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Management of the Radio Frequency Spectrum

Report from the House of Representatives
Standing Committee on Transport,
Communications and Infrastructure

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[1] Replaced Mr Michael Lee MP 23 August 1990.
[2] Mr Elliott replaced Mr Gorman from 10 April 1991 to 5 June 1991.

CONTENTS

ABBREVIATIONS

ABC	Australian Broadcasting Corporation
ABT	Australian Broadcasting Tribunal
AM	amplitude modulation
AUSTEL	Australian Telecommunications Authority
BTCE	Bureau of Transport and Communications Economics
CAA	Civil Aviation Authority
CB	citizen band
CMTS	cellular mobile telephone services
CT2	second generation cordless telephone
DOTAC	Department of Transport and Communications
EHF	extra high frequency
FACTS	Federation of Australian Commercial Television Stations
FARB	Federation of Australian Radio Broadcasters
FM	frequency modulation
FRC	frequency reservation certificate
GSM	Groupe Speciale Mobile
GHz	gigahertz
HDTV	high definition television
HF	high frequency
Hz	hertz
Inmarsat	International Maritime Satellite Organisation
Intelsat	International Satellite Organisation
ITU	International Telecommunications Union
KHz	*kilohertz*
LF	low frequency
MDS	multipoint distribution system
MF	medium frequency
MHz	megahertz
NTIA	National Telecommunications Information Administration
NTT	Nippon Telegraph and Telephone Corporation
PARR	Public Access Radiofrequency Register
PCN	Personal Communications Network
SHF	super high frequency
SMIS	Spectrum Management Information System
THz	terahertz
UHF	ultra high frequency
VHF	very high frequency
VLF	very low frequency
WARC	World Administrative Radio Conference
TPC	Trade Practices Commission

PREFACE

To many the radio frequency spectrum is a mystery, to others, sections of it are almost sacred.

As communications technologies and services rapidly assume a greater role in human and economic activity the effective management of the spectrum will be of growing importance.

It is essential that Australia be positioned to reap the potential benefits in terms of growth, productivity and efficiency that the communications revolution will bring.

In this inquiry the subcommittee had to come to grips with a complex and difficult subject. It has sought to simplify understanding of the issues involved and chart a course for spectrum management well into the future.

More than 70 submissions were received. Evidence was taken at 6 public hearings.

I thank my fellow subcommittee members, Mr Alan Cadman MP and Mr Russ Gorman MP for their strong support and valuable assistance in the preparation of the subcommittee's report to the Committee.

My appreciation goes to all who made submissions to the Committee and responded to the Discussion Paper and Preliminary Conclusions.

Those responses were of substantial value in the development of the Committee's final report.

I especially thank officers of the Department of Transport and Communications for their cooperation in responding to the subcommittee's numerous requests for additional information and I also thank SIARS Pty Ltd for their professional assistance throughout the inquiry.

PETER MORRIS MHR
Chairman

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Evaluation of the management of the radio frequency spectrum must look beyond the present and well into the future. The existing administrative system has to be assessed to determine whether it can cope with situations and circumstances where demand could exceed supply.

Spectrum Management Objectives

1. Spectrum management objectives must be clearly defined, accurate and relevant.

2. These objectives must not only take account of the immediate demands placed on the spectrum managers but also take account of the potential for rapid changes in technology and service innovation in the future.

3. Spectrum management objectives should not impede the achievement of the broader communications policy objectives of government.

4. The objectives should define spectrum management from an operational perspective with a view to maximising the availability of spectrum to all users for all purposes. The two significant objectives from an operational perspective are dynamic and technical efficiency.

5. The spectrum manager should continue to be responsible for ensuring observance of Australia's obligations with regard to the international planning process.

Does the Current System Effectively Meet the Objectives of Spectrum Management?

6. Committee concluded that the current approach to spectrum management is deficient with respect to:

- Dynamic Efficiency- current spectrum management practices lack flexibility and timeliness with regard to changing demand for spectrum use. Mis-matches in supply and demand have occurred demonstrating the difficulties involved in predicting developments in technology and the way those developments will be used to provide services;

- Technical Efficiency- DOTAC is constrained in its ability to ensure that the most spectrum efficient equipment and practices are in use. The current approach to setting standards imposes costs on new and prospective users and may in some instances benefit existing users;

- Public and Merit Goods- while the current system of spectrum management meets the needs of users who provide socially beneficial services to the community and those who use the spectrum for personal non-profit purposes, there is a need to ensure efficient use of the spectrum, particularly with respect to public sector users; and

- Allocation to the Highest Value Uses- The current system of spectrum management is not able to satisfactorily allocate spectrum to the highest value uses and this problem will become critical if demand continues to increase and congestion becomes more commonplace.

Government Charging

7. The current approach to levying charges for access to spectrum has little if any effect in managing demand, does not promote efficient use of the spectrum and is not transparent to users.

8. The cost recovery component of any charges structure should be formulated in a manner to ensure that the actual costs generated by specific users are recovered from those users. Costs not attributable to any specific user could then be recovered using a flat charge or based on some measure of the amount of spectrum used or the value of spectrum used, whichever is the most appropriate. Such an approach would assist in making spectrum charges more transparent and ensure greater scrutiny.

Future Spectrum Management: Choosing from Options

The Committee suggested four possible approaches to addressing the shortcomings identified in the current system of spectrum management and tested those approaches against the objectives.

An Administrative System for Setting Priorities for Allocation and Assignment

9. An administrative system for setting priorities for allocation and assignment is not supported. Such an approach would not meet the dynamic efficiency objective of being flexible and responsive to changes in demand, particularly if levels of congestion were to increase. Furthermore, the potential costs associated with a system of comparative assessment for assignment could impose very significant costs on spectrum management which would have to be borne by users on a cost recovery basis.

Fine Tuning the Current Administrative Approach

10. The combined effect of the suggested reforms to the current system of spectrum management would make a contribution to improving the responsiveness of spectrum management to technological change and increasing demand.

11. There would however continue to be some essential weaknesses. The ability of the spectrum manager to force the pace of change with respect to replanning and reassignment would still be limited because of the problems associated with compensating users for the costs associated with replanning.

12. Compensation would not be a satisfactory course of action in an administrative system unless a means can be found to put a value on the individual spectrum.

13. Technical efficiency is addressed to a limited extent by the proposals for monitoring spectrum utilisation, but it relies on DOTAC establishing criteria for resuming underutilised spectrum. There is no incentive for users to utilise spectrum in the most efficient manner possible, except the fear of losing an assignment. Furthermore, resumption is likely to be a long and drawn out process which may in fact make spectrum management even less responsive.

14. The suggested reforms would contribute to alleviating some of the problems associated with the current system of spectrum management. They do not solve the fundamental problem of the current system's inability to accommodate changing technology and demand and to support wider communications policy objectives with the necessary degree of dynamic efficiency. Moreover, it is highly unlikely that those reforms will enable the spectrum management to drive significant improvements in technical efficiency. Nor do the reforms address the need to ensure spectrum is allocated to the highest value uses in situations where demand exceeds supply.

A Market Based System

15. Tradeability of spectrum resources offers significant advantages in relation to the objectives of dynamic efficiency and technical efficiency over the current administrative approach. The establishment of a market would enable users to acquire spectrum or relocate to new spectrum in response to their changing needs. It would encourage users to optimise their use of spectrum in order to maximise the returns on their investment. It also provides an effective solution to the problem of compensation for users who move to new spectrum or to other means of service delivery.

16. In terms of technical efficiency it would provide non-commercial users with some incentive to seek to use their spectrum more efficiently as they would be able to sell or lease out excess requirements and use the funds to finance improvements in equipment.

17. A market system would also provide a means of recouping any economic rents from users in such a way that it does not distort investment decisions. The additional charges would be related to cost recovery from individual users for costs generated directly by them and a charge levied on the value of the spectrum to cover the broader costs of spectrum management not associated with any individual user. Such a system of charges would be economically efficient and equitable.

18. A market system would also facilitate allocation to the highest value uses for commercial applications.

19. There are a number of matters that would need to be resolved before a market based management system was introduced. The potential difficulties with interference would have to be considered in detail as wide spread interference problems and unresolved disputes would degrade the spectrum and the potential losses could be considerable.

20. The Committee is concerned at how non-commercial users might fare under a market system. There is a need to ensure that these users operate efficiently in terms of spectrum utilisation as there is no incentive for them to do so at present. However, many of the services provided by such users are essential to the well being of the community as a whole and it would be foolish to risk any degradation of those services.

21. A comprehensive market based system covering all spectrum users and uses should not be introduced at this point in time as there are some significant uncertainties, particularly with regard to ensuring continued access for public sector and non-profit organisations.

A Mixed/Market Administrative System

22. The benefits of a market based system should not be ignored, it has already been stated that any examination of spectrum management practices has to look forward and the Committee is concerned that if demand continues to grow, even a reformed administrative system may not be able to cope. It is essential that Australia be in a position to maximise the potential benefits that developments in communications may offer in terms of economic growth and increased productivity.

23. In order to ensure that Australia is positioned to take maximum advantage of this potential, it is desirable to address the problems associated with the market based approach to spectrum management and develop an implementation strategy.

24. The Committee approach to a mixed market/administrative system would generally restrict the tradeability of spectrum access to commercial applications. This approach recognises that it is essential to protect non-commercial users from premature exposure to a market based system until means have been devised to resolve current uncertainties, and hence potentially undesirable outcomes, associated with its implementation. The Committee's approach also recognises that there may be limited circumstances in which non-commercial users might benefit by shared use of assigned frequencies with, and/or disposal of rights to access underutilised spectrum, to commercial users.

25. In light of the uncertainties and potential problems associated with implementation of a market based system at this time, the Committee believes that it would be many years, if ever, before such an approach could be applied to all users and therefore the recommended reforms to the current system should be undertaken in parallel with the development of a market system.

RECOMMENDATIONS

Spectrum Management Objectives

The Committee recommends that the objectives of spectrum management should be:

1. Dynamic Efficiency - responsiveness and flexibility in meeting the needs of all spectrum users;

2. Technical Efficiency - efficient allocation of the spectrum resource in terms of spectrum efficient technologies and practices in order to accommodate the greatest number of users with an adequate quality of service;

3. Provision for public and merit goods;

4. Allocation of spectrum to the highest value uses;

5. Promotion of Australia's interests with regard to international agreements on frequency allocations, positions in the geostationary orbit and technical standards; and

6. A system of charges for spectrum access that is efficient and equitable and takes account of the value of both non-commercial and commercial use of the spectrum.

(paragraph 3.30)

Government Charging

The Committee recommends that:

1. The cost recovery component of the annual charges for spectrum access be levied in such a way that the actual costs incurred by the spectrum manager on behalf of individual users are identified and recovered from the individual users;

2. To further assist in developing a transparent charging structure, the taxation component contained in charges should be clearly identified; and

(paragraph 5.38)

3. A suitable means of recovering economic rent be formulated.

(paragraph 5.40)

Future Spectrum Management: Choosing from Options

Fine Tuning the Current Administrative System

The Committee recommends that:

1. The Department of Transport and Communications develop a system of auditing spectrum utilisation based on monitoring of frequency bands and analysis of licence data in geographical areas which are experiencing congestion in parts of the radio frequency spectrum;

2. The Department of Transport and Communications develop a publicly accessible on-line database which provides comprehensive details of all assignments including technical details, type of service and identification of the user;

3. The use of Frequency Reservation Certificates be discontinued, users wishing to reserve spectrum should be issued with a licence after submitting a plan which outlines the timescale for full utilisation;

4. Private sector spectrum engineers be accredited to provide frequency coordination services to users seeking assignments; and

5. The Department of Transport and Communications review current consultative processes and assess their impact on dynamic efficiency.

(paragraph 6.71)

A Mixed Market/Administrative System

The Committee recommends:

1. The Department of Transport and Communications develop an implementation strategy for a Mixed Market/Administrative System;

2. This proposal be developed in parallel with the recommendations made earlier for reforms to the current administrative system;

3. The development of a Mixed Market/Administrative System should take account of the following:

   a) tradeability of spectrum resources be introduced for commercial uses of the spectrum;

   b) the introduction of this approach should be gradual and should be initially introduced only in areas of the spectrum that are unencumbered or where there is high commercial demand;

   c) in the interim, non-commercial users should have the option of remaining under the current administrative system or having their licences converted to a tradeable resource;

   d) a system of regular auditing of spectrum used by public sector users be introduced;

   e) tradeable spectrum access should not be perpetual, but should provide tenure for a fixed term; and

f) the Department of Transport and Communications determine whether the capital gains tax would be applicable in the case of windfall gains accruing to incumbent users who convert existing licences to tradeable rights.

(paragraph 6.121)

1. INTRODUCTION

The Reference

1.1 On 23 July 1990 the Minister for Transport and Communications requested that the Committee inquire into and report on the management of the radio frequency spectrum. The terms of reference specified by the Minister were as follows:

> To inquire into and report on the future needs of efficiency and effectiveness in arrangements for managing the overall use of the radio frequency spectrum, having due regard to:
>
> (a) the need for efficient and equitable access to the spectrum for both commercial and non-commercial users;
> (b) Australia's international obligations; and
> (c) the current review of spectrum management within the Department of Transport and Communications.
>
> Particular attention should be given to:
>
> i) mechanisms for allocating spectrum to uses with the highest value;
> ii) means of determining and attributing the value of spectrum used for non-commercial purposes;

iii) flexibility and responsiveness of spectrum management to commercial, technical and other changes relevant to demand for spectrum use; and

iv) the role of government charges for spectrum access in ensuring appropriate financial return to government from the resource.

Conduct of the Inquiry

1.2 There are a number of aspects of the inquiry worth noting. The first is the publication by the Bureau of Transport and Communications Economics (BTCE) of Occasional Paper 102 Management of the Radio Frequency Spectrum, An Economic Analysis. The Minister referred to the publication of this paper and invited the Committee to take account of this in the conduct of the inquiry. Publication of the paper occurred shortly after the inquiry began and the issues raised in the paper were canvassed in the course of the inquiry.

1.3 The second was the publication and distribution by the Committee in June 1991 of a Discussion Paper on the issues and options in radio frequency spectrum management. The views, criticisms and suggestions contained in the Discussion Paper were based almost entirely on the submissions and the issues raised in the BTCE paper. The purpose of the Discussion Paper was to give the inquiry a definite focus and encourage responses from submitters. This was done by identifying suggested objectives for spectrum management, deficiencies in the present system and a number

of possible options for rectifying those deficiencies. In order to obtain feedback on these points, submitters were invited to respond in writing to a series of questions related to the matters covered in the Paper.

1.4 Finally, Preliminary Conclusions which were sent to all respondents to the Discussion Paper. The purpose in publishing the Preliminary Conclusions was to focus the attention of submitters specifically on the direction the Committee proposed taking in the report and to provide an opportunity for comment on those specific matters.

1.5 Details of the conduct of the inquiry are at Appendix 1.

Structure of the Report

1.6 The report examines the reasons for spectrum management, what the objectives of spectrum management should be and how those objectives can best be met.

1.7 The report makes some observations regarding the characteristics of the radio frequency spectrum and the relevance of those characteristics for spectrum management. Chapter 2 also addresses the uses of the spectrum and refers in particular to the potential for technological and service innovation in the future.

1.8 Chapter 3 examines the objectives of spectrum management, how they can be defined and their relationship with the overall communications policy objectives of government. The report then considers the current approach to spectrum management, examines the deficiencies

identified in the submissions and the BTCE paper, and assesses whether this approach to spectrum management meets the objectives identified in the previous chapter. This is followed by an evaluation of the nature of government charges for spectrum access and how they relate to spectrum management.

1.9 Having considered the objectives and the shortcomings of the current approach to management, the final chapter examines options for reforming spectrum management in order to ensure that the potential benefits from utilising the radio frequency spectrum can be maximised.

2. THE SPECTRUM

What are the Important Characteristics of the Radio Frequency Spectrum?

