management Development in India:

**A framework for
strengthening radio spectrum
management and policies**

Final Report

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InterConnect Communications Limited (hereinafter referred to as InterConnect) was commissioned by the World Bank to undertake a review of the spectrum management regimes, policies and processes in India and to develop measures which could be taken to enable the spectrum management regime to better serve the needs of spectrum users in India.

This Final Report provides a detailed review of the current spectrum management regime in India; provides a perspective on best practice as may be applied in India and in addition provides a consideration of measures which could be taken to enhance spectrum management activities in India.

In preparing this review of spectrum management in India, InterConnect met with representatives of the organisations involved in the spectrum management process as well as major users of the radio spectrum in order to gather information and views on current processes, practices, problems and potential solutions. Two workshops were held in New Delhi, the first with governmental spectrum managers and users, the second was a public workshop where InterConnect presented its understanding of the situation in India together with recommendations as to how the situation might be improved. Feedback from the workshop resulted in enhancements to the recommendations in a number of areas.

1. INTRODUCTION

InterConnect Communications Limited (hereinafter referred to as InterConnect) has been commissioned by the World Bank to conduct a project to undertake a review of the spectrum management regimes, policies and processes in India and to develop an action plan for the implementation of measures which could be taken to enhance or improve the situation and so enable the spectrum management regime to better service the needs of spectrum users in India.

This report represents the second deliverable, D4: Final Report, and performs the following functions:

- It provides a detailed review of the current spectrum management regime in India under headings of:

spectrum use and demand
spectrum licensing and management processes
national spectrum policy
institutional framework and staffing
financial resources and budgeting
stakeholder involvement
spectrum management and monitoring tools

- It provides a commentary on best practice as may be applied in India in connection with each of the above areas.
- It provides a consideration of measures which could be taken to enhance spectrum management activities in India

In preparing this review of spectrum management in India, InterConnect has met with representatives of the organisations involved in the spectrum management process as well as major users of the radio spectrum in order to gather information and views on current processes, practices, problems and potential solutions. The organisations include the following Governmental bodies, who participated in a stakeholder workshop held by InterConnect in Delhi on 25 May 2005:

- Wireless Planning and Co-ordination Wing
- Wireless Monitoring Organisation
- Naval Headquarters
- Naval Signals
- All India Radio
- Telecommunicatoins Regulatory Authority of India
- Directorate of Coordination Police Wireless (DCPW)
- TDSAT
- Doordarshan
- Department of Telecommuncations
- Telecom Engineering Center (TEC)
- Department of Information Technology
- Air Force HQ
- Army HQ
- Signals

In addition, the following non-Governmental organisations also took time to provide the project with their views on spectrum management in India.

- Association of Unified Service Providers of India (AUSPI)
- Cellular Operators Association of India (COAI)
- Internet Services Providers Association of India (ISPAI)
- Telecommunications Equipment Manufacturers Association (TEMA)
- VSAT Association of India (VSAI)
- ITU-Asia Pacific Telecommunity (ITU-APT)
- TaraHAAT

Further, InterConnect conducted a public workshop on 7 April 2006 at which InterConnect's understanding of the situation in India was presented together with recommendations as to how the situation might be brought even closer to international best practice. As a result of this workshop, several changes to the recommendations then given have been made and this report represents InterConnect's consolidated view taking into account the information gathered during visits to India.

2. THE RADIO SPECTRUM IN INDIA

2.1 Introduction

In India, the Indian Telegraph Act 1885 and the Indian Wireless Telegraphy Act 1933 and related rules and procedures provide the legal basis for spectrum management (a full list of statutory instruments can be found in section 5.2).

2.2 The Spectrum Management Organisations (SMO)

2.2.1 Wireless Planning and Coordination (WPC) Wing

The Wireless Planning and Coordination (WPC) Wing is responsible for radio spectrum policy, planning, licensing, administration, monitoring and enforcement. It is the principal radio regulatory agency responsible for radio frequency spectrum management, including licensing and caters for the needs of all wireless users in the country, Government or private, security or non-security. It is also the national nodal agency for all matters related to ITU and Asia Pacific Telecommunity (APT) and is responsible for treaty obligations on behalf of the Government of India, in the capacity of Indian Administration. WPC is headed by Wireless Adviser to the Government of India who is also responsible for the field organisation known as the Wireless Monitoring Organisation (WMO).

The National Frequency Allocation Plan (NFAP) 1981, and subsequent revisions or amendments (the latest completed version being the revised draft NFAP 2005) is derived from the Table of Frequency Allocations of the Radio Regulations, in consultation with the national users through the forum of Standing Advisory Committee on Radio Frequency Allocations (SACFA), and provides the basis for assignment of frequencies. It is intended that the NFAP should be reviewed every 2 years, however the update of 2005 table has not yet been finalised and does not appear to differ significantly from the 2002 version.

The Telecommunications Regulatory Authority of India (TRAI) takes some responsibility for national spectrum management though its mandate is more advisory than regulatory.

In addition other Indian Governmental entities have a major national and sometimes international SMO role. These include those departments responsible for spectrum policy and operational aspects in the defence, civil aviation, national security, broadcasting and transportation sectors

WPC grants Wireless Licences under Section 4 of the Indian Telegraph Act 1885 for operating captive radio communication stations in the fixed/land, land mobile, maritime mobile and aeronautical services. The spectrum usage charges at present consist of licence fee and royalty charges. The licence fee is charged to cover application processing costs and the royalty is for the frequency management costs which include monitoring, inspection, coordination and infrastructure development. Central Government ministries and departments exempt from payment of spectrum charge, however they

do pay the appropriate licence fee. Central and state public sector undertakings are levied both licence fee and royalty, as in the case of the private sector.

The responsibilities of WPC are as follows:

- Assignment of radio frequencies with associated technical parameters for all wireless networks in the country in respect of Government as well as Private Sector.
- Formulation of NFAP, Frequency Channelling Plans, and standardisation of communication equipment specifications as related to spectrum management.
- National frequency coordination with all users for electromagnetic compatibility with a view to ensuring interference free operation of all wireless networks in the country.
- International coordination and international agreements with other Administrations in relation to various satellite and terrestrial based communication networks.
- Notification and registration of frequency assignments with ITU for international recognition and protection to fulfil National obligations.
- Fulfilling national obligations as contained in international treaties of the ITU, etc. in respect of all communication networks as national nodal agency.
- All national and international radio regulatory and other allied matters, including statutory functions.
- Radio Frequency (RF) Spectrum Management and Orbit/Frequency Coordination in respect of Satellite Systems (Geo-Stationary and Non Geo-Stationary).
- Coordination in all matters connected with ITU and APT, including preparation for and participation in their meetings and conferences after coordinating and harmonising views at national level, as national nodal agency, and formulation and ratification of international treaties.
- Licensing of all Wireless Stations in the country and of Radio Officers on board ships and Aircraft and Radio Amateurs.
- Site Clearance of all wireless installations in the country and related matters concerning SACFA.
- Direction and control of Wireless Monitoring Organisation, a field organisation of WPC Wing, to provide essential monitoring, inspection and other technical support for spectrum management with a view to ensuring interference-free operation of all wireless networks, ensuring adherence to assigned technical parameters and licensing conditions as also fulfilling the international obligations.

2.2.2 Wireless Monitoring Organisation (WMO)

The Wireless Monitoring Organisation (WMO) is the field organisation of WPC Wing, providing essential monitoring, inspection and other technical support for spectrum management with a view to ensuring 'interference-free' operation of all wireless networks, ensuring adherence to assigned technical parameters and licensing conditions as well as fulfilling the international obligations. The broad activities of the WMO are:

- Measurement of technical parameters such as operating frequencies, bandwidth, modulation depth/index, field strength, power, out-of-band emission, class of emission, traffic data, etc. in all frequency bands for terrestrial, space, air-borne and ship-borne emissions in order to ascertain their adherence to technical and operating conditions of licence.
- Determining spectrum occupancy/vacancy and circuit loading.
- Investigation of cases of harmful interference.
- Detection of unauthorised wireless stations.
- International monitoring activities concerning spectrum management, radio regulatory processes and interference elimination.
- Monitoring for selection of interference free sites for transmitting and receiving stations.
- Technical assistance to users.
- Technical studies for standardisation of technical parameters, network feasibility, and electromagnetic compatibility.
- Radio noise measurement on Industrial, Scientific and Medical (ISM) equipment, power generation and distribution systems, vehicular traffic, etc. to check radio pollution environment for mutual compatibility with radio communication services.
- Inspection of radio installations for checking technical, operational, regulatory and licensing conditions.
- Issuance of possession licence for those wireless equipments which are to be regularised under suitable licence.

2.2.3 Standing Advisory Committee on Frequency Allocation (SACFA)

The Standing Advisory Committee on Radio Frequency Allocations (SACFA) is a high level committee that makes recommendations on major frequency allocation issues. It is responsible for the formulation of India's National Frequency Allocation Plan (NFAP), and provides site clearance for installation of radio equipment.

Membership of SACFA is open to all major wireless user Ministries and administrative Departments of the Government of India. WPC provides the Secretariat whose purpose is to try and ensure the smooth and effective functioning of SACFA. SACFA discharges its duties and responsibilities under a two-tier functional system, wherein, the main Committee of SACFA provides a forum for coordinating activities at the headquarters level within Ministries/Departments; and the Regional Advisory Committees (RAC) provide forum at regional levels/field formations for wireless coordination aspects.

The Committee is advisory in nature and the final responsibility for the decisions and related implementation rest with the Government. The main functions of SACFA are:

- To recommend on major frequency allocation issues requiring coordination amongst the various wireless users in the country.

- To formulate/review the National Frequency Allocation Plans (NFAP)¹.
- To formulate national proposals for international conferences/ meetings and to coordinate nationally all activities pertaining to the ITU, etc.
- To deal with frequency coordination problems referred to the committee by the administrative Ministries/Departments.
- To clear sites of all wireless installations in the country.
- To demarcate important cities into receiving and transmitting zones.
- To finalise guidelines regarding provision of day and night obstruction markings on radio masts and towers.
- To evolve technical criteria, equipment standards, channelling plans, developmental/manufacturing activities, introduction of new technologies, etc.
- To explore feasibility of sharing of an antenna mast by more than one wireless users.
- To evolve/develop special site clearance procedures like procedure for clearance of radio masts of foreign missions/embassies for their radio communication links.

SACFA sits in two separate sessions, one to take decisions on purely Governmental services and another to take decisions on non-Governmental services. This latter meeting is open to delegates from those organisations whose applications are being discussed, though such delegates may only view the meeting and not participate in it, though such participation may be requested by SACFA members where additional information is sought from the applicant.

2.2.4 Other Spectrum Management Bodies

In addition to WPC, a number of other Governmental bodies have within them a section dedicated to managing a portion of the spectrum. In some instances this spectrum is granted to the organisation on a limited delegated-responsibility basis, such that a degree of planning the spectrum is vested with the organisation. However, in most cases these organisations manage and co-ordinate the usage of the Governmental users within their department and present a unified point of contact to WPC rather than directly managing their own frequencies within a pre-defined 'block' allocation. These organisations include:

- Broadcasting
- Police
- Defence

The assignment of frequencies within blocks of spectrum to certain organisations is done only in circumstances where there is no possibility for sharing with other users such that if control were vested with WPC, no additional benefit would accrue to other spectrum users. Further, despite the day-to-day management of frequencies being undertaken by these bodies, WPC retain the responsibility for international co-ordination of any assignments made. Indeed the management of these blocks by the third-

¹ A special committee, the National Frequency Allocation Plan Review Committee assembles from SACFA members specifically to discuss issues associated with the NFAP.

party Governmental organisations reduces the workload on WPC to assign frequencies in these particular bands.

Even in situations where blocks are not specifically allocated to a given organisation, many users form user groups which work together to try and co-ordinate the needs of certain sectors to minimise and hence simplify interaction with WPC.

2.3 Spectrum Users

The radio spectrum in India provides a basis for a wide and diverse range of services and industries, including broadcasting, film and programme making, cellular telephones, wireless Internet connections, paging, radar, navigation, air traffic control, microwave point-to-point links, satellites, and low power devices. The radio spectrum is therefore a vital resource which makes a substantial and rapidly growing contribution to the economy, competitiveness and jobs. Growing demand and rapid change will place its efficient use and management at an even higher premium. Effective spectrum management involves seeking a balance between the many uses of the spectrum, commercial and non-commercial, through a strategic and coherent approach.

Spectrum is crucial to the work of the police and fire services, it is essential to air and ground transportation systems and it is used by the military for everything from two-way radios to precision guided weapons and radars. As an example and disregarding spectrum used by both civil and military aircraft for basic navigation systems and landing aids, defence usage in most countries occupies around 30% of the spectrum between 29.7 and 960 MHz.

Although spectrum is not a consumable resource, the use of a frequency at a given location usually excludes that frequency from being used by others in the same geographic area, at the same time. This need for exclusive geographic use has led to regulations that establish spectrum conditions of use by granting licences for spectrum use, and the partitioning of the spectrum for shared use between radio services.

Users in India also suffer from a situation which often arises in Asia Pacific countries: From a commercial standpoint India is 'sandwiched' between Europe, North America and East Asia. All these areas are extremely active in the telecommunications sphere and have developed equipment in accordance with ITU provisions for their respective regions. For a variety of reasons of which the predominant is the advent of global trade agreements under the auspices of the WTO, Asia Pacific countries including India have tried to adopt technologies originating from the three continents. This leads to difficulties in adopting channel arrangements which are fair to all players, some of whom have arrived in established markets.

A similar problem impacts Indian defence forces where significant amounts of operational hardware were developed in the former Soviet Union, which often utilised frequency bands for defence equipment more commonly used for commercial equipment outside the former Warsaw Pact countries and their allies. On the other hand in the 21st century India, as an important country in the region, requires modern and well-equipped defence forces,

which necessitates the freedom to buy defence equipment from NATO and other countries. Economies of scale often dictate that the most cost effective defence hardware originates from NATO countries. This again impacts the spectrum management environment where Warsaw Pact and NATO equipment co-exist within the same defence forces.

2.3.1 Governmental

2.3.1.1 Defence Users

Frequency spectrum is an essential enabling resource for modern military operations. Wireless communications, radar, Electronic Warfare (EW), and intelligence systems all depend on access to this limited resource. The defence sector (air force, navy and army), represented by the Joint Communications Electronics Services (JCES) are the principal users of frequency spectrum in India not only for strategic and tactical communication networks but also for other operationally vital systems such as Surveillance, Navigation, Fire and Weapon Control, Target Acquisition, Missile Guidance, Electronic Warfare etc. Until recently the defence sector has had little difficulty meeting its spectrum needs; however, its ability is lessening as competing defence and commercial demands for spectrum access grow rapidly.

Technological developments which are important for defence include the increasing flexibility of tactical military infrastructure as well as the widespread tendency to use, where operationally feasible, proprietary commercial equipment on cost grounds. Political issues would include any dividends arising from an easing of border tensions and an increased focus on training and support of UN Peace keeping operations.

Nevertheless defence demands for access to spectrum when needed for training or operations may be rising. Technological advances hold out the prospects for battlefield commanders to access a much wider and richer range of data delivered via the spectrum. For example, better sensor technology enables better battlefield management, provided spectrum is available to access data from remote sensors while simultaneously commanding forces. On the other hand much military spectrum use tends to be sporadic in nature, dictated by training cycles and infrequent operational requirements. Where the necessary spectrum has been allocated for exclusive use, this has the potential to create inefficiencies in spectrum use over time.

JCES mastery at managing its spectrum, both within SACFA and at international levels, maybe weakening due to changes in geopolitics, the perceived reduced primacy of defence needs and the increasing pressure for spectrum access by economically important new radio systems. Whilst the defence sector has welcomed the growth of the telecommunication industry in India and has a past history of accommodating new value added technologies into the bands allotted to defence, it has done so by transferring operations, curtailing the usage of the operational bandwidth of equipment or by reducing the number of channels utilised.

It is probable that the spectrum environment rate of change is now fast enough that JCES should act to get ahead of developments and not wait to react when they become contentious issues. Spectrum allocation issues which could limit future defence capabilities include:

- Defence spectrum needs are growing rapidly as new, “smart” technologies are applied in new systems. Sensor, communication, radar, and positioning systems are now being developed that have expanded capabilities – but that also requires additional spectrum.
- Economic pressures for transferring defence spectrum to commercial use, including border areas are growing rapidly as the same technologies that underpin leading-edge military systems enable attractive, inexpensive commercial, consumer, and professional products.
- New technologies are changing spectrum use. Established spectrum management practices are not adequate to deal with technology-based challenges to today’s fixed allocation model.
- International spectrum access for Indian forces operating abroad on UN assignments is complex and is becoming increasingly contentious as other regions go their own way in spectrum allocations.

It seems necessary that JCES and its constituent bodies must have the policy, processes, technology, and organisation to ensure that spectrum access does not limit its military options, whilst maximising access to the civil community through innovative sharing mechanisms, especially in the Indian conurbations.

In particular spectrum management (the goal of making spectrum as widely available as possible and then ensuring its efficient use) should have a higher focus within the sector and the development and enforcement of defence spectrum policy and strategies should be actively managed to take account of the changing spectrum management environment. The approach to spectrum management should be modernised, consistent with changes taking place in RF-dependent systems and the need to consider more flexible concepts in spectrum usage.

The following points may be worthy of further consideration:

- The military should implement policies, strategies and tactics that are based on military capabilities and ensure that the deployment of new systems is feasible.
- WPC should demonstrate the critical importance of spectrum policy to the defence forces and bring spectrum strategies closer to operational systems architecture.
- The military should employ spectrum considerations throughout the systems development and upgrade process.

Both should support research and development of spectrally efficient technologies.

2.3.1.2 Broadcasting

The broadcast, cable and satellite equipment market in India, comprising radio/television transmission equipment, studio/production equipment, and satellite/cable television markets, has witnessed substantial growth over the past six years. There has been a virtual explosion in satellite/cable television with many private Indian and foreign television companies broadcasting to India via satellite. Television connectivity is about 85 million households, and of this, cable reaches approximately 55 million. From one terrestrial channel in the early-1980s, there are over 300 channels available in India today.

