



10 DOWNING STREET

File AH  
ccs 'E'  
rco

From the Principal Private Secretary

6 May 1982

RESTRICTED

Dear John,

The Prime Minister has seen a copy of the Home Secretary's letter of 26 April 1982 to the Secretary of State for Industry proposing a review of the radio frequency spectrum between 30 and 960 MHz.

Subject to the views of other members of E Committee, she is content that Mr Whitelaw should proceed as he proposes. She assumes that he will consult her in due course about the appointment of the chairman of the review.

I am sending copies of this letter to the Private Secretaries to the other members of E Committee and to David Wright (Cabinet Office).

Yours sincerely,

Anne Whitelaw.

John Halliday Esq.,  
Home Office.

AH



26 April 1982

Dear Patrick

In my letter to you of 17th April concerning the regulation of radio frequencies (copied only to Robert Armstrong) I expressed the hope that very early agreement could be reached on the establishment of a comprehensive review of the frequency range 30-960 MHz. I am glad to learn that this agreement has been substantially achieved at official level and the way is now clear therefore to seek your formal agreement and the approval of other colleagues concerned to what we have in mind.

The background as briefly stated as possible is this. I have now received from my Mobile Radio Committee, on which users of mobile radio are represented, a report which assesses the current and future frequency requirements of the land mobile services. These cover the public sector and commercial and industrial services which make use of radiocommunications, and certain other major areas of demand including radiophones, cordless telephones, and specialised mobile services ancillary to broadcasting. In parallel with the Committee's study, work has been going on in the Cabinet Committee machinery which deals with frequency matters in order to determine to what extent all the requirements for spectrum in this range are likely to be met within the framework set by the World Administrative Radio Conference (W.A.R.C.) 1979.

This work is now complete and the picture that has emerged is gloomy. There is not enough spectrum available for this aggregation of civil land mobile services, and the position is worsening. Demand seems likely to grow at a significant rate, and although there may be some hope of providing some early relief for the highly congested channels in London and the south-east, there is no prospect of being able to meet the demand for growth unless and until it were decided that as a minimum all usable parts of bands I and III, which are at present occupied by the 405-line T.V. services currently being phased out, should be allocated to the land mobile services. No decision has yet been taken as to the future use of these bands, but as matters stand only very limited use could be made of the frequencies for land mobile purposes until all the 405-line transmitters have been closed down by the end of 1986, although if a decision were taken to allocate these bands to the land mobile services there might be some modest scope for acceleration of this programme of closures if this were thought politically acceptable. Subject to a favourable outcome of current negotiations concerning the co-ordination of planning with neighbouring Administrations, such as France and Ireland, which have broadcasting intentions for bands I and III, the frequencies, if devoted to the land mobile services, should take us forward to the early 1990s.

The only other significant source of spectrum for land mobile services is the U.H.F. 854-960 MHz band which is now shared with the fixed (military) services. The Ministry of Defence have given every assistance with the re-planning of this band and there is now a reasonably clear picture of the extent to which it could be used for civil purposes. These released frequencies will not be available for some

/years yet



RESTRICTED

years yet but they should be able to accommodate some of the civil requirements, and they may in due course have to make some contribution to the provision for future growth of the land mobile services, although under existing technology the band is unattractive for that purpose. That virtually exhausts the possibilities. Even with T.V. bands I and III and what is being released in the band 854-960 MHz, there is no prospect in the still longer term of accommodating further civil land mobile growth, given the existing pattern of use between 30 and 960 MHz.

In accordance with normal practice the report of the Mobile Radio Committee will be published, hopefully by the end of May, and it is certain to increase pressure on the Government to release spectrum for the land mobile services. Both manufacturing industry and the land mobile lobby have long been restive about the amount of spectrum in this range occupied by the broadcasting authorities and by the military. You may know that Sir Henry Chilver, Chairman of the Electronics Economic Development Committee, wrote to Home Office Ministers some time ago to say that the home market for radiocommunications is severely and unnecessarily constrained by the limited availability of frequencies, and by the way in which frequency allocation is managed.

It is against this background that I think it is prudent to open up the issues to public debate. The security aspects will have to be handled with care but I believe that there need not be any insuperable difficulty about producing for publication a suitably edited version of the report of the review team. As to the scope of the review, I see no escape from the conclusion that it should cover the problems in the short term as well as the long term. Quite apart from the need to complete the programme of closure of the 405-line transmitters, it would not be feasible to take the bands into land mobile use before the end of 1984, assuming a decision in their favour, and there would seem to be every advantage, therefore, in obtaining an authoritative endorsement from outside Government of the very real constraints that must inhibit expansion of the land mobile services in the short term. I recognise that the case for allocating the band I and III frequencies to the land mobile services is on one view compelling, and that delay in settling the fate of these bands is likely to provoke some criticism. On the other hand, a decision to deny to broadcasting use frequencies which remain primarily internationally allocated to broadcasting and which (it will be said) are the only frequencies available in the foreseeable future for such new developments as a regional television service or local community television services, would be a very sensitive one, even at a time when the development of cable could be opening up new ways of delivering local services, at least in some areas. Also, the I.B.A. has ideas about using these frequencies for a new teletext service. It seems prudent, therefore, to allow the issue to be ventilated publicly through the agency of the independent review before a final decision is taken about the use of these bands.

The review is likely to take about a year to complete but we have suggested that it should be asked to submit an interim report about bands I and III by September at the latest, because of the importance of deciding as soon as possible what the future use of these bands should be. We are also agreed that the opportunity should be taken to review the existing arrangements for consultation with interests outside Government about the use of the frequency spectrum and for the assignment of frequencies, with a view to ensuring that there is public confidence in the system.

/I propose,

RESTRICTED



RESTRICTED

... I propose, therefore, to set up a review with the attached terms of reference, which would be conducted by a chairman with the assistance of two assessors covering the wide range of specialised knowledge that would be required; and perhaps with some temporary reinforcement to deal with the wider issues raised by the future use of bands I and III. I am giving further thought as to who should undertake the task and will shortly be consulting about their appointment in the normal way. The Home Office will fund and provide support staff for the review; so far as we can judge at present, the additional gross cost including overheads is unlikely to exceed £120,000, although the extra cost in practice should be no more than £60,000. It is clearly important to be able to announce the establishment of this review by the time that the Mobile Radio Committee report is published.

I should be glad to know by 7th May if the other members of E Committee (to whom I am copying this letter) are content. I am also sending a copy of this letter to Sir Robert Armstrong.

*Morgan*  
*Little*

RESTRICTED

## REVIEW OF THE RADIO FREQUENCY SPECTRUM: 30-960 MHz

Terms of reference

1. To help Ministers to formulate a view on the long-term problems foreseen in the radio frequency spectrum between 30 and 960 MHz, and specifically to assist in taking a decision on the future use of TV bands I and III when the present 405-line TV services are withdrawn, there is to be an independent review of the radio frequency spectrum in this range. The review is to:

(a) examine the present pattern of spectrum occupancy in this range taking into account:

(i) the international commitments and constraints arising from the international Radio Regulations, and from membership of the United Kingdom of such bodies as NATO, ICAO, IMCO, etc; and

(ii) the desirability of aligning spectrum usage as far as possible with that of neighbouring Administrations;

(b) investigate the likely continuation of the upsurge in additional requirements for accommodation in this part of the spectrum, and consider how they might be satisfied within the available spectrum and by innovative technological developments;

(c) identify and quantify those requirements which cannot be accommodated by these means and examine what scope there is for meeting them in some other way;

(d) make recommendations for consideration by Ministers as to changes that may be required to meet the situation and specifically in respect of the future use of TV bands I and III;

(e) consider the adequacy of the existing machinery:

(i) for consultation regarding the use of the frequency spectrum; and



(ii) for the assignment of frequencies,

and to recommend any changes that might be made in the interest of public confidence in the system.

2. The review is to cover the time-scale up to the end of the century, and any foreseen improvements in technology are to be taken into account. The economic resource and operational consequences of any recommended changes in spectrum occupancy are also to be considered; and any cases of inefficient use of the spectrum - having regard to the operational characteristics and other constraints on the users - are to be brought to light, together with any recommendations for improvement.

3. The review body is to be given access to all information made available to the inter-departmental machinery of classification up to and including SECRET.

4. The review body is to submit its final report by 1 June 1983, and an interim report as to the future use of bands I and III by 1 September 1982 at the latest.

REPORT  
OF THE  
INDEPENDENT REVIEW OF THE RADIO  
SPECTRUM (30-960 MHz)

Chairman: Dr J H H Merriman, CB, OBE, F Eng



INDEPENDENT REVIEW OF THE RADIO SPECTRUM  
(30 - 960 MHz)

Dr J H H Merriman CB, OBE, F Eng (Chairman)

Air Vice Marshal A Foden CB, CBE

P M Vine Esq CBE, DL

Secretary M J Bates Esq

To the Rt Hon William Whitelaw CH, MC  
Secretary of State for the Home Department

1. Our Interim Report, The Future Use of Television Bands I and III, was submitted to you on 10 September 1982 and published (Cmnd. 8666) on 22 September 1982. We are pleased to note that you have accepted our principal recommendations, on the withdrawal of Bands I and III from broadcasting use in favour of their development for land mobile services, and the accelerated closure of the 405-line TV service.

2. The Report which we now submit deals with the much wider questions of radio spectrum usage and regulation at all frequencies above 30 MHz. In our studies (which continued without a break from the submission of our Interim Report) we received over seventy written submissions of evidence, we had twenty-three sessions of oral evidence, and we visited a number of installations, organisations, and laboratories.

3. Our recent work has confirmed the importance of the five specific points in the covering summary (paragraph 5) of our first report. They were:-

- "(i) The radio frequency spectrum is a definable and limited natural resource. Its regulation, allocation and management is of long and short-term importance to the service and manufacturing industries of the country.
- (ii) Historical events and current procedures tend to suggest that radio frequency spectrum regulation, allocation and management is a somewhat arcane business detached from the realities of service and manufacturing industry. This impression persists in spite of welcome recent changes designed to couple more closely industrial and regulatory policies, and in spite of the competence and professionalism of practitioners involved in industry and Government.
- (iii) The development of frequency allocation strategies and product or system standards need to be closely inter-related throughout all the (often lengthy) stages of research, development and manufacture. It is not yet clear to us that the importance of this interaction and its significance is recognised in emerging new systems ranging from radio telephones to digital broadcasting.
- (iv) We recognise, fully, the fact that radio waves cannot respect national frontiers. Internationalism, and its consequent effects upon both strategic and tactical management of the spectrum, imposes limits to freedom that are inescapable and must be taken fully into account.
- (v) We note that, hitherto, it has been possible to regulate usage of the radio spectrum by accommodating, or at worst delaying, demand. It seems inescapable that for the future, regulatory procedures will have to include some capability for the making of value judgments, since demand may often exceed supply."

4. We are unanimous in our recommendations. We appreciate that some of them deal with matters of Machinery of Government. Our terms of reference make this inescapable. If any further reason is needed, it is our view that the combination of changing industrial structure, social expectation and technological drive would, in any case, generate of itself a need for reappraisal of that Machinery.



5. Our recommendations stem from the intrinsic political significance of the subject, from the complex administrative issues involved, from the changing technological environment and from the complexity of the services and systems involved. But we would stress that, having evoked from witnesses the realities that lay behind their initial observations, our task was, in one sense, easy. For we became impressed by the way in which our main conclusions were being made by the spontaneous unanimity of the witnesses themselves. There were, of course, issues on which there was a diversity of opinion, but there was a general agreement, which we endorse, on eight main points underlying our specific recommendations and conclusions:-

- (i) Demand for spectrum space is accelerating. Technological development progressively exposes new spectrum areas but these cannot be exploited fast enough to satisfy demand. Present congestion and competition for limited spectrum space will persist for as far ahead as we dare see. Therefore maximum exploitation of alternative non-radio technologies must be stimulated. Regulatory and industrial policies should incorporate this objective and contain means to achieve it.
- (ii) The regulatory process should be effectively resourced. If the United Kingdom is to gain the maximum benefit, in terms of communications services and of industrial and commercial advantage, from the use of the spectrum, adequate resources must be invested in the management of the spectrum. The Radio Regulatory Department (RRD) will not be able to operate with the speed, flexibility and authority which the user and manufacturer communities need unless it has the capacity to form a considered strategy on the basis of expert knowledge, and to implement and enforce that strategy. The achievement of this will require the commitment of adequate resources to regulatory activities, including monitoring and enforcement. The RRD is for the most part held in high regard for the quality of its work and the character of its decisions, but regulatory processes are criticised for slowness, obstruction, delay and lack of openness and responsiveness. Most criticism of this type can be directly traced to severe staff shortages within the RRD. We consider that urgent and imaginative action is needed to provide the staff to do the job. The "knock-on" effect of continuing understaffing upon efficiency is in our judgement serious both for the RRD and for the community it serves.
- (iii) The scientific and engineering foundations upon which Radio Regulation stand require strengthening. Originally the foundations were simply (as seen in retrospect) the physics of the ionosphere and atmosphere. Strong organisational and operational links between the then GPO and the then Department of Scientific and Industrial Research maintained these foundations up to the late sixties. Until recently such links had fallen into disuse, and at the same time, organisations, structures and techniques have all changed. We welcome recent initiatives taken to re-establish firm links between the Home Office and the scientific community, principally through the work of the Rutherford/Appleton Laboratory of the Science and Engineering Research Council (SERC). We consider that as a matter of some urgency the RRD and SERC should stimulate and fund projects with a high level of industrial involvement. These projects should put emphasis upon fundamental systems-design and traffic-handling parameters, both crucial to effective use and efficient regulation.
- (iv) Radio Regulation should be conducted in a more open manner. By this means, the processes will, we believe, become credible and more effective. The skills, responsibilities and professionalism of the staff will not only become evident but will be enhanced. We therefore



make a series of recommendations to this end, including the publication of an Annual Report indicating clearly the performance and problems of the past year together with the emerging challenges for the years ahead. We recommend the setting up of an active, authoritative high level Advisory Committee with the principal tasks of reviewing the Annual Report, commenting to the Minister on it, and responding to such matters as the Minister may refer to it.

- (v) The Radio Regulatory Department should be empowered to develop a more active and less passive stance in the management of the nation's use of this natural resource. No other body is equipped to do this. Whilst achieving rapid and effective response to requests for licences, the Department should assign more resources to forward planning. Understandably, while under-resourced, it has had to survive by putting emphasis upon reaction to current demand. It has been able to commit few, if any, resources to a combination of internal forward planning and external anticipatory discussions with manufacturing or service industries or major users (civil, military and departmental). In the decades ahead we consider the development and preparation of forward-looking strategies to be an increasingly important element of spectrum management.
- (vi) The Department should not shrink from taking value judgements. As part of a policy of openness, it should be prepared both to indicate the factors involved in those judgements and to identify such quantifiable elements as do exist eg economic, social benefit or resource analyses.
- (vii) There is scope for more delegation of the frequency assignment process. Only limited opportunities for change in the basic mechanisms of the regulatory process exist, as a consequence of the international dimension. However, we consider that further opportunities exist and should be taken to delegate assignment responsibilities to certain definable and responsible common-interest groups. We note that where this has already been done, administrative effort has been saved and a greater sense of internal spectrum discipline has emerged within the group even though some additional boundary problems have arisen.
- (viii) Early attention should be given to resolving the accelerating difficulty in maintaining continuity and expertise in assembling delegations for international activities. The international operations of the Regulatory Department are a significant contribution to the preparation of an authoritative internationally agreed set of regulations within which member states may conduct their radio operations with confidence. We note the high regard in which the UK Delegation to the relevant International Plenary and specialist conferences is held. We consider that this regard and the expertise and experience which underpin it are important for the effectiveness of UK manufacturing and service industry in national and world-wide operations and must be maintained. Most other nations maintain a high degree of continuity and expertise. However, we are concerned at the low priority apparently given to the maintenance of expertise and continuity, even in this area of rapidly changing high technology, in the UK.

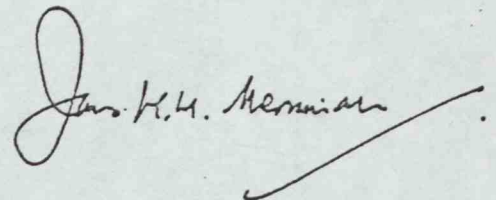
6. But we must add a point that grew insisently as we took evidence and considered our conclusions. It is to do with the location of radio spectrum regulation in the nexus of departmental responsibilities and functions.



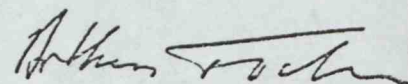
7. There is a widespread view, which we have come to share, that current fast-moving developments in various aspects of broadcasting, communications and Information Technology call urgently for centralised strategic direction. If Britain is to secure the maximum benefit from these developments, all these activities, including the regulation of the radio spectrum which has a key role, need to be brought together under the responsibility of a single Minister. This would, we believe, have the incidental advantage of making it easier to find solutions to many of the problems besetting the present radio regulatory machinery.

8. We therefore felt that in making our report to you, we should draw your attention to the weight of opinion on this subject, and indicate our own views. We endorse the views expressed to us in evidence and believe that a single independent Government Department should assume responsibility for telecommunications, broadcasting (including cable and direct broadcasting by satellite), radio regulation and Information Technology. The distinctions between the terms themselves, once vivid, are already blurred and will soon vanish. As a second and less desirable option, responsibility for these matters should rest with a distinct unit within an existing department, which on balance we consider should be the Department of Industry.

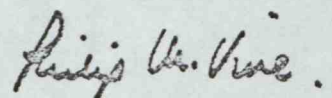
9. Our Secretary, Mr M J Bates, and his two colleagues, Miss Lyn Dilshener and Mr Laurence Hooper, have been energetic, constructive and helpful at every stage of our Review. We are grateful to them for their willing support and commitment. We also express our appreciation of the many members of the staff of the Radio Regulatory Department who willingly and authoritatively shared their expertise and experience with us.