2.1 Management of the radio frequency spectrum is influenced to a significant extent by the physical properties of electromagnetic waves. These properties determine the uses that can be made of different parts of the spectrum. No information can be usefully transferred via naturally occurring radio waves. New waves must first be generated in the form of radio energy.

2.2 The radio spectrum resource provides potential to communicate information via electromagnetic (radio) waves artificially introduced by means of transmission equipment. The spectrum resource itself is defined in terms of the range of useful frequencies over which radio waves can be transmitted and it is used to relay information through space between geographically separate points without the aid of wires.

2.3 One of the basic properties of an electromagnetic wave is its frequency which is the rate at which it oscillates when radiated in the form of radio energy. The unit in which frequency is expressed is the Hertz, one Hertz being equal to one cycle per second. The range of useable frequencies ascends from 3KHz to around 300GHz and this range is referred to as the radio frequency spectrum.

2.4 Wavelength is the distance travelled by the radiated wave in a single cycle; the shorter the wavelength, the higher its frequency and conversely, the longer the wavelength, the lower its frequency.

2.5 The next important factor to consider is the signal propagation characteristics of the different frequency bands. Radio waves are propagated in straight lines in space, but this situation does not apply within the earth's atmosphere and in the vicinity of the surface.

2.6 At low frequencies there is a tendency for a wave to follow around the curve of the earth's surface. Over a considerable range of frequencies the signal may be reflected back towards the earth by layers of ionised air in the atmosphere. These mechanisms allow radio waves to travel over very long distances, despite the earth's curvature.

2.7 Frequencies in the UHF Band and above propagate more in straight lines, although they may be affected by atmospheric conditions or blocked and scattered by natural and man made obstructions.

2.8 The relevance of these characteristics for spectrum management is that the spectrum is not homogenous in the ways in which it can be used. Specific applications are often restricted to particular frequencies.

2.9 In addition to these physical characteristics, bandwidth is also an important factor in determining which frequencies can be used for particular purposes, and therefore must be taken into account in spectrum management. For information to be transferred via radio waves it must be converted into electrical signals. These signals will span a range of frequencies dependent upon the amount of information being converted. This span of frequencies is called the base bandwidth.

2.10 The method employed to convert the electrical signals (which contain the information) to useful radio signals, is termed 'modulation'. The type of modulation together with the base bandwidth of the information signal used determines the bandwidth of radiated signals.

2.11 The significance is that different types of service can require different bandwidth. A simple illustration of this is a comparison of the frequency requirements for broadcasting. A television picture requires 6 MHz of spectrum, that same base bandwidth could cater for 35-40 FM radio channels or 1,000 AM radio channels. In short, the spectrum requirements of services vary not only in terms of specific frequency requirements, but also in terms of the quantity of spectrum required.

2.12 Finally, spectrum management must take account of interference. Signals have to be separated so that receivers can discriminate between wanted and unwanted signals. Inadequate separation of signals leads to interference which degrades reception and thereby reduces the utility and value of the spectrum resource. While interference can arise in a number of ways, separation of services is a major consideration in spectrum planning. This can take the form of leaving frequencies unused between services, geographically separating services or separation in time. The extent to which a given band of frequencies can be utilised is influenced by both the available technology and the level of interference deemed acceptable for the intended applications.

2.13 In order to accommodate these features of the radio frequency spectrum, management must be conducted in terms of frequency, space and time. However, in particular geographical areas such as Sydney and

Melbourne, high levels of demand means that all of the frequencies available for a particular purpose are often in use and the spectrum becomes congested. In such situations the finite nature of the spectrum means that it becomes a scarce resource.

2.14 The heterogenous nature of the radio frequency spectrum is pertinent to the Committee's terms of reference as the relative value of different parts of the spectrum will vary and the ability of spectrum management to respond to changes in demand becomes more difficult as the rate of change in demand increases.

2.15 Because the spectrum resource is heterogeneous, different equipment is required for different uses of different parts of the spectrum. The radical nature of change in equipment and transmission technologies impacts significantly on spectrum demand.

2.16 A critical input to the cost of spectrum utilisation, and hence to assessment of its output value for particular users and uses, is the cost of (transmission and reception) equipment. Information available to the Committee indicates that, as a general rule, the more spectrum efficient the equipment, the greater its cost.

2.17 Evidence suggests that availability of equipment impacts on efficient spectrum utilisation and is determined largely by multinational manufacturers who respond to international demand driven by increasing globalisation of communications system standards and specifications.

Why Does the Radio Frequency Spectrum Need to be Managed?

2.18 The value of the spectrum resource lies in its actual and potential exploitation for a range of public, private and commercial information purposes which can be achieved cost effectively via wireless communications. This value can only be maintained if use of spectrum is maximised and if the possibility of interference is minimised. To achieve this, spectrum must be utilised in an orderly fashion. The spectrum needs to be managed if it is to be exploited in an orderly fashion and hence maintain its utility as a reliable form of communications.

Spectrum Uses

2.19 The spectrum is used for a variety of purposes. Most commonly it used to transfer information from one place to another, between transmitter and receiver. Such uses include broadcasting, communication between mobile vehicles, sending data, voice between fixed points, long distance communication between ships and aircraft, control and signalling equipment, radiolocation and navigation. There are other applications such as radar and various scientific and industrial applications. An important point to bear in mind is that there is no feasible alternative to using the radio frequency spectrum for mobile communications and many other services.

2.20 Spectrum uses authorised under the *Radiocommunications Act 1983* can be divided into six broad categories (these categories are used for licensing purposes) namely:

1. Land Mobile Uses - most traditional systems involve voice communications between vehicle based units and/or hand held units and associated base stations. A recent addition to this category of use is cellular mobile telephone services. This use demonstrates the changing demand for spectrum access. Telecom is currently the sole provider of cellular services but the government is to license further operators, each of whom will require spectrum;

2. Fixed Uses - communications between fixed points on the earth's surface. Microwave transmissions are the most common uses and Federal and State government entities are the major users;

3. Marine Uses - this encompasses commercial and non-commercial communications between a variety of watercraft and include maritime navigation, ship to ship, ship to shore and related emergency and safety communications services;

4. Aeronautical Uses - similar range of communications services to that spanned by its marine counterpart;

5. Citizen Band Radio Use - yet another form of land mobile radiocommunications involving two way voice communications over relatively short distances; and

6. Other Uses - this category primarily includes communications with or between amateur radio operators, civil defence and emergency/disaster organisations and satellites and other space vehicles. There are also industrial, medical and scientific research applications in this category.

2.21 There are two other services which are not authorised under the *Radiocommunications Act* and they are broadcasting services (radio and television) and broadcasting satellite services (satellite delivered radio and television). These broadcasting services are regulated under the *Broadcasting Act 1942* and the *Australian Broadcasting Corporation Act 1983.*

2.22 A table outlining the general characteristics, major uses and special features of radio frequency bands is at Appendix 2.

The Future

2.23 Over recent years communications technologies and services have been developing at an ever increasing rate. This has been reflected in part by the number of radiocommunications licences issued, which have been growing at around 20% per annum since 1987.

2.24 An examination of spectrum management should not consider the current uses of spectrum in isolation. The impact of future demand for spectrum resources also needs to be taken into account.

2.25 It is difficult to predict future demand for specific spectrum resources, as evidence taken in the course of this inquiry has shown. While the question of planning for the future will be discussed further in Chapter 4, there are numerous indications that the communications revolution will continue at a rate that will place unprecedented demands on spectrum management.

2.26 Technological development is eliminating the barriers that have historically separated the different segments of the communications supply industry, there is a convergence in communications services in areas such as computers and telecommunications, information and entertainment, international and domestic services, the home and business, telecommunications and broadcasting.

2.27 As we approach the year 2000, technological advances will make it possible for users to communicate with any person or any machine, anywhere at any time. This will be possible through cost effective and easy to use networks and terminals that will have a dramatic effect on the productivity and capabilities of users.

2.28 Users are seeking communications facilities that are easy to install, easy to change, easy to use and operate, which will enable them to respond effectively to their business and personal requirements.
Many of the potential services of tomorrow are already with us in limited forms, such as multi-media information services, network intelligence, wireless telecommunications and broadband fibre optic services. The future will see many different networks being used in an integrated fashion.

2.29 The rapid development of digital technology is a key factor in network and service development. Developed for computer applications it is now being extended to voice and video applications. While digital technology holds the promise of being able to secure greater capacity from the spectrum, it will also stimulate demand through the integrated use of fibre, satellite and mobile technologies.

2.30 There will be increasing functional integration of all communications systems (including voice, data, video and image), facilitating more effective person to person communications. No one technical solution will be appropriate for all communications situations. The greatest benefits will be derived from ensuring the optimal mix of technologies. The challenge will be to determine how that optimal mix can be achieved.

2.31 Satellite systems are going to require a significant increase in spectrum resources. There are several regional and international communications satellite systems being planned in competition with Intelsat and Inmarsat. Mobile satellite services may become much more prominent before the end of the decade, greatly expanding mobile data and telephone services. Aussat's Mobilesat service is to the forefront of world developments in this field and will provide a direct voice and/or data service between satellite and small mobile or fixed terminals. There are also a number of proposals for low earth orbiting satellites, such as Motorola's Iridium project, which offer the possibility of global mobile voice, data and radio location services.

2.32 The development of personal communications is the next major step in telecommunications networks and services. Personal communications services are likely to be introduced over the coming years and network intelligence will provide ubiquity of services and wireless access will provide ubiquity of use. The effect this will have on the way we live and on the organisations which currently provide these services may be dramatic.

2.33 Personal communications is most likely to emerge from developments in and demand for mobile communications. For example, Telecom's Cellular Mobile Telephone service gained more than 100,000 additional subscribers last year, more than half of which use handportables. Australia is planning for the introduction of a second and third cellular operator and all three will use the European digital GSM standard. At the same time as sophisticated and expensive cellular systems are being planned, simpler and cheaper systems are being introduced based on digital cordless telecommunications technology, such as CT2. These systems could well complement cellular systems by providing pedestrian and office based services on a mass market basis.

2.34 The relevance of all this is that technology and service providers will tend to tailor solutions to meet the needs of a greater range of potential users. After all, not everyone wants all of the sophisticated applications and features of a cellular telephone, the result may very well be a range of products at a range of prices to satisfy a much broader market than is the case at present.

2.35 Personal communications could transform the telecommunications industry on a global scale but its extension to the mass market will be heavily dependent on the timely allocation of adequate spectrum resources. This will require action at both the domestic and international level to ensure more efficient use of existing spectrum allocations and reallocation of spectrum between different users.

2.36 The development of broadband fibre networks offers the prospect of movement of many uses from the radio frequency spectrum to the fixed network. However there would probably be a corresponding movement to the spectrum by services that currently utilise wired systems in order to take advantage of the mobility offered by radiocommunications. This is commonly referred to as the Negroponte Switch described in a recent article in the Harvard Business Review -

> `In a crisp formula, Nicholas Negroponte of MIT's Media Lab outlines the needed change: what currently goes through wires, chiefly voice, will move to the air; what currently goes through the air, chiefly video will move to wires. The phone will become wireless, as mobile as a watch and as personal as a wallet; computer video will run over fibre optic cables in switched digital systems as convenient as the telephone is today'(Harvard Business Review, March-April 1991 p.154).

2.37 The major telecommunications carriers claim that an integrated public switched broadband communications network is needed to cater for the growth of high speed intra premises communications and interest in delivery of Pay TV and related services. Others question whether such an

approach is viable. NTT America's Vice President of Research and Development says that `the business planners have not yet decided whether or not this makes sense. In the end it will be the customer who decides' (Communications Week International, 2 September 1991 p.C7).

2.38 What can be concluded from all of this is that technological change will widen the range of choices and complicate decision making. It may result in profound changes to the communications market structure with increased numbers of players and increased sophistication of services. The intensity of competition for attractive spectrum will increase both domestically and globally.

2.39 The technology capabilities that are emerging may place significant strains on management of the radio frequency spectrum. It is necessary to consider whether the current approach to spectrum management is able to plan for these developments and maximise the potential that these opportunities may offer for the development of communications in Australia. What is obvious is that an efficient, flexible and responsive communications system will be required if Australia is to reap the benefits of rapid technological change.

3. SPECTRUM MANAGEMENT OBJECTIVES

Introduction

3.1 Three critical and interrelated points emerge from analysis of inquiry evidence. The first point is that, while submitters agree that the radio frequency spectrum needs to be managed, opinions diverge on why that is so. Second, the development and implementation of a system of spectrum management should be determined by the objectives it is designed to achieve. Therefore, a vital starting point for any assessment of spectrum management is the setting of clear, definable and relevant objectives.

3.2 Clearly articulated objectives provide guidelines for those responsible for managing the spectrum. Clear objectives permit program evaluation - a measure of the extent to which objectives have been achieved and provides a rationale for retaining or changing the current system of spectrum management.

Objectives

3.3 The Department of Transport and Communication's (DOTAC) traditional objective of spectrum management has been that of `enabling information to pass through the electromagnetic spectrum between all users in the most efficient and economic manner practicable, with minimum interference between services' (Submission No 30,p.5).

3.4 This objective has been revised and expanded over recent years. The Department's 1990 -93 Corporate Plan (p.17) refers to diversity, quality and efficiency in the broadcasting and radiocommunications industry as well as efficiency and equity in access to the spectrum. The Department's Program Performance Statements 1991-92 (Budget Related Paper No 815) provide a statement of the current objectives of Radiocommunications and Policy and Operations:

- efficient and equitable allocation of the radio frequency spectrum
- efficient management and regulation of the radio frequency spectrum to the benefit of all radiocommunications users.

3.5 The problem with these objectives is that they are not specific. There would be little dispute that all users should have equitable access and that interference from unwanted signals should be held at acceptable levels. But those general principles do not provide sufficient guidance for spectrum management.

3.6 Several submitters maintained that the objectives of broadcasting and telecommunications should take precedence over those of spectrum management (Submissions No 36 p.5, 22 p.1, 46 p.3, 49 app.2 and 50 p.1). This view was also supported by DOTAC, where the point was made that the spectrum is managed to achieve a number of economic, social and political goals and that management of the spectrum should accommodate the goals of government as expressed in policies related to services which use the spectrum (Submission No 62 p.3).

3.7 While the Committee agrees that spectrum management should not impede the achievement of broader communications policies, it is worth briefly looking at what those objectives are.

3.8 The current objective of broadcasting according to the Department's Program Performance Statements (Budget Related Paper No 8.15 pp.47 and 51) is to promote high quality and efficient broadcasting industries, enabling access to the widest practicable range of services.

3.9 These objectives are so broad and vague that it is difficult to see how there could be inconsistency or conflict between the method of managing the spectrum and the government's communications/broadcasting policies. The 1988 Report into the Role and Functions of the Australian Broadcasting Tribunal (p.18) referred to alternative means of achieving objectives including regulation, deregulation and self regulation.

3.10 The spectrum should be managed for the overall benefit of all users (Submissions No 40 p.1, 52 p.1, 57 p.1 and 54 p.1). Broadcasting and telecommunications users should be required to make efficient use of the spectrum.

Criteria for Spectrum Management

3.11 In DOTAC's initial submission to the inquiry five criteria were listed which could be used in spectrum management (Submission No 30 p.31). They were: dynamic efficiency; technical efficiency; provision for public and merit goods; allocation to the highest value uses; and consideration of opportunity costs.

3.12 The responses to the Discussion Paper were generally supportive of these criteria, although a number of reservations and qualifications were expressed.

3.13 In considering spectrum management objectives, the Communications Law Centre (Submission No 36 p.5) made the point that spectrum management is essentially an input which makes possible the provision of a range of services. This suggests that it might be more appropriate to consider the objectives of spectrum management from a purely operational perspective in the first instance.

3.14 The two significant criteria from an operational perspective are dynamic and technical efficiency. Dynamic efficiency is the ability of spectrum management to be flexible and timely in its response to changes in technology for both existing and new applications. Technical efficiency is the degree to which spectrum management facilitates the use of spectrum efficient equipment and practices in order to maximise the amount of useable spectrum. If the spectrum was managed with a view to maximising technical efficiency and to be as responsive as possible to changing demand, the benefits would accrue to all existing and aspiring spectrum users. AUSSAT supported this view by making the point that use of dynamic and technical efficiency as objectives would achieve spectral efficiency (Submission No 60 att.4 p.1).