Prasar Bharati (Broadcasting Corporation of India) is a statutory autonomous body established under the Prasar Bharati Act providing public service (Government) broadcasting through All India Radio (AIR) for radio and Doordarshan for television, which prior to the establishment of Prasar Bharati in 1997 were operating as independent media units under the Ministry of Information and Broadcasting within the Government of India.

Sound broadcasting started in India in 1927; All India Radio began formally in 1936, as a Government organisation, with clear objectives to inform, educate and entertain the masses. When India attained Independence in 1947, AIR had a network of six stations and a complement of 18 transmitters. AIR today has a network of 215 broadcasting centres with 144 medium frequency (MW), 54 high frequency (SW) and 139 FM transmitters. Programming is provided to just over 91 % of the geographical area, serving about 99% of the population.

WPC is responsible for the detailed co-ordination and planning of frequencies for broadcasting services. WPC utilises ITU circulated material containing details of new LF and MF stations, including current stations in the Geneva 75 Plan and a co-ordination routine which administrations are encouraged to use to determine possible interference to their services. For HF services, ITU developed software is used to facilitate the co-ordination of broadcasting stations

The FM broadcast service uses 32 channels in the 100 – 103.4 MHz band with a few channels for the second service in 104 – 108 MHz. At present 112 transmitters cover the whole of India, with each major city being served by at least 1 channel with a second channel available in some 10 – 15 locations. ITU planning rules have been adopted for FM services i.e. using 100 kHz channels with 600 – 800 kHz separation where service areas overlap and 400 kHz separation where transmitters are co-sited. It is intended that the 104 – 108 MHz band will be exclusively available for broadcasting but some other services currently have assignments in this part of the spectrum.

Doordarshan commenced television operations with an experimental Telecast in Delhi in September 1959, regular daily transmissions started in 1965. The TV broadcast service is planned using standard ITU planning criteria. Transmitters fall into one of four categories, >10kW, 1kW, 100W and 10W. The lower power transmitters are used to cover small towns and villages, and to fill in gaps in service areas. Local VHF stations receive their programming via the 2.5 GHz, C and S-band satellite service. There are some 47 studios in India, with the majority of broadcast transmitters receiving the programmes via satellites, which operate in an exclusive band.

The Broadcast Section of WPC also performs the task of co-ordinating these satellite links. UHF TV is used extensively for low power relays and to provide additional programmes. The broadcast spectrum is shared with a wide range of very different services including the fixed service and defence forces, hence the need for frequency planning and co-ordination. Doordarshan plan their services and may request particular channels, WPC perform the co-ordination function. Growth in the terrestrial television network is now fairly static due to economic considerations.

At present, there are only two terrestrial TV Channels of Doordarshan (DD I and DD II) available in the country, though over 300 satellite channels are being received in different parts of the country. While DD I is received in about 76.8% of area of the country covering about 89% of the population, the coverage of DD-II is available to only about 35% of the population. The terrestrial transmission of Doordarshan uses traditional analogue modulation techniques through a network of 1044 terrestrial transmitters. Doordarshan operates 27 satellite Channels in all (Parliament-2, National-5, International-1, Regional-11 and State-8), but it is unable to provide these channels terrestrially. To make more terrestrial analogue channels available nationally would require the establishment of thousands of transmitters which is not economically possible due to limited financial resources and may not be technically feasible due to the limited radio spectrum available.

The Prasar Bharati therefore initiated a plan to introduce 'Digital Terrestrial' Television Broadcasting (DTTB) in India, in a phased programme spanning 10 to 12 years. Doordarshan has already started experimental transmissions of DTTB in the UHF television band by installing 1 kW digital transmitters in the four metro areas of Delhi, Chennai, Kolkata and Mumbai. Doordarshan has adopted the DVB-T digital standard for DTTB which is from the same family as DVB-S and DVB-C which was adopted by BIS in respect of DTH and digital CATV (cable) respectively. Each digital transmitter of Doordarshan carries five Doordarshan channels. The Doordarshan digital channels operate in a free to air mode and can be received using a digital set-top box.

With a DTTB network one digital transmitter can carry four to six TV channels. It would also:

- Provide vastly superior and uniform quality of reception in the entire reception area;
- Permit reception of TV/multi-media services even in moving vehicles;
- Achieve more than 50% saving in power consumption as compared to analogue transmitters.

The switching from analogue to digital transmission is considered necessary in view of similar developments taking place in other countries and the eventual phasing out of analogue equipment. It would also provide an alternative to cable network services especially in rural areas and small towns where cable networks have not been economically viable. Some of digital channels could also be used to access Internet and e-mail services using the domestic television as a terminal device.

2.3.1.3 Civil Aviation

The Director General of Civil Aviation is a statutory authority responsible for Implementation and monitoring of stipulated standards regarding Airworthiness of Aircraft, Operations of Aircraft, Licensing of Personnel, and Air Transport Operations; Licensing of Civil Aerodromes; Type Certification of indigenous aircraft and is thus responsible for radiocommunications issues arising from Annex 10 of the ICAO Convention.

Modern aircraft are equipped with many radio systems, radiodetermination and communications, operating in a possible seventeen different frequency bands ranging from 9 kHz to 15 GHz. Approximately half of the systems have both transmit and receive functions, and the remainder are receive only. Three are for primary communications purposes, and up to twelve are for radio navigation functions, including three which have integral and complementary data links. In the course of a flight, an aircraft may traverse territory other than that of its State of registry and must therefore be regulated within a systematic framework of internationally agreed rules. These must ensure that the flight is safe for passengers and crew, and free from risk of damage to persons and property on the ground. As a part of this regulatory process, the radio installations must conform to agreed performance standards, must operate in correct frequency bands, must be licensed by appropriate authorities, and be operated by authorised personnel.

The regulatory framework to ensure these requirements have, as their basis, two quite separate international agreements, which are implemented at the national level by two sets of national regulatory bodies. An outline description of the organisational elements of this framework is given below. Telecommunications regulation; in particular those pertaining to the use of frequencies for civil aviation established by the ITU is the responsibility of WPC.

The safety aspects of the operation of civil aircraft are governed by the terms of the ICAO Convention on International Civil Aviation (Dot 7300). In the context of the carriage and operation of radio, Article 30 of the Convention states that “*aircraft of each contracting State may, in or over the territory of other contracting States, carry radio transmitting apparatus only if a licence to install and operate such apparatus has been issued by the appropriate authorities of the State in which the aircraft is registered*”.

The main regulatory features which apply to the use of radio in aircraft are thus characterised by:

- The requirement to observe two sets of international treaty obligations, ITU and ICAO;
- The participation of two national regulatory bodies, one for telecommunications aspects and one for air safety approval requirements; and
- A voluntary collaborative process for the preparation of performance specifications.

The recent ITU World Radiocommunication Conference in 2003 made a number of changes to the Radio Regulations concerning, as well as initiated studies which could impact on, the way current spectrum for civil aviation will be used in the future.

2.3.1.4 Other Governmental Uses

The Government of India established the Space Commission and Department of Space (DOS) in June 1972. The Indian Space Research Organisation (ISRO), established under DOS, executes the space programme and has a number of establishments located throughout India. The main objectives of the Indian space programme include the development of satellites, launch vehicles, sounding rockets and associated ground systems. ISRO has a number of programmes for communication and scientific satellites as well as launch vehicles that require access to frequency bands allocated for space radiocommunications, telecommand and telecontrol and remote sensing.

The Directorate General of Shipping is an attached office of the Ministry of Shipping, Government of India and deals with all executive matters, relating to merchant shipping. In addition the National Maritime SAR Board was constituted by the Ministry of Shipping to provide the necessary mechanisms to implement the National Maritime SAR System. The implementation is coordinated by the Coast Guard to fulfil many of its obligatory requirements as warranted by the conventions of IMO and ICAO on search and rescue. These bodies will be essential users of spectrum allocated to the maritime mobile service in India.

The Ministry of Railways (Indian Railways) operates a rail network of some 63,000 kilometres in length with more than 7500 locomotives, which carry over a million tons of freight and more than 14 million passengers a day. By gradually equipping its main lines with GSM-R over the course of the coming years, Indian Railways intends to enhance the safety, security and reliability of its rail traffic. This technology, which is based upon the international GSM mobile communication standard, will help to integrate the voice and data applications required for rail communication into a single system. Indian Railways also employs other fixed and mobile communications networks.

The India Police Service is not a police force itself but is a branch of the Ministry of Home Affairs as is the Border Security Force; each state has a police force that is staffed (at least at the upper levels) by members of the Indian Police Service. A modern police service requires efficient voice and data communications and a corresponding infrastructure. Small bands and individual frequency assignments are provided by WPC.

Looking to the future the Asia Pacific Telecommunity PPDR project for public safety and disaster relief communications will likely be another important candidate for Governmental spectrum resources.

2.3.2 The Private/Commercial Sector

With a population of 1.05 billion there are 200 million households. Within these households there are 85 million televisions and 55 million cable television households. The India telecom market was privatised in 1994 – 1995. There are 47 Million fixed line phones which grow at only 8% per year, whilst there are 55 Million cellular phones growing at 55% per year.

As of 2005 there were 5.6 Million Internet subscribers and over 10 Million users.

2.3.2.1 Public Mobile Communications

In 1992, the Government decided to open provision of Cellular Mobile Telephone Service for private participation. India adopted the Global System of Mobile Communication (GSM). The Government initiated the process of private participation in the telecommunications sector by auctioning separate licences for providing cellular and basic services. The cellular licence provided for an initial spectrum assignment and the licence holder could apply for additional spectrum, but this was not guaranteed. Subsequently operators were permitted to migrate to a revenue sharing regime. This was in response to complaints from licensees that the cellular business was not viable because they had bid extremely high auction fees.

Today, India has more than 8 private companies providing cellular services in 19 telecom circles and 4 Metro cities. The subscriber base at present is approximately 55 million (May 2005) and is expected, without regulatory intervention, to reach 100 million by 2007.

In November 2003, the DoT announced the ratification of the unified licensing regime for fixed local and mobile services. The ruling has provided a legitimate space for code division multiple access (CDMA) wireless local loop (WLL) mobile services, which have been on the market (provided by basic service providers) since 2001. It has allowed basic service providers, through migration to the new regime, to legitimately offer both localised and fully national mobile services over their CDMA WLL systems, directly in competition with incumbent GSM network operators.

According to the new unified licensing regime, India now counts 'limited mobility' and cellular subscribers under the umbrella term 'mobile users'. Limited mobility services are those offered over WLL systems that allow a subscriber to move within a 'single cell' or local area, and to make and receive calls over the same handset. 'Cellular' refers to GSM cellular and CDMA services that provide user identification via a single handset across an operator's entire network. National roaming to other Indian mobile networks owned by other operators is also considered to be part of the cellular service offering.

The Government has a target of 200 million mobile phones by 2007, however spectrum availability suggests achieving such figures could be difficult and longer term cellular planning could be impaired. A recent study by TRAI has recommended the immediate constitution of a very high level group at the level of ministers assisted by professionals to draw up and oversee an implementation plan to achieve guaranteed spectrum availability by 2006. In addition a strategy has been offered to move the cellular industry towards the provision of third generation cellular services. It was also suggested that spectrum policy should be reviewed periodically depending upon the development in the market, level of competition, development of technologies and the availability of equipment and spectrum.

Comments from operators suggest that some elements of the regulatory climate may not be balanced. For example, different mechanisms for assigning point-to-point links have been adopted within the industry.

Furthermore there has been criticism levelled that the basic criteria for some regulatory practices have been changed after the commencement of network roll-out. This, it has been said, significantly impacts how the network has been planned, implying that, had the revised criteria been known at the initial licensing stage, the network would have been planned in a different manner.

2.3.2.2 Public Non-Cellular Mobile

India has a Public Mobile Radio Trunk Service (PMRTS) with the first system being implemented in Bangalore; similar services are being commercially launched in other cities. The PMRTS provider is granted a separate licence, on a non-exclusive basis, for each service area of operation. Licences are awarded for an initial period of twenty years, extendable by additional periods of 10 years thereafter. Direct interconnectivity between licensed PMRTS providers and any other type of service provider in their area of operation is not permitted.

So far PMRTS has been implemented as an analogue trunked service essentially for use in metro and municipal areas and their immediate environs. It is understood that the system has not been overly successful commercially and to compete effectively would have to offer PSTN connectivity and be integrated into the national numbering plan. Furthermore regional coverage areas could be helpful and appeal to businesses with large vehicle fleets that operate further a field than a single city or town.

A strategy for the introduction of digital trunking services could also be of interest to service providers and users.

2.3.2.3 Non Public Mobile Services

Several years ago 12.5 kHz channels were introduced at VHF (146 – 174 MHz) interleaved between the existing 25 kHz channels. At present, 25 stations share a given channel, with each base station serving around 3 – 4 mobiles and 4 – 6 hand portables. Each channel is used twenty times which approximates to a service range of 30-35 km. The assignment process takes account of each user's channel-occupancy, including stated hours of operation. Such channels are used for a variety of business, commercial and professional applications.

There appears to be little spectrum availability for HF, low VHF or UHF professional mobile radio and in a country as large as India with large and sometimes remote rural communities it is wondered whether the small number of HF and low VHF frequencies for business/commercial applications should be revisited. Indeed one potential user of HF fixed/mobile radio indicated that the concept had not been considered due to the non-availability of such spectrum. Indeed mobile connectivity for the organisation in this case is provided by expensive VSAT links and VHF mobile equipment, as there is no public mobile coverage in the area in question.

However it is understood that within the last 12 months a NLD (National Long Distance) element has been applied to systems providing back-haul connections to the public network, which may be having an adverse impact on bringing telecommunications to rural communications. It is understood

that these additional costs for licensing would apply also to the use of HF back-haul links.

2.3.2.4 Wireless Broadband

The access technology in India includes dial-up (3.8 Million), DSL (60,000), cable (52,000) and wireless (12,500). A Government objective is to achieve a target of approximately 250 million telephone connections by the year 2007 and a target of 3 million broadband subscribers and 6 million Internet subscribers was envisaged by December 2005. WPC deregulated the use of 2.4 GHz wireless local-area networking (WLAN) equipment based on IEEE 802.11b standards in 2002; WLAN is therefore an essential element in the Government's armoury to facilitate an increase in broadband penetration.

The majority of organisations that have installed WLANs belong to the hospitality and travel sectors. In these cases, it is a simple case of providing additional value to their clients by providing WLAN access. However cost is a factor compared with wire line options; wired LANs are still much cheaper. Unless connectivity needs dictate the usage of a WLAN, Indian companies tend to install wired LANs. Concerns about security have also hampered widespread WLAN adoption.

Overall, the 2.4 GHz 802.11b still remains the most commonly used WLAN standard in India. When it comes to new WLAN implementations, 802.11g is the preferred standard. 802.11g gives a maximum of 54 Mbps or 20 – 25 Mbps in the real world, whereas 802.11b can offer only up to 11Mbps.

Another reason behind 802.11g's appeal is its operation in the unlicensed 2.4 GHz frequency band. In India, the licensed 5 GHz band is largely reserved for radiolocation and space applications. This has proved to be a major deterrent for Indian companies wishing to adopt the 802.11a standard (the WLAN standard competing with 802.11g). Standards based on 2.4 GHz (802.11b/g) have fared better than the 5 GHz standards (802.11a) due to such licensing issues.

This appears to be another example of where spectrum management issues have not kept pace with emerging technologies which appear necessary for bringing Internet services to the population at large.

2.3.2.5 VSAT

The term VSAT refers to communications services delivered via satellite-based Very Small Aperture Terminal earth stations. VSAT services were deregulated in India in 1994. In India VSAT Service Providers are granted separate licences, on a non-exclusive basis for an initial period of twenty years, extendable by additional periods of 10 years. There are more than 38,000 VSAT users in India with around 10,000 of these coming from Governmental organisations.

India's geography is generally cost prohibitive for terrestrial optical fibre telecommunications cables. VSAT companies have as a consequence moved to address rural telecoms, thus the national telephone infrastructure is being extended with rural VSAT sites. Several dynamics have put the VSAT industry in the forefront of this trend:

- Economies of scale are being passed on to end users in the form of lower terminal prices.
- Increased competition in the VSAT industry (not least from Asian manufacturers) has exerted downward price pressure on components resulting in further cost reductions.
- Technology enhancements have removed yet another layer of cost, making VSAT solutions that much more attractive on price.
- New modulation schemes have introduced further space segment savings as well as allowing the digital information to be recovered from weaker satellite signals.
- Powerful satellites and efficient coding techniques have allowed for smaller antennas and smaller solid state power amplifiers (SSPAs), both of which account for significant savings in the overall cost of Earth stations.
- Silicon prices continue to drop and Application Specific Integrated Circuits (ASICs) that perform the majority of the VSAT functions are economically feasible.
- With 4,000 transponders on orbit globally and 2,000 more on order, space segment prices are more competitive than ever, however at present Indian VSAT operators are limited to those satellites provided by ISRO. An 'open skies' policy is under discussion (see below).

Spurred by increasing demand for an efficient and reliable transmission medium to carry internet services as well as the need for a means by which to effectively export India's indigenously-produced software - the Indian Government recently signalled its willingness to consider a relaxation of restrictions on the use of international satellites to provide communications services for India via VSATs.

Historically, the Indian Government has not permitted the use of foreign satellites, insisting instead that VSAT operators rely exclusively on the indigenous INSAT constellation of satellites. However, local demand for domestic and international VSAT services has far outstripped the supply of satellite transponder capacity. The Government, therefore, now coordinates access to certain foreign satellites on behalf of VSAT operators, but an open sky policy is still missing. This keeps transponder lease costs in India artificially inflated

In addition to access to foreign satellite capacity, the frequency of operation is an issue but this has been recently solved. Indian VSAT operators were required to use India's unique "extended C-band" frequency, which is neither cost effective nor competitive. After 3 years of negotiation, access to Ku-band frequencies (11/14 GHz) has been authorised. As the use Ku-band for VSAT applications is the norm in many parts of the World reductions in cost and enhancement of service are envisaged.

There have also been requirements for Higher Data Rates and VSAT Interconnectivity: DoT has agreed to permit interconnectivity with international private leased circuits on a case-by-case basis, but interconnectivity with all operators would allow companies to build hybrid networks, expand back-up options and enable effective transmission of data between non-Indian companies' branch offices and their headquarters.