JAMES H H MERRIMAN



ARTHUR FODEN



PHILIP M VINE



M J BATES, Secretary

7 June 1983

## CONTENTS

| CHAPTER |   | PAGE |
|---------|---|------|
| 1       | Introduction.   |      |
| 2       | The Context and Character of<br>Radio Regulation.               |      |
| 3       | Possible Future Changes and Problems<br>in Accommodating them.  |      |
| 4       | Growth in Demand for Spectrum<br>above 30 MHz.                  |      |
| 5       | Essential Elements of Regulatory<br>Processes.                  |      |
| 6       | Radio Regulatory Procedures in<br>the United Kingdom.           |      |
| 7       | International Comparisons.                                      |      |
| 8       | Strengths, Weaknesses and Criticisms<br>of Existing Procedures  |      |
| 9       | Frequency Spectrum Management.                                  |      |
| 10      | Frequency Assignment Management.                                |      |
| 11      | Spectrum Pricing.   |      |
| 12      | Staffing and Resources.   |      |
| 13      | The Place of Radio Regulation in the<br>Governmental Structure. |      |
| 14      | Summary of Conclusions and Recommendations.                     |      |
|         | List of Annexes.  |      |



## CHAPTER I

### INTRODUCTION

1.1 This Review was established by the Home Secretary in July 1982, with the following terms of reference:

"1. To help Ministers to formulate a view on the long-term problems foreseen in the radio frequency spectrum between 30-960 MHz, and specifically to assist in taking a decision on the future use of TV Bands I and III when the present 405 line TV services are withdrawn, there is to be an independent review of the radio frequency spectrum in this range. The review is to:

- (a) examine the present pattern of spectrum occupancy in this range taking into account:
  - (i) the international commitments and constraints arising from the international radio regulations, and from membership of the United Kingdom of such bodies as NATO, ICAO, IMCO, etc; and
  - (ii) the desirability of aligning spectrum usage as far as possible with that of neighbouring Administrations;
- (b) investigate the likely continuation of the upsurge in additional requirements for accommodation in this part of the spectrum, and consider how they might be satisfied within the available spectrum and by innovative technological developments;
- (c) identify and quantify those requirements that cannot be accommodated by these means and examine what scope there is for meeting them in some other way;
- (d) make recommendations for consideration by Ministers as to changes that may be required to meet the situation and specifically in respect of the future use of TV Bands I and III;
- (e) consider the adequacy of the existing machinery:
  - (i) for consultation regarding the use of the frequency spectrum; and
  - (ii) for the assignment of frequencies,and to recommend any changes that might be made in the interests of public confidence in the system.

2. The review is to cover the time scale up to the end of the century, and any foreseen improvements in technology are to be taken into account. The economic resource and operational consequences of any recommended changes in spectrum occupancy are also to be considered; and any cases of inefficient use of the spectrum - having regard to the operational characteristics and other constraints on the users - are to be brought to light, together with any recommendations for improvement.

3. The review body is to submit its final report by 1 June 1983, and an interim report as to the future use of Bands I and III by 1 September 1982 at the latest."



1.2 We began work on 19 July 1982 and submitted our Interim Report, on the Future Use of Television Bands I and III, to the Home Secretary on 10 September 1982. The Report was published on 22 September\*. On 11 November, the Home Secretary announced his acceptance of our principal recommendation, that Bands I and III should be withdrawn from broadcasting use and should be used instead primarily for land mobile radio services; and on 12 April 1983 he announced his acceptance of our further recommendation, that the planned closure programme of the 405-line TV services should be accelerated with a view to their withdrawal by the end of 1984.

#### Interpretation of Our Terms of Reference

1.3 When we turned to the second and major part of our work, we saw our terms of reference as implying two distinct tasks. First, paragraphs 1(a) to 1(d) required us to look critically at the present use of the 30-960 MHz frequency range, to assess the available evidence on the present and future demand for spectrum in this range, and on the likely impact of future technological developments, and to assess the implications of the trends we observed. Second, paragraph 1(e) of our terms of reference required a review of the machinery for consultation on the use of the frequency spectrum, and for the assignment of frequencies. We found that the narrowly technical and largely mechanical questions of the assignment of specific frequencies for specific uses could not in practice be dealt with other than in the wider context of the whole frequency management process - the formulation of policy and the allocation of bands of spectrum to different classes of use.

1.4 We also observed that our terms of reference might be seen as imposing the upper limit of 960 MHz on this second task as well as on the first. However, there is no case for a distinctive mechanism for the management of the spectrum between 30 MHz and 960 MHz and a completely different mechanism in other parts of the spectrum; and it was clear that any recommendations we might make would have implications for frequency management outside this range. The Home Secretary very helpfully clarified our terms of reference in a letter of 12 January 1983 to the Chairman, reproduced at Annex A. He confirmed that his intention had not been to place frequency limits on our considerations of machinery and consultation.

1.5 We issued a general invitation for evidence on 7 October 1982. We drew up a questionnaire (reproduced as Annex B) drawing attention to the points which we felt, on the basis of our early discussions, to be of particular relevance. Our Secretary wrote to over 70 organisations, covering a wide range of interests. We received over seventy written submissions from sixty organisations or individuals. We are grateful to all those who responded to our invitation (a list appears as Annex C); the evidence yielded much that was useful and thought-provoking, and it was clear to us that some submissions were the product of a great deal of time, effort and thought. We also took oral evidence from 24 of these organisations. We include at Annex D a paper summarising the material views expressed by respondents on the questions on machinery and procedures.

1.6 At an early stage, we decided that we needed comprehensive and up-to-date information about radio regulatory practices in a sample of overseas countries. We commissioned for this Review a study of radio regulatory practice in the United States of America, West Germany, France and Japan. We were fortunate in that the Home Office were able to make available to us the services of an official, Mr M Goddard, who, though no longer working in the Radio Regulatory Department, had previously worked there both as an engineer and as an administrator and was very familiar with both the national and international aspects of frequency management. He visited all four countries, held extensive



discussions with key officials in the regulatory authorities, prepared a comprehensive report, summarised at Annex E, and discussed his findings with us. This work forms the basis of Chapter 7 of our Report. In connection with this overseas study, we must acknowledge our debt to the regulatory authorities in the USA, West Germany, France and Japan for their ready cooperation; to members of the Energy, Science and Space Department of the Foreign and Commonwealth Office; to the staffs of the UK Embassies in Washington, Bonn, Paris and Tokyo who helped to smooth the path for Mr Goddard's visits (which were necessarily undertaken at short notice); and in particular to the Director-General of the Prison Service for his cooperation in releasing Mr Goddard from his present post for two months to help us.

1.7 In preparing this second Report we have held 43 meetings, almost all of them full day; visits or less formal meetings involving one or two members of the Review team have occupied a further five days. Taking into account also the preparation of the Interim Report we have met on 57 days, 18 of which were for the hearing of oral evidence.

1.8 The Home Office provided written and oral evidence on a number of aspects of radio regulation. In addition, it provided much useful background material including, as we mentioned in our Interim Report, a detailed interdepartmental study of the frequency range 30-960 MHz, a source document of particular value to us. We have also visited a number of parts of the Radio Regulatory Department and seen at first hand aspects of the licensing and frequency assignment procedures.

#### Terminology

1.9 We include at Annex F a glossary of some of the abbreviations and technical terms we use in this report. We also draw attention in particular to the term "telecommunications". For the purpose of our Report, the interpretation we put upon the word "telecommunications" is that derived from:

(i) the Radio Regulations of the International Telecommunications Union (Geneva 1982), Article 1, which defines telecommunications as "any transmission, emission or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems";

(ii) Clause 4 of the Telecommunications Bill considered by the last Parliament, which defines "telecommunications system" as "a system for the conveyance, through the agency of electric, magnetic, electro-magnetic, electro-chemical or electro-mechanical energy, of:-

- (a) speech, music and other sounds;
- (b) visual images;
- (c) signals serving for the impartation (whether as between persons and persons, things and things or persons and things) of any matter otherwise than in the form of sounds or visual images; or
- (d) signals serving for the actuation or control of machinery or apparatus."

However, "telecommunications" also has a narrower meaning, of services of the kind generally provided by a common carrier eg British Telecom or Mercury, and it is in this sense that we use the word in the expression "the liberalisation of telecommunications". Apart from this, we use the word in its broader sense.



## CHAPTER 2

### THE CONTEXT AND CHARACTER OF RADIO REGULATION

2.1 Regulation of the radio frequency spectrum is a necessary precondition of effectiveness in all radio operations and all manufacturing or service industries that depend upon radio. This precondition derives from:

- (i) the growing variety, scale and importance of these services and their conflicting demands for a definably limited natural resource;
- (ii) the innate characteristics of radio waves themselves and the technologies available to handle them.

2.2 Radio-borne services affect nearly every aspect of life in a highly developed nation. In many cases no technological alternative exists. The combination of mobility, communication and immediacy can only be provided by radio. The absence of these types of service could undermine the economic viability of a wide range of important service industries ranging from taxi services to airline operations. The operations of defence, law and order and safety of life services are now virtually unthinkable without effective radio spectrum usage. Escalating demands for information, news, entertainment and telecommunications can be met most readily by radio systems, though technological developments may well reduce the proportion of that dependency. No space system of any kind is viable without effective radio communication. Radio telescopes provide man with powerful and in some cases the only means of exploring the changing frontiers of knowledge of the structure of the universe. Many of the initiatives proposed by the Government to accelerate development in Information Technology depend for their effectiveness upon developments of new radio techniques and systems.

2.3 This growing dependence of society upon radio-borne services is sustained by manufacturing and service industries of significant variety, size and growth. In manufacturing, the products include, for example, radio and television transmitters, radars, navigational aids, mobile communication systems and microwave satellite and terrestrial systems, as well as pocket communicators, garage door actuators and domestic radio/TV/Teletext receivers. UK Industrial output of these products in 1982 was over £2000M. The service industries dependent upon these products range from air and seaborne transportation and common carriers to operators of services for defined user groups, for example estuary or port communications/control systems, or transport fleet and taxi operators.

2.4 The leverage that these service industries in turn exert upon industrial effectiveness and social patterns is very great and technically incalculable overall. But, as an example, a study undertaken for us by the Department of Industry (Annex G) on the impact of the use of private mobile radio on the road haulage industry showed a ratio of up to 4:1 of benefits (ie savings in capital expenditure on vehicles, operating costs and improved service to customers) to costs (ie capital and operating costs of radio communications). Other unquantifiable benefits such as reduced traffic congestion and pollution, improved security and more effective contact with rescue services would increase this ratio. We have no doubt that many other comparable examples can be constructed.

2.5 But we are well aware that not all claims for spectrum can be expressed in such simple, arithmetical terms. Allocation of channels for broadcasting, for example, must take account of the interaction of politically judged criteria as to equity and balance of the desired coverage. Difficult judgements arise when



conflicts between generically distinct and non-comparable types of usage arise, eg between civil and military authorities, or between leisure and business usage. The radio regulatory process must therefore be seen as one of great technological complexity, upon which is brought to bear a great variety of disparate economic social, industrial and political interests.

2.6 However, it is the characteristics of the radio spectrum itself considered as a natural resource that determine the need for and nature of regulation.

Among the characteristics of this resource are:-

- (i) It is international. A nation cannot in general draw up its plans unilaterally, or it will both suffer and cause harmful interference. The effective use of radio demands a very high degree of international cooperation. The more intensively the spectrum is used, the more important the international dimension becomes. For a technologically advanced trading nation, the fullest possible involvement in international radio spectrum planning is justified simply as a matter of self interest.
- (ii) It is a resource which is not consumed by use; on the contrary, when it is not being used it is being wasted. Changes in use cannot be made overnight: the capital investment involved is often so great that years or decades are needed. This means that a balance must be struck between satisfying current need and providing flexibility for the future.
- (iii). It is a resource that can be shared:
  - by a distinctive frequency assignment to each user;
  - by users of the same frequency assignment on a geographical basis, depending upon the propagation characteristics at that frequency;
  - by users of the same frequency on a time basis;
  - by invoking advanced technology to superimpose transmissions.
- (iv) It is susceptible to pollution. Harmful interference can be caused both by other users of the radio spectrum and by spurious radiation produced by other electrical equipment. Without regulatory control, parts of the spectrum could be rendered useless by interference.
- (v) It is wasted when it is used for tasks that can as easily be done in other ways.
- (vi) It is finite. While advances in technology can enable higher and higher frequencies to be exploited and can enable more intensive use to be made of a given band, there can be no expectation, much less any guarantee, that the supply of channels will keep pace with demand. Good management may enable supply and demand to be kept in step for some time but it would be short sighted not to be prepared for the day when this ceases to be true, as has already happened from time to time in some sectors.
- (vii) It is in increasing demand. Since the earliest days of the exploitation of the radio spectrum there has been a continuing growth of new uses for radio, and in general a steadily increasing demand for each new type of use as it becomes established. Given the trends in technology and communications visible in today's society, and foreseeable in tomorrow's, these trends must be expected to continue.

2.7 Of these characteristics, the international dimension and the pattern of growing demand for a limited resource call particularly for careful regulation of the use of the radio spectrum, and determine the nature of the regulatory process.

2.8 To the uninitiated, the term "radio regulation" may imply some form of censorship which interferes with the freedom to communicate. It is therefore worth emphasising that the regulation of the radio spectrum is concerned solely with ensuring the most effective use of this finite resource. It does not involve any elements of judgement on the content of individual messages. It does however imply value judgements as between classes or types of message or service, for example between safety of life services, public utility control networks, personal paging, broadcasting or defence. It also involves taking decisions on whether a particular sort of communication should be achieved by means of the radio spectrum or should be required to use other means.

2.9 To discharge, nationally, the radio regulatory responsibility therefore requires recognition, analysis and determination of the national and international factors concerned over a wide range of usage, civil and military, involving a wide range of high technology systems, complicated further by a high degree of interaction between nearly all elements in an already complex process.



## CHAPTER 3

### POSSIBLE FUTURE CHANGES AND PROBLEMS IN ACCOMMODATING THEM

3.1 We consider that any critical analysis of radio regulatory processes should take into account likely or possible future changes which might affect the environment in which regulation is carried out. By the very nature of the rapidly changing technologies involved, this environment is changing and will continue to change, particularly socially and industrially. The regulatory process must therefore take account of this but at the same time generate a framework of confidence and stability within which commercial and industrial investment can be committed and service be provided. We see at least four areas where significant change is under way or can be expected.

#### Technological Change

3.2 This is the principal motive power for change in all matters relating to the use of the radio spectrum. The history of radio spectrum usage over the past six decades shows a succession of moves into higher frequencies as devices and technologies capable of exploiting these frequencies have been developed. In the early post-war period, commercial exploitation above about 300 MHz was a rarity. By 1960 operations at around 300 MHz were commonplace. By 1980 systems at around 30,000 MHz (30 GHz) were becoming feasible. Not all segments of the radio spectrum are equally transparent to radio signals, and increasingly above about 10,000 MHz (10 GHz) the gaseous components of the atmosphere absorb energy, in consequence of which transmissions have to be restricted to definable "windows" in the spectrum. Nevertheless, as device and system developments mature we expect significantly increased operations in these higher ranges of the spectrum above 10 GHz, and we expect increased competition for what will, in its turn, undoubtedly become congested and then saturated. We have not addressed ourselves to problems that will undoubtedly arise as the further exploitation of even higher frequencies (e.g. infra-red and free space optical transmission systems) gathers momentum. We observe however the rapid growth of domestic, office and industrial infra-red devices and systems. These are to be encouraged especially in so far as services or systems can be diverted from the radio frequency spectrum into these newer regions.

3.3 There is a second, and perhaps equally powerful element of technological change that needs to be considered. The congruence of communications and computing technologies has meant that there are now available powerful means of organising the elements of information and of handling streams of traffic to make maximum effective use of limited transmission channels (either on radio or "hard wire"). Larger numbers of traffic streams, conversations or messages can be packed into a given radio frequency channel assignment. By computer-like control, effective use can be made of the gaps or idle time in speech or data links. There is no valid technical reason in many cases for specific assignment of a particular and unique channel to a particular user. Again, the use of rapidly cheapening storage technology offers opportunities of reductions by orders of magnitude (possibly as much as a thousand to one) in demand for spectrum space in certain types of information display service.

3.4 The third element of technological change that has already heavily influenced system design is the use of digital technology. The full extent of the interplay between spectrum utilisation and the design, manufacturing and service benefits of this technology are now beginning to be perceived, but may well take a decade or more to establish. It is in this area that we see powerful and probably opposing arguments developing. We observe significant resources devoted to system design, in pursuit of commercial and operational effectiveness; but regrettably we sense little effort industrially or



governmentally to develop technologically sound bases upon which to establish ground-rules for regulation of digitally modulated transmissions under conditions, which are already emerging, of congestion and interference.

#### Industrial and Economic Change

3.5 The growth of an Information Technology culture is already generating significant change in the structure and mechanisms of British industry and commerce over a wide range of activities as diverse as supermarketing, banking, leisure, consumer goods manufacture, capital goods manufacture, transportation and communications. We observe significant growth in service-oriented businesses, all of which have one common attribute: their increasing dependence upon effective information-handling systems whether for internal management, control and operation, or for maintenance of their increasingly important links with suppliers and clients. We judge that the major elements of this growth have still to develop. We consider that as they do so, there will be significant and continuing demands upon the radio spectrum, impelled additionally by the progressive reduction in real terms of the cost per megabyte, per kilometer, of transmitting information from point to point. In the particular case of mobile radio communications in manufacturing and service industries and commerce, there is already clear evidence of that growth in demand.

#### Changes in the Environment of Home, Transportation and Leisure

3.6 Society is becoming increasingly mobile and there is at the same time a growing expectation that personal communications facilities will be available all the time whether the user is at home, work or on the move. The development of new technology fosters these increasing expectations, and the society of ten or twenty years time may take for granted the existence of not just radio pagers and mobile radio telephones, but personal mobile radios communicating by means of satellites. The generation of expectations is a powerful force for change, and pressure is likely to grow to find spectrum for more and more personal communication services. But a different type of expectation already generates another type of demand which can be satisfied only by significant further consumption of radio spectrum. It is the demand for immediacy and quality. As an example, we noted in taking evidence the voraciously increasing demands by broadcasting organisations and media information providers for high quality sound and vision coverage of events on local, national and global bases. To the extent that such demands are satisfied, expectation is generated, mostly on false premises, that immediacy and high quality are easily provided and relatively inexpensive.

#### Politically Motivated Structural Change

3.7 Change in Government policy is unpredictable. It can significantly affect the nature of the regulatory operation itself and it can also alter, significantly, the nature and extent of demands made upon the spectrum. The decision to make the Post Office a public corporation instead of a Government Department in 1969 necessarily left a number of activities more appropriate to Government, including radio regulation, to be accommodated elsewhere; hence, first the formation of the Ministry of Posts and Telecommunications, and subsequently the transfer of the Radio Regulatory and Broadcasting Departments to the Home Office. Currently, the decision to liberalise telecommunications has already had very significant impact on demands for spectrum and has presented entirely new problems with significant and as yet unquantifiable future implications both for industry and the Radio Regulatory Department. The decision to allow a second common carrier, Mercury, to operate in competition with British Telecom has produced a very substantial and immediate demand for spectrum since Mercury's operation is at present virtually dependent on radio. Accommodating an unforeseen demand of this scale and urgency has posed



severe problems to the Radio Regulatory Department. Another example came to our notice as we were completing this report. The White Paper on Cable Systems and Services\* opens the way for growth of systems which are likely, inter alia, to generate growth in television programme production. This will require further spectrum for broadcasting ancillary services, but we see no sign that this admittedly unquantifiable demand has been taken into account in governmental thinking. In addition, liberalisation is likely to influence the expectations of the user community and so generate yet further demands for spectrum already heavily congested. We observe also that changes of this sort are not confined to the UK. Under these circumstances it must be expected therefore that there will be increasing difficulty in international harmonisation and notification of frequency allocations and that this may generate tension between regulatory and industrial agencies and policies.