3.15 A number of other submitters directly or indirectly identified dynamic and technical efficiency criteria as being of prime (or over-riding) importance given converging technologies and/or the need for spectrum

management to respond to changes in wider communications policy objectives (Submissions No 41 p.1, 46 p.2, 49 p.1, 54 p.1, 57 p.1 overview, and 59 p.1).

3.16 These criteria, dynamic and technical efficiency, are important if spectrum management is to cope with the potential increase in demand for spectrum that may come about due to the rapid changes in technology and service innovation.

3.17 The criterion of provision for public and merit goods at first glance appears to be a sensible and desirable objective , but it requires some definition. The BTCE used the term to identify users who are not motivated primarily by commercial incentives (BTCE Paper p.19). Such goods are unlikely to be provided through a market based system but are considered desirable in the public interest.

3.18 The Committee pursued this definition at a public hearing with representatives from DOTAC, the BTCE and Treasury. The following definition was provided -

> `a public good is one which is free, it is non-discriminatory, anyone has access to it, and anyone's access to it does not preclude anyone else's access. Merit good(s) (are) usually goods which are not provided in a market. In other words you cannot necessarily gain profit from providing them' (Transcript p.423)

3.19 DOTAC explained further that merit goods are `generally regarded as one of those goods or services that the community as a whole thinks should be provided in greater quantities than the market itself would generate and therefore it generally has to be provided by Government' (Transcript p.424). Defence and the national broadcasters are cited as examples of public and merit goods respectively.

3.20 For the purposes of the terms of reference, the Committee agrees with the DOTAC definition and equates non-commercial with public and merit goods in that they are activities supported by government for reasons other than commerciality, they are services that are basically not traded and the use of spectrum is an essential input (Transcript p.424). Such uses would include defence, national broadcasting, police and safety of life services among others.

3.21 Allocation to highest value uses attracted comment and the view expressed by almost all submitters was that it should not be interpreted solely as a value expressed in monetary terms, but that it should be interpreted in a broader sense which also assesses the overall value to the community at large.

3.22 The Committee emphasises that notions of highest value for commercial users are relevant only in situations where demand for spectrum exceeds supply or where a newcomer wants to purchase an existing

assignment. In such situations there needs to be a mechanism for selecting users who will make the most productive use of the spectrum and there are two choices:

- a system of rationing such as auctions, together with tradeability to allow entry to potentially more efficient users in the future; or
- an administrative approach such as presently exists.

3.23 The last criterion put forward by DOTAC for assessing efficient use of the spectrum was opportunity costs. This requires an assessment of the potential benefits foregone if the spectrum is used for one purpose rather than another. This is a process that would be undertaken in any management system. The Committee does not intend to use opportunity costs as a criterion.

The Terms of Reference and the Need for Objectives

3.24 There are several similarities between the Committee's terms of reference and the DOTAC criteria. For example, dynamic efficiency is related to the need for efficient and equitable access for commercial and non-commercial users and, more specifically, to flexibility and responsiveness of spectrum management to changing demand. The terms of reference concerning mechanisms for allocating spectrum to uses with the highest value and means of determining value of spectrum for non-commercial uses

are covered by the criteria of provision for public and merit goods and allocation of spectrum to the highest value uses. Technical efficiency also impacts on these terms of reference as it is concerned with maximising the amount of spectrum available for utilisation by all users.

3.25 There are also differences. The terms of reference also refer to Australia's international obligations and the need for the government to obtain an appropriate return from this resource.

3.26 The terms of reference require the Committee to consider Australia's international obligations. This aspect of spectrum management was also addressed by the majority of submitters, for example the Civil Aviation Authority (CAA) stressed the need for compliance with international civil aviation obligations for obvious safety reasons. The role and impact of international planning obligations on spectrum management is discussed in Chapter 4 (para 4.3). Spectrum management has to take account of Australia's international obligations and responsibilities and while this requirement was not addressed in the criteria, it has featured as an objective of communications policy in the past. The Committee is of the view that the need for Australia's interests to be represented at the international planning level should continue to be reflected in criteria for efficient spectrum management.

3.27 Issues pertaining to aspects of Government charging which also interact with the dynamic and technical efficiency criteria are addressed in some detail in Chapter 5. Two aspects are worthy of mention at this point. The first aspect concerns cost recovery which is linked to concepts of equitable access. The second is the financial return to government

(community) from users who exploit the resource for profit. Any spectrum management system must address both of these points and it would be appropriate for spectrum access fees to form part of the criteria for efficient spectrum management.

3.28 In short by amending the DOTAC criteria, noting the similarities between them and the terms of reference, and by adding other matters covered in the terms of reference to the amended criteria, the Committee has compiled a new set of criteria to assess the effectiveness of spectrum management.

3.29 The question remains as to whether these criteria need to be converted into objectives. The need to clearly define objectives is particularly important in view of the reforms to financial management and accountability for government departments and authorities implemented over recent years. The objectives of DOTAC's programs are stated in the Program Performance Statements and are meant to provide clear, outcome oriented statements of objectives as a basis for accountability. It is appropriate that those criteria considered important to spectrum management be expressed as objectives. This will ensure ongoing scrutiny of performance against those objectives.

3.30 **The Committee recommends that the objectives of spectrum management should be:**

1. **Dynamic Efficiency - responsiveness and flexibility in meeting the needs of all spectrum users;**

2. Technical Efficiency - efficient allocation of the spectrum resource in terms of spectrum efficient technologies and practices in order to accommodate the greatest number of users with an adequate quality of service;

3. Provision for public and merit goods;

4. Allocation of spectrum to the highest value uses;

5. Promotion of Australia's interests with regard to international agreements on frequency allocations, positions in the geostationary orbit and technical standards; and

6. A system of charges for spectrum access that is efficient and equitable and takes account of the value of both non-commercial and commercial use of the spectrum.

4. DOES THE CURRENT SYSTEM EFFECTIVELY MEET THE OBJECTIVES OF SPECTRUM MANAGEMENT?

The Current System

4.1 Management of the radio frequency spectrum is a Commonwealth responsibility under S.51(v) of the Constitution. Spectrum management is conducted principally under the provisions of the *Radiocommunications Act 1983*. The provisions of the *Broadcasting Act 1942* and the *Telecommunications Act 1991* must also be taken into account in spectrum management as they regulate activities which involve significant spectrum use and form part of the overall communications responsibilities of Government.

4.2 As the radio frequency spectrum is regarded as a Commonwealth resource (Transcript p.429), the government is responsible for developing and administering a system of spectrum management which facilitates communications via the radio frequency spectrum. To achieve this spectrum management can be broken down into two areas of activity, namely:

a. Planning - at the international and domestic level which involves the allocation of bands of frequencies for a particular use; and

b. Assignment - authorisation of the use of a designated frequency channel by a user for a particular purpose.

Spectrum Planning - International Framework

4.3 Planning at the international level is undertaken through the International Telecommunications Union (ITU). The benefits of this cooperative international approach are :

- facilitation of particular band usage by compatible services with acceptable levels of interference;
- coordination of services involving communications across national boundaries; and
- determination of internationally agreed allocations of spectrum which foster the development of international communications equipment markets and hence lower costs to users.

4.4 There is an obligation to comply with the ITU Conventions as they have been ratified by the Australian Government giving them the status of an international treaty (Transcript p.101). The ITU has no power to enforce compliance with the ratified agreements, compliance is achieved through the vested interest all member countries have in making the system work effectively.

4.5 The agreements are reached through international conferences and meetings where radio regulations are developed and adopted. These regulations provide spectrum allocation plans for particular services and related technical and regulatory provisions.

4.6 The ITU makes spectrum allocations on a worldwide and a regional basis. Allotment plans are produced for some services such as broadcasting satellites where there is a need to coordinate services across national boundaries. The ITU develops coordination procedures for services which could cause interference such as short wave and medium frequency broadcasting. The ITU also makes regulatory provisions for some services, an example is the global maritime safety and distress service (Transcript p.35).

4.7 While the ITU allocations generally limit the use of a band on a regional or world wide basis to specified services, countries are free to operate other services provided that no interference is caused to those operating in accordance with ITU allocations. Furthermore, many bands actually specify several services, for example fixed, mobile and broadcasting. This gives flexibility to individual countries to determine the appropriate service or mix of services.

4.8 International regulation is generally broad and in fact the ITU has not always been able to achieve consistent allocations of frequencies to particular applications between the geographical regions (Submission No 15 p.10). Individual countries have considerable latitude in making their own decisions on detailed planning and identification of services.

4.9 The Committee asked submitters to comment on the extent to which *international planning obligations constrained domestic planning* options. The response from submitters was that international planning is important and must be taken account of in domestic planning arrangements.

4.10 A number of responses raised the point that equipment was manufactured to meet international standards and that users would be severely disadvantaged if they were required to use equipment unique to Australia (Submissions No 40 p.1, No 46 p.5 and No 53 p.2).

4.11 Most respondents also made reference to the need to ensure coordination of international services and to ensure compliance with interference regulations. Although it is generally acknowledged that international interference control is not as significant a problem for Australia as it is in many other countries due to Australia's geographical isolation (Submissions No 15 p.12, No 26 p.11, No 51 p.2 and No 57 ann.B p.3).

4.12 The responses generally support the proposition put forward in the Discussion Paper that the need for domestic planning arrangements to comply with international obligations is restricted to situations where interference control is required, where advantages for equipment use are apparent and where international coordination is required for interoperability in areas such as defence, safety of life and satellite communications.

Spectrum Planning - Domestic Framework

4.13 This is the next step in planning. It is undertaken by DOTAC in accordance with Part (IV) of the Radiocommunications Act and involves the preparation of the Radiocommunications - Australian Spectrum Plan and

frequency band plans. This allocation process involves very detailed planning and is a major function of the current management system. The functions of the Australian Spectrum Plan are to (Transcript p.78):

- divide spectrum into a number of bands;
- designate bands primarily for defence purposes;
- specify general purposes for use of each band;
- show the type of services which may be licensed;
- define the various services and terms, describe the structure, service categories and the general purposes of frequency bands;
- identify Australian and ITU footnotes relevant to the Table of Allocations; and
- provide a framework for national planning and licensing services.

4.14 Frequency band planning involves the definition of the limits of each band of frequencies allocated to specific services or uses, consistent with the Spectrum Plan. It is based on the premise that efficiency is obtained by having segments of the spectrum contain homogenous services and allowing sharing through technical planning and licensing policy. The preparation of frequency band plans involves considerable consultation in order to ascertain what is required by users and to get consensus on what is proposed.

4.15 New frequency band plans are developed as necessary to facilitate the introduction of significant new services or to introduce more spectrum efficient arrangements into congested bands (Submission No 62 p.5). This involves detailed technical planning in relation to frequency assignment guidelines and equipment standards, which if not undertaken, may result in interference.

4.16 While it is one thing to prepare a frequency band plan it is quite another to implement the plan. The introduction of new arrangements must take account of the interests of existing users. There are costs imposed on users in the form of new equipment purchases and disruption to services. Costs are also incurred by DOTAC for the provision of resources to facilitate the reallocation and assignment of licensees.

4.17 Finally, it should be noted that at the level of frequency band planning, there is considerable discretion as to how the spectrum can be used in Australia and decisions require consideration of `the realities of the marketplace and the availability of equipment' (Transcript p.50).

4.18 As noted earlier, preparation of the Spectrum Plan and frequency band plans is an extremely complicated and time consuming task involving balancing the interests of all users and taking account of commercial factors, technical requirements and changes to communications policy. Judgements have to be made on the relative priority of different uses, particularly in areas of the spectrum that can be used for a number of purposes. According to DOTAC this may result in artificial shortages of spectrum and access can be restricted for some users. (Submission No 30 p.7).

Assignment of Frequencies and Licensing Users

4.19 The process of authorising spectrum use for a specific purpose varies according to whether it is a radiocommunications or a broadcasting application. The latter are services transmitted to the general public and are licensed under the *Broadcasting Act 1942*. The former are licensed under the *Radiocommunications Act 1983*.

4.20 Licences for commercial and public broadcasting are issued by the Australian Broadcasting Tribunal (ABT). These licences set out in a warrant, the technical conditions of the service in accordance with the Minister's planning responsibilities, as provided under S. 125D of the Broadcasting Act (Submission No 30 p.42). The situation of the national broadcasters, the ABC and SBS, is different in that they do not require a licence from the ABT and their activities are covered under separate legislation.

4.21 Under the provisions of the Radiocommunications Act, a user applies to DOTAC for a frequency assignment and provides technical details of the proposed service or use. DOTAC then assigns a frequency (if one is available) which takes account of the interference criteria. The use and technical parameters of the assignment are determined by DOTAC and form conditions on the licence.

4.22 The essential difference in these approaches to licensing is that for radiocommunications purpose the equipment is licensed while a broadcasting licence is issued to provide a service within a specified geographical area.

4.23 The assignment process for radiocommunications purposes involves authorising the use of a radio frequency or a radio frequency channel. This is done in accordance with technical frequency assignment guidelines determined by DOTAC in order to determine what the frequency re-use is going to be and the protection requirements of other services.

4.24 The technical specifications are fundamental to management of the spectrum as they are intended to maximise the number of services in a particular band and allow for re-use of channels across the country. The need to prevent harmful interference requires a trade-off to be made with regard to setting acceptable levels for interference and the number of services (assignments) that can be made available on a given band.

4.25 Licences are issued annually and a fee is paid at renewal. While licences can be cancelled or not renewed, the practice has been that once issued they are seldom terminated against the wishes of the licensee. At a public hearing DOTAC was asked whether it was the case that incumbent users had no continuing rights to spectrum, their response was -

> `In a legal sense under the Radiocommunications Act, that is so because the licence is awarded on an annual basis. But there is an expectation and one which is a realised expectation that the licence would get renewed. Indeed in our arrangements to try to achieve spectrum reallocation, we try to negotiate with people under our current system for that shift to occur... sometimes five years ahead of time...the expectation is there that tenure will continue' (Transcript p.456).

4.26 Licences cannot be legally transferred from one user to another. Although, in effect, this does happen when the entity holding the licence is sold. For example this occurs when a broadcasting company is sold. However, for most non-broadcasting users this means of acquiring or disposing of licences is not a practical proposition as radiocommunications generally forms only part of the main business of the licence holder. The Act does provide for a licence holder to transfer the operating rights conferred under a licence such as in the use of the trunked land mobile band. In this case the licensee operates the service but that service is available to multiple users ie. the channels are not dedicated to single users.

4.27 Another feature of the assignment process is the use of Frequency Reservation Certificates (FRCs). They enable assignments to be reserved for future use and are intended to assist users with their future spectrum requirements in terms of investment and growth in demand for their services. Spectrum assigned to users through an FRC is not available for reassignment to other users even in the event that demand exceeds supply in that band as long as the holder of the FRC complies with the conditions under which it was issued (Transcript p.139). The Radiocommunications Act does empower the Minister to impose strict terms and conditions on FRC assignments and these conditions have been tightened recently with regard to their use in spectrum allocated to trunking.

4.28 Some services such as garage door openers, radio controlled toys and cordless telephones are exempt from licensing. This is due to the fact that they are unlikely to cause interference and the large numbers in use would make licensing a cumbersome proposition. The use of these products is controlled through technical standards.

4.29 A further exemption from individual transmitter licensing requirements applies to a number of organisations which receive block allocations of spectrum for their sole use. These organisations include the Department of Defence and the Civil Aviation Authority and they are free to assign the relevant spectrum for their own needs.

Deficiencies of the Current System

4.30 As mentioned earlier, there are obligations on Australia to comply with international planning obligations but there is considerable flexibility available to DOTAC in determining the appropriate mix of services and the means by which domestic services are allocated and assigned. The specific international obligations relate to interference control and coordination of services that are used on an international basis. It is also important that domestic arrangements do not preclude users from utilising imported equipment, this could place them at a considerable financial disadvantage. There are however a number of significant problems with domestic arrangements not necessarily related to international considerations.