Widespread use of VSATs in India could lead to economic benefits for the majority of the Indian population once artificial policies inflating costs are removed, with provision of services such as rural telecom, distance learning, disaster recovery, telemedicine, and other state-of-the-art VSAT applications. However, the introduction of a NLD licence fee for VSAT applications providing back-haul telecommunications circuits, as mentioned in paragraph 2.3.2.3 above may impact upon these economic benefits.

2.3.2.6 Private Broadcasting

The Indian Government has allowed fully owned Indian companies to set up private FM sound radio stations on a licence fee basis in line with the policy of liberalisation and reforms. The licences have been issued for a fixed term of 10 years. In the future the existing licence period of 10 years could be extended by another 5 years on an automatic basis unless there are grounds for a complete reorganisation of the industry due to changes in technology (for example developments in the field of Digital Radio Broadcasting).

108 Broadcasting licences in 40 cities were auctioned in May 2000 (whilst each licence required a frequency assignment, it was the broadcasting licence that was auctioned, not the frequencies). However, out of the 108 licences offered at auction only 21 are today operational and another two appear to have difficulties. Even though the result of the first phase of liberalisation of FM radio broadcasting has not been very encouraging, the launch of private FM stations has resulted in a significant increase in radio listeners.

Networking had not been allowed in the first phase of private FM radio broadcasting except on important occasions with the prior permission of the Government, however for the second phase it has been recommended that:

- Networking should be permitted but only between stations located in different cities.
- No networking should be permitted across licensees, except on special occasions (i.e. programming should remain distinct on each broadcaster).
- The Licensor should make available a list of special and important occasions annually on which the licensees would not require prior permission for networking.

The question of private television is currently under review. A consultation exercise was recently conducted by TRAI on issues relating to Private Terrestrial TV Broadcasting Service. The Consultation Paper covered the following issues:

- Participation of private sector in Broadcasting
- Broadcast Television Systems
- Licensing
- Alternative Technologies

The objective of the consultation process was to obtain the views of stakeholders and to stimulate a discussion on the appropriate policy and licensing framework for the introduction of Private Terrestrial Television Broadcast service in India.

A synopsis of the comments received has recently been released by TRAI and makes interesting reading. All respondents seemed to be in favour of private television and most respondents were in favour of launching with digital modulation techniques rather than analogue. One comment was particularly pertinent, "*Spectrum allocation should be fixed upfront and should be uniform across licensees*".

It appears that a spectrum strategy for the introduction of digital broadcasting is urgently required and both sound and television digital spectrum requirements should probably be addressed at the same time, as broadcasting band III, 174 – 230 MHz could be a major factor in reaching an appropriate solution.

3. FREQUENCY USAGE AND DEMAND

3.1 Frequency Usage and Availability

With the rapid development of telecommunications in India and particularly with the Government's stated objective of targeting 200 mobile subscribers by 2007, there is clearly a need to support the industry through the appropriate assignment of radio spectrum. Radio spectrum is the key resource that is required in order to enable the wireless telecommunication market and without it, growth will become very difficult or very costly leading to increased service prices for consumers and hence stifling market growth.

At such a critical time in India's technological development it is important that spectrum demands from commercial users are balanced against the necessity to maintain a strong Governmental sector and it is this challenge which appears the most taxing amongst those responsible for frequency assignment.

Spectrum usage in India remains, to a large extent, in the hands of Governmental users. Whilst efforts have been made in recent years to wrestle control from these users (and in particular defence users) large swathes of spectrum remain under the control of Governmental and quasi-Governmental bodies (including the incumbent telecommunications operators MTNL and BSNL).

The National Frequency Allocation Plan (NFAP) indicates, through a set of footnotes, specific information with respect to frequency usage in India. Whilst the NFAP identifies a number of spot frequencies for some users, as well as occasional block allocations to certain services (e. g. broadcasting and cellular telephony) the majority of spectrum remains shared between Governmental and non-Governmental services. Such sharing has the positive benefit that it opens up spectrum to non-Government users that might otherwise be vested solely with Government users; however it also has the downside that co-ordination with Governmental users is required before any frequency assignment can be made.

Whilst frequencies may be assigned to certain users, the actual usage of the spectrum varies significantly. WMO is responsible for conducting surveys of spectrum usage (and of other issues such as 'radio noise measurements', the value of which seems questionable). The DoT annual report² indicates the level of activity of the WMO in terms of statistics such as the number of wireless transmissions monitored and the number of monitoring assignments handled, however with the exception of the number of infringements communicated to users for remedial action, the statistics give no indication of the effectiveness of the monitoring activity that has taken place. The lack of use of the monitoring information in decision making with respect to frequency assignment (as discussed in section 9) suggests that the information available to WPC and in particular to SACFA on existing frequency usage is based purely on the licence database and not on actual monitoring information.

² <http://www.dot.gov.in/annualreport/english.pdf>

It is therefore difficult to paint an accurate picture of actual spectrum usage in India. However the situation in certain bands can be interpreted in light of the vociferous way in which certain users support their cases for increased spectrum availability. Clearly, at present, there is enormous demand from the cellular operators for additional spectrum, as that which they currently have is being squeezed to the limits by the amount of traffic they are having to support. This is counterbalanced by the incumbent (defence) users' reticence to rapidly clear additional spectrum for commercial users. This would tend to suggest that spectrum usage, both commercially and by Governmental users is, in fact, relatively heavy in these bands. The very public pressure applied by the commercial operators to try and free for use more spectrum and the incumbents' reservations about doing so tend to suggest that bands are in use as opposed to there being a 'hoarding' of spectrum which would otherwise remain unused. Similarly ISP's and VSAT operators are keen to expand their spectrum usage against similar reticence from the incumbent user who appears to be in a position where spectrum is being employed and not just one of an unwillingness to cooperate.

As a contrast, in the FM broadcast band, for example, there is not yet a high degree of congestion for FM assignments, however this is largely due to the broadcast licensing regime such that the number of broadcast licences issued has been relatively small. As such there is sufficient spectrum remaining to accommodate an increase in future use and supply is plentiful.

The situation in other bands is less clear. Relying solely on the licence database (which is known to be inaccurate in many cases and in several respects – though this is common to many administrations, not just India) is far from satisfactory. If assignments are made on this basis, it seems highly likely that a small percentage of existing licences are 'paper' only in that they are not in operation.

3.2 Demand for Spectrum

Being a key natural resource for many industries, especially those associated with the growth of the information age, demand for radio spectrum from many sectors in India is high. In particular, many interviewees told us of how lack of availability of spectrum and sloth in making spectrum available were heavily constraining their businesses. In particular:

3.2.1 Mobile Telecommunications

Mobile subscriber growth in India has been rapid over recent years as the cost of equipment and calls falls increasingly within the budget of more of the population. However spectrum has been handed out to existing operators in a relatively piecemeal fashion and has left many with small, non-contiguous assignments³ which have the potential to lead to uneconomical investment in infrastructure through the need to combat spectrum shortages with additional cell-sites (though we have been informed that there are no micro- or pico-cells employed in the country's GSM networks suggesting that the full extent of spectrum mitigation through

³ Operators are working amongst themselves to rationalise their assignments in an attempt to improve spectral efficiency.

infrastructure development has not yet been reached). In the case of CDMA operators, technical restrictions limit the ability to site cells close to each other such that capacity limitations in busy areas are inevitable. International comparison also shows that India's mobile operators have significantly less spectrum than their international counterparts.

A recent public consultation by TRAI and subsequent set of recommendations⁴ recognises the demand for more spectrum for mobile services in India (whilst balancing the incompatibilities in allocations between the Americas/Region 2 based CDMA system and the Euro-Asian Region 1/3 based GSM system) and has concluded that any remaining, cleared but unassigned spectrum should be made available to existing operators as soon as possible and that spectrum for 3G services should also be made available as soon as possible. WPC has acted upon these recommendations and in April 2006 announced the criteria which would be used to award additional spectrum to existing operators.

In interviews with mobile operators, the need for additional spectrum was paramount. However, a consistent and well-documented regime for spectrum assignment was also seen as a critical issue. Examples were given whereby the criteria for obtaining additional spectrum, over and above the initial allocation, were set; then, when these criteria were met, the rules were changed (indeed this again took place with the recent WPC announcement on the criteria for additional spectrum award). Further, although the operators seemed aware of what criteria had been set for the release of further spectrum, their confidence that it would be released to them as agreed and within a reasonable timescale was doubted. This lack of confidence in the spectrum management regime is further hampering the market as the extent to which certain kinds of investment need to be made is unknown and risk is being minimised.

Further, it was stated that the speed at which site clearance requests were processed was significantly impeding roll-out.

3.2.2 Wireless Internet

Rolling out Internet connections across towns, cities and villages in India is an essential and increasingly important element of taking India forward into the information age. With the cost of laying cables both to connect towns and cities as well as connecting subscribers to the network being high, the use of radio for Internet connections is by far the most economical solution.

The main use of spectrum by ISP's in India is for cross-town connections and for the last mile connection to subscribers. Currently they use frequencies around 2.4 GHz (both in the recently de-regulated 2.4 GHz band, and in licensed frequencies above and below this band). The VSAT operators told us that the way in which they were allocated frequencies, such that they could re-use it from a central site, and the amount of spectrum that had been made available to them were not their prime concern, rather that the speed in which frequency requests and in particular the speed with which requests for site clearance were processed were a significant issue. Historically, the time taken to complete some site clearances has taken over a year. In 2005, WPC introduced a web-based

⁴ <http://www.trai.gov.in/SpectrumReco.pdf>

process for site clearances and it is claimed that this has significantly reduced the time taken to process site clearances.

3.2.3 VSAT

Very Small Aperture (Satellite) Terminals (VSAT) are used widely to provide telecommunications connectivity to remote areas where no fixed connection is available. Further, for many ISP's and corporate bodies, the use of VSAT provides one solution to providing telecommunications connectivity independently of the incumbent telecommunications operators.

VSAT usage in India is therefore quite high with predictions showing 100,000 terminals in operation by the end of 2007. However the use of frequencies for VSAT terminals has been severely restricted. When VSAT was first introduced in 1994, only 'extended C-band' frequencies were allowed. Such frequencies are almost unique to India and forced operators to use Indian satellites launched by the Indian Space Research Organisation (ISRO). To date, this restriction on the use of only ISRO satellites continues, however after 3 years of lobbying, in 1999 (as part of NTP-99) VSAT operators were allowed to use Ku-band spectrum. Currently the VSAT Association of India (VSAI), the body which represents all VSAT users, is lobbying for an 'open skies' policy to allow it to use any satellite and not just those supplied by ISRO.

The issue of the length of time which site clearance applications take to be addressed by SACFA has been one which VSAI has successfully addressed. An agreement has been reached between WPC and VSAI that, for VSAT dishes 1.5 metres and smaller, unless an objection is raised by SACFA within 30 days of application, the application will be deemed to have been approved. This 'exemption' has significantly assisted VSAT operators to roll-out infrastructure and perhaps presents a useful model which could be used in other telecommunications industry sectors to improve the site clearance process.

4. SPECTRUM LICENSING AND MANAGEMENT PROCESSES

4.1 Introduction

The radio spectrum in India is a national resource, owned and managed by the Government. The authority for day-to-day spectrum management activities is vested WPC in New Delhi. Formal interfaces have been established with key spectrum user organisations, whose spectrum management staff may be found in other parts of India, remote from the capital city.

The spectrum management regime has to date been strongly biased towards fulfilling the needs of the State and serving radiocommunications requirements funded by public sources. However, during the last 5 to 8 years a demanding private sector has made significant investments in the roll-out of new services and systems. The private sector (and indeed several segments of the public sector) are not entirely satisfied with the level of service provided by the spectrum management organisation.

4.2 Spectrum Management

The preparation and revision of the National Frequency Allocation Plan (NFAP) is one of cornerstones of good spectrum management. WPC policy is that the NFAP shall be reviewed every 2 years to reflect general technological and commercial developments. The latest edition of the NFAP should therefore have been published in 2004 which would *inter alia* have permitted changes at the ITU WRC-2003 to have been incorporated; unfortunately it has been somewhat delayed and was eventually issued as a draft (and then a revised draft) NTP 2005 and has still not been finalised. Apart from changes brought about by WRC-2003 there seems to be little substantive change of a domestic nature in the revised draft NFAP at a time of great change in the telecommunications scene. On a positive note the NFAP is publicly available on the web

Records of all frequency assignments are kept by WPC, but such records are used for internal purposes and are not accessible by spectrum users in general.

Observations on the development of the NFAP generally reflect the state of the current spectrum management situation in India. Relevant data does exist, but is difficult to access by the general public, and it may therefore take longer than expected to obtain useful output from the licensing processes.

With the proliferation of new technologies and the growing demand for telecommunication services, the demand on spectrum has increased manifold. It is, therefore, essential that spectrum be utilised efficiently, economically, rationally and optimally. There is a need for a transparent process of allocation of frequency spectrum for use by a service and making it available to various users under specific conditions.

The National Frequency Allocation Plan (NFAP) was last established in 1981, and has been modified from time to time since. With the proliferation of new technologies it is essential to revise the NFAP in its entirety so that it could become the basis for development, manufacturing and spectrum utilisation activities in the country amongst all users. The NFAP is presently under review and the revised NFAP-2000 would be made public by the end of 1999, detailing information regarding allocation of frequency bands for various services, without including security information. NFAP shall be reviewed no later than every two years and shall be in line with radio regulations of International Telecommunication Union.

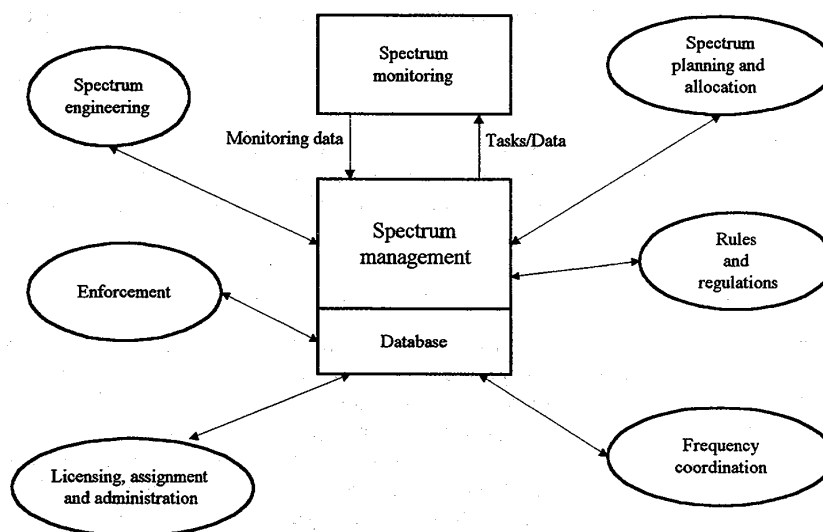
Relocation of existing Spectrum and Compensation:

- Considering the growing need of spectrum for communication services, there is a need to make adequate spectrum available
- Appropriate frequency bands have historically been assigned to defence & others and efforts would be made towards relocating them so as to have optimal utilisation of spectrum. Compensation for relocation may be provided out of spectrum fee and revenue share levied by Government.
 - There is a need to review the spectrum allocations in a planned manner so that required frequency bands are available to the service providers.

There is a need to have a transparent process of allocation of frequency spectrum which is effective and efficient. This would be examined further in the light of ITU guidelines. For the present, the following course of action shall be adopted.

- Spectrum usage fee shall be charged.
- Setting up an empowered Inter-Ministerial Group to be called as Wireless Planning Coordination Committee (WPCC) as part of the Ministry of Communications for periodical review of spectrum availability and broad allocation policy.
- Massive computerisation in WPC Wing will be started during the next three months' time so as to achieve the objective of making all operations completely computerised by the end of year 2000.

The principles that WPC employ in their spectrum management activities are generally in compliance with ITU documented practices. It can therefore be inferred that the components of the diagram below are also appropriate to the Indian administration. However, the practical implementation of the different functions and, in particular, the interrelation between such functions is not as definite, and in light of observations made by representatives from the Indian telecommunications sector with respect to the efficacy of spectrum management in India, it is possible that whilst all these functions are present in WPC, they do not work together particularly well as a whole.



A prerequisite for a modern and efficient spectrum management regime is the availability of data and sharing of the same data in real time between different parts of the organisation, i.e. a structure building upon an IT-

controlled database and a network solution reaching out to all entities in the organisation. The systems currently used in Indian spectrum management do not match such requirements, as many processes are still dependant on manual procedures and distribution by ordinary mail and/or courier services.

The IT system being commissioned by WPC, the NRSMMMS, is currently partially in service but is still being commissioned in some areas. When complete it will provide an appropriate platform for a modern spectrum management regime. Furthermore, DoT has established a comprehensive web-site providing information to the public on different issues related to the regulation of the Indian telecommunications sector. Information included on this web-site is for security reasons 'physically' disconnected from any of DoT's internal databases; it is thus not possible to obtain an impression of the extent to which information on the web is updated to reflect the data available to the authorities.

However, facilities and networks are not, by themselves, a guarantee of an efficient operation. Equally important is the ability of the spectrum management staff to utilise the facilities effectively and to make the most of their functionality. This requires comprehensive training and a thorough understanding of the underlying principles and processes of spectrum management, plus a willingness to welcome change and to perform tasks differently in order to promote the concept of providing a better quality service to spectrum users.

Any 'new approach' will need to be embraced by the entire organisation from senior management to junior staff. It is likely that any culture change proposed could take a considerable time to take effect and this should be taken into account.

4.2.1.1 Spectrum Engineering

Within WPC there is no tradition of detailed spectrum engineering work (e.g. studies into inter-service compatibility, sharing or equipment specification) being performed on a regular basis. Such studies typically rely on academic institutions or sophisticated software tools, neither of which appear to be within the day-to-day remit of WPC or WMO. Limited manual work has been carried out in the past, but the real breakthrough will occur when the data and facilities within the NRSMMMS system can be utilised to support spectrum engineering evaluations

4.2.1.2 Spectrum Planning and Allocation

This is a long term planning activity carried out by senior experts of the DoT and the cross-Governmental Wireless Planning and Co-ordination Committee (WPCC). Other user interests are obtained through consultations with SACFA members. The principal deliverable should be the regular revision of the NFAP to reflect Indian national requirements, but this objective, detailed in the New Telecom Policy document of 1999, has not been delivered upon as envisaged in the policy. This leaves the market with a confusing lack of factual knowledge concerning spectrum allocation developments, which again could become the basis for dissatisfaction regarding commercially 'unfair' decisions.