### Conclusions

3.8 The inescapable deductions that we make from these influences for change is that demand for spectrum space will continue to increase and accelerate. We find no evidence for any contrary view. We explore in later chapters the more detailed consequences of this situation, but it is already clear from these fundamental statements that an effective radio spectrum regulatory process has an essential role in the conduct of a very wide range of both public and private sector activities.



## CHAPTER 4

### GROWTH IN DEMAND FOR SPECTRUM ABOVE 30 MHz

4.1 In our study of growth, we have considered a detailed interdepartmental study of the range 30-960 MHz and examined such evidence as was available on growth at higher frequencies. The block diagrams at Annex H show, in broad outline, the purposes for which the spectrum is allocated between 30 MHz and 51.4 GHz. We have discussed the question in some detail with the administrative and technical staff of RRD; and we have read the numerous and varied responses to our consultative questionnaire. Our purpose in undertaking this was to obtain a feel for the trend of developments and to arrive at an overview of the current and likely future pattern of demand. The mass of evidence we considered conveyed to us very successfully and forcibly both the general pattern of demand and the flavour of individual users' operations and needs.

4.2 We should perhaps make it clear that it was not our role to sift, evaluate and comment on individual assignments or applications, much less to take on the Home Office's executive function and authorise such assignments. Appropriate machinery exists for considering bids for new allocations or assignments and we have assumed that, where evidence contained or implied such bids, application would be made to the RRD in the normal way.

4.3 A thorough, quantitative analysis of the implications of the evidence we received is a task which would have taken far longer than the time we had available. To take one example, we were given by the broadcasting authorities statements of their projected needs for spectrum for ancillary services. This is now one of the topics in a Study of Requirements for a Revised Broadcast Ancillary Radio Frequency Allocation Plan being carried out in the RRD by four part-time consultants over a period of some months. The fact that the RRD had to call in consultants reflects the acute shortage of man-power available within the Department for tasks of this sort.

4.4 We did not see it as our proper task to make value judgements on the balance between different services in the allocation of the spectrum. Our Interim Report, on the use of Bands I and III, was an exception; that was an issue of great importance, on which an urgent decision was needed, and on which our advice had been specifically sought. However, such decisions, even the most fundamental, ought really to be taken by the regulatory authority itself, and we have therefore concentrated in the other chapters of this Report on ways of ensuring that the regulatory authority can discharge that responsibility satisfactorily.

4.5 In our study of growth, we have identified four areas of particular importance: the land mobile services, broadcasting, defence and the fixed services. We consider these in turn.

#### Land Mobile Radio

4.6 We discussed the growth estimates for civil land mobile radio in some detail in our Interim Report. Nothing we have seen since has led us to doubt the potential for continuing growth. There are many areas of uncertainty. The provision of more spectrum for land mobile services may itself have the effect of releasing pent-up demand. Technical change can both ease and exacerbate the problem: the development of new techniques such as single sideband and dynamic frequency assignment can aid spectrum efficiency but some techniques, especially those leading to improvements in quality, can also generate significant increases in demand for services thus imposing new pressures on the spectrum.



4.7 The most significant development we see is the emergence of a trend, which we believe will increasingly be forced upon users in the future, away from individual assignments towards the greater use of multi-service providers. Cellular radio is one, but by no means the only, example of this trend. The use of such techniques offers potential economies both in spectrum use and in regulatory procedures, since its widespread adoption could relieve the RRD of some of its burden of detailed assignment work, even though its monitoring functions would have to become more sophisticated.

4.8 There appears to us to be no likelihood of the demand for land mobile radio services slackening. The technical, social and economic developments we describe in Chapter 3 are likely to ensure a continuing or even increasing rate of growth. This picture is borne out by international comparisons: there is nowhere any sign of a diminution in the growth of demand, even in those countries which are more advanced in their exploitation of mobile radio than the UK. It is clear from the evidence we have studied that there is already a high degree of congestion in some of the civil land mobile bands, though the exploitation of Band III, and to a lesser extent Band I, will offer some relief. The diagram at Annex J shows the likely pattern of spectrum availability, as seen by the RRD, between now and 1998. Numerous assumptions have had to be made in preparing this diagram, but the picture it presents accords with the picture we have obtained from the evidence. We conclude that while the situation is likely to be manageable until the late 1980s, problems thereafter are likely to become acute unless significant use can be made of other bands and/or new technology.

#### Broadcasting

4.9 The Home Secretary has accepted the recommendation of our Interim Report and Bands I and III are being withdrawn from broadcasting use by the end of 1984. The extension of Band II for VHF sound broadcasting, a decision taken at the 1979 WARC, will be implemented in accordance with the decisions of the 1984 Region 1 VHF Planning Conference. The other significant possible change which was brought to our notice, apart from the growth in demand for broadcasting ancillary services with which we deal later, was the possible improvement of UHF TV coverage by the use of the gap between Bands IV and V.

4.10 Our consideration of the broadcasting authorities' spectrum use has therefore been largely directed to the frequencies used for broadcasting ancillary services. We gave in our interim report figures for the estimates then made by the BBC and IBA for the spectrum they would need both to accommodate new developments and to compensate for the loss of the use of Bands I and III. A number of further points emerged from the evidence from broadcasting authorities. The BBC suggested that the gap between Bands IV and V, currently used by aeronautical services, could provide spectrum for ancillary services if it were not used to improve UHF coverage. The growth of TV with stereo sound might also increase the BBC's frequency requirement for ancillary services.

4.11 The IBA foresaw an increasing need for ancillary services, especially for local radio. The 69 stations at present on the air or planned are expected to attach importance to producing news and "actuality" programmes, which make heavy demands on ancillary services. We have also received representations that more spectrum should be made available for radio microphones, in theatres etc as well as for broadcasting purposes.

4.12 We can foresee that present and expected future developments in broadcasting (including cable TV) are likely to generate a continual and possibly accelerating growth in demand for ancillary services. An increasing



number of programmes will be needed to fill the available air time. The extent to which this development will impinge upon the demand for spectrum nationally depends upon the balance of programmes involved; news, current affairs, and other outside broadcast programmes and studio management all generate a high requirement for ancillary services; imported programmes or films do not. We must emphasise our concern that, on the evidence available to us, no forward estimates have been made of the likely spectrum demands of the makers of programmes arising from the explosive growth of new services implied by recent Government statements on cable and satellite systems. Evidence put to us emphasises the congestion already foreseen by the BBC and the IBA. We accept this evidence. It is the enlarged community of programme makers of the future which will generate the demand for broadcasting ancillary services, and it seems highly unlikely that all will be able to be satisfied. We recommend that:

- (i) as a matter of some urgency, the demands emerging from this enlarged community of programme makers be taken into account in policy formulation;
- (ii) the broadcasting authorities be given every encouragement to make the maximum use of the existing broadcasting bands to accommodate their ancillary requirements; and
- (iii) any further requests for spectrum for these services be given very close scrutiny in view of the many other competing claims for frequencies.

4.13 The development of new forms of "broadcasting" also has implications for the future usage of spectrum for terrestrial broadcasting. We can see no justification for the provision of additional spectrum for terrestrial TV or sound services without very serious consideration of the frequency implications, in the light of the undoubted emergence of alternatives.

4.14 However, reduction in the amount of spectrum used for broadcasting would be very difficult to achieve. The investment in equipment, both by the broadcasting authorities and by the millions of consumers, is so great that any conceivable change - say, the reduction of bandwidth from 8 to 6 MHz, or at the extreme the termination of terrestrial UHF broadcasting in favour of a combination of satellite and cable broadcasting - would need to be planned both nationally and internationally, agreed in principle, and implemented over an extremely long span of time. We conclude therefore that within the timescales we are considering, we can see no scope for any reduction in the use of spectrum for terrestrial broadcasting.

#### Defence Bands

4.15 We are constrained in discussing the defence use of the spectrum in a report intended for open publication. We have however had full information on the bands within the 30-960 MHz range allocated for defence purposes, and the use to which they are put. We have also, and more importantly, had useful high level discussions with those in the Ministry of Defence responsible for the policy and management of the use of the spectrum by the armed forces. We have considered two main issues: the suggestion that the allocation for defence purposes is unnecessarily large and wastefully used; and the question of the internal mechanisms within MoD and the armed forces for ensuring efficient usage.

4.16 The amount of spectrum used by the armed forces is the subject of frequent criticism by civil users, and the strength of feeling was clear in the evidence we received. This feeling is understandable, given the pressures upon civil users and the fact that the defence community is not - and would argue that it cannot be - open about the justification for the size of its allocation. However, we are in no doubt that the criticisms are largely misconceived. There



are a number of constraints on military spectrum usage, of which the most obvious is the fact that it is to a large extent determined by international frequency planning within NATO.

4.17 Critics of the MoD's spectrum usage have told us of bands which, according to monitoring, are unused. We accept that some of the bands allocated to defence are used in ways which appear to be inefficient according to the normal criteria; but we are satisfied that these criteria are not always relevant to defence usage. It is a characteristic of many aspects of defence activity, not merely the use of radio frequencies, that resources need to be kept available for virtually instant use should the need arise. The sharing of bands in peacetime between military and civil usage is already being exploited to a certain extent, but there are practical constraints. Many of the user groups suggested as possible sharers, eg public utilities and transport services, are services which would need to keep going or even intensify their operations in a period of crisis, rather than cease operations and relinquish their spectrum for military use.

4.18 It is also worth emphasising the difficulties faced in achieving spectrum efficient usage with military equipment. Some military telecommunications equipment needs wider bandwidths than used by civil equipment; the timescale for the procurement of military equipment is long; the equipment itself needs to have a long operational life, in order to make the most economic use of it; and new equipment has to be compatible with its predecessors. These factors together make the implementation of technical developments in spectrum efficiency a slow process. To these problems must be added the demands of inter-operability with the armed forces of the other NATO countries. We should add that we have been impressed by the degree to which frequency considerations are taken into account at the early stages of defence equipment and system development.

4.19 We accept that usage sometimes appears to be inefficient by conventional criteria, but we accept that these criteria are less relevant when applied to defence use. Our conclusion is that there is little scope for the reductions in defence spectrum usage which some respondents have suggested.

4.20 We acknowledge that there is, nevertheless, a need to ensure that the military use of the spectrum is subject to regular critical review, and to restore the confidence of civil users in the justification for military allocations by instituting some form of high-level independent scrutiny. We make recommendations to this end in Chapter 9.

#### Fixed Services

4.21 This generic term covers a wide range of services using a variety of technologies. The large majority of these services operate at microwave frequencies above 1.0 GHz. Essentially they can be regarded as bulk carriers for high volume telecommunications traffic of great variety: voice, vision or data. The services may either form part of public national common carriers' telecommunications systems (British Telecom or Mercury) or form part of private "in-house" communications systems for major commercial or industrial enterprises and broadcasting. Large inter-city intercommunicating networks using these microwave systems exist. Their operating characteristics are prescribed by international standards since they constitute part of the public global telecommunications system. Their usage of the radio frequency spectrum is predetermined in part by their integration into the global system, but also by the fact that most of the same frequency bands have also to accommodate the world's space-borne telecommunications traffic.



4.22 Allocations are in fact provided in the UK for these fixed, point-to-point and space communications in the bands between 1.5 GHz and 29 GHz and these bands are shared between private users and the two major common carriers, British Telecom and Mercury.

4.23 Growth in the demand to use these bands is steadily rising and some are virtually fully loaded. The effect of the competitive impact of Government policy in liberalising the provision of certain telecommunications facilities necessarily reduces the effectiveness of radio spectrum usage as well as increasing the demand for spectrum itself. The constraining effects of having to share some of these bands between terrestrial and space services raises important issues of the relative importance of accelerating growth in international as opposed to national services. Other factors that could accelerate growth in the demand for fixed links are the need to provide means of distribution to cable systems, the increased use of remote telecommand and telemetry systems and the increased use of digital links for data communications. As against these, factors that might limit growth in demand are the developing use of fibre optics and other line communications.

4.24 Examples of the rate of growth of these services over the past decade and reasonable forward projections are summarised in Annex K. While there may be small but locally significant differences between individual bands, our judgement is that saturation of the spectrum by increasing demands for these services will occur with increasing severity in the latter years of this decade and the early years of the next.

4.25 We recommend therefore that early special arrangements be made with all parties concerned to review the policy and practice of frequency spectrum management in relation to fixed services so that overall strategies can be developed in the face of the saturation likely to be begin in the late 1980's.

#### General

4.26 On the basis of the evidence we have seen, the growth trends we have described in the land mobile and fixed services will continue for the foreseeable future. It is clear to us that saturation has already been reached, in some parts of the country, in some of the bands above 30 MHz. Even in those bands where there is still some spare capacity, growth in demand is rapid and shows no sign of slackening. For many such bands, saturation is clearly foreseeable within the normal planning period of users, manufacturing industry and the RRD.

4.27 This is illustrated in the contrasting positions of the broadcasting bands, which are already more or less fully used, and the civil land mobile bands, the likely demand for which is charted at Annex J. Saturation is already being reached in some of the bands in this range, although the position can be contained in the short-term, particularly with the assistance of Bands I and III, until the late 1980s. After this date it is by no means clear how continuing growth can be accommodated. Technical or other developments may defer this point, but the user community and the Regulatory Authority must both face the fact that demand will eventually significantly outrun supply. We note the belief, expressed by some respondents, that unused or under-used spectrum could be found in the 30-960 MHz range and redeployed to accommodate this growth. We are satisfied that such reserves do not exist.

4.28 The problem will not be one of finding unused spectrum but of choosing between uses, and this will put particular pressure on the allocation machinery. The options will be to leave the existing pattern of usage broadly unchanged, and thereby suppress further growth in mobile services; or to facilitate the continuing expansion of mobile services by finding ways, progressively over a



period of decades, of reducing the spectrum usage of the existing major users such as broadcasting or defence. These will be difficult decisions, and are ultimately political in character. We cannot, in 1983, say what those decisions ought to be; they can only be taken by the Government of the day, in the light of the spectrum needs of mobile radio and of the defence services, the state of development of other means of "broadcasting" (ie satellite and cable) and the importance attached to these activities by tomorrow's society. On the basis of our studies of the processes of frequency management and the operations of the major users, we conclude that:

- (i) there is no prospect of any significant reserve of unused or under-used spectrum being identified in the 30-960 MHz range and reallocated;
- (ii) the long timescale involved in bringing about major changes in the pattern of use means that fundamental decisions will have to be taken at an early date on the relative priorities to be accorded to different services.

4.29 However, it will be essential for these decisions to be taken on an informed basis of consultation and discussion, nationally and internationally, and on the basis of a balanced assessment of the nation's social, telecommunications and industrial needs. The machinery and procedures for frequency management are already under some considerable strain, as is implicit in the terms of reference of our review, and explicit in the analysis of the four important usage groups summarised above. The increasing pressure which will be put upon the regulatory mechanisms in the future makes it all the more important to take the opportunity to look critically at them and to seek, wherever possible, to strengthen them. We have therefore devoted by far the larger part of our report to a detailed study of the regulatory machinery.



## CHAPTER 5

### ESSENTIAL ELEMENTS OF REGULATORY PROCESSES

5.1 We have found it helpful to distinguish three levels of decision making which are or should be involved in determining who uses what bands for what purposes. These are the formulation of policy, the allocation of specific bands for specific types of user, and the assignment of frequencies to users within those bands. Both policy formulation and allocation have to proceed in accordance with the results of yet another tier of decision making, the international level. The corollary of this is that a significant part of the decision making at broad policy and allocation levels is concerned with formulating national objectives and actions in international regulatory processes.

#### (i) Policy

Given the significance of the spectrum as a national resource, major decisions on its use need to be considered at a strategic level, in full awareness of the direct relationship between radio regulatory, telecommunications, Information Technology and industrial policies. It appears to us that it is all too easy for decisions at this level to go by default. The regulatory process should enable government to have an overview of the way the resource is being used, for example the balance between civil and military use or between broadcasting and common carrier use; of the options for change; and of the costs and benefits of changes and of maintaining the status quo. The aim should be to deploy this resource to the maximum benefit of the nation. This judgement, essentially political, on the balance to be struck between distinctively different and separate departmental activities with non-comparable costs and benefits ought not to be left to the practitioners of radio regulation themselves, without appropriate and evident guidance. All this may seem too obvious to be worth saying; but we believe (as we go on to explain) that it has in fact been largely neglected.

#### (ii) Allocation

The primary objective of the allocation process should be to secure the best practicable satisfaction of UK interests in the international negotiations for allocations of specified segments of the radio frequency spectrum for specified types of usage (eg broadcasting, aeronautical navigation, fixed common carrier links) in specified countries. The secondary objective should be to determine, for UK operations, a series of broad subdivisions that take account of the competing operational, technical and commercial interests in the provision of the services involved. Clearly such decisions have significant and long lasting consequences for those services and industries. The machinery of allocation should therefore not be a series of ad hoc decisions. Desirably, it should be as far as possible open to scrutiny, derived from appropriate consultation with users and manufacturers, and be evidently related to social, industrial and telecommunications policies.

#### (iii) Assignment

Assignment is the task of designating specific frequencies for use by specified persons for specified types of usage in specified locations. This is the day-to-day operational activity of most staff of the Radio Regulatory Department. The process should be swift, manifestly fair as between different users, and again should be as far as possible open. The applicant should know what is happening to his application, and if it is refused or granted in a modified way he should know why.



period of decades, of reducing the spectrum usage of the existing major users such as broadcasting or defence. These will be difficult decisions, and are ultimately political in character. We cannot, in 1983, say what those decisions ought to be; they can only be taken by the Government of the day, in the light of the spectrum needs of mobile radio and of the defence services, the state of development of other means of "broadcasting" (ie satellite and cable) and the importance attached to these activities by tomorrow's society. On the basis of our studies of the processes of frequency management and the operations of the major users, we conclude that:

- (i) there is no prospect of any significant reserve of unused or under-used spectrum being identified in the 30-960 MHz range and reallocated;
- (ii) the long timescale involved in bringing about major changes in the pattern of use means that fundamental decisions will have to be taken at an early date on the relative priorities to be accorded to different services.

4.29 However, it will be essential for these decisions to be taken on an informed basis of consultation and discussion, nationally and internationally, and on the basis of a balanced assessment of the nation's social, telecommunications and industrial needs. The machinery and procedures for frequency management are already under some considerable strain, as is implicit in the terms of reference of our review, and explicit in the analysis of the four important usage groups summarised above. The increasing pressure which will be put upon the regulatory mechanisms in the future makes it all the more important to take the opportunity to look critically at them and to seek, wherever possible, to strengthen them. We have therefore devoted by far the larger part of our report to a detailed study of the regulatory machinery.