Dynamic Efficiency

4.31 The Committee considers the objective of dynamic efficiency to be one of the most important considerations in assessing the suitability of current management practices. The question that must be examined is how responsive and flexible the current system is in meeting the changing needs of spectrum users.

4.32 The BTCE Paper (p.32) argued that the current process reduced flexibility of spectrum access and as a result spectrum is not used in an economically efficient manner.

4.33 The difficulties involved in planing were noted in DOTAC's submission (Submission No 62 p.5) and they included accommodating the interests of existing users, international obligations, government policy decisions, foreseeing technological change and resolution of complex engineering and technical issues. These factors can lead to the need for compromise which results in inappropriate spectrum planning and/or inefficient spectrum allocations in the short, medium or long term. There are a number of examples of these inefficiencies.

4.34 The most commonly cited example of inappropriate spectrum planning concerns assignment of spectrum in the VHF-FM band to television services in the early 1960s. That decision was driven by a combination of government policy imperatives and short-sighted judgements by a regulatory agency that future demand for FM broadcasting could and should be accommodated within the UHF band. That decision has led to severe curtailment of FM radio development over the past 20 years and is yet to be fully resolved.

4.35 A more recent example concerns allocations for Multipoint Distribution Services (MDS) under a frequency band plan gazetted in mid-1988 (some two years after expressions of interest in use of that band for MDS video, audio, entertainment and information services had been invited). The 1988 MDS band plan provided for allocation of 19 broadband channels. Six of those channels were reserved for allocation to proposed

secondary distribution of future Pay-TV services: the other 13 were earmarked for immediate allocation for specified use categories (most of which involved narrowband service applications which would utilise but a fraction of 7MHz channel capacity). That, coupled with the absence of clear government policy on Pay TV delivery, created an artificially high demand for MDS frequencies which subsequently collapsed to produce under-utilisation even in high density metropolitan population centres. The responsibility for allowing an artificial demand situation to develop in the first place clearly rests with the Department.

4.36 Yet another recent example of the difficulties in dealing with strong demand for spectrum under the current system is the allocation made for trunked land mobile services, where demand has dramatically outstripped supply (Submission No 14 p.5). In this case DOTAC is unable to provide additional spectrum for a service that utilises spectrum in a very efficient manner. This has resulted in congestion in trunked land mobile spectrum in Sydney and Melbourne.

4.37 This example highlights the losses in efficiency. When this inquiry began, 200 channels had been assigned, only 20% of them were actually used, the remainder were covered by FRCs and effectively locked up. The congestion was a result of underutilisation of much sought after spectrum (Submission No 14 p.5). Not only was the spectrum not being efficiently exploited but new users, who may have been more efficient service providers than the incumbent users, were being denied access and competition was being restrained.

4.38 Further examples of reduced flexibility are given in a number of submissions (Submissions No 60 att.4 p.8 and 50 ann.B p.1). There was a general acknowledgment among many submitters that current practices have not always resulted in efficient allocation of spectrum.

4.39 Under current spectrum allocation arrangements, it is unlikely that those responsible for planning spectrum allocations can ever expect to accurately predict future technological developments nor assess future changes in demand. Given this unpredictability, it is necessary to consider what processes are available to deal with unexpected changes. This is an important consideration, especially if the acceleration in demand for spectrum resources continues as it has over recent years.

4.40 It is worth considering those developments which could reasonably be expected to produce high demand for spectrum access for commercial uses, and hence are likely to lead to congestion and scarcity in certain frequency bands. Evidence to the inquiry demonstrates that the present spectrum management system is not equipped to undertake the long term planning with the dynamic efficiency essential to anticipate and cater for such developments.

4.41 General developments which could exert longer term pressure on achievement of the dynamic efficiency objective for spectrum management in the future have been outlined in chapter 2 (paras 2.23-2.39). Rapid developments in and high demand for services such as the following could be driving forces leading to congestion in certain parts of the spectrum over the next 10-15 years:

- public mobile voice telephony (eg cellular, Telepoint and PCN);
- international cellular telephony;
- private mobile;
- point-to-multipoint audio, video and data;
- advanced forms of television broadcasting; and
- data communications and data broadcasting.

Spectrum frequency bands most likely to be affected by demand for these and other services are identified in the table at Appendix 3.

4.42 Access to spectrum is an obvious imperative for provision of all forms of mobile communications services given the absence of practical alternative delivery modes.

4.43 As previously stated (para 2.36) optical cable would be the optimum delivery solution for advanced high definition television (HDTV) services and for interactive video services in the ideal `wired' community. For the foreseeable future, strong demand for delivery of television services via radiocommunications systems is likely to continue. This arises from increasingly competitive broadcasting market environments, the capacity for rapid penetration and wide area market coverage available through a mix of satellite and terrestrial radiocommunications systems.

4.44 The table at Appendix 3 indicates that demand for mobile telephony and, to a lesser extent, digital audio broadcasting services will exert intense pressure in the UHF band within 10-15 years. International experience to date shows that such demand exerts pressure for relocation

of television services to higher microwave frequency ranges. Such pressure will serve, in turn, to intensify demand for currently underutilised frequency ranges within the microwave band where satellite technology offers viable technical solutions.

4.45 In terms of likely developments over the next 10-15 years, the ability of spectrum managers to respond to dynamic efficiency imperatives is most likely to be tested within the 1500-2300 MHz band (for terrestrial services) and, to a lesser extent, in the Ka band (for satellite services).

4.46 The PCN revolution in mobile telephone communications will impact on the UHF terrestrial band because that part of the spectrum has the most ideal characteristics for such services and will be subject to extensive redevelopment in the years ahead. Such redevelopment provides a unique opportunity to implement new and dynamically efficient spectrum planning for new types of services.

4.47 As regards future satellite communications services, it is noteworthy that allocations for the Ka band are the subject of current international review. Because the C and Ku satellite bands are already characterised by extensive prior allocation and use, the Ka band is now targeted as potentially the best compromise solution for introduction of HDTV services.

4.48 At face value, it may appear that there is a large segment of unused spectrum within the Ka band. However, greater susceptibility to rain attenuation in certain parts of the Ka band renders a collectively significant portion of the overall band largely unsuitable for cost-effective TV broadcasting applications.

4.49 The `wild card' which will finally determine the medium to longer term impact of advanced television services on spectrum, of course, concerns the speed with which telecommunications carriers will commit capital to `last mile' development of local loop optical fibre networks. Australian spectrum management cannot afford to take it for granted that such development will occur within a time frame which takes the pressure off planning performance to meet the dynamic efficiency objective.

4.50 It is now necessary to consider the relevance of the actual frequency assignment process to dynamic efficiency in spectrum management. DOTAC says that replanning of bands to accommodate new services and technologies is becoming more difficult (Submission No 62 p.7). There was a high degree of agreement among submitters that current arrangements do not produce flexible and timely responses to changing demand for spectrum use. The ABC identified a lack of resources within DOTAC to undertake the necessary technical planning as a prime cause (Submission No 61 p.5), a point also raised in earlier submissions. The Electricity Supply Association of Australia (Submission No 53 p.2) cites the need to wait six months for a microwave licence. Telecom notes that while responsiveness is adequate in a technical sense it is lacking in commercial considerations (Submission No 59 p.5).

4.51 Other concerns included a perceived bias towards some classes of users, rigidity of current licensing categories and a lack of co-ordination within DOTAC itself.

4.52 However the factor that came through loud and clear from existing users with regard to replanning of allocations was the cost of moving to new assignments. The inability of DOTAC to compensate users who are required to move means that extensive consultation must be undertaken and an often lengthy timetable for change determined. The concern of users is quite understandable and the Committee believes that this is probably the major factor inhibiting the allocation and assignment processes.

4.53 Examples of the potential costs are cited by some users. For example the CAA noted that clearance of the 400 Mhz band involves equipment replacement costs of $20m (Submission No 43 p.7). Telecom also raised the matter of the short time allowed for the new spectrum arrangements for cellular telephones (Submission No 59 p.4).

4.54 While acknowledging the problem, there were no suggestions as to how this question of compensation might be satisfactorily resolved. The difficulty is that while it might be possible to agree on the direct costs involved in terms of re-equipping, the salient question is from whom should DOTAC recover the costs. In some cases it might be possible to recover them from the new users, if that were not possible they might have to be recovered from all users. Questions of equity would need to be considered and this process could become just as drawn out as present arrangements.

4.55 Another factor in relation to commercial users is the notion of compensation for any commercial losses that might be incurred either directly by the service provider or indirectly by customers. These are commercial judgements which DOTAC is not equipped to handle in a satisfactory manner.

4.56 Suggested reforms to the current management system will be considered further in the next chapter. From discussion thus far, the evidence suggests that current spectrum management practices lack flexibility and timeliness with regard to changing demand for spectrum use. Furthermore, mis-matches in supply and demand demonstrate the difficulties involved in the current approach to predicting and responding to changes in demand.

Technical Efficiency

4.57 The objective of technical efficiency involves the allocation of spectrum in terms of spectrum efficient technologies and practices in order to maximise the number of services and maintain an adequate quality of transmission/reception.

4.58 The question that is examined is whether users are in a better position than planners to determine acceptable levels of interference. This is significant as interference standards are a prime determinant of the number of services that can be accommodated in any given band.

4.59 The BTCE Paper (p.68) argued that the maximum levels of interference are set to a standard where interference is almost non-existent. The problem with this approach being that it reduces the number of services that can be accommodated in a given band of spectrum. It would be possible to place users closer together on the spectrum and make greater re-use of frequency channels across the country by having reduced power levels.

4.60 The BTCE said that a trade-off could be determined between the costs of controlling interference and the costs of interference itself. But that under present arrangements individual users are unable to negotiate to determine levels of interference that they deem acceptable or to choose equipment that they deem appropriate (BTCE Paper p.68).

4.61 With the exceptions of FARB and the ABC there is general agreement that greater input from users on these matters would be desirable. Aussat goes further and states that such decisions `should be made by people who have expertise and hands on experience of their day-to-day work' (Submission No 60 att.4 p.9). But concern was expressed that there still needs to be a central authority with responsibility for policing interference standards.

4.62 DOTAC points out that it tends to err on the conservative side in order to avoid the risk of criticism. The point is also made that maintenance of stringent interference controls comes at a cost of limiting access to additional users, a situation which may benefit existing users (Submission No 62 p.6).

4.63 It is worth noting that major spectrum users such as Defence, Telecom and the CAA already exercise considerable independence in this regard and this appears to work satisfactorily (Submissions No p.4 and No 43 p.5). Difficulties would arise where there are multiple users in a band.

4.64 Most users believe that if they had a greater input then more acceptable standards could be determined and DOTAC acknowledges that it sets standards in a very conservative fashion in order to avoid the possibility of criticism. The Committee believes that there needs to be a re-assessment of the way in which technical and interference standards are determined.

4.65 Users views were canvassed on what constituted an efficient user of the spectrum. The responses varied but there was a general view best summed up by Defence: `an efficient user is one who derives the greatest effect from the use of the spectrum and in doing so minimises the extent that use of the spectrum is denied to other users' (Submission No 57 p.6). There was little comment on how current management practices could be changed to encourage efficient use of spectrum with the exception of the view that DOTAC should ensure that the planning process made provision to encourage efficient use (Submission No 59 p.4). The problem that has been highlighted already is that DOTAC is inhibited in its ability to replan spectrum allocations and frequency band plans.

4.66 The evidence suggests that DOTAC is constrained in its ability to ensure that the most spectrum efficient equipment and practices are in use and that the current approach to setting standards comes at a cost to new and prospective users and may in some instances benefit existing users.

4.67 Nevertheless it is still necessary for the spectrum manager to continue to continue to play a central role in determining interference standards and arbitrate on disputes.

Public and Merit Goods

4.68 The definition of public and merit goods was discussed in the previous chapter (paras 3.18-3.20). Access to the spectrum for these purposes has, to a certain extent, been determined by the nature of the service ie. whether it is a broadcasting or telecommunications service, or whether it is a radiocommunications application.

4.69 Access to spectrum for broadcasting purposes is determined primarily through broadcasting policy, where the number of licensees is regulated through the ABT or, in the case of the ABC and SBS, directly by the Minister. The only significant impediment spectrum management offers to broadcasters is in the area of Band 2 clearance mentioned earlier.

4.70 For telecommunications purposes AUSTEL regulates the activities of Telecom and will similarly regulate the new carrier. Once again, the most significant problems in the past seem to relate to difficulties with replanning of spectrum. A current example is the new spectrum arrangements and associated band replanning for cellular telephones.

4.71 With regard to these classes of user there is a concern that they may not in fact be efficient users of the spectrum. There was agreement among submitters that efficient use of spectrum was desirable for all users. DOTAC made the point that there is no real incentive for users who are

not charged for spectrum to upgrade their equipment to use spectrum efficiently (Transcript pp.431-2). The Committee agrees with this; there is little point in spending money on renewing equipment that may be functioning effectively when there are likely to be other pressing demands for funds. Even where users are paying licence fees, a glance through the fees schedule will indicate that the licence fees (for radiocommunications uses) are generally small when compared to the cost of equipment.

4.72 The Committee is of the view that while maintenance of a high standard of spectrum efficiency is desirable for all users in this category, there is scope for inefficiencies with regard to public sector users. There are two factors which give rise to this concern. Firstly, the large proportion of the spectrum that they use and second, that they are not necessarily subject to commercial pressures to ensure equipment is of the highest standard. In addition they are subject to budget constraints imposed on all publicly funded activities and continuing to use old equipment would be an understandable budget strategy for many such users.

4.73 The evidence taken in the course of this inquiry suggests that the current system of spectrum management meets the needs of users who provide socially beneficial services to the community and those who use the spectrum for personal non-profit purposes. The concern of the Committee is whether the current system can ensure efficient use of the spectrum, particularly with respect to public sector users.

Allocation to Highest Value Uses

4.74 The desirability of ensuring that spectrum is allocated to the highest value uses only becomes important where there is congestion ie. where demand for spectrum resources cannot be met. If this is not the situation and all user requirements can be met then allocation to highest value uses is not as relevant as no choice is required.

4.75 At present there is no satisfactory method of dealing with demand for spectrum between competing uses. The current approach requires the Department to make judgements on the basis of consultation and then embark on a time consuming process of replanning and reassigning spectrum. There is no means of making precise judgements on the comparative values of competing users. This situation may become critical in ensuring that spectrum is used efficiently if overall demand increases in the future. A means of objectively selecting between competing use will be needed.

Conclusions

4.76 The conclusions reached by the Committee with respect to whether the current approach to spectrum management meets the objectives set out in Chapter 2 are as follows:

- Dynamic Efficiency- current spectrum management practices lack flexibility and timeliness with regard to changing demand for spectrum use. Mis-matches in supply and demand have occurred demonstrating

the difficulties involved in predicting developments in technology and the way those developments will be used to provide services;

- Technical Efficiency- DOTAC is constrained in its ability to ensure that the most spectrum efficient equipment and practices are in use. The current approach to setting standards imposes costs on new and prospective users and may in some instances benefit existing users;

- Public and Merit Goods- while the current system of spectrum management meets the needs of users who provide socially beneficial services to the community and those who use the spectrum for personal non-profit purposes, there is a need to ensure efficient use of the spectrum, particularly with respect to public sector users; and

- Allocation to the Highest Value Uses- the current system of spectrum management is not able to satisfactorily allocate spectrum to the highest value uses and this problem will become critical if demand continues to increase and congestion becomes more commonplace.

5. GOVERNMENT CHARGING

Introduction

5.1 The terms of reference require the Committee to examine the role of government charges for spectrum access in ensuring appropriate financial return to government from the resource. The Committee has interpreted financial returns from the resource to include two aspects:

- recovery of administrative costs incurred in managing the spectrum resource; and
- recovery of a portion of the spectrum's value from commercial use of the spectrum.