Spectrum planning work is often politically influenced and has to be systematic and visionary in order to balance requirements. Inadequate planning leads to a poorer utilisation of the spectrum, but cannot realistically

be changed overnight. Improving the situation in order to realise the objectives of the telecommunications policy (*.... that spectrum be utilised efficiently, economically, rationally and optimally*) takes time, a strong political will and possibly considerable financial resources for re-farming spectrum.

4.2.1.3 Rules and Regulations

The legal basis for spectrum management is provided by a fairly simple set of rules empowering the Government (by way of DoT) to decide and resolve all matters. This principle is also called upon when legislation and rulemaking might appear inadequate in view of the pace of development taking place in the telecommunications sector. However, this broad regulatory framework may also lead to delayed and opaque decisions, whenever clear guidelines are missing, which in turn may cause problems in a modern, competitive market.

In cases where day-to-day work ends up in conflicts or uncertainty with respect to the interpretation of rules and regulations, a case may be forwarded to the Telecommunications Commission (TC). This commission comprises the top-level management of DoT. For the purposes of fulfilling process requirements, TC liaises with TRAI and cross-Governmental bodies such as WPCC for technical/political advice. When necessary TC prepares new rules and regulations for submission to the political process and issues directions concerning the day-to-day operation of WPC.

The authorities and the vast majority of spectrum users are not currently in favour of introducing legislation, which would permit spectrum trading in India due to the inadequacies of the current policy and decision making legislation, and to the lack of an accurate spectrum database.

4.2.1.4 Frequency Co-ordination

National frequency co-ordination is the responsibility of WPC in order to ensure undisturbed use of assigned frequencies to different users. This task can be rather challenging when conducted using manual methods in the absence of a comprehensive spectrum management database.

International co-ordination is also the responsibility of WPC and is conducted in accordance with the appropriate ITU guidelines. However, co-operation and the establishment of a regular dialogue with spectrum management bodies in neighbouring countries seem not to have been established. Border co-ordination problems are handled on a case-by-case basis and are usually resolved in a technically satisfactory manner.

4.2.1.5 Licensing, Assignment and Administration

These activities represent the core day-to-day business of WPC. The organisation receives and handles all licence applications from both the public and Governmental spectrum users, and is responsible for maintaining records of all spectrum management decisions. Furthermore, the organisation's remit allows it to undertake the prescribed measures and investigations when issuing a new service licence and assigning frequencies to be used in accordance with that licence should it see fit to do so, however this would be a function of WMO and there is no evidence to indicate that regular inspections are conducted to support this activity.

The processing time for licence applications is considerable and perhaps more significantly, unpredictable. This is explained, at least in part, by the

lack of efficient computerised tools. Spectrum users have also claimed there is unfair discrimination between different user groups.

4.2.1.6 Spectrum Monitoring

WMO is responsible for monitoring activities throughout the territory of India and has fixed and mobile stations for this purpose in geographically distributed locations (see Chapter. 9). From a spectrum management point of view it is unclear to what extent monitoring processes are carried out proactively in a cooperative effort between WPC and WMO or reactively to resolve cases of reported interference.

It is understood that problems are often handled and resolved directly by the parties involved, without help from the authorities, as the processing time for a formal complaint may be considerable. Several of the major spectrum users have established their own spectrum control functions in order to be able to respond to problems in a timely and effective manner.

Staff members working in the monitoring department appear anxious to see the new NRSMMS system put into regular and fully-operational use. This would substantially boost the quality and volume of work that could be conducted however full exploitation of the facility requires additional skills, familiarity with the system and operational experience. Such experience cannot always be attained through training in the benign atmosphere of training courses that are included as part of the procurement contract and significant hands-on experience will be required in order to fully benefit from the capabilities of the equipment.

4.2.1.7 Enforcement

Anecdotal evidence suggests that the use of unauthorised transmitters seems to be a minor problem in India, however the extent to which this is the case is not evident from any reports provided by WMO. Licensed equipment operating contrary to its specified technical operating parameters are apparently corrected without major difficulties. It therefore appears that enforcement activities do not currently represent a major work-load.

This could be an effect of recent policy not to tolerate radio regulatory infringements or because obtaining a licence has been fraught with difficulty such that the licensee will do his utmost to comply with the stated licence terms and conditions. The duration of a licence is very short in India (1 – 2 years), but as long as the licensee complies with the terms and conditions there is no basis for denying a renewal.

For the same reason revocation of assigned frequencies may sometimes be problematical, as a result the sector seems to be concerned that frequencies could be assigned to an organisation, which for business reasons decides not to bring that spectrum to use. Recent proposals for new licence conditions appear to take this possibility into consideration.

4.3 Spectrum Licensing Processes

The applicable spectrum licensing processes in India are entirely in the hands of WPC, but there is little public knowledge of them. In principle all prospective spectrum users must apply for a licence from WPC in New Delhi, and even though WPC has tried to disseminate supporting information on 12 simple types of applications via its website, there remains

considerable uncertainty concerning the appropriate procedure. Further, for other services not covered by the list, once a service licence has been granted by the DoT, a subsequent assignment of frequencies for that particular licence is triggered by an application for a spectrum licence from WPC, thus completing the process.

The 12 application types supported by information on WPC web-site are:

1.	Proforma for Equipment Type Approval
2.	Application for license to establish, maintain and work wireless Telegraphs in aircraft registered in India
3.	Application for license to establish, maintain and work wireless Telephone station in India for non-commercial purpose in citizen band in Rural Areas
4.	Application for licence to possess wireless receiving and/or transmitting apparatus in India (Under the Indian Wireless Telegraph Act, 1933)
5.	Application form for a licence to demonstrate a Wireless Transmitter or a Receiver set
6.	WPC application form for earth stations
7.	Application for an experimental Wireless licence
8.	Application for Frequency Assignment for Transmission/Reception
9.	Application form to operate Wireless Link/Network under Indian Telegraph Act 1885
10.	Application for a licence to import Wireless Transmitting and/or Transreceiving Apparatus into India
11.	Application for licence to establish, maintain and work Radio Paging Systems
12.	Application form for licence to establish, maintain and operate Wireless Telegraph stations in India for short range UHF hand held Radios

It may not be obvious for an applicant to easily decide which application type to follow when a new service is under consideration.

Once an application has been submitted to WPC, its contents are scrutinised for accuracy, consistency and completeness; the availability of appropriate frequencies for the intended service is then investigated. In principle WPC holds the necessary information for evaluating an application, but it is often still necessary to check the application with respect to the interests of other (typically Government) spectrum users. This is done by copying the application to the 20 members of SACFA, asking each and every one of them to confirm frequency (and site) clearance for the new assignment.

4.3.1.1 Clearing the application with SACFA

SACFA's involvement has been seen as a major obstacle for speeding up the licensing process because SACFA members have carried out this activity by checking the new service for compatibility with their own organisation's network. A check of this nature may involve a remote location in India which in turn may be dependant on the postal service.

Furthermore, it is reported that the accompanying material has often been incomplete, i.e. the necessary cartographic material has not been included. This is a problem whenever a site is located in a national border region as detailed maps of such areas may be confidential.

An attempt to speed up SACFA approval procedure was made in 2005 by providing a facility which allows members to submit their site clearance requests by use of the Internet. However we understand that, as the Internet is 'physically' disconnected from any internal databases of DoT, WPC staff must still transfer the responses manually to the spectrum management database of DoT.

4.3.1.2 Licensing processes in WPC

WPC's handling of licence applications is assumed to take place according to established work procedures. However, detailed workflow descriptions with block diagrams or job descriptions could not be provided, despite reassurances that such descriptions are in existence. Consequently the licensing processes were evaluated by considering the statements received from spectrum users regarding their experiences.

The primary and over-riding observation was that the licensing processes are opaque and unpredictable in terms of duration. Some improvements have occurred and the overall process is slowly moving in the right direction. Reports provided to the consults in 2005 mention handling times for service licences of up to 12 months (satellite communications and microwave link for the infrastructure of a cellular network). It is interesting to note that applications for similar services in Western countries are processed within a few days or - when things are complicated - in several weeks.

The foregoing assumes that the application is complete and includes all relevant and required information. Apart from situations where the rules for the award of a licence or frequencies were amended while an application was still under consideration, a licensing application experiences less problems if an applicant has developed a network of personal contacts in WPC. Where this is not the case, an applicant could choose to involve the support of a so-called 'facilitator' for steering the application through the process. A facilitator is a person who knows the 'system' from inside, e.g. a former WPC staff member. He would obviously be equipped with a personal network of contact persons, which could be a useful asset for tracking progress and lobbying for a particular application.

The use of a facilitator adds extra expense to the process, but could save costs when the applicant is located geographically far from New Delhi. As mentioned previously, all applications must be considered by the central authority in New Delhi, an applicant from a city remote from New Delhi might therefore incur considerable travel expenditure and time burdens if he were to undertake the task himself without a facilitator.

Once an application has completed its journey through the system the desired service licence will be granted. The service licence will specify which frequency(ies) which should be utilised for that specific service and it would subsequently be required that these frequencies are allocated/assigned to the applicant. However, it may well be that due to residual spectrum occupancy by an incumbent user, the ultimate

frequencies assigned to the applicant may not be those requested in the licence application.

This situation is more likely to occur in and around the large Indian conurbations (metros) and could cause increased investment costs because equipment required may no longer be available for purchase by the applicant as a standard item. The situation may arise when all the designated frequencies in the service licence are not available for assignment because they still need to be vacated by the previous user. Unfortunately such situations can easily occur when only very little information is publicly available regarding the actual occupancy of the spectrum.

4.4 Observations

A fundamental problem arises from the fact that the lifetime of a licence is short in comparison with international best practice. Licences are valid for 1 year, with an option for 2 years. This does not permit the preparation of a secure business plan that would typically require fixed tenure of at least 7 to 10 years. International practice shows that the duration of a licence varies from 5 years (land mobile, fixed terrestrial, fixed satellite, etc) to 7 to 10 years (broadcasting). Therefore a typical licensee in India usually needs to have a licence renewed more frequently than licensees in many other countries. Such a situation also creates an unnecessary and artificial loading of the licensing process that could be avoided. The justification for such a frequent renewal requirement is that through this, an effective control can be exercised on licensees. Such control could be more effective by means of an efficient monitoring system, to identify unused licensed frequencies.

The spectrum licensing procedures described here reflect negatively upon current Indian practice. This is likely to be somewhat exaggerated as the views of spectrum users will be particularly focussed on such issues, especially if they have experienced financial or commercial difficulties as a result. However, exceptions do exist in, for example, terrestrial television broadcasting (still a monopoly) where the industry itself manages the allocated spectrum. Likewise, once frequencies are allocated to a national GSM-operator, that operator carries out his own frequency/cell planning provided the necessary information is given to WPC concerning frequency usage at specific locations, and that operation is not subject to international coordination requirements.

Other institutions for example the defence forces, expressed a wish to also revert to a regime based on block allocations of spectrum which could be locally managed. Defence already has an overall instrument for self-administration known as the Joint Communication Electronic Staff (JCES), which also co-operates and liaises with DOT and WPC.

The situation concerning India's spectrum management regime could be summarised in the words provided by one of the major spectrum users:

Spectrum in India is essentially not a scarce national resource, but poor spectrum management hampers its effective exploitation.

5. NATIONAL SPECTRUM POLICY

5.1 Introduction

A mission statement, or overriding objective, of a policy on spectrum use can be considered to be:

Create a predictable environment for current and future use of radio spectrum in India, in a manner, which is in the public interest.

The use of the radio spectrum needs to be strategically planned in order to create an environment, which allows for the long term planning and harmonisation with international trends concerning radio services and products.

5.2 Legal and Regulatory Framework - Overview

For almost 50 years the Department of Telecommunications (DOT) was the monopolistic provider of basic telecommunications services, subsidising local calls with expensive long-distance rates (as was common in most countries). It was not only the principal operator, but also the regulator. This changed when the Telecom Regulatory Authority of India (TRAI) was inaugurated in January 1997. The DoT is still responsible for the allocation of new licences and for spectrum management.

The pertinent Regulations and Policy Documents are:

- Indian Telegraph Act (1885)
- Indian Wireless telegraphy Act (1933)
- National Telecom Policy 1994 (<http://www.trai.gov.in/ntp1994.htm>)
- Telecom Regulatory Authority of India (TRAI) Act (1997) (<http://www.trai.gov.in/ac.htm>)
- New Telecom Policy 1999 (<http://www.trai.gov.in/npt1999.htm>)

A stated policy objective (New Telecommunications Policy 1999) of the Government of India is to: “*Achieve efficiency and transparency in spectrum management*”.

5.2.1 Communication Convergence Bill 2000

Under the present scenario different services including basic telecom, cellular, Internet and satellite television have different licenses and are regulated by different agencies, which hinder bundling of services, like Internet telephony. The Communication Convergence Bill 2000 provides for the formation of the 'Communications Commission of India', which will be made responsible for issuance of licenses and regulating the entire communications sector including the infrastructure and the content. The bill, however, has been on hold for a very long time pending work being

conducted by the Prime Minister's Office on a new regulatory framework for India that will include not just telecommunications but media markets too.

5.3 Dealing with Current Issues

From InterConnect's limited but intensive consultations there are clearly difficulties of lengthy, disproportionate and opaque (or translucent) spectrum management processes. Therefore if new innovative radiocommunications opportunities and applications are to be exploited in India, whilst implementing an approach to defence spectrum which continues to meet national requirements, a strategic review of how spectrum is managed should be initiated.

In Europe a process known as the Detailed Spectrum Investigation (DSI) was initiated to arrive at framework for spectrum management across the region in the longer term and this may prove a suitable model in the Indian context. The DSI looked at current and future civil and Government requirements and the way the spectrum is administered. Similarly, an initial step in a national spectrum management reform process could be a strategic review or DSI that should develop through transparent consultation processes and a high level management team, a national spectrum policy and plan including the organisational and management structure. This might include a NFAP for 10 to 15 years hence and an agreed migration strategy.

The terms of reference for a DSI might, in addition to the preceding points, include:

- The identification of key applications such as cellular mobile, digital broadcasting, wireless broadband delivery and low power short range applications that are likely to drive economic and social activity
- A framework for the dynamic review of spectrum allocations
- Policies for spectrum pricing and the details of a spectrum reforming policy

The detailed terms of reference for a DSI should be developed by WPC and approved by WPCC or DoT. The main feature of any DSI type process should be transparency; input material should be placed in the public domain wherever possible. Furthermore, interim findings should be published to allow for stakeholder feedback. In time it may even be possible to conduct the majority part of a DSI process on-line as an E-Government initiative, with perhaps 2 public meetings, the first a quasi press-conference to explain the objectives and milestones and a second to describe interim results and to invite comment on the DSI's proposals and recommendations.

In addition to a top-level spectrum review, such as a DSI, transparency and consultation can be beneficial on any major issue in the field of radiocommunications where the use of spectrum is involved and customers may have critical views on the process employed. In undertaking a review such as a DSI, it is advantageous to maintain the current balance of responsibility and continue with a traditional approach with WPC officials

developing policy, albeit with increased transparency and consultation, rather than responding to public demands via a consultation process and then using judicial procedures to resolve conflicts that may arise.

WPC could decide to consult on any major spectrum management issue decided by WPC, WPCC or the DoT. Typical examples of where public consultation could be beneficial would be the introduction of a new public mobile system, proposals for digital broadcasting and phasing out analogue, or introducing further market mechanisms to spectrum management.

The on-line web based E-Government options being gradually implemented by WPC should be extended to consultations and should be used to the maximum extent possible. A further factor that needs to be considered is whether there is also benefit in encouraging opinion from outside India, such as from manufacturers who can give future insight into how technology developments may shape spectrum usage.

The basic principles used to develop any national plan should provide for a forward looking, objective, timely, proportionate, non-discriminatory and transparent approach to the spectrum allocated to major users and proportionality in charges and fees for cost recovery and spectrum usage irrespective of the technology employed. A general technology neutral approach to systems and standards should be adopted unless there are overriding reasons to apply a specific technology. An example would be the harmonised system being developed by APT for disaster relief communications. The means for charging Government users for spectrum use also need to be reconsidered.

A second step, following the undertaking of a DSI, would be to carry out a survey of licensing records to determine numbers of stations and age of equipment and radio spectrum occupancy in the key bands. This could also include factors which might be used in an administrative pricing regime e.g. the cost of using alternative means to effect communications.

A third step could be to evaluate efficiency of spectrum usage for various user categories. The results would help to determine any weighting factors needed in establish a transparent charges and fees regime.

The following sections take account of the foregoing in developing the framework of a possible future policy framework for WPC.

5.4 Possible Future Policy

5.4.1 General

Until a Department of Spectrum Management (DSM) is formed (see section 6.1.1) or the CCB 2000 is adopted and the CCI established, WPC shall remain the centre of expertise for spectrum management in India; it shall ensure that the radio frequency is managed in an efficient and effective manner. It shall manage radio frequencies used for non-Governmental applications in a transparent, non-discriminatory and proportionate manner. The New Telecommunications Policy clearly places the overall responsibility for spectrum management on the DoT and WPC.

Therefore in any situation where the WPCC agrees that limited delegated responsibility for detailed frequency management in certain frequency bands should be transferred to other state bodies, WPC shall continue to ensure that such frequency bands are utilised in an efficient and effective manner through regular review. Furthermore, WPC shall ensure that all obligations on India arising from the Constitution, Convention and Radio Regulations of the International Telecommunication Union are fully respected.

5.4.2 Frequency Allocation

WPC should be the lead body in India with respect to developing national spectrum plans, the National Frequency Allocation Plan (NFAP) and other interdepartmental co-ordinating activities, in consultation with all Government Departments having a declared operational or strategic interest in the radio spectrum, through their membership of WPCC and SACFA.

Regulatory instruments, procedures, processes, regulations, standards and spectrum management guidelines shall be developed by WPC concerning the management electromagnetic (EM) emissions in the frequency range 9 kHz to 275 GHz. Equipment or networks employing EM emissions outside this range shall be regulated by Electro Magnetic Compatibility (EMC) provisions.