## CHAPTER 5

### ESSENTIAL ELEMENTS OF REGULATORY PROCESSES

5.1 We have found it helpful to distinguish three levels of decision making which are or should be involved in determining who uses what bands for what purposes. These are the formulation of policy, the allocation of specific bands for specific types of user, and the assignment of frequencies to users within those bands. Both policy formulation and allocation have to proceed in accordance with the results of yet another tier of decision making, the international level. The corollary of this is that a significant part of the decision making at broad policy and allocation levels is concerned with formulating national objectives and actions in international regulatory processes.

#### (i) Policy

Given the significance of the spectrum as a national resource, major decisions on its use need to be considered at a strategic level, in full awareness of the direct relationship between radio regulatory, telecommunications, Information Technology and industrial policies. It appears to us that it is all too easy for decisions at this level to go by default. The regulatory process should enable government to have an overview of the way the resource is being used, for example the balance between civil and military use or between broadcasting and common carrier use; of the options for change; and of the costs and benefits of changes and of maintaining the status quo. The aim should be to deploy this resource to the maximum benefit of the nation. This judgement, essentially political, on the balance to be struck between distinctively different and separate departmental activities with non-comparable costs and benefits ought not to be left to the practitioners of radio regulation themselves, without appropriate and evident guidance. All this may seem too obvious to be worth saying; but we believe (as we go on to explain) that it has in fact been largely neglected.

#### (ii) Allocation

The primary objective of the allocation process should be to secure the best practicable satisfaction of UK interests in the international negotiations for allocations of specified segments of the radio frequency spectrum for specified types of usage (eg broadcasting, aeronautical navigation, fixed common carrier links) in specified countries. The secondary objective should be to determine, for UK operations, a series of broad subdivisions that take account of the competing operational, technical and commercial interests in the provision of the services involved. Clearly such decisions have significant and long lasting consequences for those services and industries. The machinery of allocation should therefore not be a series of ad hoc decisions. Desirably, it should be as far as possible open to scrutiny, derived from appropriate consultation with users and manufacturers, and be evidently related to social, industrial and telecommunications policies.

#### (iii) Assignment

Assignment is the task of designating specific frequencies for use by specified persons for specified types of usage in specified locations. This is the day-to-day operational activity of most staff of the Radio Regulatory Department. The process should be swift, manifestly fair as between different users, and again should be as far as possible open. The applicant should know what is happening to his application, and if it is refused or granted in a modified way he should know why.



5.2 To these three levels of decision making, we add three more areas of activity which, while implicit in the foregoing, are worth mentioning explicitly.

(i) Monitoring and Review

Frequency management should not end with the assignment of a frequency. Neither allocation nor assignment should be once and for all processes. The regulatory body should ideally be able to check the records of usage against reality. Allocations and assignments cannot usually be changed quickly, but this is no reason to regard them as fixed for all time: it should be possible to re-deploy spectrum which is underused or could be used more effectively.

(ii) Standards-setting

Efficiency in the use of the spectrum and the maintenance of a reasonable quality of service implies the imposition of standards for equipment and procedures. There is a variety of approaches - licence conditions, type approval, differential licence fees (and the advocates of spectrum pricing would argue that market forces themselves maximise efficiency in equipment and procedure). Whatever the regulatory philosophy adopted, the regulatory authority has a role in encouraging and enforcing good practice.

(iii) Forward Planning

The regulatory machinery should provide for regular systematic forward looks at the foreseeable trends in demand, technology, resources and opportunities for change. Such forward looks should be constructed around effective discussions involving the manufacturing industry and user communities in as open a manner as practicable, subject to commercial and governmental security.



## CHAPTER 6

### RADIO REGULATORY PROCEDURES IN THE UNITED KINGDOM

6.1 Responsibility for radio regulation in the UK rests with the Home Secretary, who is responsible both for UK participation in the international negotiations in the International Telecommunications Union and for licensing the use of the spectrum nationally, under the powers conferred by the Wireless Telegraphy Acts 1949 and 1967. His functions are carried out on his behalf by the Radio Regulatory Department, and can be summarised as:

- (i) International aspects: coordination of UK interests and representation of the UK at international discussions on the use and allocation of radio frequencies and on the technical and operating standards for radiocommunication services;
- (ii) National frequency planning: formulation of policy governing the planning and broad allocation of radio frequencies in the UK;
- (iii) Licensing of radio frequency usage nationally; non-Crown uses (except in relation to broadcasting); assignment of frequencies for particular licencees; specification of the technical standards to be observed and where necessary the technical specifications for equipment.

The Radio Regulatory Department (RRD) has a complement of some 250, of whom some 120 are professional and technical engineers, and it is headed by an Assistant Under-Secretary of State. It comprises two administrative divisions and the Directorate of Radio Technology. An organisational chart of the RRD and of the Home Office Broadcasting Department is at Annex L.

6.2 Until 1969, these functions were vested in the Postmaster General and the RRD formed part of the Post Office. At that time the Post Office was a Government Department, responsible both for policy on posts and telecommunications matters, and for the actual provision of those services. When the Post Office became a public corporation in 1969, those parts of it which dealt with matters more appropriate to Government were detached and formed a new Department, the Ministry of Posts and Telecommunications. This small Department was disbanded in 1974, and the responsibility for the international and internal licensing aspects of radio regulation and responsibility for broadcasting matters passed to the Home Office. Responsibility for other matters, such as the operational and industrial aspects of public common carrier telecommunications services, passed to the Department of Industry. The details of the regulatory process which we discuss in the remainder of this chapter have not changed significantly as a result of the Department's transplantations. However, post-1969, the engineering arm of the Radio Regulatory Department lost virtually all opportunities for the cross-posting of professional and technical staff, whereas before 1969 it had reported directly to the Engineer-in-Chief of the GPO and through him secured authoritative contacts with industrial and research developments over a wide range of telecommunications technologies in the UK and abroad.

6.3 While, for convenience, we speak of the regulation of the use of radio as the "responsibility" of the Home Office, this is in fact imprecise. Superimposed on the Home Office apparatus, largely within it but at the highest level outside it, is an interdepartmental coordinating committee structure. Both national and international frequency planning are conducted under the auspices of this structure (though within the Home Office); and it provides a machinery for the resolution, interdepartmentally, of those major conflicts or



difficulties over frequency allocation which cannot be resolved at the working level. It is extremely rare for problems over spectrum management to be taken to the highest level for resolution: probably less than once a year on average. This machinery appears then not to have been used at the highest levels in the formulation of general policy on spectrum management - it appears to be essentially only a conflict-resolving procedure. The foregoing is of course our own perception of the situation, but we doubt that it would be seriously questioned by those involved.

#### International Frequency Regulation

6.4 The interdepartmental machinery provides, at a lower level, for the coordination of the UK input to international conferences. It prepares the UK proposals and briefs for Administrative Radio Conferences of the ITU which periodically revise the radio regulations including the International Frequency Allocation Table. We have described briefly in our Interim Report (paragraph 2.2) the way in which national frequency planning is constrained by the results of international decision making.

6.5 The Administrative Radio Conferences derive considerable input from the highly technical work of the CCIR and the CCITT, the consultative committees of the ITU dealing with radio and telecommunications matters respectively. It is at these committees that technical, operational and industrial experts meet, at fairly frequent intervals, in international Study Groups to endeavour to develop acceptable technical bases for operation and regulation. As information technology and other development generates closer and firmer bonds between radio and wire (or optical) systems, there is increasing need to secure cohesion and compatibility in the work of these two sets of committees at all levels, national and international. We observe that not only does the division of administrative responsibility for these two functions between the Home Office and the Department of Industry create practical problems in achieving cohesion, but that the intended privatisation of British Telecom and the proposed creation of a body such as OFTEL could create additional administrative boundaries in an area which is both fast moving and of great complexity.

6.6. We note, also, the emergence over the past two decades of a European telecommunications coordinating and planning body, the Conference of European Posts and Telecommunications Administrations (CEPT) operating at inter-governmental levels. Virtually all other European telecommunications agencies are departments of state covering both regulatory and executive functions. Increasingly therefore the UK has, in its approach to international standards and regulation, participated in and been obliged to take note of the influence of, the CEPT and the added complexity that this implies.

#### National Radio Frequency Regulation

6.7 Part of the function of the interdepartmental coordinating machinery is to produce and update the UK National Frequency Allocation Table. This document, which is classified, sets out the international allocations and alongside each entry the allocation to services in the UK. In most cases this follows the international allocations but differs in some cases to meet the UK's special requirements, provided that there is no infringement of the international radio regulations. For example, a band shared between a number of radio services internationally may be restricted to one of them in the UK. In other cases the status of services may be altered. For example, radio astronomy might be given secondary status internationally but given equal primary status with other radio services in the UK. These decisions are the result of consensus agreement arrived at collectively through the coordinating machinery.



6.8 The UK Table is accompanied by footnotes which qualify the use to be made of the frequency band concerned and also identify the usage, or name the department to which the band is allocated. Where a frequency requirement cannot be met within the allocated bands the department involved can seek agreement bilaterally with other departments concerned, or through the coordinating machinery, to obtain access to other bands.

#### Frequency Assignment and Licensing

6.9 The detailed work of assigning frequencies within the allocated bands is carried out by the Radio Regulatory Department or in some cases is delegated to the user. In most bands, assignments must be cleared within the interdepartmental machinery for national, and if necessary international, registration. Supplementing this frequency clearance process there is a separate site clearance procedure to resolve on-site and proximity interference problems before they arise and to avoid unnecessary proliferation of radio sites.

6.10 At this stage a distinction needs to be drawn between Crown and non-Crown users. Crown users of the spectrum, eg the Ministry of Defence, Foreign and Commonwealth Office, do not require licences from the Home Office and they are in general free to make their own plans and manage their own assignments within the frequency bands allocated to them. Non-Crown users require a licence issued under Section 1 of the Wireless Telegraphy Act 1949 by the Home Secretary. Frequency assignments for non-Crown users are made by the Home Office itself, or by the user on a delegated basis and subject to Home Office approval. The frequency assignment is then included in the licence.

6.11 The BBC, IBA, British Telecom and Mercury each have a single omnibus licence with schedules authorising the use of their various frequencies. The fees payable for these omnibus licences are subject to negotiation between the organisation and the Home Office.

6.12 Other users must apply for one of a variety of standard licences, for which the fees are fixed by Statutory Instrument. Regulatory policy is imposed both by the decision to licence or not to licence certain types of service (eg until 1981 licences were not issued for CB radio); and also by the conditions attached to the issue of a licence. Licences are valid for one year (some of the less expensive ones are valid for longer) and there is no legal right to renewal; however, as long as the renewal fee is paid and the conditions of use of the equipment have not been breached, licences are normally renewed as a matter of course.

6.13 There are about seventy types of standard licence to meet a variety of needs. The licences also specify technical criteria to be observed including, where necessary, technical specifications for equipment, except in the case of police and fire radio services for which technical guidance is given by the Directorate of Telecommunications (D Tels), Home Office. In general, however, technical guidance is given by the Radio Regulatory Department following discussions with equipment manufacturers and users and, where desirable, may follow specifications recommended by the CCIR of the ITU or, for European use, by CEPT.

6.14 These licences issued by the Radio Regulatory Department under the Wireless Telegraphy Act are distinct from those issued by the Secretary of State for Industry under the British Telecommunications Act 1981. The Home Office licences represent permission to use radio in such a way as to meet our international obligations and not to inconvenience other users. Those issued under the 1981 Act are designed to permit operation in competition with British Telecom or in areas where British Telecom is entitled to provide a service but



chooses not to. The Telecommunications Bill considered by the last Parliament and which fell when Parliament was dissolved would have set up a new body, the Office of Telecommunications (OFTEL) headed by a Director-General of Telecommunications. Under such an arrangement, the Secretary of State for Industry would be able to delegate his licensing power to the Director of OFTEL, and would be required to consult the Director before exercising the power himself.

6.15 At the time of writing this Report the distinctive responsibilities which had been envisaged for OFTEL and the Home Office were perceivable, but it was by no means clear how the relative powers of these two bodies would have been exercised in relation to applications for licences and the maintenance of effective spectrum usage. Also during this period, the Government's White Paper on Cable Systems and Services\* was published. It is similarly unclear how the relative licensing of cable operators, cable providers and such radio systems as may be needed (eg for ancillary services) would be achieved. The issue is not only one of procedure; it is one of the cohesion of individual policies. If one of the licensing bodies, for example the Home Office for radio channels, found a particular part of the spectrum already saturated, as might well be the case, then that decision might well frustrate prior decisions taken on other grounds by other Departments. We do not doubt that in practice there would be coordination; but we note that the commercial and service consequences of the realities of radio regulation do not appear to have been taken into account in some recent governmental proposals.

#### Licensing Policy

6.16 RRD's licensing policy is to group users of radio in frequency bands within which individual assignments for similar radio services can make the best use of radio frequencies without harmful interference. Reasonable life-time has to be given to existing systems to make a just return on the investment, but use is made of advancing technology to improve the efficiency of spectrum usage. Radio licences are not given where the user's needs can reasonably easily be met by alternative means of communication, such as, in the case of applications for private radio fixed links, British Telecom or other common carrier services. CB apart, mobile radio services are in general confined to commercial or public use.

#### Consultative Machinery

6.17 In the field of land mobile radio, the Home Secretary receives advice from the Mobile Radio Committee on which manufacturers, users and some independent viewpoints are represented. A continuing dialogue is maintained with equipment manufacturers in the Land Mobile Working Party and with both manufacturers and commercial users in the Microwave Fixed Links Committee. The development of new radio applications is catered for by the issue of testing and development licences. When development reaches the stage where a new operational use is foreseen, the consultative process outlined above or bilateral talks with the company concerned help to guide the applicant to the appropriate frequency band for the new application. Where no existing band is available, it is the responsibility of the Home Office in agreement with any other Government Departments concerned, bilaterally or through the interdepartmental machinery, to identify a new area of spectrum which conforms to the UK's international and national obligations. The development of telemetry for medical purposes in a part of a military band is an example of this approach.

\*Cmnd 8866, April 1983



## Competition for Spectrum Space

6.18 Constraints on the growth of usage of the radio spectrum arise from an excess of demand over available spectrum space, and it is at that point that priorities enter into frequency allocation or assignment policy. However, congestion is not uniform over the country or over the whole spectrum. The propagation characteristics of different parts of the spectrum vary and indicate correspondingly different types of usage and hence differing levels of demand. Similarly, the state of development varies, so that for some parts of the spectrum equipment is already designed and involves relatively low investment. Other parts are relatively or completely unexploited and call for the use of heavy investment with sophisticated and expensive equipment. To give one example: the High Frequency bands are under heavy demand for long-range circuits using relatively simple equipment. For advanced countries the need has been met by switching to fixed satellite services, such as INTELSAT, that have been developed in the 4 and 6 GHz bands, and are now moving to the 10 and 14 GHz bands. There are even higher bands which can be exploited progressively to meet further demands as technology advances.

6.19 Another example lies in the land mobile field where the narrowing of channels, the adoption of trunking and the use of common base stations, as well as the phasing out of fixed services, all help to satisfy increasing demand albeit at higher cost by the use of more sophisticated equipment. More space is available at UHF (450 MHz) than VHF, but this is more costly to exploit. In the higher UHF band (900 MHz) the required technology is now becoming available in the UK. Since, for propagation and technological reasons, terrestrial land mobile systems need to be accommodated below 1 GHz, there will inevitably be continuing competition in the immediate future between land mobile and other services where the frequency bands are shared. But new possibilities are being explored for mobile services provided by satellite at much higher frequency ranges (above 10 GHz) hitherto considered impracticable.

6.20 The resolution of conflicting demands for spectrum, at the level of frequency band allocation to services rather than at the level of frequency assignments to individual stations, is one of the most difficult tasks of the frequency regulatory machinery. The approach employed for many years has been to accommodate new requirements with the acceptable minimum of disturbance to existing users, exploiting every factor in the competing services to find a solution. Factors such as geography, timing, compatibility, flexibility, even the nature of the operational requirement for a new service and the radio techniques proposed, have had to be examined to ensure that only the minimum spectrum requirement was stated and met. Generally, solutions have been found at the working level, though these solutions are inevitably compromises which leave some or all of those involved dissatisfied. This approach worked more or less successfully for many years, but has come under increasing pressure in recent years as demand for spectrum has grown.

6.21 Only when no acceptable solution could be found at the working level of the interdepartmental machinery have cases been referred to higher levels for decision. Since 1945, perhaps half a dozen such cases have been referred to Ministers; the fact that most of them directly or indirectly involved broadcasting is a reflection of the intense public interest in this service and of the high costs involved in any frequency changes affecting the service.



## CHAPTER 7

### INTERNATIONAL COMPARISONS

7.1 In preparing our response to our tasks, we considered that an insight into the regulatory machinery in certain other countries would be of considerable value. Such knowledge would provide a sound basis for comparison with UK practices, it could generate ideas for alternative approaches in the UK or at least provide some reliable indication of the relative merits of alternative approaches, and it would help to put into perspective those comments which were likely to be submitted to the Review in which UK procedures were compared with overseas practice.

7.2 In order that the comparisons should be realistic we decided to include in the study only industrialised democracies in which the technical development of radio communications had reached a fairly advanced stage and the use of radio was such as to put considerable pressure on the spectrum especially in the range 30-960 MHz. In view of the time available - about eight weeks for the preparatory work, visits to the countries and subsequent preparation of the report - the number of countries was limited to four, and for the reasons outlined above those selected were, in the order visited, the United States of America, the Federal Republic of Germany, France and Japan.

#### Method of Working

7.3 We recognised at an early stage that although some information was available on the radio regulatory practice in at least some of the countries selected, this information was fragmented, not always up-to-date and certainly far from complete. To obtain further information by correspondence would have taken more time than we had available. A study at first hand was therefore needed, and this had the additional benefit that it would make it possible to obtain more detailed insight into the internal workings of the government machinery and, of particular significance, the reaction of users of the spectrum to the operation of that machinery.

7.4 The Review team invited the Home Office to nominate someone to carry out this task and Mr Michael Goddard was appointed by the Department. He had previously worked in the Radio Regulatory Department, both as an engineer and as an administrator and had been closely involved in the international aspects of radio regulation.

7.5 Mr Goddard spent some three to five days in each country. In each, meetings were arranged with representatives of the main regulatory authority and where possible with selected government departments, broadcasting interests, radio users and radio equipment manufacturers. Because the visits were planned at short notice it was not possible to cover the same range of interests in all four countries but nevertheless the contacts made were sufficiently representative to obtain a reasonably accurate picture of the situation in each country.

7.6 The detailed notes he made during the visits and the documents he collected including national frequency tables and relevant legislation have been available to us. In addition Mr Goddard made a written report and discussed his findings with us. A summary of his report is at Annex E.

7.7 The differences between countries in style of government, pattern of radio use and industrial infrastructure mean that it is unwise to put too much reliance on international comparisons. However, there are a number of points exposed by our international study which we believe are particularly worthy of mention.