5.2 The report has previously foreshadowed that consideration of government charging raises specific issues which need to be addressed separately from those raised by other inquiry terms of reference. The point has also been made, that the role of government charges for spectrum access and the financial return to government from exploitation of the resource is closely related to efficient use of the spectrum (para 3.27).

5.3 Chapter 3 (para 3.30) identifies six spectrum management objectives recommended by the Committee. Chapter 4 has assessed the performance of the current spectrum management system against each of those objectives.

5.4 The Committee sought to focus the attention of submitters upon a broader range of issues than the two aspects identified. Responses indicated a general view that government charges should have a role in ensuring efficient and equitable spectrum access and that the value of both non-commercial and commercial uses be taken into account. Recommendation No 6 in Chapter 3 (para 3.30) is consistent with that view.

5.5 A number of submitters consider that government charges have an important bearing on achievement of the dynamic efficiency and technical efficiency objectives. Some respondents also expressed views to the effect that the public and merit goods objective should be facilitated by exemptions from any charge for spectrum access.

5.6 This chapter addresses current charges as they relate to spectrum management objectives recommended by the Committee and the relevance of those charges to inquiry terms of reference.

Current Position

5.7 Fees are levied for both radiocommunications and broadcasting licences. Radiocommunications licence fees are set by regulation under separate tax acts. Fees were originally aimed at recovering costs, but since 1983 have been levied as taxes and are comprised of a cost recovery and a royalty component (Paper by V H Jones called `How Should the Spectrum be Priced?' 1987 p.6). The royalty component of these taxes for some transmitter categories represents a de-facto attempt to capture a share of the economic rent accruing from commercial use of the spectrum. While the

royalty component is not related to the market value of a piece of spectrum, it has been used in some situations in an attempt to control demand in allocations where congestion has occurred.

5.8 The Department identified the factors used in the formulation of radiocommunications licence fees. They include frequency and bandwidth, relative scarcity, commercial and social considerations and the need to encourage efficiency (Submission No 30 p.44).

5.9 Fee reductions and exemptions are available for certain categories of users (Submission No 30 p.44). Services related to safety of life activities such as fire brigades and ambulance services are exempt from licence fees. Also exempt from fees are the non-licensed uses referred to in Para 4.28.

5.10 Reduced fees are provided for users who provide services regarded as having a significant social value and comprise a range of users involved in safety, private non-profit activities and users living in remote areas. Reduced fees are also levied for some government users in the form of bulk licence fees. These users are being converted to individual licensing for all assignments but there are still significant bulk assignments for defence and aviation purposes.

5.11 These reductions and exemptions are a result of government decisions to subsidise certain users of the spectrum; however, the value of the subsidies are not formally quantified.

5.12 Broadcasting licence fees apply to commercial television and radio broadcasters and are based on the gross earnings of the broadcaster. They provide a financial return in excess of the cost of planning and assigning the spectrum used for broadcasting purposes. In addition to annual fees, additional fees have also been levied recently with regard to radio broadcasters. They are establishment fees for new radio stations and conversion fees for changeover from the AM to FM band. Conversions are being implemented in metropolitan areas through a tender process involving undisclosed reserved prices. Current arrangements for regional areas involve establishment fees for new FM licences and conversion fees for existing stations set at a percentage of the establishment fee for their new licence competitors.

5.13 The lack of any identifiable royalty component in these taxing measures for the de-facto capture of economic rent for exploitation of the spectrum resources and the relevance thereof to inquiry terms of reference is addressed later in this chapter (para 5.21).

5.14 Spectrum access by national and public broadcasters for transmission of programs intended for direct reception by the general public is granted at no charge. As already mentioned these broadcasters do pay licence fees for other activities licensed under the Radcom Act such as outside broadcast links, as do commercial broadcasters.

Deficiencies of the Current System

5.15 The current system of structuring and levying fees has a number of shortcomings. The first is that while charges are meant to play a role in regulating demand in congested areas of the spectrum, there is little evidence to suggest that this approach works. This point was acknowledged by DOTAC and supported by many submitters (Submissions No 62 p.9, 40 p.2, 49 app.2 p.2, 53 p.3, 60 att.4 p.13, 52 p.4 and 59 p.5). Thus, it is safe to conclude that the current charges system would not play a significant role in dealing with any future increases in demand.

5.16 The second shortcoming is that discounted charges and exemptions for spectrum access are a form of subsidy which is not currently quantified. There was little input from submitters on appropriate ways of measuring the cost of such subsidies. Perhaps the reason was that given by DOTAC -

> `the issue that you are raising is the well known fear that goes across a whole range of issues in government, that if you actually move an implicit or non-transparent subsidy into the transparent regime, or worse still from the viewpoint of the beneficiary of that subsidy, into the budget regime, then the fear is that as soon as you can see it or as soon as you have got to appropriate it, governments are inclined to reduce them and eliminate them (Transcript p.434).'

5.17 The Committee agrees that it is essential that socially desirable services continue to have appropriate access to the spectrum. The problem is that if the level of subsidy is not known, then it is not possible to determine the impact the subsidies are having on the level of charges imposed on other users. It is a question of equity: should other users bear all of this unknown cost equally or should the government make a direct payment to the spectrum manager to cover the costs of those decisions to extend such treatment to selected users?

5.18 A third point raised in the BTCE paper (pp 57-58) and DOTAC (Transcript pp.431-3) is that discounted fees or subsidies provide very little incentive for users to maximise their productive use of the spectrum. This is of course undesirable and a number of submitters made the point that charges should be structured to provide incentives for more efficient spectrum use (Submissions No 51 p.3, 52 p.5 and 57 p.8). Telecom took a different view that fees 'should not be used to drive technology change (towards more spectrum efficient technologies). This would lead to a loss of orderly development and planning' (Submission No 59 p.5).

5.19 A number of submitters expressed views to the effect that government charges are not, but should be, structured specifically to encourage (dynamic and/or technical) efficiency in spectrum usage (Submissions No 53 p.3, 54 p.4, 55 p.3, 56 p.3, 59 p.4 and 60 att.4 p.14). Others considered that government charges could be related to the amount of bandwidth actually used (as distinct from assigned to particular uses) and/or the efficiency with which assigned bandwidth is actually used (Submissions No 43 p.10, 51 p.3 and 58 ann.B p.8).

5.20 The Committee concludes that the current approach to levying charges is of little assistance in managing demand, does not encourage efficient spectrum use and is not transparent to users.

Government Charges and the Terms of Reference

5.21 As previously mentioned, for the purposes of the terms of reference, government charges can be divided into two components. First, the recovery of the costs of spectrum management and second, additional charges to provide a level of revenue for government.

5.22 With regard to cost recovery, charges have to cover the costs of specific tasks attributable to specific users. These costs relate to management functions such as frequency coordination, individual planning and resolution of interference problems. Cost recovery also includes overhead costs that are not attributable to any specific user such as international planning activities.

5.23 There is currently no attempt to charge individual users for the management costs generated directly by them in their use of the spectrum. Cost recovery is at present undertaken with a view to ensuring that the total level of fees covers the total costs of spectrum management. As can be seen from the table following paragraph 5.26, charges currently exceed overall management costs. Such an approach serves to penalise users who require very little work to be undertaken by DOTAC and such users would include those who seek assignments in bands that are not congested, especially those users outside major metropolitan centres.

5.24 The Committee considers that if cost recovery is to be a component of the charging structure, then it should be done in such a way that the actual costs generated by individual users are identified and recovered. This process would still have to take account of those users who are granted concessional or privileged access to the spectrum.

5.25 The remaining administrative costs could then be recovered across all users. There are a number of methods for recovering those costs including dividing the amount between all users, relating the charge to the amount of spectrum used or relating the charge to the value of the spectrum.

5.26 The following table shows that, in recent years, government revenues derived from general radiocommunications and broadcasting uses of the spectrum resource have been substantially in excess of administrative outlays on its management. This excess can regarded as a tax on spectrum use (Transcript, p.131). As already mentioned, there is a royalty component of that tax on some transmitter categories for general radiocommunications uses which represents a de-facto attempt to capture a share of the economic rent accruing from commercial use of the spectrum resource (para 5.7).

Spectrum Management: Comparison Revenue and Outlays

Year	Radiocommunications		Broadcasting	
	Revenue $	Number of Times Revenue Exceeds Outlays	Revenue $	Number of Times Revenue Exceeds Outlays
1983-84	7.5	1.5	40.1	5.8
1984-85	11.4	1.7	46.6	4.8
1985-86	11.6	1.6	53.8	4.6
1986-87	17.5	1.9	60.8	4.8
1987-88	23.8	2.2	68.6	5.0
1988-89	50.4	2.5	*110.2	6.1
1989-90	61.9	2.3	*175.2	9.8

* Inflated by receipts for Conversion Fees and auctioning of FM frequencies.

Source: Derived from BTCE Paper, p.54 and Department of Transport and Communications Annual Report 1989/90.

5.27 Consistent with related points made elsewhere in this chapter, the Committee agrees with the support from submitters for a transparent charging system which provides public scrutiny and enables users to see what is being done on their behalf (Submissions No 45 p.11 and 43 p.10).

5.28 It is imperative that any consideration of appropriate charges for spectrum access recognise that economic rent can be captured by commercial users of the spectrum. There are two noteworthy reasons for this. One reason has to do with increasing commercial use being made of

the spectrum. The other reason has to do with developments likely to lead to high demand for access to certain parts of the spectrum resource in the future.

5.29 The critical issue of economic rent which can be earned by users from commercial use of the spectrum was raised in the BTCE Paper. The Committee questioned DOTAC and Treasury on the definition of economic rent and sought information on other relevant matters at a public hearing. Economic rent can be defined as returns to a factor of production over and above that return which would draw the factor into production (Transcript p.438). In simpler terms as far as spectrum access is concerned, it is an unearned gain which can be acquired by a user through having access to a valuable piece of spectrum (Transcript p.440). That unearned gain can be manifested as an above normal profit or it can be dissipated through higher than normal costs.

5.30 In the case of spectrum use these economic rents can come about through the limitation of access to desirable parts of the spectrum for other users due to scarcity of spectrum (congestion) or through government regulation (broadcasting, cellular telephones).

5.31 An important consideration in recovering economic rent is that it is one form of taxation revenue that does not create inefficiencies in the economy, 'if economic rent is over and above that which is required to get you to undertake some activity, then taking it away will not affect your decision to undertake that activity' (Transcript p.440).

5.32 There are a number of ways of recovering economic rent. Royalties on output and annual taxes on revenue are one means but they do not take account of a situation where the rents are dissipated through higher than normal costs. In such a situation spectrum is being used inefficiently and the community loses.

5.33 Community obligations can be placed on users as a means of redistributing the rents to the community, such as is the case with commercial broadcasting at present. The costs associated with administering this type of approach are potentially very high and this approach might not be suitable for the majority of spectrum users.

5.34 Other methods of capturing economic rent are through the existing taxation system (capital gains tax, stamp duties, company tax, sales tax and income tax) or through a system of auctioning or tendering the right to provide a service (Submission No 75, p.1).

5.35 The Committee considers that it is important that a means be found to efficiently recover economic rents that may accrue to individual users either as a result of scarcity or government regulation. The specific application of these approaches will be considered in the next chapter.

Conclusions

5.36 The current approach to levying charges for access to spectrum has little if any effect in managing demand, does not promote efficient use of the spectrum and is not transparent to users.

5.37 The Committee believes that the cost recovery component of any charges structure should be formulated in a manner to ensure that the actual costs generated by specific users are recovered from those users. Costs not attributable to any specific user could then be recovered using a flat charge, or based on some measure of the amount of spectrum used or the value of spectrum used, whichever is the most appropriate. Such an approach would assist in making spectrum charges more transparent and ensure greater scrutiny.

5.38 **The Committee recommends that:**

1. **The cost recovery component of the annual charges for spectrum access be levied in such a way that the actual costs incurred by the spectrum manager on behalf of individual users are identified and recovered from the individual users; and**

2. **To further assist in developing a transparent charging structure, the taxation component contained in charges should be clearly identified.**

5.39 Whatever the level of taxation, the Committee believes that the potential for increased congestion and the growing exploitation of the spectrum for commercial purposes will lead to situations where individual users will be in a position to earn economic rent.

5.40 The Committee recommends that:

3. A suitable means of recovering economic rent be formulated.

6. FUTURE SPECTRUM MANAGEMENT: CHOOSING FROM OPTIONS

The Problem Restated

6.1 The development of a system of extensive planning and regulation has been the traditional method of spectrum management in Australia. This method is generally similar to that which has been adopted overseas for the administration of the radio frequency spectrum. While it has operated satisfactorily in the past from the point of view of users and regulators, a rethink is now taking place in light of rapidly increasing demand and accelerating technological change. These changes have made it increasingly difficult to achieve efficient, equitable and timely access to certain parts of the spectrum resource for new and existing users under the traditional method. These and related shortcomings have led to a fundamental reconsideration of approaches to spectrum allocation and frequency assignment.

6.2 Chapter 2 identifies characteristics of the spectrum resource (including its non-homogenous nature) as relevant factors to be taken into account in considering issues raised under the inquiry terms of reference.

6.3 A fundamental problem addressed in Chapter 3 is the lack of clear, definable and relevant spectrum management objectives under the current system. The Committee accordingly identified six objectives to provide a rational framework for examination of that system (paragraph 3.30).

6.4 Examination of the current system within that framework found spectrum management practices to be deficient on several counts (see Chapter 4). The current system neither addresses adequately the need for dynamic and technical efficiency nor facilitates satisfactory allocation of spectrum to uses with the highest value. Although it meets the needs of providers of public and merit goods and for personal non-profit uses, the current system does not ensure efficient spectrum use, particularly by public sector users.

6.5 The Committee has also identified major deficiencies with current spectrum access pricing mechanisms (see chapter 5). Government charges are not levied in a way that enables the actual costs incurred in spectrum management to be identified and recovered from individual users. Current arrangements do not provide a suitable means of ensuring the return to government of an appropriate share of economic rents accruing to users from commercial use of the spectrum.

6.6 In short, the current system fails in a number of significant ways to meet spectrum management objectives recommended by the Committee. If demand escalates over the coming decade, then losses in growth, economic productivity and efficiency could be substantial. It is necessary to consider what changes can be made to spectrum management to redress these deficiencies.

6.7 Inquiry inputs have presented a wide range of the `pros' and `cons' of different aspects of the current administrative system and on the nature of reforms that could be implemented in any future management system. Opinions have generally centred upon reforming the current

administrative based arrangements or on the introduction of market based principles into the allocation and assignment process. What has become evident to the Committee in the course of the inquiry is that the two approaches are not mutually exclusive and that it is possible to take advantage of the desirable features of both approaches to improve spectrum management.

6.8 In the Discussion Paper the Committee suggested four possible approaches to addressing the shortcomings identified in the current system of spectrum management. They were:

- an administrative system for setting priorities for allocation and assignment;
- fine tuning the current administrative approach;
- introduction of a market based system along the lines suggested in the BTCE Paper; and
- a combination of market and administrative approaches.

6.9 The purpose of this chapter is to choose the most suitable spectrum management approach to remedy deficiencies in the current system by testing these four approaches against the objectives identified by the Committee.

AN ADMINISTRATIVE SYSTEM FOR SETTING PRIORITIES FOR ALLOCATION AND ASSIGNMENT

Background

6.10 One alternative to the current system of allocation and assignment is a system of setting priorities for different spectrum uses. This approach was strongly supported by the Western Australian Government and a similar approach was outlined in a recent Canadian Government discussion paper: `Towards a Spectrum Policy Framework for the Twenty-First Century'. It was also supported by the CLC (Submission No 47 p.1).

6.11 The Western Australian Government approach requires balancing the economic and commercial value of spectrum use with the social value. This approach would necessitate specific inquiries, case by case examination and allocation of blocks of frequencies for specific periods and purposes.

6.12 To do this a weighting factor would be applied to each of several criteria. This would then be used to determine spectrum allocation priorities and as a means of determining pricing for use of the spectrum. The criteria suggested included among others, essentiality to the community, potential benefits to the community, potential for commercial returns and spectral efficiency (Submission No 27 p.8).