5.4.3 International

WPC shall be responsible for developing the Indian strategy for spectrum management matters in respect of foreign administrations, Regional bodies (e.g. Asia Pacific Telecommunity (APT), South Asian Association for Regional Cooperation (SAARC)), International Civil Aviation Organisation (ICAO) and International organisations (e.g. International Telecommunication Union (ITU), ICAO and International Maritime Organisation (IMO)).

In developing the NFAP and revisions WPC shall promote and support the harmonising of spectrum usage within the Region, thus maximising economies of scale and reducing equipment costs for users as well as reducing the likelihood of cross-border interference cases. All frequency assignments (civil or Governmental) capable of causing interference to, or requiring protection from, the stations of neighbouring administrations, shall be co-ordinated with the administration in question. Where a direct approach is not possible WPC shall seek the help of the ITU in the co-ordination process.

5.4.4 Frequency Policy

The process of assigning frequencies shall be open, transparent and non-discriminatory and support the promotion of competition in the telecommunications sector. WPC in consultation with WPCC and SACFA shall ensure that adequate spectrum is available for new technological developments in order to:

- Provide for competitive telecommunication infrastructures
- Support rural telecommunications

- Introduce future generations of public and private mobile technologies
- Facilitate the rollout of broadband telecommunications networks
- Ensure the timely introduction of digitised broadcasting networks
- Meet the needs of civil aviation
- Satisfy the spectrum requirements of WPC and SACFA members
- Stimulate technological innovation and competitiveness
- Support economic growth and create employment
- An appropriate refarming or spectrum transfer method shall be implemented for circumstances where an urgent change of frequency usage is required

5.4.5 Enforcement and Control

An effective Enforcement Service, either from within the existing function in WMO, or as a new section of WPC, shall be established to resolve interference cases quickly (particularly in the case of interference to safety services) and ensuring that equipment deployed meets appropriate standards, in the case of complaint.

The Enforcement Service shall also take physical or legal action against any unauthorised use of the radio spectrum.

An Electro Magnetic Compatibility (EMC) policy shall be developed to minimise problems of immunity and interference occurring to radiocommunications systems from non-radio, active electrical and electronic apparatus, equipment and networks.

5.4.6 Licensing and Spectrum Pricing

WPC should adopt a system of spectrum licensing and charging using spectrum pricing techniques supported by regulation, as appropriate.

Techniques which WPC should consider on a case-by-case basis should include, cost based licensing, comparative selection of licensees, administrative incentive pricing (AIP) and auctions.

Where a licensee requires the use of spectrum and the allocation of that spectrum is unlikely to constrain the number of applicants the spectrum will be issued on a non-competitive basis. Where there is likely to be a higher demand than there is frequency available then a competitive tendering process should be used.

Individual licences authorising the establishment of radiocommunications stations are generally valid for a term of between 1 and 2 years. However if the licence is for the provision of a public telecommunications service and the licence term is longer than any radiocommunications station directly associated with the provision of that service should be licensed for the same

term. Stations indirectly associated with the service should be authorised separately.

The use of Class licences for specific categories of short range, low power devices in accordance with technical regulations concerning frequency of operation and radiated output power should be encouraged.

The cost of a licence where spectrum is utilised may comprise two elements, an administrative charge and a spectrum fee. The administrative charge is intended to cover the direct and indirect costs of WPC; the spectrum fee will reflect the value of the spectrum, the amount used and the efficiency of use.

The spectrum fees payable to license a station of each category of radiocommunications service or user-group should be prepared by WPC in accordance with procedures agreed through consultation and published in a transparent manner. WPC should review spectrum fees annually and prepare amendments, as appropriate.

WPC shall address within WPCC the development of an appropriate licensing and pricing structure for non-civil and Governmental use of the spectrum.

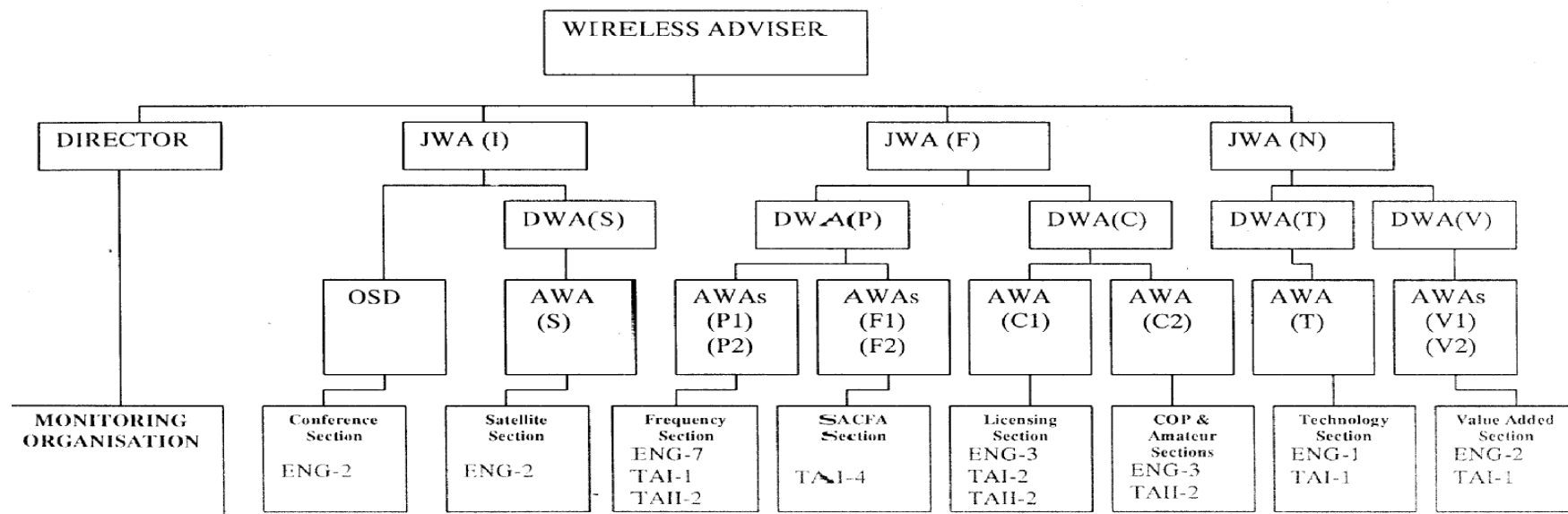
6. INSTITUTIONAL FRAMEWORK AND STAFFING

6.1 Organisational Structures

WPC comprises four departments (as indicated in the diagram below), each under the control of a Joint Wireless Advisor (JWA) or a director:

- **International**, under the control of the Joint Wireless Advisor, International - JWA(I) - responsible for dealing with international spectrum management policy matters, contributing to the formulation of national telecommunications policy, and international satellite co-ordination;
- **Frequency**, under control of the JWA(F) responsible for frequency assignment and licensing of domestic telecommunications services, including broadcasting and amateur, and site clearance (SACFA);
- **New Technology**, under control of the JWA(N), responsible for frequency assignments for the competitive public services; viz basic, cellular, paging and trunking;
- **Wireless Monitoring Organisation (WMO)**, under the control of the director of the WMO, responsible for all monitoring and licence enforcement activities.

ORGANISATION CHART OF WPC WING
Appendix 1.1



LEGEND : JWA : JOINT WIRELESS ADVISER
 DWA : DEPUTY WIRELESS ADVISER
 AWA : ASSISTANT WIRELESS ADVISER
 ENG : ENGINEERS

TAI : TECHNICAL ASSISTANT GRADE I
 TAII : TECHNICAL ASSISTANT GRADE II

Beneath the Joint Wireless Advisors sit a number of Deputy Wireless Advisors, each with specific remits. The Deputy Wireless Advisors are supported by Assistant Wireless Advisors who are in turn supported by a number of technical assistants and engineers.

Fundamentally, the organisational structure of WPC contains all the functions that a spectrum administration should contain, in particular:

- Licence applications and renewals (administrative);
- Frequency assignment (this may be further subdivided into user types, for example, fixed, broadcasting, mobile etc);
- Spectrum engineering (including the maintenance of the NFAP and National Frequency Register (NFR));
- International co-ordination;
- Monitoring and enforcement;
- Market surveillance.

Indeed, WPC structure largely follows these functions. The greater issue appears to be co-ordination and co-operation between the various departments. It appears, from the comments received from interviewees, that following a single process, such as making a licence application, requires the application to be passed internally from one department to another rather than their being a central function within WPC which takes control. The employment of 'facilitators' (see section 4) to walk licences between the various members of staff in the various department to expedite applications clearly illustrates the lack of internal co-ordination. In particular, there is concern that the interaction between WMO and the other departments in WPC is not delivering the support which the spectrum management process requires.

Whilst WPC is clearly a technically capable organisation, spectrum management in the 21st century is a matter of balancing technical requirements with the need to ensure that spectrum is used in an economically efficient manner. Although WPC has made some inroads into assigning and pricing spectrum using market-based techniques, its primary function remains the technical management of the spectrum, as clearly demonstrated by the existing organisational structure. There is clearly a need for more of an economic and market focus in the activities of WPC in issuing new licences and in dealing with existing ones and there appears to be no inherent expertise in this field within WPC.

WPC should therefore seek to develop an economic/market focussed unit to ensure that decisions which WPC makes with respect to the assignment of frequencies is in the best economic interest of consumers as well as being technically sound.

In addition to WPC, a number of committees, which have some element of control of or by WPC, also exist. These have been mentioned before in this report but they are worth recalling here

- **Standing Advisory Committee on Frequency Allocation (SACFA):** This committee comprises 18 members made up from the various Governmental departments which takes decisions on site

clearance as well as on more general frequency allocation issues. The chair of SACFA is the Secretary of the DoT (who is also the chair of the Telecommunications Commission);

- **Wireless Planning and Co-ordination Wing Committee (WPCC):** This is a high-level committee that meets occasionally to discuss issues of significant which require a decision beyond that which it is possible to achieve in SACFA. It comprises top-level representatives from a few Government departments (including defence, broadcasting, finance, IT and home affairs). Typical issues which WPCC might address include the de-regulation of the 2. 4GHz band, and changes to site clearance criteria;
- **National Frequency Allocation Plan Review Committee (NFAPRC):** This committee, chaired by WPC is formed every two years to review the Indian NFAP and may meet several times until the review is complete. It is open to membership from any organisation (Governmental or otherwise).

With the possible exception of SACFA, it is unclear exactly how some of these organisations inter-relate to WPC and in particular which have the power to make changes to WPC activities or processes and which are just advisory boards, and more importantly, it is very unclear as to what remit and set of processes these committees work under.

6.1.1 A Transparent Structure

WPC is a unit of the Department of Telecommunications (DoT) which is in turn a department of the Ministry of Communications and Information Technology (MOCIT). As such WPC is part of the same Government body which also directly oversees the operation of the two main incumbent telecommunications operators, MTNL and BSNL. In this environment it is difficult for WPC to be perceived to be truly independent and acting in the best interest of the telecommunications industry as a whole. This is further exacerbated by the fact that BSNL staff sit on SACFA panel, and thus are seen to have the option to favour their own interest, whether this happens or not in reality.

In many countries, the role of spectrum (and for that matter, telecommunications) regulation is handled from within a structure where the regulation takes place remote from Government control. It is often difficult to completely disassociate spectrum management from the process of Government due to the fact that the asset which is being managed fundamentally belongs to the State. It is for this reason that a State body which still retains control of the spectrum needs to ensure that the regulatory process is completely transparent and cannot be conceived as offering the potential for bias. This is often the key to industry acceptance of any harsh or difficult decisions that the regulator may need to make.

WPC, with its direct connection with the MOCIT does allude to the potential for Government telecommunications to be favoured over new competitors and often the perception of the potential for such bias is more destructive than anything which might actually happen. For all the reasons mentioned InterConnect recommends that action should be taken to remove any

possible advantages (actual or perceived) that former incumbents may have in respect of new entrants to the telecommunications sector.

6.1.2 Reporting Structure

InterConnect has, for some time, been concerned that the status of spectrum management within India does not appear to carry sufficient weight in a country which is technologically important in the Asia Pacific region. The efficient and effective management of spectrum is a key element in the development of existing and new industries; it is also important for the development of employment opportunities in a number of sectors.

As mentioned previously WPC is currently a unit of the Department of Telecommunications (DoT) which is in turn a department of the Ministry of Communications and Information Technology (MOCIT). When InterConnect first reviewed the structure of spectrum management and telecommunications regulation within India consideration was given to recommending an independent regulatory organisation for spectrum management, similar to TRAI. However, this was rejected in view of the strong tradition within India of managing scarce resources by the State sector. A further cause for concern with such an approach is the difficulties being experienced with the Communications Convergence Bill and the proposal to establish a 'super' ICT regulator. With these issues in mind an alternative option is proposed for consideration.

In the scenario recommended by InterConnect WPC would remain a Governmental organisation but would be established as a Department reporting to the Prime Ministers Office (PMO) e.g. Department of Spectrum Management (DSM). This organisation should have a management with the administrative skill sets of career civil servants as well as the highly competent engineering staff currently employed in WPC. It is understood there are similar organisations with such status, for example DOS (Department of Space) and DONE (Department of Nuclear Energy).

Some additional skills and powers would be required in the new DSM, which would permit market based spectrum management initiatives to be taken, whenever it was seen to be advantageous in the interest of efficient spectrum management. However, most importantly the status of spectrum management in India would be elevated to a level similar to that of other Governmental, spectrum user organisations.

6.1.3 SACFA

It appears that the day-to-day decision making with respect to frequency allocation and site clearances in India takes place through SACFA. Every site clearance application has to be circulated to all 18 members (or to an appropriate subset where such a subset can be clearly identified from the type of application) who must each, in turn, respond before any final decision can be taken. Despite the introduction of a web-based process for site clearances, this process typically takes several months.

This process of approval by each of the members and the necessity in many cases for applications to be circulated within the member organisations for internal approval appears to be the single greatest element which is slowing

down the spectrum management process in India. Further, many interviewees noted that it was only where approval was granted that they received any communication from WPC concerning their application. Where no approval was forthcoming, no communication was received leaving the applicant unaware of whether the application was still pending or whether it had been turned down. However, most interviewees recognised the need for inter-department Governmental involvement in decision making as important for the effectiveness of implementation of any decisions taken. Given the large and growing number of licence and site clearance applications that pass through WPC (and thus SACFA) each year, improvements in SACFA process are essential if the time necessary to approve licence applications is to be brought in line with international benchmarks mentioned in section 4 of this report. For example:

- SACFA could establish a number of 'exceptions' for which applications would not need to be seen directly by them (the situation for site clearance for VSAT dishes given in section 3.2 is a good example of this);
- SACFA should become more strategic, making decisions on frequency allocation and site clearance rules instead of vetting each application;
- SACFA members should be given a deadline by which any objections must be registered, otherwise applications will automatically be approved;
- The process by which SACFA makes decisions should be clearly published such that applicants may know in advance the likely progress of an application;
- The status of an application, including which members have approved it (or turned it down) should be made clearly available to applicants (preferably via the web-based interface being introduced by WPC).

6.2 Staffing

The total number of staff positions at WPC is somewhere between 650 and 750 (two separate figures were given by two different people within WPC), with around 450 technical staff including 125 engineers. Though exact figures did not come to light, it appears that a significant proportion of these staff positions remain vacant. Growth in staff numbers has been about 4 to 5% per annum which, although in line with other Governmental departments, does not reflect the enormous growth in spectrum-based services in India.

Given the paper-based nature of the historical licensing processes, the number of staff in WPC does not appear excessive, however the move to a computerised system of operation will impact in a number of areas, in particular:

- There will be a need for training for all staff to ensure that they develop the correct skill-set to deal with the new systems;
- There will be a move away from administrative burden towards more technical and computer skills;
- There will be a drift towards more strategic and long-term activities rather than dealing with the 'day-to-day';
- There may be an overall reduction in staffing levels.

Though there may be an overall reduction in staffing levels, the need to operate in a more strategic and technical manner, with more highly trained staff, will remain a priority in order to provide an effective spectrum management service.

7. FINANCIAL RESOURCES AND BUDGETING

7.1 Income and Funding

WPC's annual budget forms part of the DoT budget, and is agreed on an annual basis with DoT whose budget is in turn agreed with the Ministry of Finance as part of the central Government budget. The Wireless Advisor is responsible for setting and defending this budget with DoT.

In 2004 WPC budget was approximately Rs 250 million (~US\$5.7 million)⁵. This budget has been increasing in line with staff numbers at approximately 4-5% per annum (subject to one-off changes resulting from modifications to Governmental pay scales).

Revenues generated from spectrum licence fees in 2004 amounted to around Rs 10 billion (~US\$230 million), solely from non-Governmental spectrum users. As of 2004, WPC has instigated a scheme whereby Government users are now eligible to pay for their use of the spectrum to the same extent as commercial users. The invoices submitted to Government departments for spectrum use for 2004 amounted to Rs 10 billion, however as of yet, no department has made any payment to WPC. Whilst the payment of these invoices is merely passing funds from one Government department to another (and thus is effectively revenue neutral for central Government) it does play a very important factor in recognising the value of the spectrum equally for both Governmental and non-Governmental users. Payment of charges and fees for access to spectrum should also act as an encouragement to Government users to use spectrum more efficiently – especially if the Government departments are able to retain any savings made within their budget allocations.

All revenue generated by WPC from spectrum licences is returned immediately to Government coffers with no financial benefit being accrued by WPC for any initiatives it may take to increase licence revenue. WPC has not yet auctioned any spectrum (though there are debates about how 3G cellular spectrum should be paid for) but it would appear that even if such an auction took place, none of the funds generated would remain with WPC. Such a situation is not uncommon, however in recognising the value of the radio spectrum, the Indian Government should equally recognise the need to manage it in a way that reflects the value and allow the management organisation (WPC or DSM if InterConnect's recommendation is accepted) to retain additional funds to support justified investments in infrastructure and salaries, where it has proven successful in exceeding management expectations. To do this however requires a series of performance indicators to be developed which can then be used to measure whether or not WPC is effective in its function. The performance indicators currently published in the DoT Annual Report include:

- New radio frequencies assigned (190,000);
- Frequency assignments notified to the ITU (615);

⁵ This excludes payments of the US\$40 million loan made by the World Bank to WPC for the current spectrum management strengthening project

- Number of WPCC & SACFA meetings held;
- Inter-departmental meetings held;
- Site clearances processed (50,000);
- Number of licences issued to new stations (16,000); and
- Number of licences renewed (10,000).