## Nature of the Regulatory Authority

7.8 In the United States, a dual structure exists: the non-governmental use of the spectrum (but including local and state government) is regulated by an independent body, the Federal Communications Commission, which operates in a completely open way and has quasi-judicial procedures; management of governmental spectrum use, and responsibility for fundamental frequency allocation, rests with a government agency, the National Telecommunications and Information Administration (NTIA), a part of the Department of Commerce. The other countries studied all have Ministries of Posts and Telecommunications which take responsibility for radio regulatory matters. In France and Germany, the Ministries also provide the public telephone service. This is of assistance to the radio regulatory function as the comprehensive network of regional and local offices which already exists affords opportunity for limited delegation of certain actions. In Japan, national and international telecommunication services are the responsibility of two separate public corporations, and the Ministry has only regulatory and policy responsibilities, though it still operates postal services.

## Openness and Style of Spectrum Management

7.9 Considerable differences between countries are apparent here. The United States is often quoted as the paradigm of the open system and indeed our study confirmed that the management of the spectrum, other than that allocated to federal government, is carried out in an open manner. However, while this openness appears to command the support and approval of the user communities in the USA, we note that it is achieved only at considerable cost both in financial terms and in time scales. The FCC's rule making procedure and the legal battles that are often entailed lead to extremely long delays in reaching final decisions on all matters other than routine frequency assignments. The costs to users (unsuccessful as well as successful applicants) are not possible to quantify, but must be extremely high, as must the running costs of the FCC itself. It should also be noted that this degree of openness does not extend to the determination of the balance between the civil and military use of the spectrum, or to federal governmental use generally. These matters are, by US standards, closed and we gather that this is, as in the UK, the subject of some criticism.

7.10 The style of frequency management in France seems to be similar to that in the United Kingdom; similar problems are faced and similar complaints are voiced. The authorities in Japan and West Germany maintain a tight control over spectrum usage and thereby achieve high spectrum efficiency but at the cost of imposing strict requirements upon users. Regulation in these three countries does not seem to be significantly more open than in the UK, although Japan has an Advisory Council which reports direct to the Minister and acts as a "watch-dog" and in West Germany liaison between the authority and users is helped by the existence of disciplined user associations.

## Stability of Staffing of the Regulatory Authority

7.11 Continuity and stability were evident in the staffing of the overseas regulatory authorities. Mr Goddard encountered many officials who were familiar from previous personal contact in preparation for conferences in 1979, 1977 and even earlier. There was some surprise abroad at the turnover of staff, particularly administrative staff, in the UK. There was also a much less rigid distinction in most of the countries investigated between administrators and engineers. Administrators in eg West Germany generally had long experience of telecommunications, and many had engineering backgrounds. It was thus possible in these countries for one representative only to attend an international meeting on a particular subject, as he was competent to cover both the administrative and technical aspects.



## Staff Levels

7.12 Because of the different types of organisation involved, and their differing responsibilities, it was found almost impossible to establish adequate comparative figures on the number of staff employed in radio regulatory work. However, some figures were obtained which indicate the orders of magnitude. In the United States, the FCC alone has some 2,200 staff, and further staff are employed on government spectrum management in the NTIA. Some 700 of the staff of the Japanese MPT are employed on frequency matters, mostly in local offices. In West Germany some 700 staff are involved, about 500 of whom are directly involved in licensing.

7.13 For comparison, the complement of the Home Office Radio Regulatory Department is some 250. All we would say with any confidence is that the number employed on this work in the United Kingdom is certainly not greater than in any of the other countries studied, and is substantially less than in the United States, even when allowance is made for differences in population and usage of telecommunications services.

## Monitoring

7.14 All four countries appear to take monitoring seriously with fairly extensive exercises to measure spectrum occupancy and to check on compliance with licensing conditions. In the case of the United States, and probably elsewhere, such activities extend into the government use of the spectrum. In addition, West Germany and Japan in particular enforce equipment standards not only by type approval but also by examining individual installations which is admittedly expensive but the costs are recovered either directly or through the licence fee. Intensive monitoring ensures that most installations are operating according to licence conditions, that frequency usage records are accurate and that violations of the regulations are detected. It is possible also that such activities result in the regulatory authority being held in higher regard by users than would otherwise be the case.

## The Basis for Calculating Licence Fees

7.15 In none of the countries we studied, and in no others that we are aware of, are licence fees set to reflect the "market price" of the spectrum. Apart from the USA, where no licence fee at all is charged, fees are in general set to recover the costs associated with the administration of licensing and frequency assignment, which is the approach adopted in the United Kingdom. While a particular fee may not precisely reflect the costs associated with issuing the licence, the overall intention is to simply balance the books, rather than to raise revenue or to charge a realistic price for spectrum.

7.16 It is noteworthy that in the USA the FCC has not only abandoned charging a licence fee altogether, following a court decision overturning the basis on which it set the fees, but seems unlikely to attempt any spectrum pricing for the present at least, notwithstanding the degree of attention that has been paid to this idea in the United States.

7.17 West Germany has made limited use of the device of weighting fees, to attempt to persuade mobile radio users away from private radio and into the public system. France has done the same, with little success apparently, in the area of fixed links. In Japan, the fee for the inspection of equipment, which is compulsory, is calculated separately and accounts for a high proportion of the cost to the user.



## Publication of a National Frequency Allocation Table

7.18 All four countries publish a national frequency table showing, with varying degrees of detail, the agreed allocation of frequency spectrum to various services and users. In some cases, the spectrum allocated to the armed forces is shown explicitly. The equivalent table in the UK is a classified document, and hence is not publicly available. However, a comparison between the UK table and the published tables from the other countries reveals many similarities in terms of the details shown.



## CHAPTER 8

### STRENGTHS, WEAKNESSES AND CRITICISMS OF EXISTING PROCEDURES

8.1 During our work, we have had many opportunities to meet and talk to those involved in all aspects of the regulatory process - engineers and administrators in RRD and senior officials in the Home Office and other Departments. They talked to us frankly about their problems and the flaws they saw in the present system. In the written and oral evidence we received, there was a considerable volume of criticism of the workings of the present procedures, ranging from the mildly reproachful to the abusive. A certain level of criticism is perhaps unavoidable when a limited resource has to be rationed and some applicants are given less than they have asked for. Much criticism, too, was made from a position of ignorance; though the critics would quite rightly say that this was not their fault and that they would like nothing better than to be able to comment from a position of knowledge. Allowing for these factors, it is clear that there is a very considerable level of unease in many parts of the user and manufacturer communities. The setting up of this Review with the terms of reference it has is evidence that this unease is shared in some measure at least within the Home Office

8.2 We have taken note of all the points made in the evidence and we have weighed them against our own perceptions of the regulatory process. We think it is significant that, of all those we have spoken to or taken evidence from, the only parties who expressed satisfaction with the present procedures were the Ministry of Defence, the Civil Aviation Authority and the broadcasting authorities. The criticisms expressed by some of the local authority associations and the representative bodies of the fuel and water industries (the Joint Radio Committee of the Nationalised Power Industries, and the National Water Council) were relatively muted; the toughest criticisms came from the bodies representing the private users and manufacturing industries. Whether or not the harshest of the criticisms are justified, there is a clear need for some bridge building: the restoration of a greater level of confidence, of trust and indeed of knowledge among the private user and manufacturer communities.

8.3 Since most of this chapter deals with criticisms of the present procedures, we should mention the significant areas which were not subject to criticism, or indeed were singled out for praise. In particular, few if any of those offering evidence criticised the technical expertise and competence of the Department and its judgements. No one said that it took decisions which were wrong (though the central point of some complaints was that the system was too closed for such a judgement to be made by an outsider). Several of those who expressed quite strong criticisms of the machinery were at pains to add that they were entirely satisfied with the level of help and cooperation they received from the officials in the RRD, once they had made contact with those officials. A recurrent theme was that it was very difficult to find out whom to talk to about a particular matter, but that when contact was finally established the response was helpful and efficient; and many respondents clearly valued the quality of their informal day-to-day relations with the RRD. The defects, we were told, were in the system not in the individuals who were toiling to make it work.

8.4 Few of the respondents commented on the RRD's activities in international regulation. The comments we did receive were entirely to the Department's credit. Within the rather restricted community of those who understand the international radio regulatory world, there is a very high level of regard for the Radio Regulatory Department's competence and effectiveness on the world stage.



8.5 There is a degree of consensus among critics as to the major weaknesses of the present procedures. On reading the submissions and listening to oral evidence, we found the same words and phrases frequently recurring: "slow"; "closed"; "lack of consultation"; "lack of information"; "under-staffed"; "not responsive to users' needs"; "insufficient weight given to manufacturers' needs"; "has a reactive rather than positive approach". Our study of the regulatory processes and of the evidence put to us, leads us to identify four significant areas in which the existing machinery shows weaknesses. We see problems of institutional structures and relationships; a lack of openness and credibility in the regulatory process; problems of resources and staffing; and a limited ability to respond to demand and change.

#### Institutional Structures and Relationships

8.6 The position of the RRD as a part of the Home Office has some effect on the way it functions. The split of Ministerial responsibilities between regulatory policy on the one hand and telecommunications and industrial policy on the other is noted as a defect by many critics. It is generally felt that there is insufficient coordination of regulatory with industrial and telecommunications policy, and that this is increasingly damaging in its effects as the spectrum becomes more congested and as the pace of change in telecommunications and related industries accelerates. We discuss these weaknesses and possible remedies in Chapter 13. We heard of no comparable criticisms from users or industries concerned with, for example, aerospace or military systems, where user, industry and radio regulatory functions were fully associated if not integrated.

#### Openness and Credibility of Processes

8.7 There is little awareness among users of the nature of radio regulatory activities. Decisions about spectrum allocations are taken within Government, which is perhaps unavoidable, but there is a wide degree of dissatisfaction with the quality of the consultation on these matters. At the level of individual assignments, the process appears to the applicant to be closed. The user has little understanding of how his application is being processed, or why, and we have heard criticism that there is too little introductory explanatory information for the benefit of the would-be user. A disappointed applicant has no assurance that his case has been fairly dealt with. The result of all this is that there is nothing to reassure the private user, and certainly no way he can know directly, that the allocation of bands and the assignment of frequencies is being carried out fairly and reasonably. Nor can the representatives of industry and commerce be reassured that due weight has been given to the industrial and economic implications of these decisions. In these circumstances, it is only those bodies which are to a greater or lesser extent "in the know", eg the CAA, defence, the broadcasting authorities, which remain reasonably satisfied.

#### Resources

8.8 Like all other parts of the public service, the Radio Regulatory Department has been required to keep its expenditure and staff numbers severely in check. Several of those who have commented on delay in frequency assignment work have attributed it to under-staffing. The shortage of engineers is marked, and is particularly harmful in its effect. The problem is serious because, with the increasingly intensive use of the spectrum, more and more frequency assignments will not be able to be dealt with as routine by reference to rules, but will require a considerable amount of technical work before a usable assignment can be identified. Staff shortages will thus increasingly lead to delays. Furthermore the shortage of staff hinders effective spectrum monitoring.



8.9 The Department faces a further problem as a result of the small size of its engineering branch and the relative isolation of that branch. It is difficult in these circumstances to sustain professional expertise at a high pitch. The engineers in the Directorate of Radio Technology do not form part of a wider group of such engineers either in the Home Office or in the Government service generally, though there is a limited interchange of staff with the Home Office Directorate of Telecommunications. With the administrative staff, particularly at the more senior levels, the problem is one of maintaining continuity and expertise in a field which is totally unrelated to the Home Office's other activities. Expertise, built up over several years, is squandered when a member of staff moves in the course of normal career development back to another section of the Home Office and is replaced by someone with no grounding in radio regulatory work. This imposes considerable strains not only on the administrators themselves but also on the engineering staff, as it throws a greater burden of responsibility on the latter as the only providers of continuity within the Department. This practice on occasions weakens the UK stance in international negotiations, when protagonists from other countries have a continuity and ease of contact denied to us.

#### Responsiveness to Demand and Change

8.10 The present regulatory machinery is widely felt to be essentially reactive in its approach: in general, spectrum management decisions are taken only in response to the pressure of events, and not as part of a deliberate, positive, strategy for making the best use of the spectrum. For many years, when there was less pressure on the spectrum, this was not a cause of concern and indeed could be represented as a tidy and economical means of administration. However, with the growth in demand for spectrum and the pace of technological change, this approach is increasingly felt to be unsatisfactory. To exploit technical developments and to secure commercial competitiveness UK industry needs to react quickly to new opportunities and needs a speedy and flexible response from the RRD.

8.11 The problems arise in part from the shortage of staff. At present, the Department is more than fully stretched attempting to cope with the burden of day to day work responding to demands as they arrive; in consequence, it is difficult for it to look ahead and to develop a long-term policy.

8.12 However, staffing is not the only problem. Some respondents have pointed to what they see as a lack of foresight and a slowness to react, but we do not believe that there is any significant lack of awareness and foresight among the engineers and administrators in RRD; the problem is rather that even when a problem and a need for change has been identified, it is difficult to generate the necessary political and administrative imperative to carry the change through. A positive and responsive frequency management strategy, and the development of a long term plan, necessarily involve exerting authority over users and taking away as well as giving. Our feeling is that the regulatory machinery at present has no difficulty in identifying that which ought to be done in the interests of good spectrum management. However, it finds it difficult to generate the necessary momentum to carry its view against other powerful interests. It is a truism of administration that problems tend not to be tackled until they become critical and we believe that spectrum management offers some illustrations of this. The RRD's relative lack of weight and the fact that regulatory issues take a very low priority means that it is difficult to implement changes except under the pressure of events.

8.13 But our criticism is wider than this. Industry itself, with some notable exceptions, must accept the fact that an awareness of the relevance of radio spectrum regulation and effective usage is not perceived as a compelling factor in the early stages of product development or system design. The RRD's weight



is therefore diminished still further since it is so frequently seen as an obstacle to progress late in the day, rather than a partner fully involved and fully committed in the early stages of product or system development with awareness of marketing and manufacturing strategies as well as of technical detail.

#### Current Policy Background

8.14 Before looking in detail at options for change, we believe that we must restate a problem we have already identified since it is so fundamental to our critique. The problem is the lack of cohesion or coordination between regulatory and other policies, notably industrial policy and telecommunications policy. The requirements of different policies, all justifiable in their own terms, can pull in different directions with regard to the use of the spectrum, and thus lead to inefficiency.

8.15 Spectrum considerations rarely impinge on the formulation of policies and strategies, whether in Government, in industry or in commerce. Radio is taken for granted as a resource which is always available and is perceived as largely cost-free.

8.16 Even during the period of our Review, we have seen developments in telecommunications policy being taken forward at great speed. On the evidence available to us, little if any consideration appears to have been given beforehand, for lack of time if for no other reason, to the radio regulatory consequences. Inevitably, problems arise over spectrum availability and the regulatory process comes to be seen, quite unfairly, as a hindrance to progress instead of, as it should be, an essential and constructive element in any coordinated strategy on telecommunications. Spectrum regulation needs to be seen as an essential component in the development of telecommunications and associated industrial policies. An earlier and more positive grappling with the radio regulatory implications of decisions will however require policy makers to face up to difficult judgements on priorities.

8.17 We are in no doubt that the importance of spectrum considerations needs to be taken into account at a much earlier stage and that in particular the interests of Government would be better served by greater coordination between regulatory and other policies. Later in the Report we shall make specific recommendations for improvement in this area.



## CHAPTER 9

### FREQUENCY SPECTRUM MANAGEMENT

9.1 We perceive a need for radical change in the Radio Regulatory Department's approach to spectrum management, from an essentially reactive to a positive approach. By a reactive approach we mean dealing with the problems as they arise, and seeking to satisfy new claims with the minimum disturbance to existing users. The positive approach which we believe will become increasingly necessary means adopting a more interventionist management philosophy, in which spectrum management decisions are taken, and imposed upon users, on the basis of strategic planning and of considered assessments of future need. The spectrum is a resource which needs to be deployed to the best advantage, and this is not necessarily obtained by simply accommodating each new user on a first come first served basis, without reviewing existing usage. The priorities of yesterday may be changed completely by the growth of new demands, and spectrum management policy must be flexible and positive enough to respond to a changed situation - even though, because of the cost of equipment involved, any change necessarily has a long lead time. The difficulty of bringing about change only increases the importance both of long term forward planning and of swiftness of response.

9.2 In the rest of this chapter, we discuss the practical changes, and certain associated changes of underlying philosophy and attitudes, necessary to give effect to a more positive spectrum management policy. These include:-

- (i) openness and external relations: the development of better relations with and knowledge of the user and manufacturer communities; and the fostering of more openness generally;
- (ii) the machinery for allocation: the involvement of an authoritative and high level advisory committee in the frequency management process, both to introduce an element of openness and to give the regulatory body's decisions more authority and weight;
- (iii) the greater use of judgements of worth, including cost/benefit analysis;
- (iv) the use of licence fees as a tool of spectrum management;
- (v) the greater use of monitoring of the spectrum.

#### Openness and External Relations

9.3 One of the most widespread criticisms of the present procedures was, as we discussed in Chapter 8, that they are too closed. At the lowest level, applicants have little idea of what happens to their applications or why, and of the background to the delays and problems which sometimes arise. There is no published set of rules or policy guidelines which would indicate to potential users what uses of radio are and are not permitted, and the justification for such decisions. At a higher level, the allocation of frequency bands to particular services is in effect largely closed even though there are several consultative or advisory committees whose views might in principle be expected to influence the allocation decisions. The user and manufacturer communities clearly do not feel that they have any significant say in allocation decisions. At the most general level, we have seen no evidence that the RRD undertakes any significant public relations activity, or seek to explain its structure, its activities or the need for these activities, to users or to the community at large. In this, it is in the traditional mould of Government departments, but it contrasts sharply with the telecommunications authorities of many other countries, who appear to attach considerable importance to public relations.



9.4 We also feel that there are insufficiently strong links between the RRD and manufacturing industry, commerce and the scientific world. We acknowledge that the problem is at least in part a result of the shortage of staff, which means there is little free time to devote to fostering such links. However, both the elements we have identified - improved relations with customers on the basis of better mutual knowledge, and stronger links with the industrial and scientific communities - are essential to improve and sustain the RRD's authority and credibility. These will in themselves make regulation easier, and we believe that the investment of time and money in these activities can easily be justified by the prospect of improved effectiveness. Recommendations aimed at bringing about these changes follow.

9.5 If the RRD were to form part of a separate department responsible for telecommunications (which as we go on to discuss in Chapter 13 is a development we would welcome) this in itself should open the way for improvement. A telecommunications department could adopt a more customer-oriented approach and could be expected to mount a substantial public relations effort, a part of which could easily be devoted to familiarising customers with the work of the RRD and the rationale for its operations, and helping them to appreciate the realities of spectrum management problems. The staff of a telecommunications department would also, we imagine, be in very close liaison with the industrial, user and scientific communities.