6.13 The Canadian proposal also requires the setting of priorities by making a distinction between essential and non-essential services. As with the WA approach, the aim is to ensure that those services considered to be essential are given guaranteed access to the spectrum.

6.14 There was little general support for adoption of either the WA Government or Canadian models of an administrative system for setting priorities for spectrum allocation and assignment. Submitters which supported such models were typically large public sector users (Submissions No 61, p.18, 43 p.16, 57 ann.B p.14 and 53 p.6). There was little comment on this approach from commercial/private sector users. AUSSAT identified significant disadvantages inherent in this approach (Submission No 60 att.4 p.25-26).

6.15 It is at the assignment level that the Committee has serious misgivings about the practicality of a priorities system (comparative in Canadian system). The Committee agrees with DOTAC's position `(t)here are approximately 1.3 million radiocommunications licences on issue, and demand for licences is increasing. Using comparative processes as a general tool to assign radiocommunications licences could only result in costs and delays which would be unacceptable both to government and to industry. Such a process would, by its nature, be inefficient' (Submission No 62 p.19).

6.16 Two approaches to frequency assignment are possible under a priorities-based administrative system. Individual frequency assignments could be implemented either through a licence grant type process involving comparative assessment of the relative merits of applicants or through some form of auction/tender process. It would be possible to implement both approaches under such a system.

6.17 Under the Western Australian Government model, however, such frequency assignment approaches would need to be implemented in tandem with a separate, highly complex and ongoing process at the spectrum allocation level. This would entail not only initial and `case-by-case' reservation of blocks of frequencies for particular uses over specified periods but also subsequent reviews at the end of such periods to establish whether such reservations remained appropriate. In all probability, it would be considerably more lengthy than is the case for spectrum allocation under the current system.

6.18 The comparative licence grant approach, in theory, could be implemented in a modified version of that presently provided for `limited licences' under the Broadcasting Act. Under such a version, the licence grant authority would judge the relative merits of a number of applications seeking access to a particular frequency (or group of frequencies) for the provision of the same type of service.

6.19 It is entirely unclear how such a frequency assignment process would work in the case of `green fields' or other parts of the spectrum subject to low demand for frequency assignments. This is but one of many practical obstacles to implementation of either the Western Australian Government or Canadian models.

6.20 In cases where demand exceeds supply, auctions (or tender) processes can be used to assign frequencies under any of the options considered in this chapter. The use of auctions in tandem with a comparative assessment process for new regional commercial radio licences was contemplated by government several years ago. Assignment of frequencies in the congested VHF-FM band to commercial radio services has already been implemented for AM/FM conversions in metropolitan markets. It is appropriate to consider the utility of auctions in the assignment process at this point.

6.21 Submitters raised a number of concerns regarding the use of auctions. The drawbacks with auctions are identified as possibly being a deterrent to competitive services, increasing the costs of a service to the consumer (due to the auction price being recovered from the users), that they could lessen the development of new services and that they may be used as a revenue gathering exercise (Submissions No 49 app.2 and 60 p.26). There was also a concern that using auctions is `equating the public interest with the ability to pay' (Submissions No 61 p.18, 49 app.1 p.7 and 53 p.6).

6.22 It appears to the Committee that a number of the drawbacks attributed to auctions are based on misconceptions regarding their potential role in the frequency assignment process.

6.23 Undue focus on the notion that auctions can be used as a government revenue gathering exercise tends to lose sight of the fact that, because they would be applied only in cases where demand exceeds supply, they can be utilised to achieve three specific spectrum management objectives. They are dynamic efficiency, allocation of uses to highest commercial values, and the establishment of an efficient and equitable system of charges for spectrum access that takes account of the value of both non-commercial and commercial uses of the resource.

6.24 Auctions meet two aspects of the dynamic efficiency objective. Firstly, they can be used in a timely fashion to select between aspiring commercial users wishing to provide competitive services in areas where demand exceeds supply. Secondly, they are highly cost efficient relative to an administrative system involving comparative assessments.

6.25 As evident from analysis in Chapter 5, if government wishes to raise revenue it can do so simply by imposing new or increasing existing charges. Auctions will only raise significant revenue if there is excess demand. If that demand were manipulated by the spectrum manager in order to maximise revenue then the efficient use of the spectrum would not be maximised thus defeating one of the main benefits in using auctions (Transcript p.442) .

6.26 In cases where there is an excess of demand over supply from those seeking commercial use of the spectrum, revenue from auctions would return to government what the Committee considers would be an appropriate share of economic rent accruing from such use. This outcome would meet the efficient and equitable system of charges objective.

6.27 DOTAC and Treasury made two important points pertinent to auctions for commercial applications (Transcript pp.440-443, 447 and 449). One was that successful bidders in such auctions will be those who can maximise both economically productive and technically efficient uses of the spectrum resource. The other was that auctions also provide an incentive for successful bidders to seek highest value uses.

6.28 The use of auctions as a frequency assignment mechanism does not equate the public interest with the ability to pay. There is nothing to prevent users who access the spectrum at no cost from charging whatever the market will bear. Auctions for commercial applications may result in successful bidders seeking to recoup economic rent paid to government by charging higher prices for their services. Provided that there is competition, those costs should be at the minimum possible to achieve a return on the investment made by the user.

6.29 Auctions would be applied only to commercial applications for parts of the spectrum where demand exceeds supply. This would promote dynamic and technical efficiency as well as allocation to highest value uses. It would also form part of an efficient and equitable charging system which captures economic rent for government.

Conclusions

6.30 The Committee does not support an administrative system for setting priorities for allocation and assignment. Such an approach would not meet the dynamic efficiency objective of being flexible and responsive to changes in demand, particularly if levels of congestion were to increase. Furthermore, a system of comparative assessment for assignment could impose very significant costs on spectrum management which would have to be borne by users on a cost recovery basis.

6.31 Auctions are a desirable way of assigning spectrum in situations where demand exceeds supply as they should ensure that the most efficient user gains access to the resource and economic rents are not foregone by government. The legitimate interests of non-commercial users would have to be taken into account if auctions are to be introduced into the spectrum management system.

FINE TUNING THE CURRENT ADMINISTRATIVE SYSTEM

Background

6.32 A number of changes to current procedures and practice were canvassed in submissions to the inquiry. These reforms mainly concern improving the ability of the spectrum manager to respond to changes in technology and demand with a view to reducing current congestion and the potential for future congestion.

6.33 They are intended to improve the level of utilisation of the spectrum and improve the spectrum managers ability to replan and reassign spectrum in order to meet the requirements of changing technology and demand. The reforms are intended to improve the current system without fundamentally changing the administrative nature of the approach.

Suggested Reforms to Current Spectrum Management Practices

(1) Monitoring spectrum utilisation

6.34 There was considerable support from submitters for increased monitoring of the level of spectrum utilisation. It was considered that an adequate level of spectrum monitoring could identify areas of potential congestion (Submission No 43 p.17) and achieve improved spectrum efficiency (Submissions No 60 att.4 p.27 and 59 p.8). The monitoring process should be undertaken in such a way as to provide an improved level of understanding of the detail of spectrum utilisation. In order to achieve this, monitoring should not be considered solely in the strict technical sense of monitoring the airwaves, but should take the form of an audit of actual use (Submissions No 40 p.2 and 41 p.3). This is considered necessary as whether a frequency or channel is being used constantly is not necessarily an indication of efficient usage. Spectrum assigned for many safety of life related services need not be used constantly, but the service has to be available.

6.35 DOTAC agreed that spectrum monitoring combined with analysis of records could help to identify underutilised spectrum but raises the valid point that there is currently no effective means of resuming that spectrum for alternate uses. DOTAC also raise the potential for high implementation costs if such an approach were adopted throughout Australia (Submission No 62 p.21). It would be necessary to target such a process at parts of the spectrum and geographic locations considered to be most at risk of underutilisation and/or congestion. This is but a practical recognition of the complex processes involved, not only in monitoring utilisation of any part of the spectrum, but also in deriving useful information on the efficiency of that utilisation.

6.36 Auditing the level of spectrum utilisation as a means of identifying inefficient use of spectrum both in terms of actual usage and use of spectrum efficient equipment would assist in identifying inefficient use of the spectrum. The main difficulty is that it will still be left to the spectrum manager to determine what is or is not efficient. This may result in there being little change from the status quo.

6.37 The potential benefit from improved monitoring is that it might provide the only practical means of assessing efficient use of spectrum by non-commercial users, particularly large public sector users.

(2) Publishing comprehensive and accurate information on all allocations and assignments

6.38 DOTAC currently provides information on allocations and assignments through the publication of the Australian Spectrum Plan and the Public Access Radiofrequency Register (PARR). Consideration is also being given to providing on-line access to frequency assignment records (Submission No 62 p.22).

6.39 The benefits of improved access to accurate and comprehensive information on allocations and assignments identified by submitters included enabling users to resolve many of their spectrum access requirements before approaching DOTAC, assistance in the resolution of interference problems and in planning for rearrangements or the introduction of new services.

6.40 The Committee strongly supports the development of an on-line database which provides comprehensive details of all assignments including technical details, type of service and identification of the user. The level of information which is not released for reasons of confidentiality should be kept to an absolute minimum.

(3) Improving the ability of the spectrum manager to recover and reassign spectrum

6.41 The report has already noted that there are substantial difficulties involved in replanning and reassigning spectrum (paragraph 4.56). This inhibits DOTAC's ability to respond to changes in demand and encourage more efficient spectrum management practices (Submissions No 59 p.8 and 57 ann.B p.15).

6.42 Users have proposed a number of reforms that might assist in speeding up this process. One approach suggested by a number of submitters is that applicants for frequencies should be required to submit a development plan covering timescales and levels of use and that if the plan is not adhered to then recovery action should be undertaken (Submissions No 40 p.2, 41 p.3, 44 p.2 and 50 p.C2).

6.43 While this process is desirable, it is difficult to see how it could be implemented given that any decision not to regrant a licence would be subject to appeal with consequent delays. It is also questionable as to whether the Department would have the expertise to properly evaluate development plans formulated on the basis of commercial judgements. On the other hand, this approach would have definite advantages with regard to FRC's which should not present the problems associated with incumbent rights as licences.

6.44 A further point raised was the need to take account of the capital costs incurred by users in the reassignment process (Submissions No 43 p.8, 46 p.6 and 53 p.3). Some users have stressed the need to allow appropriate periods of time in the requirement to move (Submissions No 57 ann.B p.15, 61 p.19, 49 app.2 p.2 and 54 p.6). This is currently the case and is one of the reasons for the delays involved in replanning. It is contradictory to suggest that replanning proceed more rapidly and at the same time qualify that with a requirement to consult extensively with all users with a view to agreeing on a timetable.

6.45 Linked to this question of the capital costs associated with replanning is the suggestion that compensation should be used as an incentive for incumbent users. This was raised by a number of submitters (Submissions No 2 p.1, 13 p.2, 59 p.9, 54 p.7 and 57 ann.B p.17).

6.46 It is clear that compensation is desirable and would undoubtedly be of considerable assistance in encouraging users to cooperate in replanning. However, there are a number of problems which pose considerable obstacles to effective implementation of this approach under a purely administrative system.

6.47 A workable system of compensation would achieve the dynamic efficiency objective in cases where it is imperative for spectrum managers to resume significant portions of spectrum to meet wider or specific communications policy objectives (such as the introduction of competitive digital cellular mobile telephone services). The difficulties inherent in determination and application of compensation mechanisms in the absence of some form of statutorily defined spectrum access right are considerable.

Common law problems could arise with respect to determination of damages for any loss of business by commercial users. Other problems would arise regarding determination of reasonable levels of compensation payable to commercial versus non-commercial and public versus private sector users. An arbitration process may be needed to resolve any disputes over equipment changeover costs.

6.48 Under a purely administrative system there is also the matter of determining how the compensation is to be funded. In cases of clearances to accommodate demand for commercial applications, the costs of relocating existing users could be recouped from the new users, possibly with DOTAC acting as a broker. This would be practicable in cases (such as the clearance of spectrum for competitive digital cellular mobile telephone services) where the new users are identifiable. In cases where new commercial users cannot be identified prior to implementation of the clearance process, means could be devised for initial funding by government and subsequent recovery from new users when they are identified. In cases of spectrum clearance for non-commercial uses, it would be possible to recover costs across all users: evident from discussion in Chapter 5, however, this would require important questions of equity and transparency to be addressed.

(4) Restricting or discontinuing the use of Frequency Reservation Certificates

6.49 The use of FRCs has been identified as a major cause of underutilisation of spectrum, the prime example being in the trunked land mobile band. There was almost unanimous support for abolishing or severely restricting the use of FRCs by submitters.

6.50 The Committee agrees with the argument that some applications may take several years to develop and implement. Accordingly, some assurance of spectrum availability is required. There is no reason why this could not take the form of a licence, with an appropriate development plan indicating the timescale anticipated for full utilisation.

6.51 Two purposes would be served, it would enable the possible use of that spectrum for other applications in the interim and it would ensure that revenue was not lost if demand was in excess of available frequencies.

(5) Private sector involvement in frequency coordination and other operational matters

6.52 The benefits associated with this proposal are that the spectrum manager would be better able to concentrate resources on longer term planning requirements and that the actual costs associated with frequency assignments are met by the individual user.

6.53 Concern expressed by submitters to this proposition appears to be related to a broader than intended interpretation of the suggestion in the Discussion Paper. The suggestion was that the engineering function of determining suitable frequencies for particular applications could be undertaken by the private sector. There was no compelling evidence as to why this should not pursued if the on-line data base referred to earlier was developed and made available to users. There would be a requirement for private sector engineers to be accredited by the spectrum manager, but there is no reason to believe that they could not carry out this task efficiently.

6.54 The potential benefits are significant. Frequency coordination by private sector engineers would assist in ensuring that specific users meet the costs associated with the assignment process and would allow users to take control of the time taken in determining suitable frequencies. Users' requirements would not be subject to wider Departmental work priorities. The Department would also be able to devote more resources to broader planning considerations.

6.55 Private sector involvement in frequency coordination should be facilitated as it offers potential benefits in terms of reducing delays and ensuring that cost recovery is more equitable.

(6) Creation of an independent spectrum management authority

6.56 The proposal that an independent spectrum management authority be created was also raised in the Discussion Paper. It was suggested that the creation of an independent authority would bring a number of benefits such as allowing resources to be allocated more efficiently and encourage the development of a more stable professional staff. The implication was that these things were not possible under a budget driven departmental structure (Submissions No 7 pp.3-4, 14 p.10 and Transcript p.221).

6.57 Other potential benefits include the management expertise that could be gained through a board with experience in commercial, technical and policy fields (Submission No 26 p.18). In addition, if the organisation were self funding there would be a positive incentive to ensure that

spectrum utilisation was maximised (Transcript pp.178,190 and 191). In short, there would be an incentive to be responsive and innovative, something that does not exist under current arrangements.

6.58 There was general support for this proposition by submitters (Submissions No 40 p.3, 41 p.4, 43 p.18, 44 p.3 and 54 p.7). There were some concerns expressed by Defence regarding the potential costs associated with statutory authorities and by Telecom concerning the need to maintain strong links at the policy level between telecommunications, spectrum management and broadcasting.

6.59 It is also worth noting that spectrum planning and operations have now been consolidated into a single radiocommunications division within DOTAC, which should enable a more efficient operation. There are potential benefits associated with an independent authority but it is also important that the Minister continue to be directly responsible for spectrum management.

6.60 The creation of an independent statutory authority may lead to an increase in overall management costs and reduce Ministerial control and responsibility. This would add costs to users and may cause difficulties in maintaining the policy links between the wider aspects of communications policy. There would, however be merit in the creation of an organisational framework which maximises autonomy in terms of operations, resource allocation and budget, yet is still directly responsible to the Minister. This might take the form of an office of spectrum management within DOTAC.

(7) Consultation with users on future demand for spectrum resources

6.61 AEEMA and FACTS suggested that there would be merit in the establishment of a consumer advisory council to provide independent advice to the Minister on Departmental decisions and policies (Submissions No 37 p.2 and 34 p.10). The body would have to be representative of all users, commercial and non-commercial.