Whilst some of these give an indication of the level of activity within WPC they do not measure the effectiveness of the spectrum management processes in action. In addition to those metrics identified above, additional indicators such as the following would enable a better assessment of WPC's performance:

- The time taken to process new frequency assignments;
- The number of new assignments which caused interference to existing licensed users once transmissions started;
- The number of frequency requests that were denied, together with the reason for rejection (to assess levels of congestion);
- The time taken to process site clearances; and
- The number of interference problems that were successfully rectified.

7.2 Setting of Licence Fees and Charges

7.2.1 General Fees and Charges Issues

DoT issues the service licence and WPC provides a wireless licence. Once the service licence has been authorised the wireless licence is then provided. The spectrum required to operate the service is however priced additionally to the licence. This is in the form of spectrum charge levied by WPC

The spectrum charge is derived from the costs related to spectrum management. It comprises a licence charge and a royalty charge. The licence charge is determined by the cost of processing the application by the spectrum management functions which include the examination of the application form, preparation of documents, etc. The royalty charge covers the frequency management costs, which includes monitoring, inspection, coordination, infrastructure development, etc.

On 23 March 2005 in pursuance of the Indian Telegraph Act, 1885 (13 of 1885), the Central Government prescribed in the table below the following rates of licence charge for the grant and renewal of various categories of licences.

S. No.	Type of Licence	Revised charge Rs per annum	Remarks
1.	Fixed / Land Station	500	Per station
2.	Land Mobile Station	250	Per Station
3.	Captive Paging (for Hub)	2000	(No royalty)
4.	Import Licence	500	per import licence
5.	Maritime Mobile Station (Fishing Trawlers)	500	per trawler
6.	Maritime Mobile Station (Ships)	5000	per ship
7.	Aeromobile Station Licence	5000	per aircraft
8.	USR (Short Range)	250	per station

Beyond this, most spectrum charges seem to be calculated on an individual basis and the application of charges across different user groups (e. g. broadcasting versus telecommunications) is neither uniform nor transparent.

7.2.2 Spectrum Pricing

In the Indian telecommunications sector, auctions have been used for allocation of basic and cellular licences. As in most countries, it is the ability to offer a service and not the spectrum that is being auctioned (however clearly there is an intention to offer spectrum to services which fundamentally require it). Nevertheless some value of the spectrum can be determined indirectly from the auction process i. e. through the services that could be provided over it.

Since the spectrum charge imposed on most radiocommunications services is essentially a cost recovery mechanism, a major disadvantage of this approach is that there is a minimal relationship between the level of charge and the value of the spectrum used. For instance, one licensee may use radio frequencies in a relatively unpopulated area and pay the same charge as a second user who uses the identical band in a heavily populated area even though the latter band has far greater value.

As an example point-to-point telecommunications can be provided either by optical fibre or copper links or by radio whereas mobile services can only function through the use of radio. If the price for spectrum is below the market value, fixed-line service providers would likely prefer to use radio to provide point to point communications rather than other available alternatives. This could result in less spectrum being available for mobile telephony in congested areas. This is also a good example of inefficient use of the radio spectrum – use of radio spectrum when there is a perfectly acceptable alternative, to the detriment of services for which there is no alternative but to use the radio spectrum.

Such situations have been addressed in some countries through administrative incentive pricing or a carefully designed licence auction process, where the associated spectrum is clearly indicated and available.

7.2.3 Indian Auctions

In 1991 India saw licences auctioned for the provision of basic and cellular services by DoT. The entire country was divided into roughly 20 circular areas, known as circles and categorised as A, B, or C depending upon their revenue potential. For administrative convenience, the larger states were divided into two circles, while some smaller states were amalgamated. For cellular services, DoT decided to license two operators per service area, while for basic services there would be one more operator in addition to DoT in each service area.

For all licences, bidding was a two-stage process, the first being a pre-qualification based on the evaluation of financial net worth (linked to the category of the geographical area (circle) and type of service) and experience in service provision. The second stage involved the evaluation of bids. The process comprised a single round, with the award going to the highest bidder drawn from those that satisfied the pre-qualification conditions. For cellular licences GSM was the specified technology and for basic services, a combination of optical fibre and wireless local loop (WLL) was selected.

For cellular services, there were separate licences for the four major metros of Kolkata, Chennai, Mumbai and New Delhi and the 20 licences for the circles containing the metros excluded these cities. For metro licences, the financial bids were to be evaluated on the rental to be charged to the customer for the first 3 years.

After the auction the 'goal posts' were moved when the Government required one winning bidder to 'choose' three circles from the nine it had won legitimately according to the process. Subsequently the process was fraught with problems, especially for the basic service licences.

Despite relatively fewer problems with the award of cellular licences, the services were slow to take off, due to the high bids, slow clearances for frequency allocations and lack of a suitable framework for managing the interconnect arrangements.

Under NTP 99 a roadmap was developed for resolving some contentious issues. All existing licence holders could "migrate" to a new regime that involved a one-time payment as entry fee and an annual revenue share with the Government. The entry fee was based on a percentage of the total amount of the original bid.

In the auction design for the fourth cellular operator the bidders could apply for any number of service areas, subject to the fulfilment of the specified entry conditions. The existing licensees could not bid for the same service area. Rollout obligations would be imposed on the winning bidders such as covering at least 10 percent of the district headquarters in the first year and 50 percent within 3 years of the effective date of the licence. Having been criticised for the single round highest bid mechanism that caused inflated licence fee in earlier rounds, the Government produced a bidding process which it called the informed ascending bidding process. The bidding process would have three rounds. The highest pre-qualified offer in the first financial bid would be treated as the reserve price for subsequent rounds of bidding. The lowest bidder in any round would not be allowed to participate

in the next round, provided there were four or more bidders in any round. In case there were only two short listed bidders, both would qualify. The highest bidder in the third round would be declared successful for the grant of a licence.

7.2.4 Improved transparency and proportionality - the options

One of the principles of spectrum management in the twenty-first century requires administrations to exercise transparent and proportionate procedures with respect to their activities. WPC must collect the direct and indirect costs of administration from licensees and in order to determine the administration charge component of the licence tariff, it is necessary to know the cost base of the various licensing groups.

The Consultant therefore suggests that the direct and indirect costs associated with spectrum management should be documented by WPC in a manner, which will facilitate the setting of administrative charges to ensure that the costs of spectrum management are recovered from licensees.

There are also difficulties with international terminology concerning the monies procured by licensing. Throughout this document the following has been assumed:

- Charges: recover costs associated with developing telecommunications policy, issuing licences, monitoring market behaviour and enforcing licence conditions
- Fees: provide incentive to use spectrum efficiently, ensuring optimum use of scarce resources

There are several approaches to licensing and charging both administrative and market based, to ensure that spectrum is assigned to the user who values it the most. The table below provides an overview of how different approaches to spectrum assignment can realise benefits or produce problems.

The four main options are:

- Traditional cost-based, first-come first-served licensing
- Comparative selection, where the administration decides on criteria to judge applications
- Administrative incentive pricing (AIP), where the administration seeks to assess the true economic value to users of spectrum and to charge licence fees accordingly
- Auctions, where the value of the spectrum is tested in the market and the user who values it the most wins the auction

None of these options can be viewed as the most or least appropriate. For each requirement WPC could consider what best meets its spectrum planning needs and the demands faced in the market for the service and particular application in question.

In most countries utilising pricing schemes, a mix of all four methods has been used in different circumstances. The key point is that these are tools to be used when needed according to local circumstances.

Method	Potential Problems	Potential Benefits
Cost-based (or first come first served)	Economically inefficient, leads to unsatisfied demand for spectrum. Slow process for change, impedes competitive development of markets. Creates incentive to hoard unused spectrum.	Transparent costing based on reallocation of overheads. Straightforward.
Comparative selection or "beauty contest" (not based on economic value considerations)	Criteria inevitably subjective, therefore less transparent. Less chance of economic efficiency as potential winners do not disclose all of their information on the value of the spectrum and do not benefit from revision of their valuations as information is revealed by others. Tends to favour incumbents. Subjective assessment can result in increased scope for legal challenge.	Provides spectrum manager with control over final decisions, although use is limited by information available. Enables non-commercial policies to influence outcome (for example licence requirement to roll out networks).
Administrative Pricing (based on economic value considerations)	May be difficult to calculate true economic value if not tested in the market.	Significant benefits in economic efficiency. Incentive to return spectrum not needed. Incentive to licensees to develop spectrum efficient technologies and alternative services. Flexible in its implementation and offers least degree of change from traditional approaches.
Auctions	Careful design of auction necessary to achieve optimum result. Not appropriate if fewer bidders than number of licences. Difficult if same number of bidders as number of licences. Not appropriate if quantity or quality of spectrum very uncertain. In addition, there is some concern that auctions can lead to grossly inflated licence fees (as is the case with 3G licences in the UK, Germany, Italy and maybe also the Netherlands). This is not an inherent 'generic' short coming of auctions; rather it is a function or combination of, poor commercial judgement, lack of experience on the part of the bidders and auction design. 3G licence fees generated by more recent auctions have been significantly lower, thus demonstrating that lessons have been learned and that auctions can be used to determine realistic licence fees.	Variety of auction design provides scope to achieve variety of objectives e. g. encouraging new entrants, raising funds, getting licences to those who will use the spectrum most valuably. Greatest chance of achieving most economically efficient use of spectrum (if designed to achieve this). Open, fair and objective if properly designed. Market price achieved at auction is strong incentive to licensees to optimise use (rollout quickly, use spectrum efficiently etc). Can combine with non-commercial policies to influence outcome (for example related to network roll out). Requirement for deposit can put responsibility for checking business plans onto providers of finance to bidders. Less vulnerable to legal challenge.

Table 1. Overview of charging mechanisms

It is important in considering options for particular markets that these issues are fully considered against the situation prevailing in each market. For example, an objective set by WPC to promote competition will require analysis of the current market situation and the likely take up of new entrants. Answers to these questions will assist in considering which method will best meet the objective set. It is also important to recognise that, under each option, certain problems such as transparency can be mitigated against during the implementation processes.

Likewise an option that should be more transparent could be implemented in a secretive way (i. e. denying bidders access to information in an auction) which can undermine the potential benefit. It should also be recognised that these options are not necessarily exclusive. It may be possible to devise hybrid solutions, such as an auction with a comparative selection qualifying round, to meet particular objectives.

In addition different radio services have different characteristics and may require different approaches. Typically a combination of administrative pricing and regulation would be used to manage spectrum for most mobile radio and point-to-point fixed links. Public telecommunications mobile networks and broadcasting networks or stations could be auctioned, or could be the subject of a comparative bidding approach, while regulation alone could continue to be sufficient for some other applications and radiocommunication services.

In summary dependent on the licence to be awarded, India should consider utilising the most appropriate choice of licensing and tariffing from all the available spectrum pricing techniques available. These should be supported by regulation as appropriate. Before implementing a spectrum pricing approach WPC should consider the following criteria:

- The extent of spectrum availability
- The current and expected future demand for use of the spectrum and the desirability of promoting competition
- Efficient spectrum use and management
- Economic benefits
- Development of innovative services and competition

Auctions or comparative methods will generally be used for public mobile telecommunications and possibly broadcasting licences.

The construction of auctions and comparative tenders should follow best international practice and be developed iteratively on a case-by-case basis using experience from previous processes.

Administrative Incentive Pricing (AIP) could be used for most other commercial radiocommunications e. g. mobile and fixed links.

Regulatory methods will continue for other categories of radiocommunications.

AIP spectrum fees payable for each application category should be based on an appropriate method, to be determined based on the actual situation in India.

7.2.5 Future Introduction of Spectrum Pricing

In deciding the frequency bands and services which should be the subject for spectrum pricing, the following tests should be applied:

- Is there excess demand for spectrum now or in the near future from existing uses?
- Can the spectrum be used for another purpose and, if so, is there excess demand from other uses?
- Is it practically feasible to collect AIP fees given possible constraints due to avoidance or illegal use?
- Are there any policy or political factors that prohibit the use of spectrum pricing?

The answers to these questions could then be used to ascertain where spectrum pricing may be applied in India. As a guide and subject to an evaluation of whether there is congestion, the initial implementation of AIP might be feasible for spectrum fees for all categories of non-public civil mobile radio applications and subsequently for all categories of civil fixed, point-to-point and point to multipoint fixed links.

However such a decision should be subjected to the rigours of a public consultation process to ascertain the views of all stakeholders.

8. STAKEHOLDER INVOLVEMENT

8.1 Introduction

As addressed in prior sections, one of the main issues that stakeholders, both those who are in Government and those from the private sector, raise is that of transparency. While this issue surfaces in all other aspects of spectrum management, the root cause of doubt and uncertainty in spectrum related procedures begins in the process of the actual policy formulation. The experience of participants in such processes and the resulting outcomes has lead users to distrust the system.

The policy followed by the DoT and WPC for soliciting stakeholder opinion and ensuring that stakeholders' involvement is quite open and provides appropriate opportunities to present viewpoints and express concerns. The NFAP review process, which is supposed to be every two years, is the primary mechanism for WPC to solicit the opinion of interested parties. While this is an open process with working groups assigned different tasks, and is similar to the processes followed by other international forums, the overall sentiment of participants is mixed concerning its effectiveness and the ability to clearly understand the results.

Furthermore, through various committees and groups, Government stakeholders have the opportunity for more regular and frequent policy-making influence. These committees include SACFA, WPCC and the National Working Groups (NWG), which are formed to coordinate the preparation of WRC conferences. Membership of these committees and groups therefore provide Government users and stakeholders a substantially higher level of involvement in policy making than those from the private, academic or R&D sectors.

InterConnect has developed recommendations that would improve stakeholder participation and provide greater transparency of the decisions bring made. This would substantially contribute to removing the prevailing sentiment of questioning the true value of interaction with WPC. These procedures would also attempt to reduce the dependence on personal networks as discussed in Chapter 4, and thereby increase overall transparency.

8.2 Policy

The overall framework that WPC follows in creating spectrum management policy can be best described by examining the policies of particular groups and processes, which form part of the overall WPC Indian spectrum management environment. There is no specific overriding policy framework, which dictates what the processes are for creating and modifying frequency allocation plans, fees, charges, assignment procedures, etc. These decisions therefore come as a result of the policies agreed by the committees and groups discussed below. The lack of a specific policy and framework has led stakeholders in the private sector to comment that they are uncertain how to influence a change in policy or to even explore jointly

with the Government what are the possibilities for new services and technologies to acquire spectrum in India.

8.2.1.1 National Frequency Allocation Plan Review Committee

The National Frequency Allocation Plan Review Committee (NFAPRC) is constituted for purposes of conducting the periodic review of the NFAP to reflect the results of ITU WRCs, implement international commitments and to also reflect the changing requirements of the user community in India. The most recent process was initiated in March 2003 for purposes of creating NFAP 2004, but it is still ongoing. A draft NFAP 2005 and ensuing revision have been produced, however this remains in draft status.

8.2.1.2 National Working Groups

The National Working Groups to prepare Indian proposals to ITU WRCs are constituted by WPC with a designated chairperson determined by WPC and DoT. They consist entirely of Government representatives, including those from public sector spectrum user agencies, who are designated as members. The groups are modelled on the various ITU-R study groups, e. g. Spectrum Management, Propagation, Fixed-Satellite Service, Broadcasting Service, Space Science Services, Mobile as well as Radiodetermination, Amateur and related satellite services and the Fixed Service. The overall preparatory process is chaired by the Wireless Advisor to whom the individual working group chairmen report.

8.2.1.3 SAFCA / WPCC

Both SACFA and WPCC have been discussed in detail in previous sections. They play a substantial role in stakeholder involvement and were originally constituted with the view to guide policy making.

While SACFA has the prime role of granting site clearance, it is the body which oversees the first level of inter-organisational policy coordination and discussion. WPCC is only convened on an ad-hoc basis when required to overcome an impasse in negotiations in the traditional SACFA processes between different departments or groups.

8.2.1.4 Others

Spectrum policy is also influenced by other actors within the Indian Government. These include TRAI, the Planning Commission, and the Cabinet and Prime Minister's Office (PMO).

Though the role of TRAI in spectrum policy making has not been defined specifically in the TRAI Act or NTP 1999, the Authority was requested by the DoT to review certain aspects of the growing conflict between GSM and CDMA operators concerning the spectrum assignments for 2G mobile services. TRAI was also requested to consider allocations for 3G as part of its responsibility for fostering growth in the telecommunications sector. However TRAI is only able empowered to provide views and recommendations and is not able to take regulatory action concerning spectrum. But it did conduct an extensive process that lasted more than a year, which resulted in recommendations being released in May 2005.

From time to time, other organisations such as the Planning Commission and the Cabinet in combination with the PMO can influence WPC or Government spectrum users to advance specific policy initiatives they may

have. Furthermore, the Cabinet and PMO may also become involved in decision making when SACFA or WPCC are unable to resolve an issue, or a particular issue is submitted to the inter-ministerial political process, rather than handling it at an operational level between the secretariats of the different departments or with the Cabinet Secretary.

8.3 Procedure

8.3.1.1 National Frequency Allocation Plan Review Committee

As discussed above, the NFAPRC is constituted on a periodic basis for the review of the Indian NFAP. The NFAPRC consists of a number of study groups assigned to work on specific frequency ranges; they are chaired by members of WPC and DoT, whilst the overall NFAPRC process is chaired by the Secretary, DoT. Each study group has members from Government organisations who are responsible for making policy decisions for that study group. Such policy decisions would subsequently require ratification by the parent Committee.

Stakeholders are allowed to participate in any study group they wish, though confidential material or information, particularly from Defence services, is not shared with all members. Stakeholders are also given the opportunity to present their proposals to working group members and general participants for open discussion.