9.6 We recommend the publication of an Annual Report by the RRD. We envisage this covering two main areas: a review of the current state of spectrum management, and information on the administration of the department. Under the first heading might come an analysis of changes and trends in spectrum usage; information on past and forthcoming international conferences and their likely significance; policy developments which were having or seemed likely to have an influence on spectrum management (eg the liberalisation of telecommunications); some evaluation of the results of spectrum monitoring; and relevant statistics. The section on administration might describe any changes in structure and working methods, note any changes in senior staff (we would see this as part of a deliberate policy of making senior staff and their responsibilities known to the user and manufacturer communities); and statistical information on case loads, average time to deal with cases, backlogs of work, staff turnover, and any staffing shortfalls.

9.7 The Advisory Committee which we propose and describe in more detail in the next part of this chapter should also help. Any reports, reviews, recommendations or other documents it prepared or commissioned, including its annual report to the Minister, would wherever possible be published. We see the work of this Committee as an extremely valuable bridge between the RRD and the user and manufacturer communities, and would see its publications as having a valuable educative function. The Advisory Committee's report to the Minister would comprise the Committee's recommendations and those reports that had not otherwise been published; any forward looks it had carried out or commissioned; and the Committee's own review of the operation of spectrum management for the year, based both on its own observations and on the RRD's report.

9.8 We recommend that the RRD institutes regular reviews not less than every five years, related to specific user groups or systems, of the growth in spectrum usage, technical and operational changes taking place or foreseen, and spectrum efficiency. These Reviews would in time embrace all user groups both governmental and non-governmental and should be carried out by the RRD in conjunction with representatives of the user groups and the manufacturing industries concerned. The results of these reviews would, as far as considerations of security and commercial confidentiality allowed, be published in the Annual Report, as would proposals for future reviews.



9.9 We recommend that in addition to the publication of an Annual Report explanatory material be produced, to a high standard of presentation, for the user, potential user, or general reader. The absence of any public relations effort at present is, we believe, a hindrance to good relations between the RRD and its customers. The content of this material might cover the structure of the RRD; the functions of its various parts; the frequency management process (both national and international aspects); the consultative machinery, and means whereby individual users' or manufacturers' views can be made known; the procedure for applying for frequency assignment, the stages through which such an application progresses within the Department, and the reasons for these stages; and an account of the current pressures on the various parts of the radio spectrum and of the frequency management problems this causes.

9.10 Our overall aim, it will be seen, is that in the administration of the radio regulatory machinery there should be a presumption of openness at all times save when this is inescapably and demonstrably not desirable, rather than the reverse. This is a change in attitude rather than in procedures and no formula can be devised for achieving it overnight. It requires a conscious effort by management, over a long period, to modify their own attitudes and to inculcate more open attitudes into their staff. There is however, one action which could be taken which would be widely seen among users as a demonstration of good intent: it is the publication, with the retention of as much detail as possible, of the Frequency Allocation Table. The UK Allocation Table is currently a classified document; the administrations in the four other countries we studied, and we suspect in many others, find it possible to publish a table containing very much the same information without any prejudicial effect to their security, and we see absolutely no reason why the UK should not follow suit. Accordingly, we recommend that the Frequency Allocation Table should be published.

#### The Machinery for Allocation

9.11 We set out in Chapter 8 the main weaknesses and criticisms observed in the present structure. The most important of these in the context of the allocation machinery is the question of visibility and credibility. We reserve until Chapter 13 our discussion of the main options for structural change, but in the following section we consider a change which could be effected within the present structure.

9.12 We have considered what might be done to ensure that allocation decisions are taken with openness, in coordination with other areas of policy, and in consultation with the user and manufacturer communities. In Chapter 6 we described briefly the existing structure of departmental advisory committees. This committee structure seems to have grown up piecemeal, and while it is undoubtedly useful, our view is that none of these committees has the scope or the authority necessary to make a real contribution to governmental policy making at the level of major allocation decisions.

9.13 We note that there used to be a committee, the Frequency Advisory Committee, with the following terms of reference:-

"To advise the Home Secretary on the broad aspects of radio frequency planning with a view to the efficient use of the radio frequency spectrum and the economic development of equipment for that purpose by the radio industry."

It comprised representatives of users, manufacturers and Government Departments. It was abolished in 1980 after a long period in which it never met.



9.14 Notwithstanding this discouraging precedent, we believe there is a need for a high level Advisory Committee which is able to speak with authority, grapple with major issues of principle rather than being sidetracked into trivialities, and which does not allow itself to become a talking shop for representatives of numerous lobbies. We therefore recommend that such an Advisory Committee be established.

9.15 The Committee should preferably be a statutory one and should comprise a small number of members, say eight to ten, appointed by the Minister as individuals rather than as representatives of different interests. They should be selected from people of high standing and authority in the user, service provider and manufacturer communities. The Ministry of Defence should be represented, as should the RRD and the Department of Industry. Responsibility for appointments should rest with the Minister, and the emphasis should be on securing members of high calibre and high public standing, rather than attempting to secure breadth of representation.

9.16 We see advantages in the secretariat being provided by the RRD. However, servicing this Committee should not be allowed to degenerate into a routine administrative task; we see the Committee's deliberations as forming a key part of the regulatory policy making procedure, and the calibre, grade and number of administrative staff servicing it should reflect this. We visualise that it might meet quarterly. We believe that the Advisory Committee's reports and other working papers should as a rule be publicly available, though we appreciate that exceptions may have to be made on the grounds of security or of commercial confidentiality.

9.17 We believe the functions of the Advisory Committee should be as follows:

(i) to receive from the Regulatory Department, and to pass on to the Minister, an Annual Report from the Department; and to make its own report to the Minister in which it would both describe its own activities and comment on the Department's Report. We envisage the Minister publishing both reports, probably as a single document;

(ii) to advise the Minister on major allocation questions;

(iii) to advise and comment on guidelines for the RRD in dealing with the minor allocation matters and frequency assignment issues which constitute the major day-to-day executive burden of the Department. These guidelines would be published and would be evidence of the attitudes taken by the Department in conducting its business;

(iv) to commission or to undertake forward-looking studies on, for example the future growth of demand, possible developments in technology, or possible opportunities for manufacturing industry; and to report on these to the Minister by means of the Annual Report;

(v) to advise on the UK input to international regulatory conferences;

(vi) to review from time to time, and to advise the responsible Minister on, the administrative effectiveness of the regulatory machinery;

(vii) to draw the Minister's attention to any matters of concern.

9.18 By such means, the user, service provider and manufacturer communities would know that any allocation decision had been taken either on the basis of specific advice from the Advisory Committee or was in line with a general policy recommendation from that Committee. While the Committee's recommendations would not be binding, if the Department disagreed with its advice that fact would be public knowledge and it would be incumbent upon the Department, and ultimately its Minister, to defend its position.



9.19 This proposal does not meet one need. Many respondents expressed disquiet about the balance between the civil and military spectrum allocations and challenged the need of the armed forces for all the spectrum allocated to them. In Chapter 4, we discussed the defence use of the spectrum and concluded that the normal criteria of efficiency were less relevant here. However, we see a need for a means whereby public confidence can be maintained or restored in the equitability of the defence spectrum allocation, and we feel that this would be helpful to the Ministry of Defence and the Services. We have already, at paragraph 9.8 above, recommended five-yearly systematic departmental reviews, for each user group, of spectrum usage in the light of future trends in technology and operations. Defence would not be excluded. However, for all its practical value, this might not succeed in dispelling the unease of the civil user as the review would be carried out, at the working level, by representatives of the RRD and the Ministry of Defence. We therefore recommend that the overall allocation of spectrum for defence purposes be reviewed periodically, perhaps every five to ten years, by a small committee of Privy Councillors or people of similar standing to whom the appropriate classified details of defence arrangements could be disclosed.

### Value Judgements

9.20 Our impression is that at present, decisions between competing services are made on an ad hoc basis with little explicit statement of value judgement, either of social value or of economic worth. We canvassed in our consultative document the question of value judgements, and received a varied response. The majority of respondents felt that it was difficult to make explicit, or to quantify, value judgements on the worth of services to society; several respondents noted that the present system did this implicitly. Many felt that decisions of this sort were ultimately political and that they should therefore be left with Government; and several suggested that, because such judgements were inevitably involved, the decision-making process should be more open, and be influenced by advisory committees. We have developed these points in earlier paragraphs.

9.21 The majority of respondents were opposed to using commercial criteria of worth, feeling that worth to the community was more important, but a small number of respondents argued strongly for a completely different basis for deciding between competing uses - spectrum pricing. This would, in its purest form at least, let the "market" make the allocation decision. We discuss this option later in Chapter 11.

9.22 We agree with respondents that it is not possible to make social value judgements more explicit. However, we have looked more closely at the possibility of using more evident assessments of the economic worth of competing services. It seems to us that there is scope for the use of cost/benefit analysis or similar techniques to compare the economic consequences of allocating spectrum to different uses, and for this to be a recognised and open element of the regulatory processes. It would not be practicable to apply this at the assignment level, but applications from major users for significant blocks of spectrum could be handled in this way. In such a case, the applicant would have to supply economic evidence as well as technical evidence in support of his application, and this would expose the real strengths and weaknesses of the case. The RRD, in conjunction with the Department of Industry we would expect, would have the additional responsibility of evaluating the economic as well as the technical arguments. Such procedures should make it possible for the regulatory process to be more evidently related to criteria used in commerce, industry and the major service sectors of the economy. At our request, the Department of Industry prepared specimen cost/benefit case studies, one of which, on the costs and benefits to the user and the national economy of the use of private mobile radio by the road haulage industry, is reproduced at Annex G. Such studies, we believe, could be of real value in spectrum management.



9.23 Our consideration of the merits of spectrum pricing, discussed in detail in Chapter 11 led us to the view inter alia that it would be highly desirable to make more explicit the economic implications of different uses of the spectrum. We therefore recommend:-

- (i) that cost/benefit analysis or similar techniques should, wherever relevant, be an element in spectrum management decisions; and that applicants should be encouraged to submit supporting evidence of such analyses where available.
- (ii) that more general techniques of costing spectrum use be progressively developed.

#### Licence Fees as a Regulator of Demand

9.24 As a consequence of our general consideration of spectrum pricing, we also looked at the case for a limited adjustment of licence fees to support spectrum management policy, by influencing users towards or away from particular types of equipment or particular areas of the spectrum, and to help bring home to them the fact that they are using a resource which has a value, even though it has not customarily been expressed in money terms. We have considerable doubts about the extent to which the use of the spectrum is price sensitive. We doubt therefore that manipulating the licence fee will have a decisive effect on usage; nevertheless, we feel that the licence fee has a place among the repertoire of spectrum management tools available to the RRD. We believe that weighting licence fees according (say) to the congestion of the band, on the basis that this reflects the popularity and hence the market value of that band, would at least have a demonstrative and educative effect; and the RRD should, at the very least, ensure that its licence fee structure supports rather than undermines its regulatory aims.

9.25 Clearly, this approach would be controversial, and we can see several problems though none which in our view rule it out of further consideration. The level of licence fees and in particular the relative fees paid by different types of service are already a source of some controversy. The basis for any revised scale of fees would therefore have to be readily apparent to users and defensible if those fees were not to be the source of endless argument. However, though it might in some cases be difficult to construct a rational and defensible system, the task should not be impossible. If the intention was to weight fees according to the congestion or popularity of the band, we believe that objective measures of these factors could easily be developed and used. If the intention was to encourage the use of equipment which was spectrum efficient but more expensive, the difference in cost of the new technology (amortised over the life of the equipment) could be calculated and the fee set so as to offset the disadvantage, or to make the efficient technology the better investment.

9.26 An example of a more spectrum efficient practice is the range of technologies now available for incorporation in public and private mobile radio-communications systems in which a unique radio-frequency channel is not assigned to each individual user. Instead, a number of users are grouped together and the group is assigned a smaller number of channels. The equipment selects automatically whatever channel is available. This principle, called trunking, is a particular example of a well proven practice in line telecommunications, but made practicable for radio systems only by recent technical developments variously named synthesised carrier generation, frequency-agile systems, automatic channel assignment and so on. These techniques can increase availability, operational effectiveness, cost effectiveness and spectrum-efficiency of systems. These are excellent examples of classes of systems which could be encouraged by appropriate differentiation in licence fee structure.



9.27 We therefore recommend that, in appropriate frequency bands, the basis for calculating licence fees be amended so as to further regulatory objectives and in particular to encourage by financial incentives:

- (i) the use of less frequency-demanding equipment;
- (ii) the use of less congested frequency bands.

9.28 The aim of amending fees in this way would be to influence users' decisions, not to raise extra revenue. In principle, this aim could be achieved by raising some fees, lowering others and leaving the total sum raised from licence fees unchanged. In practice however we can foresee that several of the changes we propose, and particularly the introduction of an element of commerciality into licence fees, would be likely to lead users to expect a higher standard of "service" from the RRD in terms of freedom from interference, channel availability etc. If the RRD were to be able to respond to these expectations, it would need to devote more resources to spectrum management, and in particular to monitoring, enforcement and the regular review of assignments. The cost of the regulatory activity would thus rise, and while our recommendation on fees does not of itself imply raising a greater total sum from the user community in fees, we would expect this to be the consequence in practice.

#### Monitoring

9.29 A significant difference between the UK and the other countries we studied was in the degree of monitoring undertaken. The USA, West Germany and Japan all devote considerable resources to monitoring the spectrum in order to achieve effective spectrum management, check the efficiency of usage and check the regulatory authorities' records of assignments against reality. In the UK, some resources are devoted to national and international HF monitoring, satellite monitoring, and monitoring for illicit use of radio. However, no monitoring is undertaken for the specific purpose of checking the efficiency of spectrum use. The UK has undertaken some monitoring of this sort in the fixed and mobile bands in the past though on a small scale, and the need for, and value of, such monitoring is fully appreciated in the RRD; but current staff shortages mean that even this small effort has now been drastically curtailed.

9.30 We are very concerned at this state of affairs. The increasing pressures on the spectrum make it essential for the RRD to support its spectrum management activities with adequate enforcement, and to maintain the fullest information on spectrum use. Detailed monitoring of services such as the land mobile and maritime mobile services is desirable to ensure that the spectrum is being used efficiently, and to provide information for future planning of those services. In particular, data are required on the mean duration of typical messages and the mean holding time so that the grade of service (the length of time that a user has to wait before access can be gained to a communication channel) can be readily assessed. In addition, detailed traffic monitoring provides information on current usage which enables channels to be assigned with traffic loadings which give an acceptable grade of service. A number of respondents commented adversely on the lack of monitoring, and we agree with their views. We therefore recommend that adequate resources be devoted to spectrum monitoring, particularly of the mobile and fixed bands, as an aid to efficient spectrum usage and effective management.



## CHAPTER 10

### FREQUENCY ASSIGNMENT MANAGEMENT

10.1 Frequency assignment processes are technically and administratively complex, and are distinctively different for various types of use and in different parts of the radio frequency spectrum. The growth of demands on the spectrum has made the processes more complex. The majority of users of land mobile and fixed services do not have access to their own exclusive frequency. Frequencies can be re-used across the UK by exploiting geographical separation and terrain. This reuse means that every proposed frequency assignment has to be coordinated with other existing and proposed assignments for the same frequency, together with adjacent and related frequencies. Further coordination requirements are imposed where users of a service are required to share the same frequencies with other services.

10.2 In some frequency bands, notably those for fixed terrestrial services shared with space services, the work of coordination is increasingly international. The work necessarily involves expert knowledge of propagation characteristics at the particular intended frequencies, of the operational performance required from the systems, and of the detailed operating characteristics of the equipment to be installed. The work of frequency assignment is further complicated when difficult issues of compatibility between different classes of user have to be resolved, such as those that exist near the boundaries of countries, or at the boundaries of sectors of the allocation tables.

10.3 In the past, frequency assignment techniques were largely based on manual methods but in the face of mounting demand the RRD has introduced computerised methods of frequency assignment in the case of the land mobile, fixed and broadcasting services. These methods represent a significant advance in frequency management effectiveness. The RRD is to be congratulated on its initiative in this area, but even with this significant advance, the frequency assignment process can be time consuming, particularly when, as at present, the relevant parts of the Department are under-staffed. Increasing congestion of the radio spectrum can only make matters worse.

10.4 It is this slowness which was the main focus of complaint about the assignment machinery in the evidence put to us. Many of the users of radio are operating in highly competitive environments and find their operations severely jeopardized by the RRD's slowness to respond. This problem over delays is not disputed by the Home Office, who point to a number of contributory factors. As regards land mobile assignments, many of the frequency bands are so heavily utilised already that identifying a usable frequency requires extensive work; there has been a substantial increase in the number of complex radio schemes which need detailed engineering analysis before frequency assignment; and the land mobile frequency assignment section was, at the time we took evidence, 50% under complement. Similar problems affect the assignment of frequencies for fixed services: that frequency assignment section was also 50% under complement; the heavy utilisation of bands means that such analysis is required before a usable band can be identified; and the existence of two common carriers (British Telecom and Mercury) instead of one has reduced the amount of spectrum available to private fixed link users and thus made delays more likely.

10.5 Apart from the problem of delays, the other main criticisms related to allegedly unnecessary and over-complicated procedures in dealing with assignments, the fact that it is not possible to reserve a frequency assignment provisionally, and the allegedly closed nature of the process. We have already discussed in Chapter 9 the need for more openness. We shall return to the other two points later in this chapter.



10.6 The evidence we received also contained numerous complaints about the non-availability of frequencies for particular purposes, the unsuitability of frequencies that were assigned, and the general shortage of frequencies. However, we do not see these as defects in the assignment machinery but rather as problems of spectrum allocation and management generally.

#### An Assignment Quango

10.7 We considered, briefly, the idea of a separate non-Government body to carry out the detailed task of assignment. Under such a scheme, part of the Regulatory Department would remain within the Governmental structure and would be concerned with general policy and frequency allocation. The execution of the policy thus decided would however be in the hands of a quasi-independent body, which might also be responsible for monitoring the use of the spectrum. User and manufacturer interests could be represented on the management of this executive body. It could be argued that such a body would be able to be more responsive to the needs of users and manufacturers. It would have greater freedom than the Regulatory Department to recruit the necessary staff and to invest in support facilities such as computers.

10.8 However, although this proposals has some superficially attractive features, we do not believe that it stands up to close scrutiny. We believe that the split between policy and executive levels would cause severe difficulties in practice. Individual casework and policy questions cannot be divorced as easily as this scheme presupposes; and the formulation of policy, both for domestic frequency planning and even more importantly for international work, depends crucially on feedback from the executive level. It is not only the administrative activities of the RRD but also the technical ones which would be split; since the quango would be carrying out frequency assignment work it would require the Directorate of Radio Technology as well as the administrative divisions of the RRD to be divided, thus turning an already small unit into two even smaller ones. We do not believe that efficiency would be likely to result from such a dual structure as there would be a constant risk of duplication of effort and lack of coordination. We do not therefore recommend setting up a body of this sort.