6.62 The formation of such a peak consultative body was again supported by many submitters, however the view was put by some that it is essential that the role of such a body be clearly defined and concentrate on spectrum use policy rather than get involved in arbitration on specific issues.

6.63 The Department already undertakes a plethora of consultations on every conceivable area of concern in spectrum management. It does appear that there may be some benefit in establishing an overall consultative body as developments in technology blur the old boundaries between services.

6.64 Current consultative processes should be reviewed and assessed for their impact on dynamic efficiency.

Conclusions

6.65 The combined effect of the suggested reforms to the current system of spectrum management would make a contribution to improving the responsiveness of spectrum management to technological change and increasing demand.

6.66 There would however continue to be some essential weaknesses. The ability of the spectrum manager to force the pace of change with respect to replanning and reassignment would still be limited because of the problems associated with compensating users for the costs associated with replanning.

6.67 This is a legitimate concern on the part of users and if a satisfactory system of compensation cannot be formulated, then the only course of action is to continue with current arrangements. Compensation would not be a satisfactory course of action in an administrative system unless a means can be found to put a value on individual assignments.

6.68 Technical efficiency is addressed to a limited extent by the proposals for monitoring spectrum utilisation, but it relies on DOTAC establishing criteria for resuming underutilised spectrum. There is no incentive for users to utilise spectrum in the most efficient manner possible, except the fear of losing an assignment. Furthermore, resumption is likely to be a long and drawn out process which may in fact make spectrum management even less responsive. One approach would be to remove all avenues of appeal, a situation with which few would be happy.

6.69 While the Committee believes that the proposed reforms would improve spectrum management in terms of responsiveness and technical efficiency, the improvements are only incremental. There is no indication that there would be the substantial improvement required if demand continues to escalate and congestion becomes a growing problem.

6.70 The suggested reforms would help to alleviate some of the problems associated with the current system of spectrum management. They would not solve the fundamental problem of the current system's inability to accommodate changing technology and demand and to support wider communications policy objectives with the necessary degree of dynamic efficiency. Moreover, it is highly unlikely that those reforms will enable the spectrum manager to drive significant improvements in technical efficiency. Nor do the reforms address the need to ensure spectrum is allocated to the highest value uses in situations where demand exceeds supply.

6.71 The Committee recommends that:

1. The Department of Transport and Communications develop a system of auditing spectrum utilisation based on monitoring of frequency bands and analysis of licence data in geographical areas which are experiencing congestion in parts of the radio frequency spectrum;

2. The Department of Transport and Communications develop a publicly accessible on-line database which provides comprehensive details of all assignments including technical details, type of service and identification of the user;

3. The use of Frequency Reservation Certificates be discontinued, users wishing to reserve spectrum should be issued with a licence after submitting a plan which outlines the timescale for full utilisation;

4. Private sector spectrum engineers be accredited to provide frequency coordination services to users seeking assignments; and

5. The Department of Transport and Communications review current consultative process and assess their impact on dynamic efficiency.

A MARKET BASED SYSTEM

The Features of a Market System

6.72 The BTCE advocated the development and implementation of a market based system of spectrum management. The framework recommended by the BTCE is based on the premise that decision makers in an administrative system are in an inferior position when compared to spectrum users in obtaining and using information to judge the opportunities offered by developments in technology and innovations in services. Furthermore, there is no incentive for the regulatory authority to seek out and act upon economic information as their position is not directly affected by the decisions it takes. Other key features of the system proposed by the BTCE are addressed below.

6.73 The fundamental point is that the resources put into radiocommunications services are distorted under an administrative approach and do not promote economic efficiency. There are a number of concerns raised by submitters that will be examined in this consideration of a market system.

6.74 The basis of a market approach is that spectrum resources become tradeable. The BTCE suggests that this be done through the creation of a Spectrum Access Right (SAR). This right would have to be defined in terms of space, time and frequency and the holders of those rights would be entitled to have them protected legally. The right would be defined to allow the user more flexibility to determine the appropriate use, quality of service and other technical requirements as they see fit. This would be done within parameters which would only specify general use and any necessary technical requirements and would be determined by the spectrum manager.

6.75 The creation of access rights would enable spectrum to be traded, combined, divided, leased or otherwise negotiated by any entity wishing to control the access rights.

6.76 The introduction of a market based system would require converting existing assignments to a tradeable right and unused spectrum would be offered to users through an auction or tender.

6.77 If there were more bidders than access rights (demand exceeded supply) an auction process would have the positive outcome of ensuring that any economic rent was recouped by the government and that the user who can utilise the spectrum most productively in providing a service would gain access. As previously discussed (para 6.29), auctions or tenders would be used only to assign spectrum in cases where supply exceeds demand and would ensure two positive outcomes. A share of economic rent for commercial exploitation of the spectrum would be returned to government. Users able to maximise both economically productive and technically efficient uses would gain access. Auctions or tenders would achieve the objectives of dynamic and technical efficiency, allocation to highest value uses, and an efficient and equitable system of charges for spectrum access. Under this approach, they would not be used as an exercise in government revenue raising.

6.78 If demand did not exceed supply, as is the case in much of the spectrum at present, then the right would be sold over the counter at a price equal to the administrative cost associated with the issue. Users acquiring access rights in this manner would also have to pay an annual charge to enable recovery of spectrum management costs (para 6.84). Annual charges would similarly be levied on users acquiring access rights either through conversion of existing assignments for incumbent users or through an auction or tender process.

6.79 With regard to non-commercial users, the BTCE suggests that economic arguments support an approach whereby non-commercial users of the spectrum are treated in the same way as commercial users. They retain what they have, sell what they do not need and from there on would

compete for what they want. The BTCE acknowledged the continuing need for government to ensure access for non-commercial users and proposed the use of subsidies for users providing public and merit goods. Direct subsidies are considered more efficient than cross subsidy by other users as direct subsidies are generally more visible and are less likely to distort investment in spectrum (Submission No 48 p.2).

6.80 The BTCE also considered that it would be possible to afford special treatment for non-commercial uses considered to be of prime importance to the community by zoning the spectrum for some specific uses. These might include international services, safety of life, broadcasting or services requiring a high degree of protection from interference such as radiolocation and radioastronomy (Submission No 48 p.2). The Department considered that existing band planning practices could be modified to achieve this (Submission No 62 p.17).

6.81 The BTCE proposals for charges are based on efficient pricing techniques. Its major features are auctions where rationing is required due to demand exceeding supply, over-the counter sales where there is a lack of demand and annual charges to recover the costs associated with managing the spectrum by the regulatory agency.

6.82 As was discussed earlier auctions (or tenders) offer the attraction of not only being an efficient rationing mechanism, but they recoup any economic rent. This is not possible under an administrative system as there is no way of effectively assessing the value of the spectrum and relating that value to the income derived from the use of the spectrum.

6.83 Turnover taxes are considered to be an alternative means of assessing economic rent for commercial uses under an administrative system. This is not as simple as it sounds. The NTIA noted in its recent report that a gross revenue fee -

> `would not have universal application to all spectrum users ... because it presumably would only apply to those users with revenue directly attributable to spectrum use, such as broadcasters and cellular telephone providers, and not to other commercial users who reap indirect financial benefits through spectrum use'(NTIA Special Publication 91-23 U.S. Spectrum Management Policy: An Agenda for the Future p.125).

6.84 It should be borne in mind that annual charges to recover spectrum management costs would be levied on all access rights holders under the BTCE proposals. This would be necessary as the spectrum manager would still be responsible for international planning, resolution of interference disputes, providing technical advice, definition of the access right (including terms and conditions of spectrum use) and maintenance of a register of all access rights. Cost recovery components associated with initial acquisition of access rights by individual users would be recouped at that time by means appropriate to the category concerned. Under related BTCE proposals for a market-based system, additional annual charges for all categories of access rights would be formulated to recover costs for spectrum management activities directly attributable to individual users plus those incurred on behalf of users in general (BTCE Report pp.xix and 87-89).

Advantages of a Market Based System

6.85 There are a number of advantages of a market based system. One of the major benefits is the ability to ration spectrum in situations where supply exceeds demand. The resource will be rationed to those users who place the highest value on the resource as an input to providing goods. In this way a value will be established for the resource and the ability to trade will result in allocation to users who are able to maximise the productive value of the resource. Value in this sense relates primarily to commercial use of the spectrum.

6.86 Tradeability will also provide greater flexibility and responsiveness to changes in technology and demand. One of the major constraints in band planning in the current administrative system is the inability of the spectrum manager to compensate users for planned changes in spectrum use. A system of tradeable spectrum will provide such a compensation mechanism.

6.87 Furthermore, as a value will have been established for the spectrum, users will seek to maximise their return from the investment and this will promote efficient spectrum usage.

6.88 There is also potential for increasing the amount of useable spectrum by leaving it to users to determine the appropriate trade-off between the number of services and the quality of signals.

6.89 It is also worth noting that in the event that spectrum had to be resumed by the spectrum manager for some purpose that the market did not allow for, such as a new international allocation for a safety of life service or for security purposes, the market system would allow a fair value to be assessed for compensation to the existing user. Compensation is not able to be adequately dealt with under an administrative system (para 6.67).

6.90 There are also benefits associated with a market system for non-commercial users. The level of subsidy would equate with the foregone revenue from selling to a commercial user. This enables quantification of the level of subsidy which is not possible at present.

6.91 Under the current system, the actual costs associated with reduced or exempt fees are effectively cross subsidised by those licensees who pay fees. There is also no satisfactory way of assessing the opportunity costs of providing spectrum to non-commercial users. While it is argued that government may be reluctant to maintain funding for non-commercial users it can also be legitimately argued that government should know the level of subsidy and make decisions on what the appropriate level should be.

6.92 Under the BTCE proposals, incumbent users would be granted an access right at no cost other than the administrative cost of granting the right. The initial impact would be minimal and it would only be for future requirements that concerns over adequate access might arise. The BTCE specially addressed the issue of the potential for `windfall gains' accruing to users from the conversion of existing assignments for incumbent users (BTCE Paper p.84). The Committee pursued BTCE and alternative suggestions for ensuring that government would recoup a share of the

economic rent accruing to access right holders from such windfall gains. Responses to questions from the Committee to DOTAC and Treasury officials (Transcript pp.448 and 455-457) together with subsequent advice from Treasury (Submission No 74) demonstrate that appropriate arrangements could be made in this regard under a market based system, although it would still be necessary to ensure that the capital gains tax was applicable in this case.

6.93 The benefit of having the spectrum resources of non-commercial users converted to a tradeable resource is that they would have an incentive to utilise their spectrum resources efficiently. It may for example be possible to sell or lease extra capacity and use the income to upgrade equipment (Transcript pp. 432-34). This may yield significant gains in terms of technical efficiency.

Problems Associated with a Market System

Interference

6.94 The potential for interference problems is the principal concern among the majority of submitters with regard to a market system. The Department of Defence stressed that interference is very difficult to calculate with any accuracy as radio wave propagation characteristics are dependent on many factors that often behave in variable and unpredictable ways (Submission No 57 ann.A p.3). The concern is how interference

disputes are to be resolved under such a system and that they would inevitably lead to long and costly legal problems for users. One submitter is of the view that current technical based administrative arrangements could be adapted to a market system (Submission No 45 p.14).

6.95 DOTAC offers the view that settlement of interference disputes would more than likely occur through negotiation and that this could be encouraged by making the parameters of the access right flexible (Submission No 62 p.13). The BTCE noted in its submission that acceptable interference levels would have to be determined by the regulatory agency and that the regulatory agency would have an arbitration role if disputes could not be resolved by the users (Submission No 48 p.6). This view is also supported by DOTAC (Submission No 62 p 12).

6.96 The Committee agrees that interference is a complex problem and the case of 7HO in Hobart is a good example of how interference can occur where nobody is really at fault (Transcript p.245). The concerns that submitters have regarding the lack of clarity on interference dispute resolution are genuine. There would need to be careful definition of access rights to ensure legal protection and the development of a suitable system for arbitrating interference disputes. It may be that Part IX of the *Radiocommunications Act 1983* would provide a suitable conciliation model for a market based system.

6.97 These are issues that would have to be resolved in the course of developing an implementation program, a point acknowledged by DOTAC -

> `further consideration would have to be given to the obligations and duties of rightholders, and the role government might take in the arbitration of disputes and the control of interference, before a market system could be implemented' (Submission No 62 p.14).

Access for Non-Commercial Users

6.98 Continued access to the spectrum for non-commercial users is also a major concern among submitters. The CLC sums up a view expressed in a number of submissions -

> `The reality is that governments are likely to be extremely reluctant to increase on-budget spending in the foreseeable future, even though some of those funds would be returned by way of revenue. The practical result of the BTCE's recommendation is that non-commercial services would be unlikely to receive adequate funding to allow access to the spectrum' (Submission No 36 p.11).

This view was strongly supported in responses to the Discussion Paper.

6.99 It is not only a problem of ensuring that the commitment to provide subsidies is ongoing, but it would also be necessary to set criteria to determine which non-commercial or social users of the spectrum are eligible for subsidy. There are a core of such users who are easily identified, for example safety of life services, amateurs and radioastronomy. The situation with regard to some other users is less clear. DOTAC offers a definition that could be applied to determine eligibility of non-commercial users and, on the face of it, this should not be a difficult procedure to develop (Submission No 62 p.15).

6.100 While the proposals for ensuring continued access to the spectrum for non-commercial users are all very well in theory, there are many unknowns regarding the outcomes of such an approach. It would be foolhardy to impose a market system upon non-commercial users without being very certain of the outcome. The value of many of these services is such that they should not be jeopardised.

Long Term Planning

6.101 It has been suggested that a market system would in fact reduce flexibility in that it may not be possible take advantage of long term spectrum opportunities or meet long term international obligations if the spectrum has been sold off (Submission No 14 p.5). It was even put to the Committee that congestion may increase and technological change be inhibited (Submission No 26 pp.14,15). Defence offered a similar view and

was concerned that after access rights had been sold the ability of the spectrum manager to effect change would require the cooperation of what might be a large number of owners of spectrum rights (Submission No 57 ann.B p.10).

6.102 With regard to technological change and other long term opportunities, a market system offers incentives for users to adopt new technologies and to buy and sell spectrum capacity to take advantage of long term opportunities (Submission No 48 p.4).

6.103 The spectrum manager would also have the right to resume spectrum (with compensation) if there was an overriding need to do so. This combined with the broad planning that would still be undertaken should cope with any problems that cannot be sorted out through the market.

Market Dominance

6.104 In its response to the Discussion Paper AUSSAT was concerned that major participants in the market may use their power to engage in anti-competitive practices (Submission No 60 p.2). This view was also supported by a number of other submitters (Submissions No 5 p.4, 54 p.5 and 41 p.2).

6.105 Anti-competitive practices and market dominance are potential problems associated with any market based activity. The BTCE proposed that Trade Practices legislation could deal with this problem or that it might be necessary to limit the amount of spectrum acquired by a single user (BTCE Paper p.84).

6.106 Section 46 of the Trade Practices Act is designed to deal with misuse of market power. Considerations taken into account by the TPC include situations where the conduct of a corporation adversely affects the competitive process, adversely affects consumers or users of services, raises the costs of entry to a market or prevents or hinders potential competitors from entering the market.

6.107 One further means of countering such problems over the longer term is to limit the life of an access right. If they were issued for fixed terms of say 10 years (dependent on the nature of the anticipated uses), an opportunity would be provided to redistribute spectrum on a regular basis to ensure that competition is maintained. This would allow planning to be undertaken over the long term. It would also address many concerns regarding provision for non-commercial users, the need to provide appropriate spectrum for international requirements and potential problems for users who are restricted in terms of equipment that only operates in specific areas of the spectrum.

Conclusions

6.108 Tradeability of spectrum offers significant advantages in relation to the objectives of dynamic efficiency and technical efficiency over the current administrative approach. The establishment of a market would enable users to acquire spectrum or relocate to new spectrum in response to their changing needs. It would encourage users to optimise their use of spectrum in order to maximise the returns on their investment. It also provides an effective solution to the problem of compensation for users who move to new spectrum or to other means of service delivery.