While in principal this process is created to be open and all-inclusive, the manner in which it is executed brings in question the issue of transparency. For example, proceedings were delayed in the past because of disagreements between the CDMA and GSM sectors concerning 2G and 3G spectrum policies. Other users proposing policy changes in similar or adjacent bands were sometimes ignored due to the strength of the GSM and CDMA lobbies. Furthermore, because of the duration of the process and since it is held only in New Delhi, smaller companies, members of R&D firms, academics and those located in cities remote from New Delhi are unable to contribute effectively and consistently because of the tremendous amount of time and therefore expense required to participate and influence the outcome.

The NFAP review process achieved a milestone at the end of May 2005 by publishing a draft of the IND footnotes for NFAP 2005. While the intent of WPC is sound in publishing a draft prior to finalisation, stakeholders have expressed concern that no associated discussion document or summary of decisions of each working group to provide the bases for decisions has been released. Therefore participants in the process are unaware as to what effect their submissions have had on the process and the basis on which decisions were made. And though WPC has requested formal feedback, stakeholders are not clear on what aspects of the draft NFAP feedback should be given, for example several saw little value in repeating their initial submissions.

8.3.1.2 Other

The process that TRAI undertook in order to reach its recommendations on spectrum policy related to public cellular mobile and terrestrial microwave links followed its standard process of public consultation. The initial

document released by TRAI in May 2004 discussed the various issues that it thought relevant, and solicited the inputs of all stakeholders on those topics. After holding open house sessions in a number of cities, numerous meetings with virtually all categories of stakeholders, and consulting international experts and other regulatory bodies, TRAI released its final recommendations. The topics covered policies for allocation of specific bands, eligibility and spectrum fees associated with assignment, and future issues that were outstanding and needed to be addressed.

The TRAI process for involvement of the Planning Commission, the Cabinet, or the PMO is completely on a case-by-case basis. Therefore no standard protocol exists and is typically driven by the individuals undertaking any consultations. This creates another potential area for lack of transparency as external participants are unclear as to who has the final decision making power on policy and what the process for engagement is at such levels of decision making.

8.4 Summary and Recommendations

The existing policies and processes for gaining stakeholder involvement in spectrum policy design and execution promote a lack of trust in the system's ability to deliver the most appropriate outcomes. This feeling is prevalent among both Government users and non-Government users alike, even though the former group has many more avenues to participate and influence policymaking.

Certain Government users have commented that while they are willing to compromise and co-ordinate to meet the needs of others, they are not confident that the policy making bodies are inclined or willing to meet their counterbalancing needs. Even within Government circles they feel there may be some lack of transparency. Civilian users do not have insight into what the steps and agencies involved in influencing a change in policy decision are. Further, they are not able to gain any understanding of how, why and when certain decisions are made, other than, potentially, through one-to-one discussions with senior WPC staff.

InterConnect recommends that WPC and its sub-committees should pursue a more open and involving method for making policy decisions and particularly for providing feedback and insight into the decisions made. One model which WPC could follow is that of TRAI, where explicit consultation processes are followed, accompanied by explanatory documents and memoranda for each recommendation or decision. The process includes publishing an initial paper (a consultation paper) to enable the public to understand the issue at hand, the potential directions that could be taken, and what topics need to be addressed by stakeholders. Following this the non-confidential portions of stakeholders' submissions are published and open discussions held in various cities around the country. When the final recommendations are issued, they are accompanied with detailed discussions of the basis for arriving at those decisions. There may also be merit in considering a forum for a formal appeal process as there is for general telecommunications policy initiatives.

There is also a need to accommodate feedback from R&D and academic institutions, small companies, and stakeholders who are not located in New

Delhi. The establishment of regional offices could play a part in facilitating such involvement. Furthermore, as is the case in various other countries, WPC could have an annual national symposium where they would travel to a number of cities and have stakeholders in the telecom community, such as license holders, manufacturers, academic and R&D institutions, etc, participate in discussions with them. WPC could use this symposium to update stakeholders on their progress over the past year, what decisions had been made, what they were currently working on, and finally what important policy topics needed to be addressed in the future. WPC would benefit from this by having a better understanding of the concerns of the industry, which technologies are being developed, and therefore what potential spectrum policy alterations may be required to meet user needs in the coming years.

The national symposium is likely to be a relatively simple action to take but would have substantial positive impact both for stakeholders and for WPC. On the other hand, the process of open consultation and increased transparency in decision making is likely something that needs to be integrated into the system of spectrum management and policy making over a longer period of time.

9. SPECTRUM MANAGEMENT AND MONITORING TOOLS

9.1 Spectrum Management Tools

A report commissioned by the World Bank in 1999 indicated that the telecommunications sector performance in India remained unsatisfactory and failed to live up to expectations. Among others, ineffective radio frequency spectrum management was identified as a significant problem by several private investors in the sector, as characterised by: an excessively time consuming licensing process, inadequate or inefficient band allocations, interference caused by unauthorised transmitters, and significant delays in resolving interference complaints.

Therefore the Government committed to institute a transparent process of spectrum allocation and frequency assignment, with WPC to be strengthened in order to effectively discharge all functions of spectrum management and radio regulatory process and meet the best international spectrum management practices.

In view of the above, the Government has applied for, and obtained, a Loan from the World Bank for financing the “Telecommunications Sector Reform Technical Assistance Project”, which targets the strengthening of the elements of the policy and regulatory environment, including the modernisation of spectrum licensing and monitoring systems, in order to promote the development of the telecommunications sector of India. The most significant component of referred Project is development and implementation of the National Radio Spectrum Management and Monitoring System (NRSMMS).

NRSMMS has a global architecture that includes two main operational sub-systems, Automated Spectrum Management System (ASMS) and National Spectrum Monitoring System (NSMS). Specifically, the NRSMMS Project is composed of three main components, namely:

- (1) Computer System distributed in a LAN / WAN configuration;
- (2) Automated Spectrum Management System (ASMS) and its application software; and
- (3) National Spectrum Monitoring System (NSMS), which includes spectrum monitoring and direction finding facilities in HF, V/UHF and SHF bands, and corresponding spectrum monitoring application software.

A database that used to be partially recorded on paper and partially recorded in electronic format (dBase III, limited capabilities) constituted the information basis for licensing and other spectrum management activities carried out by WPC. The records included essential information and characteristics relating to licensed radio stations. However, this information was not complete (e. g. coordinates were missing for some older records) and not 100% accurate. Prior to implementation of the NRSMMS, there were no software applications available for technical analysis and spectrum engineering, which are crucial activities in the process of licensing. Most of the estimations or calculations were made by specialists using manual tools.

The whole process of licensing, fee calculation and invoicing was not computerised and thus slow and inefficient. There was no overall electronic communication network (WAN/LAN) within WPC or between WPC and WMO, therefore the coordination as well as the efficiency of licensing and monitoring was (and still is) poor.

The ASMS currently being implemented is based on the ELLIPSE Spectrum solution, which relies on a Centralised Database located at WPC HQ. This database can be accessed from WPC HQ as well as from Monitoring Headquarters (MHQ), Regional Headquarters (RHQ) and each of the Monitoring Stations (MS) of NRSMMMS.

ASMS is an integrated suite of application software programs which will be available throughout the organisation to assist WPC, in a semi-automated manner, in processing licence applications, providing frequency assignments, issuing licences, and providing data for spectrum planning and engineering. This whole process relies on field information provided by NSMS through spectrum monitoring and direction finding activities.

NRSMMMS implementation started early in 2003 and although expected to be completed by the end of 2005, full implementation has not been completed, mainly due to the absence and accuracy of some relevant licensing data. The installation of the computer network is completed and it is already being utilised by WPC/WMO personnel. The Web server is now open to the public who can submit some applications on-line. The customised part of the licensing software has almost been completed and delivered to WPC however new or additional requests have caused problems. Such problems reveal poor system descriptions and lack of procedures concerning computerised licensing and utilisation of modern tools for spectrum management.

9.2 Spectrum Monitoring System

In India, the Wireless Monitoring Organisation (WMO), a constituent body within WPC, performs the spectrum monitoring activity.

Currently WMO operates twenty-one HF and V/UHF monitoring facilities uniformly distributed over the territory of India: Delhi Region (Ghitorni, Ajmer, Gorakhpur, Jammu, Jalandhar), Mumbai Region (Mumbai, Ahmedabad, Nagpur, Bhopal, Goa), Chennai Region (Chennai, Trivandrum, Vizag, Mangalore, Bangalore, Hyderabad), and Kolkata Region (Kolkata, Ranchi, Shilong, Dibrugarh, Siliguri). The infrastructure for monitoring the H/V/UHF bands as above mentioned is complemented by one satellite monitoring station operating in C and S bands and located at Jalna.

All monitoring stations mentioned above are manually operated. Five of the HF stations are equipped to participate in the international monitoring activity and 3 include HF DF facilities. In addition, 4 vehicles equipped with monitoring capabilities in the band 1 – 12.5 GHz and 1 vehicle operating in the band 1 - 40 GHz constitute the mobile monitoring capabilities of WMO.

Most of the equipment mentioned above has limited capabilities to monitor the radio spectrum and the technology involved is obsolete and needs to be replaced. Besides that, the operation does not allow for automation, thus

does not support for efficient operation. Further, the stations are operated independently and therefore there is no coherent communications network connecting them and neither is there a well-developed and coherent coordination of monitoring operations. Mobile stations are not equipped with any communications facilities for coordination.

There is no proper and systematic planning of the monitoring activity and this activity seems not to be utilised for justification of spectrum management decisions. The staff of the existing monitoring stations appears to require a significant amount of training. Most of the stations include one engineer, at most two, except those designated as regional centres (called also "international monitoring stations").

The current problems with inadequate spectrum monitoring facilities will be resolved by the implementation of the NSMS under the World Bank funded project. The NSMS will have the following hierarchy and geographic distribution:

- a) 1 National Center, located at WPC HQ and MHQ (Sanchar Bhawan and Pushpa Bhawan);
- b) 4 Regional Centres, RHQ, located in Delhi – Ghitorni, Mumbai, Chennai and Kolkata;
- c) 4 Fixed Stations directly attached to RHQs, called IMS;
- d) 1 Satellite station, ISMES, located at Jalna, directly reporting to MHQ;
- e) 17 Monitoring Stations, MS, located at Jammu, Jalandhar, Ajmer and Gorakhpur (Delhi – Ghitorni RHQ), Nagpur, Ahmedabad, Goa and Bhopal (Mumbai RHQ), Vizag, Hyderabad, Bangalore, Mangalore and Trivandrum (Chennai RHQ) and Shilong, Siliguri, Dibrugarh and Ranchi (Kolkata RHQ);
- f) 9 MS and all 4 IMS (total 13) will be provided with tower facilities and antennas system attached to such towers;
- g) 21 Mobile Stations (HF / VHF / UHF monitoring, VHF / UHF direction finding), MMS, which are allocated one to each IMS (4) and one to each MS (17);
- h) 20 SHF mobile stations (SHF/EHF monitoring), which are allocated one to each IMS (4) and one to each MS (17) except Dibrugarh.

The main missions that can be performed through NSMS are (a) automatic spectrum monitoring, (b) direction finding and (c) remote operation of fixed monitoring stations. The information is exchanged between ASMS and NSMS subsystems through a standardised interface.

Despite the fact that the above new technology was due to be implemented by the end of 2005, deficiencies in the WMO still remain partially unresolved. Work efficiency is likely to remain poor until specific procedures and workflows or plans (these are non-existent at this time) are developed and proper operational training has been effected.

The design of the new system and the allocation of resources did not unfortunately follow the most appropriate scientific criteria. As a result, main cities with a significant radiocommunications utilisation such as Bangalore and Hyderabad will remain without proper fixed (permanent) monitoring facilities. Consequentially cities with a relatively insignificant spectrum utilisation such as Siliguri or Shilong, have been designated as tower sites and are equipped with fixed monitoring facilities.

It is also important to mention that no studies or detailed estimations of the monitoring coverage available from the existing fixed stations have been carried out. In addition it is important to record that the technical specifications that have been utilised for procurement of the current NSMS system include a significant number of ambiguities and unrealistic technical requirements have created disputes with the suppliers of the system currently being implemented.

9.3 Recommendations for Improvement

In order to improve significantly the effectiveness and efficiency of the system currently being implemented and maximize benefits from its utilisation, it is recommended that the following measures should be adopted either for the operation of NRSMMS or for the further extension of the system:

- I. Utilise specialised qualified consultants, with consistent international experience, for executing the basic design of further extensions based primarily on technical and economic criteria. Technical specifications should be cleared of existing bugs, inconsistencies and ambiguities. The specifications should be realistic and achievable and should be based on the operational requirements of a spectrum management organisation.
- II. Selection of sites for further development should be based on technical criteria. Administrative criteria should therefore not prevail, for example the availability of land for site development. Design of the further system extension should be based on real evidence of existing radio traffic and justified projections in traffic growth, rather than vague estimates. Such a design should be developed by experienced international consultants. In respect of the development of the design for further extensions, coverage of fixed stations should be technically estimated using the latest software planning tools. Maximisation of coverage by one station should be the main site selection criteria. At this point in time, the development of the design for the extension of the NRSMMS is not within the capabilities of WPC or WMO.
- III. Development and implementation of consistent operational procedures for spectrum monitoring and spectrum management. These procedures should ensure the proper interfacing of the spectrum management and monitoring operations.
- IV. Development of systematic monitoring plans which should support spectrum management decisions, spectrum reallocation and re-farming. For such an operational development InterConnect believes that specialised consultancy is required.
- V. Specialised training of personnel for the enhancement of operational capabilities and maximisation of benefits from NSMS utilisation. The training provided by the suppliers as part of the procurement of the equipment is not sufficient. Training which involves specialised

operational skills, from similar agencies or specialised consultants, is required for the purposes mentioned above.

- VI. Improved management and development of WMO activities and actions to support principal WPC spectrum management policies, decisions and activities as well as WPC products and services.
- VII. Bringing an end to the practice of exchanging personnel between WPC and WMO. Currently, personnel are moved from WMO to WPC and vice-versa in an apparently arbitrary way. This practice does not enable personnel to become sufficiently specialised in their field and develop the required professional capabilities. Personnel from spectrum monitoring and spectrum management fields should be well informed about each others' activities and about the importance of effective collaboration through periodic refresher training events, however they should maintain a consistent focus on their primary job function. International experience shows that a good engineer in spectrum monitoring requires some 8 to 10 years to develop the necessary skills and a very good engineer more than 12 – 15 years, especially in goniometry techniques. Moreover radio technology develops constantly and additional practical skills are required to be developed periodically in order to keep abreast with best practices in spectrum monitoring. The continuous movement of staff between licensing and monitoring activities tends to disrupt the development of specialist skills and knowledge required to become effective in either role.

10. FINDINGS AND CONCLUSIONS

10.1 Overview

There is clearly concern at the way in which spectrum is managed in India, however many interviewees believed that the structures that are in place are appropriate in an Indian context in that:

- the necessity for inter-departmental Governmental involvement in decision making was essential to ensure that decisions are upheld;
- WPC itself was organised in such a way that spectrum users understand who to contact; and
- the organisational structure of WPC enabled it to relatively effectively deliver the services it is remitted to provide.

However a number of key issues were clearly identified as needing to be rectified for spectrum management in India to become more effective:

- the status of WPC as a section within a Department of a Ministry does not seem appropriate in view of the importance of efficient spectrum management to a country where radio frequencies are essential for economic development and national defence as well as an increasingly important space industry.
- the processes by which decisions are taken, whether with respect to frequency assignment and licensing or site clearance need to be clearly and unequivocally documented and published to ensure transparency in decision making;
- decisions, especially with respect to site clearance, need to be made more quickly; and
- there need to be more 'exceptions' such that not every application needs to be processed through the full decision making structure.

10.2 Quick Wins

There are a number of issues which could be addressed relatively quickly which would bring about immediate improvements in spectrum management across India, or improvements in the transparency of the spectrum management processes such that licence applicants and spectrum users become more clear concerning the environment in which they are operating.

In considering areas which are 'quick wins' we have concentrated on issues whose resolution could begin immediately, though the effects of which may take time to filter through. These do not, therefore, include structural or policy changes but instead focus on procedural changes which could be made within the existing management and procedural structures.

10.2.1 Restructuring of SACFA approval processes

The time taken by SACFA to process site clearance applications is a major cause for consternation amongst the spectrum users we spoke to. However all recognised the need for inter-Governmental involvement in order to ensure that decisions taken by SACFA had the necessary authority. However, the fact that BSNL have a seat on SACFA decision-making board was seen as offering the potential for favouritism to occur.

The process by which SACFA takes decisions remains somewhat opaque to spectrum users, meaning that they are unsure what needs to happen in order that their application can be processed.

A further concern is that rejection decisions taken by SACFA are not communicated to applicants such that they were unaware of whether an application remained pending or had been turned down.

One possible solution for site clearances that has been considered by InterConnect but rejected is moving the decision on clearance to local authorities (such as city or district development authorities) who take such decisions for other buildings and constructions. However many interviewees believed that the process by which the local authorities made decisions remained slower and more opaque than that which SACFA are believed to follow and hence did not believe that such a move would bring about immediate benefits.

One solution for site clearances that appears to have been successful is the move by VSAI to negotiate an 'exemption' such that if no objection is received for any applications for dishes of a size of 1.5 metres or less within 30 days of the application being made, the application is deemed to have been successful. Further exemptions could be envisaged with similar rules such that if no objection is received within 30 days the application is deemed successful, both for site clearance and frequency assignment, such as:

- Any masts greater than a set distance from a restricted area (such as an airport – a list of such areas being published) and lower than a certain height;
- Frequencies in specific pre-agreed bands (such as VHF or UHF PMR bands) with powers lower than a set value and from aerials lower than a certain height;

Making such exemptions would speed the application process from the current 3 to 4 months to around 6 weeks in the case of exemptions.

We therefore recommend that:

- **BSNL's position on SACFA board is rescinded;**
- **SACFA identify a number of 'exemptions' whereby if no rejection is received from SACFA members within 30 days, the application is automatically deemed to be successful;**

- **For non-exempted applications, the process whereby SACFA decisions are taken should be clearly communicated to applicants;**
- **Applicants should be informed immediately if their application is rejected along with specific details of the reasons for the rejection.**

10.2.2 WPC performance targets

The annual performance targets which WPC publishes as part of the DoT Annual Report serve only to measure how busy WPC has been over the preceding year and not to give any measure of how effective WPC has been in managing the radio spectrum in India. We therefore propose that **WPC should establish a representative set of performance management criteria**, and begin measuring their performance against these criteria so that going forward, the effectiveness of WPC in managing the radio spectrum can be easily identified. Such criteria might include:

- The time taken to process new frequency assignments;
- The number of new assignments which caused interference to existing licensed users once transmissions started;
- The number of frequency requests that were denied, together with the reason for rejection (to assess levels of congestion);
- The time taken to process site clearances; and
- The number of interference problems that were successfully rectified.