#### Delegation to User Groups

10.9 It is not essential however for all frequency assignment to be carried out centrally. A block of spectrum may be allocated to particular users, or groups of users, who then undertake the detailed frequency management themselves. This relieves the regulatory authority of a burden of detailed work, but it presupposes a degree of knowledge and technical competence on the part of the user, and entails a certain loss of control of the spectrum by the regulatory authority.

10.10 A number of bodies already exercise in practice delegated authority to a greater or lesser extent: the broadcasting authorities in respect of broadcasting ancillary services located within the broadcasting bands, though not those outside those bands; British Telecom; the Home Office Directorate of Telecommunications on behalf of the police and fire services; and the Joint Radio Committee of the Nationalised Power Industries. In addition, Government users such as the Civil Aviation Authority and Ministry of Defence manage their own allocations of spectrum.

10.11 In our consultative letter we specifically asked for views on the question of delegation, and we took oral and written evidence from many groups who either exercise such authority or might have the ability to do so. The general view expressed was that there was scope for further delegation to responsible users and user groups, and that this would be an aid to the efficient use of the spectrum.



10.12 We have considered this carefully; we are conscious that there are arguments both for and against. On the one hand, the necessity to assign spectrum in blocks to user groups leads to some loss of efficiency: guard-bands are needed, and unless the group in question is geographically localized, the allocation has to be UK-wide with the result that the spectrum may not be put to the fullest use in all parts of the country. There is also the vexed question of how big the block allocation should be, and how bids for an enlarged block should be evaluated. It has to be accepted that it would not be sufficient simply to show that the spectrum was needed, since the aggregate of users' genuine needs would certainly outrun the spectrum available. On the other hand, the most effective and flexible management is in general to be obtained by delegating decision making to the lowest practical level. We therefore see strong arguments both of principle and of practice for putting the responsibility upon the users themselves to meet their needs from the resources available to them, and where conflicts occur, to reach accommodations with their fellow users without relying upon the RRD to intervene.

10.13 We accept the possibility of some marginal loss of spectrum efficiency but we believe that this will be more than offset by the greater flexibility and economy engendered among users by the knowledge that they have to meet their needs within the spectrum already allocated to them. It is evident that the greatest steps towards spectrum economy have been made by those users who have had to cope with growth despite an unchanging allocation. For example, the Civil Aviation Authority has had to accommodate the increasing requirements of aeronautical radio communications within the unchanging limits of the spectrum internationally allocated to civil aviation. We believe that the internal imperative towards economy generated in such circumstances is a more potent force for spectrum efficiency than the centralised control, however skilfully applied, of a regulatory authority. We therefore recommend that responsibility for assignment should be delegated wherever practicable and defensible to definable and responsible common interest groups.

10.14 We also recommend two safeguards to operate in conjunction with delegation. One is that the delegation should, where appropriate, be made conditional upon the acceptance of technical criteria, eg the type of spectrum efficient technology to be employed. The second is that the user group exercising delegated authority should be required to report annually to the RRD details of its management of the spectrum and in particular of the intensity of use.

#### Delegation to service providers

10.15 There is another form of delegation which we believe will be of increasing significance in the future. This is the allocation of spectrum, not to individual users, but to providers of communications services to user groups or to the public. The most obvious example of this is, in the mobile field, the common base station operator. Such operations can be small or large, operated by private enterprise or as a public service, and can have national coverage or be localised. While the use of service providers means that the user no longer has a radio system tailored to his individual needs, and thus reduces the level of consumer choice, it has a number of very important advantages both for the user and for efficient spectrum management. Such systems offer speed and flexibility to the user, who can in effect buy radio services "off the shelf" rather than negotiating with the Home Office for an individual assignment, and he can, subject to availability, change his system in line with his needs. Spectrum allocated on a national basis is likely to be under-used in at least some areas; if spectrum is allocated to a service provider on a regional or local basis the amount allocated can be tailored to the need in that area, thus achieving greater efficiency of use.



10.16 The possibilities of such systems should be seen in the light of certain technical developments which are likely to come into more common use in the future: synthesized equipment, which within limits can be switched with the minimum of trouble from one frequency to another; spread spectrum techniques, a blanket term for a variety of techniques whereby a number of users share a frequency band without the band having to be divided into individually assigned channels; and other forms of on-demand channel assignment. Such systems have the potential for reducing the inefficiency of use which results from uneven channel loadings: in simple terms, they spread the load over the whole band. This can allow more intensive use to be made of the band.

10.17 In effect, these techniques obviate the need for much repetitive and detailed frequency assignment work, and their large scale adoption, under rigorous and clearly defined ground rules, should therefore relieve the RRD of a considerable burden. We therefore recommend that wherever practicable, preference be given to the establishment of further service-providing systems when spectrum is being re-allocated; and that the long-term regulatory policy should be directed to encouraging users to use such systems rather than to seek individual assignments.

10.18 As an aid to this objective, we do not rule out the use of preferential licence fees, or of regulatory policy decisions. For example, just as the RRD might refuse to licence the use of radio when wire communications might reasonably be used, it might equally refuse to licence an individual system when a user could obtain adequate facilities from a service provider.

#### Fixed Period Assignments

10.19 At present, although licences have to be renewed annually, a user can expect in normal circumstances that his licence and frequency assignment will be renewed. With some exceptions, assignments are not reviewed before renewal or at less frequent intervals to ensure that they are still justified. In general, the RRD withdraws assignments or refuses to renew them only where there is an overriding need to do so because of, say, a change in frequency allocations internationally. This limits the flexibility of frequency management to reorder the use of the spectrum to obtain the most effective overall pattern of usage. We suggested in our consultative questionnaire that this tended to foster the idea that the user once issued with a frequency has a perpetual right to it in effect, though not in law. We canvassed, as an alternative to this, the idea of fixed period frequency assignments.

10.20 Clearly, a frequency assignment cannot be changed by the regulatory authority at whim or without notice, since the cost of equipment means that the user needs an assurance of a fixed assignment for a reasonable period of time. No user of radio could operate economically if he did not know from one year to the next what frequency he would be assigned. However, all equipment has a finite economic working life, and it is not unreasonable to assign frequencies for a limited term which is related to this working life.

10.21 We were encouraged by the responses in evidence. Whilst some users disliked the "leasehold" idea, arguing for absolute security of tenure, many recognised the contribution fixed term assignments could make to flexible spectrum management and effective use of the spectrum. They clearly saw this proposal as being of indirect benefit to the user community. All respondents stressed the importance of a reasonably long assignment term and one which was related to the economic life of the equipment.

10.22 The change we envisage does not involve any change in the legal basis of licensing. Rather, it is a change in management practice and in users' expectations, and it would be important to introduce the new procedure with an



adequate period of notice and with extensive publicity. Licences would still be renewable annually, as at present; but there would be a presumption, made clear to the user at the outset, that after n years (where n is related to the economic life of the equipment and would probably vary according to the type of equipment) the assignment would be critically reviewed in the light both of the use made of it by the holder, and in particular of the other demands for spectrum in the band and the general needs of frequency management. The assignment would not be renewed if the RRD concluded that the frequency could be put to better use in some other way. We acknowledge that the implementation of such a policy could well lead to controversy. Users have become accustomed to security of tenure and, however well the intended change of philosophy was publicized, the first time a user was dispossessed at the end of his fixed term there would probably be complaint and controversy. The regulatory authority would have to steel itself to withstand this. If it is to cope with greater flexibility and speed with the changing pattern of spectrum usage (and this is what users and their representatives on the whole want) it will need to have flexibility and room for manoeuvre in spectrum management; and this inevitably will involve having both the power and the will to say "no" when necessary.

10.23 It was also put to us that fixed term assignments might in fact reduce the flexibility of the RRD to intervene and move users when necessary. We do not think so. The RRD would not have less power than at present to terminate assignments when forced to do so by "force majeure". The possibility of this happening is a fact of life for users, and they would be no worse off than at present. We therefore recommend the adoption of fixed-term frequency assignments.

#### Administrative Procedures

10.24 We must record the criticisms we have heard from some respondents that the administrative procedures involved in licensing and frequency assignment are unnecessarily complex and cumbersome. This criticism has been directed in particular at the radio site clearance procedure. We do no more than note these criticisms, since we have not attempted to take on the role of management consultants and conduct an O&M review of the RRD. We note with interest however that an O&M review, combined with a staff inspection, has recently been carried out under the Home Office's own internal management procedures and we trust that the organisational efficiency of the Department will continue to be kept under close review by management.

#### Provisional Assignments

10.25 Two respondents drew our attention to a particular difficulty which sometimes causes a substantial investment in preparatory work to be wasted. The RRD does not assign a frequency to an applicant until it has received a fully completed application form, and has processed the application. However, we understand that it is not possible to submit an application form immediately upon identifying a suitable frequency since the prospective user needs time in which to consult equipment manufacturers and develop a proposal to put to the RRD. By the time the formal application is submitted, the previously identified frequency may have been assigned to another user thus wasting perhaps several thousands of pounds worth of investment and effort.

10.26 It was put to us that many organisations would be content to pay a substantial sum for the provisional assignment of a frequency: ie, a guarantee from the RRD that the frequency would not be assigned to another user for, say, one year to avoid the risk of undertaking fruitless and expensive development work. We therefore recommend that such short term provisional assignments should be introduced. We further recommend that the fee should be high, to deter applications on a "just in case" basis and should be related to the level of costs involved to the user in preparing an application.



## Grievances over Assignments

10.27 The significant level of criticism of the assignment process led us to consider whether there should be any formal method for airing grievances over individual assignments. However, the more formal methods, such as a right of appeal to a body which would decide the issue in a quasi-judicial manner, or a consumer watchdog body seem likely to result in a proliferation of bureaucracy. In any event, if there is an allegation of maladministration, this is a matter for the Parliamentary Commissioner for Administration. To the extent that the frequency assignment process can be delegated to common interest groups of users, the remedy for grievances will lie in the hands of the users themselves. To the extent that spectrum is delegated to service providers, (and assuming that there are several such providers in a given area, in competition) market forces will operate and an aggrieved consumer will be free to take his custom elsewhere. In addition, we believe that the greater openness which we wish to see in the regulatory process, would do much to satisfy users of the equitableness of the system. An ethos of greater openness in the administrative machinery would both act as a discipline upon the regulatory body itself, and also educate the user community into a maturer awareness of the real problems involved in radio regulation. The key to improved relations lies as much in greater mutual knowledge, mutual understanding and trust as in changes of machinery.



## CHAPTER 11

### SPECTRUM PRICING

11.1 A number of respondents have drawn our attention to the possibility of using an entirely different philosophy for allocating and assigning spectrum. This is the idea of spectrum pricing, or renting the spectrum. All the variants of this idea are based on the observation that radio spectrum is at present a virtually cost-free resource to the user. This distorts the pattern of demand for spectrum. It is argued that a more equitable and efficient use of the spectrum would result if market forces rather than centralized regulation were allowed to determine spectrum usage. Within this general philosophy, a wide range of different ideas have been put forward at one time or another. The idea has been widely discussed, particularly in the United States. Proposals vary both as to the amount of the spectrum to which the pricing philosophy is to be applied, and as to the precise mechanism by which the influence of the "market" is to be brought to bear.

11.2 Two respondents in particular advocated approaches of this sort. Members of the Transport Science Policy Unit of the Department of Transport submitted a paper arguing the merits of a system of spectrum renting. Dr C Veljanovski, of the Centre for Socio-Legal Studies, Wolfson College, Oxford, drew our attention to a paper on Cable Television by himself and a colleague, which inter alia criticised the arguments usually put forward against using the market to regulate broadcasting. The DHSS and the Civil Aviation Authority also discussed the question. In addition, among the evidence submitted by the RRD was a paper discussing some of the problems involved from the regulatory standpoint in spectrum pricing. We also saw a need for economic advice on this subject, and sought the views of economists working in the Department of Industry. The pressure of work on them however meant that their paper was submitted to us only at a very late stage in the preparation of this Report, and we were unable to take it into account in reaching our views.

11.3 On this question we see advantage in letting the various arguments speak for themselves. Dr Veljanovski's paper was published in February 1983\*. Some of the other material, the papers from the RRD, the Transport Science Policy Unit and the Department of Industry's economists, are included as Annex M to this Report.

11.4 The most thorough-going market approach is to argue that there should be a free market in frequencies, over the whole spectrum - civil and military, government and non-government. Users would be free to buy and sell assignments, each assignment conferring the right to use a given frequency within a given geographical area, subject to stated technical conditions relating to interference etc. As usually envisaged, this would be for a fixed period, ie a "leasehold" rather than a "freehold" right. No restriction would be placed on the type of use; the technical conditions would, it is argued, obviate mutual interference. The advocates of this approach argue that this would lead eventually to every frequency band being in the hands of the user who put the highest value upon it. This, it is argued, would constitute the greatest economic efficiency since the price a user was prepared to pay for spectrum would depend upon the value of the service he proposed to provide. The fact that for example defence and emergency services would also have to compete in this market, and so would have to be funded accordingly, would do no more, it is said, than make explicit the existing opportunity cost of these services' spectrum usage.

\* Choice by Cable - The Economics of a New Era in Television, C G Veljanovski and W D Bishop, 1983, Institute of Economic Affairs.



11.5 This is the proposal in its purest form. Modifications of it are of two main sorts. It is sometimes suggested that a spectrum market be created in part of the spectrum only; the non-government spectrum, or perhaps certain bands within the non-government spectrum. Other proposals envisage a system wherein the regulatory authority continues to set the price of spectrum but charges the market price. In a watered-down version of this idea, the regulatory authority would merely apply loading or weighting factors to existing licence fees in order to give partial recognition to commercial factors. Such a scheme might involve a licence fee being composed of several different elements, one of which would be a "spectrum price" element.

11.6 We are not economists, and if there is to be a detailed and expert examination of the merits and defects of the pricing argument, it must be carried out by others. We confined ourselves to two questions. The first was whether, on the basis of the arguments in the papers put to us, we could say with confidence that spectrum pricing or renting was prima facie a useful and practical approach which was clearly worthy of further study. The second was whether there were any other ways of bringing economic realities to bear on the operation of the regulatory machinery, and we have already discussed this point and made our recommendations in Chapter 9 (paragraphs 9.20 to 9.28).

#### The Case for Charging a Realistic Price for Spectrum

11.7 We do not question the general principle that it would be desirable to make users more aware of the value of the resource they are using. Because the use of spectrum appears to be free, users have not recognised it as a scarce resource, and have no incentive for economy beyond that which is needed to meet their needs within the spectrum available to them. We have noted that users who organise their own allocations on a delegated basis, do not seek spectrum economy for its own sake. They accommodate their own requirements on a non-interference basis but they take their existing allocations for granted and do not appear to review their usage to see if they could manage with less. This is not intended as a criticism. They are behaving rationally since there would be no point in spending time and effort attempting to economise on the use of a resource which is free.

11.8 We have noted the size of the existing and potential demand for broadcasting ancillary services such as radio microphones and programme links. Programme makers appear to us to have assumed that they could be provided with as many of these services as they wanted or needed. A further point we have noted is that much of the enthusiasm for the use of mobile radio stems from its relative cheapness compared to wire communications. We feel inclined to question whether radio should in fact continue to be so cheap in relation to wire. The use of radio, it is claimed, is an aid to efficiency in many services; but we suspect that, at least in some cases, this is simply because the cost to society of using radio is not adequately reflected in the actual cost to the user. The bill is paid in spectrum terms, not in cash. We see this undervaluing of spectrum as leading to an underestimation of the importance of the frequency implications of policy decisions, both governmental and commercial. It has become increasingly obvious to us that in very many governmental and industrial organisations, strategic decisions are taken with little or no regard to the spectrum implications. These implications are not seen as having cost consequences and therefore come very low in order of priority.

11.9 It is also argued by proponents of spectrum pricing, whether on the free market basis or with prices set by government, that this would bring about more efficient use of the spectrum. In those bands where demand is high and the price or rent would be correspondingly high, users would have every incentive to use as little spectrum as possible by investing in sophisticated spectrum-



efficient technology. Alternative bands which are less crowded because the equipment costs are higher would become more attractive options since the price would be lower. We should note however that a counter-argument has been put to us, that the operation of a free market would in fact lead to the entrenching of inefficient technology since users faced with overcrowding and a deteriorating service would be able to respond, not by investing in more efficient technology, but by outbidding other users and thereby increasing the spectrum available to themselves.

#### The Difficulties of Spectrum Pricing

11.10 The paper by the RRD exposes a number of apparently serious difficulties. Since this paper is reproduced as part of Annex M, we need not repeat the arguments here. We note however in particular the suggestions that it would prove virtually impossible in practice to create a free market in spectrum, because of the international regulatory framework and the extent of Government use of the spectrum (paragraph 12) and that the commercial competitiveness of some UK industries might well suffer. There are also special problems associated with space-borne communications services which inevitably contain internationally negotiated elements in the specification of both their operating frequencies and their orbital geometry.

11.11 We also considered the fundamental question as to whether spectrum use is in fact price-sensitive to any significant degree. If it is not, and if the actions of users are not in general likely to be affected by varying the price of the spectrum, there is little point in taking the argument further. Sensitivity to spectrum price is determined by the relationship of the actual level of spectrum charges to the total capital and operating costs of the system to be licensed, and to the profit margins expected. A large system, dependent upon radio technologies, requiring capital investments of the order of tens of millions of pounds, and with annual operating costs of the order of hundreds of thousands of pounds clearly exhibits totally different sensitivities to a system having similar spectrum occupancy but much lower capital or operating costs.

11.12 In a free market, if demand exceeded supply the price would rise until it reached a level at which it began to bite and some users dropped out of the bidding. We note that even though licence fees are at present low in relation to users' other costs, considerable controversy is aroused by relatively modest increases. In consequence, the substantial increases which would probably flow from such a policy might prove to be generally unacceptable.

11.13 It is perhaps easier to visualize spectrum pricing applied, not to allocation between bands, but to the assignment of frequencies within bands. The paper by the Transport Science Policy Unit argues for a spectrum renting system to be introduced, first, in individual bands. Some of the possible problems are discussed at paragraphs 14 to 17 of the RRD's paper. We note the argument that a pricing policy could act against equitable access by smaller undertakings and make it more difficult for newcomers to establish themselves against established users. It also seems to us that a pricing policy would make it possible for a user to trade-off price against quality. If a user was prepared to pay for the extra spectrum and there were no other regulatory restrictions, he could ensure for himself a higher standard of communication and less congestion. A service provider such as a common base station operator might in fact find it was in his economic interests to offer such a "premium" quality service to a smaller number of customers rather than to take on the maximum number of customers consistent with an acceptable grade of service. This raises the question of spectrum efficiency against economic efficiency. If a user felt that his interests were best served by paying more to obtain a premium grade of service, that would be the most economic use of that spectrum;



but it clearly would not be the most spectrum-efficient use. Before embarking on any policy of spectrum pricing, a government would need to consider whether its aim was spectrum efficiency or economic efficiency. A pricing policy would give every appearance of tending to maximise economic efficiency but would not necessarily maximise the amount of communication achieved for a given bandwidth of spectrum.