6.109 In terms of technical efficiency it would provide non-commercial users with some incentive to seek to use their spectrum more efficiently as they would be able to sell or lease out excess requirements and use the funds to finance improvements in equipment.

6.110 A market system would also provide a means of recouping any economic rents from users in such a way that it does not distort investment decisions. The additional charges would be related to cost recovery from individual users for costs generated directly by them and a charge levied on the value of the spectrum to cover the broader costs of spectrum management not associated with any individual user. Such a system of charges would be economically efficient and equitable.

6.111 A market system would also facilitate allocation to the highest value uses for commercial applications.

6.112 The concerns the Committee has have already been covered. There are a number of matters that would need to be resolved before a market based management system was introduced. The potential difficulties with interference would have to be considered in detail as wide spread interference problems and unresolved disputes would degrade the spectrum and the potential losses could be considerable.

6.113 The Committee is also concerned at how non-commercial users might fare under a market system. There is a need to ensure that these users operate efficiently in terms of spectrum utilisation as there is no incentive for them to do so at present. However, many of the services provided by such users are essential to the well being of the community as a whole and it would be foolish to risk any degradation of those services.

6.114 The Committee concludes that a comprehensive market based system covering all spectrum users and uses should not be introduced at this point in time as there are some significant uncertainties, particularly with regard to ensuring continued access for public sector and non-profit organisations.

A MIXED/MARKET ADMINISTRATIVE SYSTEM

6.115 The Committee considers that benefits of a market based system (para 6.85-6.93) should not be ignored. The Committee also believes that the potential problems associated with the implementation of such a system (para 6.94-6.107) militate against its introduction in the immediate future.

6.116 The report has already highlighted the deficiencies of the current system and noted that the reforms suggested under the fine tuning proposal are not the complete answer (para 6.70).

6.117 It has already been stated that any examination of spectrum management practices has to look forward and the Committee is concerned that if demand continues to grow, even a reformed administrative system may not be able to cope. It is essential that Australia be in a position to maximise the potential benefits that developments in communications may offer in terms of economic growth and increased productivity.

6.118 In order to ensure that Australia is positioned to take maximum advantage of this potential, it is desirable to address the problems associated with the market based approach to spectrum management and develop an implementation strategy.

6.119 The Committee approach to a mixed market/administrative system would generally restrict the tradeability of spectrum access to commercial applications. This approach recognises that it is essential to protect non-commercial users from premature exposure to a market based system until means have been devised to resolve current uncertainties, and hence potentially undesirable outcomes, associated with its implementation. The Committee's approach also recognises that there may be limited circumstances in which non-commercial users might benefit by shared use of assigned frequencies with, and/or disposal of rights to access underutilised spectrum, to commercial users.

6.120 In light of the uncertainties and potential problems associated with implementation of a market based system at this time, the Committee believes that it would be many years, if ever, before such an approach could be applied to all users and therefore the reforms to the current system recommended earlier should be undertaken in parallel with the development of a market system.

6.121 The Committee recommends:

1. The Department of Transport and Communications develop an implementation strategy for a Mixed Market/Administrative System;

2. This proposal be developed in parallel with the recommendations made earlier for reforms to the current administrative system;

3. The development of a Mixed Market/Administrative System should take account of the following:

    a) tradeability of spectrum resources be introduced for commercial uses of the spectrum;

    b) the introduction of this approach should be gradual and should be initially introduced only in areas of the spectrum that are unencumbered or where there is high commercial demand;

c) in the interim, non-commercial users should have the option of remaining under the current administrative system or having their licences converted to a tradeable resource;

d) a system of regular auditing of spectrum used by public sector users be introduced;

e) tradeable spectrum access should not be perpetual, but should provide tenure for a fixed term; and

f) the Department of Transport and Communications determine whether the capital gains tax would be applicable in the case of windfall gains accruing to incumbent users who convert existing licences to tradeable rights.

Peter Morris MHR
Chairman

14 October 1991

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APPENDIX 1

CONDUCT OF THE INQUIRY, EVIDENCE AND WITNESSES

The Inquiry

1. The House of Representatives Standing Committee on Transport, Communications and Infrastructure was appointed under Sessional Order 28B on 8 May 1990. The Committee is empowered to inquiry into and report on any matter referred to it by either the House or a Minister.

2. On 27 June 1990 the Chairman wrote to the Minister for Transport and Communications, the Hon Kim C Beazley MP seeking a reference on the Management of the Radio Frequency Spectrum. The reference was received from the Minister on the 23 July 1990.

3. The Committee appointed a subcommittee comprising the Hon P F Morris (Chairman), Mr A G Cadman and Mr R Gorman on 12 September 1990 to inquire and report on the reference.

4. The reference was advertised in the metropolitan daily newspapers on 28 July 1990. The advertisement asked for initial submissions to be lodged by 14 September 1990.

5. The subcommittee released a Discussion Paper on 4 June 1991. The Discussion Paper contained questions to which submitters were asked to respond and after considering these responses a Preliminary Conclusions document was released in August 1991.

6. The subcommittee took evidence at 6 public hearings and inspected the Department of Transport and Communications' Laboratory at Beleconnen.

Evidence

7. The evidence consists mostly of written submissions made to the Committee, oral evidence taken by the subcommittee at public hearings and documents received in the course of the inquiry.

8. Over 70 written submissions were received. The written submissions which have been authorised for publication will be bound and copies will be sent to the National Library and the Parliamentary Library. A set will be retained in the committee secretariat.

9. The submissions authorised for publication are as follows:

SUBMISSION NUMBER	ORGANISATION/PERSON
1	Australian Telecommunications Authority (AUSTEL)
2	Queensland Railways
3	Queensland Police Dept Radio & Electronics Section

4	Australia Telescope National Facility
5, 40	Motorola Communications Pty Ltd
6, 59	Australian Telecommunications Corporation
7, 37, 41	Australian Electrical Electronic Manufacturers' Association Limited
8	Water Board Sydney-Illawarra- Blue Mountains
9	Queensland State Emergency Service
10, 47, 69	Federation of Australian Radio Broadcasters
11, 34, 42, 70	Federation of Australian Commercial Television Stations
12, 51	Wireless Institute of Australia

13	Centre for Information Technology and Communications
14, 44	Spectrum Engineering Australia Pty Ltd
15, 45	Mr G V Northover New South Wales
16, 53	Electricity Supply Association of Australia
17, 50	Australian Telecommunications Users Group
18	Electricity Commission of NSW
19	Ministry of Education WA
20	Jazz Broadcasters Inc
21	Australian National
22	Television Australia Satellite Systems
23	Multicultural and Ethnic Affairs Commission of WA

24, 52	Australian Federal Police
25, 61, 71	Australian Broadcasting Corporation
26	BellSouth Australia Pty Ltd
27, 49, 73	Government of Western Australia
28, 63	Public Broadcasting Association of Australia
29	NSW Police Service Information Technology Branch
30, 62, 72, 75	Department of Transport and Communications
31, 66	Australian Water Resource Council Water Technology Committee
32, 57, 58	Department of Defence
33	Hoyts Media Ltd
35, 65	Government of Victoria

36, 46, 68	Communications Law Centre
38, 43	Civil Aviation Authority Australia
39, 60, 67	AUSSAT Pty Ltd
48	Bureau of Transport and Communications Economics
54	State Electricity Commission of Victoria
55	Queensland Electricity Commission
56	The South East Queensland Electricity Board
63	Bureau of Meteorology
75	Department of the Treasury

10. Oral evidence was taken at 6 public hearings in Canberra and Sydney as follows:

Canberra	-	19 September 1990, 18 October 1990, 14 November 1990, 16 May 1991 and 5 September 1991
Sydney	-	3 December 1990

11. Copies of the proof transcripts of proceedings were sent to witnesses. The corrected proofs will be bound and sets sent to the National Library and the Parliamentary Library. One set will be retained in the committee secretariat.

Witnesses

12. The following witnesses appeared before the subcommittee and were examined:

ORGANISATION/WITNESSES	DATE(S) OF APPEARANCE
Department of Transport and Communications	
Mr Michael Hutchinson Deputy Secretary Communications	5 September 1991

Mr Roger Smith	19 September 1990
First Assistant Secretary	18 October 1990
Communications Policy and Planning Division	5 September 1991
Mr David Hartley	19 September 1990
Acting Branch Head	18 October 1990
Transmission Policy and Spectrum Planning Branch	
Communications Policy and Planning Division	
Mr Geoffrey Hutchins	19 September 1990
Acting Director	18 October 1990
Spectrum Planning Section	
Communications Policy and Planning Division	
Mr Denis McNeill	19 September 1990
Acting Director	18 October 1990
Transmission Policy and Spectrum Planning Branch	
Communications Policy and Planning Division	
Mr Colin Oliver	18 October 1990
Director	
International Section	
Transmission Policy and Spectrum Planning Branch	

Ms Gwenyth Andrews — 5 September 1991
Director
Spectrum Pricing and Management
Review
Radio Communications Division

Mr Paul Palmer — 5 September 1991
Research Leader
Bureau of Transport and Communications
Economics

Australian Electrical and Electronic Manufacturers Association

Mr Bernard O'Shannassy — 14 November 1990
Chairman
Radio Communications Product Division

Mr Richard Brett — 14 November 1990
Chief Executive
Radio Communications Product Division

Mr Peter Hilly — 14 November 1990
Consultant
Radio Communications Product Division

BellSouth Australia Pty Ltd

Mr Mervyn Ramsay Director of Corporate Development	14 November 1990

ATN Channel 7

Mr Roger Barrett Engineering Director	3 December 1990

Federation of Australian Commercial Television Stations

Mr Richard Barton Deputy General Manager	3 December 1990

Federation of Australian Radio Broadcasters

Mr Nigel Milan President	3 December 1990
Mr Martin Hartcher Federal Director	3 December 1990
Mr Neil McCrae Consulting Engineer	3 December 1990

Public Broadcasting Association of Australia

Ms Grada Hulshoff Executive Director	3 December 1990

Australian Broadcasting Corporation

Mr Gerald Moriarty Assistant Managing Director Resources	3 December 1990
Mr Barry Matson Manager Telecommunications Policy	3 December 1990

Hutchison Telecommunications (Australia) Ltd

Mr William McDonald National Technical Manager	3 December 1990

CSIRO

Dr John Whiteoak Deputy Director Australia Telescope National Facility	3 December 1990

Dr Brian Robinson Chief Research Scientist Division of Radiophysics	3 December 1990

Department of Defence

Commodore Alan Brecht Director-General Command Control and Communications	16 May 1991
Mr Michael Brown Director Communications Engineering	16 May 1991
Mr George Wardle Director Communications Engineering	16 May 1991
Lieutenant William Franklin Frequency Manager Spectrum Management Section	16 May 1991

Civil Aviation Authority

Mr Donald Knox Manager Engineering and Technical Services	16 May 1991

Mr Glen McDougall Manager Budget Planning	16 May 1991
Mr Wesley Willoughby Acting General Manager Technical Services Division	16 May 1991
Mr David Tarbet Principal Engineer Communications Engineering Section	5 September 1991

Department of the Treasury

Mr David Imber Director Communications and Public Enterprise Policy Section Structural Policy Division	5 September 1991
Mr Terrance Lowndes Assistant Secretary Business Taxation Branch	5 September 1991

Mr Roger Brake

Administrative Services Officer

Communications and Public Enterprise

Policy Section

Structural Policy Division

5 September 1991

APPENDIX 2

RADIO FREQUENCY BANDS: GENERAL CHARACTERISTICS, MAJOR USES AND SPECIAL FEATURES

Table Prepared by SIARS Pty Ltd/CEMDIA Pty Ltd

RADIO FREQUENCY BANDS: GENERAL CHARACTERISTICS, MAJOR USES AND SPECIAL FEATURES

BAND	FREQUENCY RANGE	MAJOR USES	SPECIAL FEATURES
VLF	3 to 30 kHz	Omega (radio navigation)	Requires huge, high power transmitters. Signals travel as ground waves - follow earth surface. Will penetrate sea water half way round the earth. Used for one way transmission to submarines.
LF	30 to 300 kHz	Decca (radio navigation) Air traffic beacons Ship communications	High and low power transmitter operation. Signals travel as ground waves - follow earth surface. Suitable for long distance communications.
MF	300 to 3000 kHz	Radio navigation AM broadcasting Maritime mobile	Generally medium and high power transmitters. Suitable for medium distance communications. Can clear low mountains. Signal propagation affected by soil conductivity. Sky-wave bounce under certain atmospheric condition. Special domestic and international coordination requirements.
HF	3 to 30 MHz	Short wave broadcasters International broadcasting Aircraft & ship communications Amateur Radio Citizen's Band Radio	High, medium and low power transmitters. Signals travel as sky waves reflected by the ionosphere. Unique in interaction with the ionosphere. Long range global signals with many and variable effects. Transmission effectiveness especially affected by solar flare and associated sunspot activity. Most suitable for long range narrowband communications.

VHF	30 to 300 MHz	Land mobile communications FM radio broadcasting Television Disaster communications Telemetry Radio pagers	High demand band suitable for many different uses. Mainly high and medium power transmitters. Signals travel as space waves. Quasi-optical transmission path. Very suitable for a variety of land mobile applications as signals can be received on quite small and FM receivers.
UHF	300 to 3000 MHz	Aircraft & weather radar Car telephones Meteorological radios Personal radio communications Space research Telephone relay stations Television broadcasting	Signals travel as space waves. Optical transmission path. Essentially line of sight. Good technical quality for medium coverage applications. Another high demand band suitable for many uses.
SHF	3 to 30 GHz	Terrestrial and high capacity microwave service Relay and bearer applications for business and public telecommunications Radar and radioastronomy Satellite broadcasting Satellite communications	Terrestrial and high capacity microwave services. Signals travel as space waves closely resembling light. Weakened by rain and fog in higher frequencies. Restricted utility for point to point communications on earth's surface because not refracted by atmosphere.
EHF	30 to 300 GHz	Satellite communications Simplified land communications Radioastronomy and radar	Some atmospheric absorption. Otherwise generally as above.

APPENDIX 3

COMMUNICATIONS SERVICE GROWTH AREAS LIKELY TO IMPACT ON FUTURE DEMAND FOR SPECTRUM ACCESS OVER THE NEXT 10-15 YEARS

COMMUNICATIONS SERVICE	TERRESTRIAL DELIVERY	SATELLITE DELIVERY
VHF BANDS (30-300 MHz)		
Private Mobile	Yes	No
Conventional TV Broadcasting	Yes	No
FM Radio Broadcasting	Yes	No
Digital Radio Broadcasting	Yes	No
Point-to-Multipoint Audio and Data	Yes	No
LOWER & MIDDLE UHF BANDS (300-960 MHz)		
Private Mobile	Yes	No
Public Cellular	Yes	No
Public Telepoint	Yes	No
Conventional TV Broadcasting	Yes	No
Advanced TV Broadcasting	Yes	No
Digital Audio Broadcasting	Yes	Yes
Global Cellular	Yes	Yes
Global Paging & Data	Yes	Yes

COMMUNICATIONS SERVICES	TERRESTRIAL DELIVERY	SATELLITE DELIVERY
UPPER UHF & LOW MICROWAVE BANDS (960-3000 MHz)		
Advanced Cellular (PCN)	Yes	No
Digital Radio Broadcasting	No	Yes
Point-to Multipoint Audio, Video & Data	Yes	No
Global Cellular	No	Yes
Global Paging & Data	No	Yes
Electronic News Gathering	Yes	No
Fixed Links	Yes	No
KU BAND (10-14 GHz)		
Conventional TV Broadcasting	No	Yes
Multichannel Audio Broadcasting	No	Yes
Wideband Data Broadcasting	No	Yes
Advanced TV Broadcasting	No	Yes
Ka BAND (20-26 GHz)		
Advanced TV Broadcasting	No	Yes
Multichannel Audio Broadcasting	No	Yes
Wideband Data Broadcasting	No	Yes