10.2.3 The Establishment of a National Spectrum Symposium

At present there is a lack of knowledge on behalf of spectrum users as to the processes that take place in managing the radio spectrum in India. Further, there is no formal structure whereby spectrum users can provide feedback to WPC on issues concerning the effectiveness of spectrum management or licensing in India.

Whilst there are occasional groups such as the NFAP Review Committee, a 'National Spectrum Symposium', chaired by WPC but open to participation from any spectrum user (or potential spectrum users) at which issues concerning the performance of WPC and spectrum users' concerns over spectrum management can be discussed and documented such that progress could be charted over a given period would be much more effective in addressing users' concerns. Indeed the public workshop convened as part of this project in April 2005, which provided a forum for questions and concerns to be aired was seen by most participants as a useful consultative mechanism. A regular 'National Spectrum Symposium' would further extend the process.

Such a symposium could form the basis of a regular conference which toured the country to ensure as wide a participation as possible, and could be established immediately. We therefore recommend that **WPC should**

establish a National Spectrum Symposium, the inaugural meeting of which should take place not later than Spring 2007.

10.2.4 Raising the profile of Spectrum Management in Government

The Government of India is one of the biggest (if not the actual biggest) user of spectrum in India. At a time when pressure for access to spectrum from non-Governmental bodies is ever increasing, the awareness of this pressure within the Government, though increasing, remains relatively low. In particular, until the recent move by WPC to charge Government users for their spectrum usage, there was probably no recognition by these departments of the value of the spectrum they occupy.

In order to increase awareness of these issues, **WPC should conduct an awareness raising campaign within Governmental spectrum users** such that the value of the spectrum is recognised and the need for Government users to make efficient use of the spectrum is clearly indicated. This is particularly the case within the defence forces where much of the Government's use of spectrum resides. In this area **WPC should work with JCES to raise the profile of spectrum management within the defence forces.**

10.3 Longer Term Goals

Beyond those issues which could be dealt with immediately, there are a wide range of areas where, over the longer term, we believe improvements could be made.

10.3.1 WPC to become an independent Government unit

The status of spectrum management within India does not appear to carry sufficient weight in a country which is technologically important in the Asia Pacific region. The efficient and effective management of spectrum is a key element in the development of existing and new industries; it is also important for the development of employment opportunities in a number of sectors. However, in view of the strong tradition within India of managing scarce resources by the State sector InterConnect considers it appropriate that the basic structure of WPC wing should be retained, albeit with some changes to take account of concerns expressed in this Report. With these issues in mind an alternative option is proposed for consideration.

It is therefore recommended that **WPC should become a department of the Prime Minister's Office and be re-named the Department for Spectrum Management (DSM)** such that control of the radio spectrum remains with the Government of India but that it is effectively independent of many of the internal pressures which might otherwise come to bear on its ability to take unbiased decisions. This organisation should have a **management** with the administrative skill sets of **career civil servants** as well as the highly **competent engineering staff** currently employed in WPC. There is also a need to **enhance the expertise** of the spectrum management organisation in India in the area of **economics and market surveillance.**

10.3.2 An in-depth review and revision of spectrum usage

The Indian NFAP concerns itself more with the documentation of spectrum usage in India and the NFAP Review Committee (NFAPRC) concerns itself with ensuring that, as far as possible, the NFAP reflects spectrum usage. However, **there is a clear need to review and potentially revise spectrum usage** to ensure that spectrum management and national telecommunications, broadcasting and other Governmental objectives are capable of being met. Such a review would ascertain whether or not spectrum usage was appropriate and recommend and agree changes to frequency usage. The review should take into account any new requirements or changes which are likely to take place over the next 10 to 15 years and the resulting plan should include details of how migration of users from the existing to the proposed plan should take place.

10.3.3 The use of market based pricing mechanisms

There is clearly congestion and scarcity of spectrum in several bands in India and at present administrative mechanisms are used to calculate the fees which should be paid for the use of this spectrum. During the recent consideration of 3G cellular licensing, one operator has already indicated that it would welcome a more market based pricing system (rather than the share of annual gross revenue which applies at present).

WPC therefore needs to **consider the use of market based pricing mechanisms** such as beauty parades and auctions for some spectrum users and uses (and consider applying the same fees to other users who may be occupying equally valuable spectrum).

To do this, WPC may need to **recruit staff with economic skills** to bolster the low level of available skills within the existing structure. Further it is likely to need to have to come to agreements with other Government departments such as the Department of Economic Affairs in order to agree the necessary financial rules and regulations.

This is not a simple task for WPC, however it is clearly in the interests of many spectrum users (non-Governmental) to move to a more transparent regime which allows certainty over spectrum availability and licence fees.

10.3.4 A more strategic SACFA

The role of SACFA at present is effectively one of an approvals body, that is to say that it processes every site clearance and many licences applications. However, it is an inefficient use of the time of SACFA members to have to work in this fashion. Rather, **SACFA should become more strategic**, focussing on the policy decisions that will enable spectrum usage and site clearance processes to be lightened such as the ideas presented in section 10.2.

10.3.5 Regional Offices

At present, all WPC functions (with the exception of some of the monitoring functions performed at the regional stations by WMO) take place in New Delhi. This requires applicants who wish to make personal approaches to ascertain the progress of their application or to make enquiries concerning

unusual applications to travel to Delhi. Further, though monitoring activities are conducted on a regional basis, the establishment of regional offices would enable enforcement activities (and both technical and personnel resources) to be co-ordinated locally

10.3.6 Review of Block allocations

At present, only a small handful of users have what could be described as 'block' allocations inasmuch as they have a block of spectrum assigned to them which they manage themselves, without the need for intervention from SACFA or WPC (other than where international registration is required). Historically, other users (such as defence) also had block allocations but in order to open up more spectrum to a greater number of users, these block allocations have been discontinued.

In some circumstances, however, the assignment of blocks to certain users may reduce the administrative burden on WPC/SACFA (such as with broadcasting at present). Whilst a move back to wholesale block allocations for some users may not be appropriate, **a consideration of whether there are specific bands that might be more appropriately managed by user organisations (such as JCES) would be worthwhile.**

10.3.7 Increased Computerisation

As the ASMS is beginning to be activated, there is a slow move of some processes away from the traditional paper-based systems to more computer-based solutions. As the computer system is still in its infancy, there is still scope for the computerisation of a wide range of procedures. Whilst a move away from paper-based processes may never take place in some fields, **there is little reason why spectrum licensing could not become an almost totally computerised function.**

10.3.8 Transparency of Processes

One of the major issues raised by spectrum stakeholders was that of the current lack of transparency in all processes related to spectrum management and licensing in India. Whilst WPC has recently published items such as:

- Procedure for submission of deployment plan in respect of telecoms service providers;
- Guidelines for users; and
- Information required from operators about their wireless telecommunication licences

on its web-site⁶, these do not provide any process information on how decisions are taken; what processes are undertaken internally to WPC; what communications are to be expected from or by WPC; or the timescales for actions to be completed.

Publication of all licensing processes is essential and urgent. Further, **there is a need to document the internal processes** such as those

⁶ <http://www.wpc.dot.gov.in>

between WMO and the rest of WPC such that individuals and departments clearly understand what is expected of them in any given situation.

10.3.9 Data Availability

Many administrations are moving towards a situation where the database of frequencies and licences (the National Frequency Register – NFR) is published. This enables licence applicants to better recognise the likelihood of an assignment being made to them and also allows potential applicants to survey existing licences for suitable bands or frequencies before making an application.

Whilst recognising that WPC is at present in the process of transferring its NFR to a computerised database, **consideration needs to be given now, and in particular with reference to any future investment in IT systems, to making certain data publicly available.**

10.3.10 Service and Frequency Licensing

The current licensing regime in India requires licensees in some sectors to obtain both a service licence, enabling them to offer a service, as well as a frequency licence, enabling them to use certain frequencies. Whilst there are some circumstances in which this situation is appropriate (such as for a fixed telecommunications operator who may either use wired or wireless links between locations), in many cases a service licence is useless without the associated access to spectrum (such as for a broadcaster or cellular operator).

The licensing regime needs to be re-evaluated to ensure that where services licences are invalid without access to spectrum, the service and spectrum licence are combined into a single licence.

10.3.11 Staff training/re-training

The move to a more computerised system of working will inevitably require staff to be re-trained in order to operate the new system. Training on the use of the new system will be provided by the vendor, however there is a greater need for staff to be given training not just on how to operate the systems, but how to utilise the functions effectively to manage the spectrum in an efficient and effective manner. Typically such training can not be provided by the vendors as the knowledge of how to use the information in the context of an individual country differs significantly. One option would be to recruit spectrum management expertise from another administration who could effect a 'knowledge transfer' to WPC staff. Another may be to have a specialist agency or consultancy to provide a tailored package of training to meet these needs.

10.3.12 Cultural Change

The culture within WPC (and WMO) is currently one whereby decision and policy making are led on the whole by technical and engineering dictums such that it could be argued that the overarching principles in use are that:

Spectrum management should be in the hands of experienced spectrum managers.

However, with the need to consider market based approaches to spectrum management and the need to provide increased levels of service to spectrum users, the move to a more commercial and service oriented culture would bring significant benefits to the interaction with spectrum users. Cultural changes are difficult to effect and must be filtered down through an organisation from the top if staff are to 'buy-in' to the changes. **The appointment of a senior member of staff responsible for internal and external communication and culture would greatly assist** in taking the necessary changes forward.

10.3.13 Examination of cost recovery

The fees raised through spectrum licences at present outweigh the costs of managing the spectrum by a factor of almost 40 to 1 (excluding World Bank loan repayments). It is unclear whether this additional revenue, effectively a form of spectrum pricing, is justified. **A breakdown and examination of the licence fees paid by different licence holders would be beneficial** and may reveal that this excess of cost recovery is by just a limited number of users, or that there is an across-the-board over-charging. Such an examination needs to be conducted to ensure that spectrum prices are set to encourage usage.

10.3.14 Extension to the NSMS

Section 9.3 covers many of the issues relating to the proposed extension to the NSMS, which for brevity are not repeated here. However, one issue that needs particular attention is that of ensuring that the planning of the extension is done in a way that ensures **areas of high radio usage are covered with fixed stations**.

10.4 Major Challenges

In addition to recommendations made above, further scenarios for the development of spectrum management activities and policies were considered. Many of these scenarios either represent a quantum step forward given the prevailing regime in India and thus require that the current regime evolves before they can even be considered for implementation or they fly in the face of strongly entrenched opinion. Never the less, we would recommend that they be retained as a future possibility and that stakeholders be consulted, at an appropriate point in the future. Such scenarios are discussed in the sections which follow.

10.4.1 Spectrum trading and commons

As recorded in section 4.2.1.3 of this report, during our consultations in the first phase of this project the consultant found little evidence to support the introduction of spectrum trading. Furthermore, we understand that during recent TRAI consultations, which touched on spectrum issues TRAI were told repeatedly that although desirable such an approach would not be possible. We therefore do not believe India is in a position to go so far. Indeed spectrum commons regimes, generally based on wide bands of frequencies may impact directly on spectrum already subject to spectrum

rights attained through large investments in a market based licensing process.

The use of market mechanisms to apportion spectrum rights in emerging countries such as India has to be performed with caution and careful planning. Allocating spectrum rights on the basis of comparative hearings is controversial in the sector whilst customisation of auction design needs to be done in accordance with local factors. As stated elsewhere in this report WPC needs to develop the necessary economic expertise to resolve spectrum congestion issues in established services based on pricing techniques, which identify the value of such spectrum to licensees. India also needs to develop expertise in the design of auctions and avoid replicating mistakes made during the award of licences for basic and cellular services in the 1990s.

Amongst experts there is some disagreement over whether a spectrum 'commons' approach or an 'exclusive usage rights' approach is appropriate. Both approaches have advantages and disadvantages. The challenge for any country is to instil sufficient flexibility into national processes to be able to implement the best blend of the different approaches drawing on the strengths of each. For example, a non-exclusive usage rights approach, which permits spectrum sharing between a principal user holding spectrum rights and an 'underlay' user granted access on the basis of non-interference. Such a concept could be applied to significant parts of the spectrum where congestion is high and transaction costs low. Secondary markets to enable spectrum trading can be an important part of a non-exclusive usage rights approach. This is because a major reason for the problem of inefficient spectrum usage occurring is the failure to assign spectrum usage rights such that the resource may be effectively used by those who value it the most. Secondary markets will enable spectrum resources to transfer from low-value uses to higher value uses.

Spectrum trading and liberalisation are separate developments. Even without liberalisation of spectrum use, spectrum trading has considerable benefits. However, liberalisation allows the needed flexibility giving spectrum users freedom to adopt new technologies and offer new services. Spectrum trading combined with liberalisation will enable the market to decide how much spectrum should be allocated to different uses; enable faster flexible access to spectrum, including unused and underused spectrum; help to promote the development of new, spectrum efficient technologies; and boost innovation in the use of the spectrum and spectrum-based products and services.

Even though spectrum trading is not appropriate in all frequency bands, it permits the opportunity cost of frequencies allocated by traditional command-and-control or the 'commons' approach to be determined from those that are traded. All spectrum users should in general be encouraged to use spectrum more efficiently. Administrative incentive pricing could be applied equally to public and private sectors in scarcity situations. Incentive pricing will also stimulate spectrum trading since it increases the cost of holding spectrum it does not need. Apportioning spectrum rights is a complex process that requires an understanding of the market and bidder behaviour in the case of auctions. An independent regulatory body is

necessary to design and implement auctions; it is also necessary to have secured the necessary spectrum prior to the date required for the roll-out of services. A system where service area consolidation can flourish is also required. In a developing country context, where growth in service is of prime concern, specification of common standards by a regulatory agency (although not ideal) can facilitate growth. However, in choosing specific standards, regulatory bodies need to work with academic institutes and industry associations in a transparent manner. While the current framework appears to have focused on attracting investments, the future focus should be on policies that optimise spectrum usage, which may lead to greater economic benefits.

10.4.2 Outsourcing

There are many reasons why an organisation might consider to outsource some of its activities, however in the context of this project, outsourcing would only be justified if it resulted in either:

1. More efficient use of the radio spectrum; or
2. Improved services to spectrum users.

It is with these criteria on mind that we considered the following as possible candidates for outsourcing:

Management of blocks of radio spectrum

Our recommendation on 10.3.6 of the report demonstrates the consultant's support for the expansion of block allocations. However, WPC stated very clearly that it was NOT in favour of spectrum block management systems at all. WPC felt that such a situation leads to inefficiency since users in one block might use their spectrum less efficiently than another and would not then release spare capacity to overcome congestion. Of course WPC is correct in that unless there is an overall manager or administrative processes implemented that work efficiently and are not cumbersome this maybe the case. However defence electronics tends to be developed in clearly defined frequency bands so there is certainly scope for some delegated authority in the future, once the legacy of the USSR can be resolved and provided an effective overall spectrum management system and process can be installed.

The detailed management of certain blocks of spectrum through delegated responsibility is one area where out-sourcing could be effective. Although InterConnect has focussed on government users this is not the only category of user where delegated management could be effective. InterConnect would however advocate that the NRA monitors carefully the situation in most of the block allocations. Furthermore, before implementing such an approach further steps along the path of improving working relationships between governmental departments needs to be effected. Bands for defence applications should be available on a national basis to facilitate national spectrum availability for non governmental services in other bands. This will not be a quick task, which is why we proposed a forward looking version of the NFAP and a migration plan to move from the present to future (see 10.3.2).

Other areas where delegated authority can be useful would be to provide mobile operators with fixed point to point link bands where they can link new cell sites into the network quickly. Another example could be to provide a body able to respond quickly to the needs of broadcasters, programme makers and the film industry to provide assignments quickly for news, sporting and cultural events. Such requirements might require a quick turn-round and thus a commercial body may be better suited for such activities.

Monitoring

A monitoring, interference resolution and enforcement function, at first sight might appear to be able to function as an autonomous body. However the consultant would normally take the view that the monitoring function should be a fully integrated part of the spectrum management body. There should ideally be a considerable amount of software and hardware IT integration; moreover spectrum occupancy campaigns should be running continuously to provide data to those making decisions on spectrum scarcity issues. Thus we would not support any measures which would make it more difficult for monitoring and licensing activities to work in close harmony. Never the less, the issue is not totally black and white for example in Denmark and France, the resolution of complaints to broadcasting falls to broadcasting organisations.

Licensing

Some routine licensing issuing functions could be outsourced, such as licences for ships and aircraft, CB operators and radio amateurs. Concerning ship and aircraft licensing it is quite logical to consider proposing that the body responsible for maritime safety, seafarers' competence and ships' safety inspections could be asked to include the issue of ships radio licences as a one stop shop activity. This is especially pertinent for ships that are subject to the mandatory carriage of specific equipment, as part of the IMO's Safety of Life at Sea requirements. Similarly, the civil aviation administration could take on the licensing of aircraft. The licensing of hobby radio enthusiasts could be undertaken by a commercial body, if commercially viable, as could the issue of broadcast receiving licences, if such a licence is required in India. Indeed in this regard the national amateur radio society might be able to assist the administration in a number of areas, such as conducting competence examinations. There are however other means of dealing with some of the routine licensing issues by exempting categories from licensing, by introducing longer licensing periods or introducing class licences. In this way an administration remains fully in control of the licensing process. As an example the United Kingdom has outsourced amateur and CB licensing for almost 20 years; recently Ofcom has decided not to continue the process, instead it will issue life time licences free of charge on the Internet, saving the money it is paying its contractor.

As mentioned under block allocations above, above another outsourcing arrangement could be to entrust an external body which is able to respond quickly to the needs of broadcasters, programme makers and the film industry to provide assignments and licences quickly for news, sporting and cultural events.