#### Implications for Relations between the Regulatory Authority and the User

11.14 At present, the RRD does not guarantee any particular standard of service. The assignment process is directed to finding a frequency which is usable and appropriate to the user's needs, but no more. If a regulatory authority were to charge a high price for use of the spectrum it is likely that users' expectations would rise correspondingly. They might well feel that they were entitled to some return for their money, in terms of a guaranteed level of freedom from interference, better enforcement of the regulations on illicit use and more monitoring. So, while spectrum pricing could be expected to generate a considerable amount of extra revenue, some at least of this revenue would need to be ploughed back in the form of investment in regulatory activity. Guaranteeing a minimum standard of service would also be likely to entail some loss of spectrum efficiency.

#### Conclusion

11.15 The proposals for spectrum pricing we have seen are theoretical and not written with detailed knowledge of frequency management problems. Our study of overseas practice did not produce any evidence that any administration has attempted to introduce a realistic system of spectrum pricing. While such ideas have been quite widely discussed in the United States, we are not aware that they have been put into practice. Nor have we seen any fully worked-out proposal for introducing any system of this sort into the UK. By a "fully worked-out proposal", we mean one drawn up in full appreciation of the present regulatory system, and which explains in practical terms exactly how the new system would work, and what administrative steps would be needed to graft it onto the existing regulatory machinery. The onus must be upon the proponents of such systems to show that their introduction is feasible and advantageous as compared with the present system.

11.16 We incline to the view that spectrum pricing may well be impracticable. However, if Government believe that this matter should be further pursued, then we recommend that, before any action is taken, a detailed and critical feasibility study, carried out by a team including economists and experts in radio regulation, should be commissioned.



## CHAPTER 12

### STAFFING AND RESOURCES

12.1 Questions of staffing have arisen at a number of points in the earlier chapters of our Report. In this chapter we bring these points together, and make a number of recommendations. We identify four main problems: the maintenance of the engineering and scientific bases for regulation; an acute shortage of engineering staff; the isolation of this small body of engineering staff from others in similar areas of work; and the problem of developing and keeping expertise among the administrative staff.

#### The Engineering and Scientific Bases for Regulation

12.2 A firm understanding of the fundamental characteristics of radio wave propagation is a necessary foundation for effective regulation. These characteristics are not the same throughout the radio spectrum, neither are they constant. They fluctuate as the characteristics of the atmosphere, troposphere and ionosphere change. At very short wavelengths the gaseous components of the atmosphere absorb signals to the extent that certain portions of the spectrum are unusable for certain purposes. Transmissions can also be affected by upper atmosphere disturbances or by the "trapping" of signals in atmospheric layers, giving rise to unusually long distance reception of signals normally limited to a few tens of miles.

12.3 Knowledge of these behaviour patterns is crucial to the regulatory authority. Without it, reliable plans for frequency allocation or assignment cannot be constructed. For it is these factors that determine what options, if any, exist for assignment sharing, and what reasonable operational and economic balance can be struck between, say, transmitter power limitation and acceptable system performance. These factors, overall, determine how maximum spectrum usage can be reconciled with maximum user satisfaction. This is the essence of frequency spectrum management.

12.4 Rigorous scientific exploration of the radio propagation behaviour of the atmosphere is therefore a necessary precursor of system design. As collateral scientific development discloses possibilities for new advanced electronic materials, devices and techniques at progressively shorter wavelengths so it is necessary to ensure that work on radio propagation behaviour marches in step.

12.5 Evidence from the Home Office, users, and the Science and Engineering Research Council has indicated that until very recently, and for a decade or more, fundamental research in each of the two areas, propagation and systems, was undertaken largely independently of the other, with little conscious harmonisation. In addition, such propagation research as was being done was minimally resourced and ineffectively related to the systems technologies emerging in industrial organisations. Systems development potential was therefore running ahead, not simply of propagation knowledge but of the ability of the regulatory authority to develop or apply effective ground rules for mutual protection, let alone spectrum efficiency.

12.6 There is a fundamental problem in maintaining the engineering or scientific credibility of any relatively small detached unit such as the DRT. Science and engineering are best in an atmosphere of symbiotic argument and growth. The challenge of multi-disciplinary argument and change is difficult to achieve in small units. We therefore welcome initiatives being taken to establish programmes of work, coordinated by SERC under the general title "Specially Promoted Programme into Radio Communication Systems" and having as their principal objective the promotion of "research and development in Radio Communication Systems and their associated components leading toward the more



effective and efficient use of the electromagnetic spectrum.....". A list of possible research topics for mobile radio is at Annex N. We understand that the Home Office is represented on the steering committee of this programme and on a parallel Departmental Users' Committee specifically directed towards propagation work.

12.7 Setting these programmes in the context of the regulatory, operational and industrial challenges emerging as Information Technology initiatives gather momentum and as device technologies in the regions above 30 GHz increasingly reveal new options, we recommend that:

- (i) RRD interests in these programmes be increased and adequately resourced (both in the programme and the RRD);
- (ii) RRD experience, knowledge and guidance, not only at technical, but also at policy levels, be made available to SERC;
- (iii) an annual review of the relevance and effectiveness of these programmes be made by the RRD and SERC and incorporated in the Annual Report we refer to elsewhere in this Report; and
- (iv) system-oriented research, with the maximum practicable industrial participation, be increased. We consider that this programme should, inter alia, put increased emphasis upon studies of behaviour of newly emerging techniques (eg spread spectrum and on-demand channel assignment) under conditions of interference and high loading.

#### Staff Shortages

12.8 There are currently 21 vacancies in a complement of 116 engineers in the Directorate of Radio Technology. The difficulty of filling these posts (and, in particular, through direct recruitment) may in part reflect a general shortage of staff with the necessary qualifications, but a more obvious cause is the uncompetitiveness of the salary scales offered. The work of engineers in DRT is similar in responsibility and character to that of engineers in British Telecom, Mercury and certain sectors of the electronics industry. Investment worth many millions of pounds may rest on their judgements. The facts are that these organisations are able to offer salaries considerably more attractive than those offered by the Civil Service (even when account is taken of pension contributions). Our attention was drawn to advertisements which appeared in late 1982 for engineering posts, which we understand were of comparable standard, in the RRD, British Telecom and Mercury. The starting salary ranges offered for candidates with a degree or equivalent qualification and two years' experience, were: Home Office £7955 to £10,325; BT £9015 to £13,263; and Mercury £12,000 to £18,000\*. The present shortfall in engineering staff is serious. There is a steady and in some sectors increasing workload both nationally, not least in implementing the recommendations of our Interim Report, and internationally, where there is particularly heavy programme of conferences for the next decade. We find no evidence that this increase is transient. We also consider that there should be no question of lowering standards in order to fill the vacant posts.

#### Isolation

12.9 Under-complementing is, we observe, generating an additional, perhaps even insidious problem. It is diminishing opportunities for staff who are concerned with rapidly changing high technology systems to maintain strong and frequent contacts with industries and services. Without frequent and effective contacts awareness and knowledge is not exchanged freely, particularly in the early

\* This range applied to a number of posts, some of which were at a higher level and required more experience.



formative stages of new developments or new policies. Developing industrial policies and developing regulatory policies are not sufficiently exposed to informal creative debate. As engineering staff of the Directorate are forced to spend more time on the increasing case-load of specific applications, not only are they denied opportunities for creative dialogue with their "clients", but they are increasingly perceived as part of an impervious bureaucratic machine.

#### Administrative Staff

12.10 With the exception of a small and reducing number of staff who have served in the RRD since the days of the Post Office or Ministry of Posts and Telecommunications, the administrative staff are Home Office personnel who in most cases will have moved to the RRD from a mainstream Home Office Department and who will move back again after a number of years. The work of the RRD is specialised and it has very little in common with the other activities of the Home Office. It does not have a great deal in common even with the Home Office Broadcasting Department, which is in any event a policy department with only a small staff. This situation has adverse effects both for the staff and for the conduct of the work. The administrative side of RRD is too small for it to be regarded as a self-contained unit with its own permanent administrative staff. To set up a closed group of staff of this sort is contrary to what we know of general management practice in the Civil Service, and we doubt that it would be welcome to the staff. However, the interchange of staff with the rest of the Home Office means that a significant proportion of the staff is learning the ropes at any given time, and that hard-earned expertise is constantly being drained away. This does not assist either the needs of the work, or, we imagine, the job satisfaction of the staff.

#### General

12.11 There are no ready solutions for these problems. We discuss in the next chapter possible changes in the position of this function within the machinery of government which could make solutions easier to find. Aside from this, we recommend two more limited changes which could be implemented within the present structure. First, we recommend that a special grade structure should be created with appropriately increased salary levels, for the engineering staff in RRD. The purpose of this would be to place them on less disadvantageous terms than at present in comparison with similar staff in say British Telecom and Mercury. We suggest that such expenditure is easily justifiable in the light of the evident difficulty in recruiting such staff, and of the highly specialised and responsible nature of their work, carried out as it often is in a highly politicized environment.

12.12 As a further aid to sustaining a high level of engineering expertise and an appropriate balance between, on the one hand, experience and continuity, and on the other, intimate knowledge of the latest technological developments we recommend the regular interchange of staff between the RRD and industry. This could take the form of cross-postings or, particularly if DRT remains under-strength, the loan or secondment of staff from relevant sectors of industry. Exchanges would do much to foster a better understanding between the regulatory authority and industry and need not be restricted to engineering staff.

#### Resources

12.13 We realise that many of our recommendations, both in this chapter and in earlier ones, imply increased manpower and expenditure, though it should be noted that our recommendations in favour of the greater use of delegation offer the prospect of some saving in detailed assignment work. The effect of our recommendations would be that the RRD would have a more active role in frequency management and that it would conduct more forward-looking studies, more reviews



of existing usage patterns and more monitoring, than at present. It would be supporting the activities of a high level Advisory Committee, and producing an annual report and a range of publicity material. This would require not merely that existing staff vacancies be filled but that the complement be increased appropriately in recognition of the new work-load.

12.14 We note that priority is being given to reducing public service staff numbers and expenditure. Nevertheless we have no hesitation in arguing both that the relatively small increase implied by our proposals is vitally necessary, and that it should be regarded as an investment which will be repaid many times in terms of an improved communications infrastructure and consequent economic benefits. The efficient, forward-looking and creative execution of radio regulation is an essential element in the expansion of telecommunications services which this Government has sought to foster and encourage. The latter will not be able to achieve its full potential without the former.

12.15 We understand that the estimated cost of the RRD's activities for the financial year 1982/83 was approximately £18 million, of which £9.2 million represents the cost of the Radio Interference Service. The income from all licence or other fees was approximately £15.2 million\*, the net cost to the Exchequer thus being 2.8 million. The effect of an increase in activity and hence in cost of, say, ten per cent, while not insignificant, is very small when compared with the annual output of the industries producing radio equipment, some £2000M in 1982, to say nothing of the value of the service industries dependent upon radio, all of which stand to benefit from the adequate resourcing of radio regulation. Even a minute improvement in the profitability or efficiency of such industries would be sufficient to recoup the extra cost.

\*This includes both income from licensed users of radio and also a proportion of the income from TV Licence fees in respect of the work of the Radio Interference Service.



## CHAPTER 13

### THE PLACE OF RADIO REGULATION IN THE GOVERNMENTAL STRUCTURE

13.1 It became apparent to us that we could not do justice to our task if we restricted ourselves to considering the adequacy of the lowest levels of the decision making machinery. Dissatisfaction with the assignment process has its roots in the perceived inadequacies of the frequency management processes as a whole. In turn, the location of this regulatory machinery within the governmental structure also affects very greatly the nature of the problems to be faced, and the ease with which they can be solved.

13.2 We noted the widespread view among respondents that more coordination was needed over the range of disparate activities within the telecommunications field. There has been a marked growth of new activities in this field within the last few years: cable TV, direct broadcasting by satellite, the liberalisation of telecommunications and the proposal to create an Office of Telecommunications (OFTEL); the growth of Information Technology; and the continuing increase in the demand for better and more flexible communications, both while on the move and while in the home or work place. Many respondents, from a wide variety of different interests, argued that responsibility for these diverse developments should be brought together and that the UK should have a coherent strategy for telecommunications, preferably developed and implemented by a single authority. Given the number of respondents who clearly saw this issue as directly relevant to the Review's work, it would be wrong to submit this Report without drawing attention to the weight of the views expressed, and without offering some indication of our own views.

13.3 Other commentators recommended structural change on the basis of a less wide-ranging argument: that the efficient functioning of the Radio Regulatory Department itself requires that it be moved from the Home Office. A number of commentators felt that the importance of regulatory activity to industrial policy meant that the RRD should desirably be part of an industrial department. However, there were others who argued that, precisely because industrial departments were interested parties, they should not be in control of an operation which involved balancing industrial against other interests.

13.4 We perceive a third consideration: what organisational structure is the most likely to ensure that radio regulation has devoted to it adequate numbers of staff with the necessary experience and expertise. It can be argued that the main concerns and priorities of the Home Office are quite unrelated to radio regulation. Moreover, it is not in a position to provide an interchange of administrative staff between the RRD and other similar areas of work. It thus has to choose between forming a very small body of permanent RRD administrators, which would be contrary to general Civil Service management practice, and would not, we imagine, be welcome to staff; or interchanging staff in the normal way between RRD and other Home Office Departments, with often uncomfortable results both for the continuity of the work and, we imagine, the job satisfaction of the staff. Both these problems could be mitigated by setting the RRD within a different framework; although we acknowledge that this would not necessarily deal with a third problem, that of maintaining an adequate body of professional and technical staff to perform the very specialised and responsible tasks required.

13.5 For all these reasons, we felt that it was necessary to look at, and comment upon, the main options for structural change which had been canvassed.



## An Independent Regulatory Body

13.6 Some respondents have suggested that the needs of regulation would best be met by the creation of a regulatory "quango": an independent body carrying out the present functions of the Radio Regulatory Department and possibly others in addition. The example most often cited is the Federal Communications Commission in the USA - though this is responsible only for non-Government spectrum management.

13.7 A number of advantages are claimed for such an organisation. It is argued that such a body could be self financing, obtaining its income from licence fees and possibly by charging for other services. It would have greater flexibility than a Government department to recruit staff, to offer competitive salaries to attract the appropriate expertise and to invest in, for example, new technology, in order to operate more efficiently.

13.8 A more open organisational and management style might come more naturally to an independent body than to a Government department, and a more responsive approach to customers' needs should be easier to inculcate and maintain. Liaison with the user, industrial and scientific communities might be improved by the interchange of staff, or by staffing the regulatory body, in part, with people seconded from other areas.

13.9 At the level of policy making, an awareness of the needs of the manufacturer and user communities could be fostered by having representatives of these communities closely associated with management and policy making of the independent regulatory body eg by being included on the controlling board or committee of the new body.

13.10 However, while we acknowledge the attractions of a quango, we see some very significant drawbacks. One is the issue of appropriate frequency allocations between military and civil users of the spectrum. It must be remembered that the main model for this type of structure, the Federal Communications Commission of the USA, deals only with the non-Government spectrum and does not determine the division of the spectrum between civil and military use. If a body were created in the UK to regulate the civil spectrum only, this would presuppose retaining a residual Government regulatory department to deal with Governmental use and to decide the most fundamental questions of allocation. This would, we fear, fail to satisfy many of the critics of the present system, who are, we believe, concerned to see these fundamental allocation decisions, as well as the lower level decisions of sub-allocation and assignment, taken in a more open way and influenced by wider range of considerations than at present. We also feel that a dual system, with a government department and a quango, would be unsatisfactory in organisational terms: there would be considerable risk of duplication of effort, lack of coordination and a general proliferation of bureaucracy.

13.11 An alternative to a dual structure would be a quango which dealt with all regulatory issues, including the most fundamental questions of military and civil usage. It is difficult in practice to envisage such a body: an organisation so intimately concerned with Governmental matters would surely constitute a Government department in all but name.

13.12 A further consideration is the international dimension to radio regulation. Participation in the work of the ITU and other international bodies is a very significant part of RRD's activity, and the domestic use of radio spectrum is very greatly determined by the results of this international work. The UK delegations at such conferences speak for the United Kingdom government, and although other agencies are very heavily involved in this work, the leading



and coordinating role rests, and must rest, with Government. An independent quango alone could not speak for the UK Government; but, where all the expertise and all the knowledge rested with the independent regulatory authority, a joint delegation could lack authority and speed of response.

13.13 We can also see difficulty in sustaining the independence of a quango dealing with only civil usage. We have observed how recent government policy decisions such as the liberalisation of telecommunications appear to create imperatives which override the purely regulatory priorities of achieving maximum spectrum efficiency. A regulatory quango would seem to be unlikely to be able to contribute to Government policy formation and to argue the case for technical efficiency and its views would in practice be unlikely to carry much weight.

13.14 We see a very strong case, which is endorsed by a number of respondents, for keeping regulatory matters within Government and indeed making it easier rather than harder for the regulatory or spectrum-efficiency side of the argument to be articulated in Government policy formation. A number of contributors have said firmly that the most basic allocation decisions - judgements as to the relative worth to the nation of widely different services - must ultimately be under the control of a Government Minister, answerable to Parliament. We agree, and we recommend that radio regulation should remain within Government.

#### A Department of Telecommunications

13.15 This was commended to us by a wide variety of respondents. It is perhaps significant that, while we did not ask in our consultative letter for views on matters as wide ranging as the question of the Governmental machinery, many respondents nevertheless volunteered the view that a change of this sort was the only sensible long-term solution.

13.16 Such a department might be independent, with its own Secretary of State; or it might form a separate identifiable unit, with its own Minister, within a larger department. As to prospective parent departments, the Department of Industry seems to be generally regarded as the most appropriate location though there are several drawbacks which we discuss in paragraphs 13.22 to 13.27 in the context of transferring the RRD alone to the DoI; and the Department of Transport and the Department of Trade both merit consideration.

13.17 We do not doubt that, other things being equal, a completely independent department is the ideal. We have noted with great concern the uncoordinated and piecemeal nature of recent developments in telecommunications. A separate department offers the prospect of a coordinated policy. Telecommunications is a growth industry; Britain's future depends upon an efficient and flexible telecommunications infrastructure, and the demand for such services and the variety of services on offer grow continually. A separate department would provide an identifiable and visible location for the formation of a coordinated policy, and would provide an evident focal point for consideration of industrial and service policies. Further, it would make for effective and efficient relationships in a variety of important executive areas ranging from industrial development to regulation. A single department is not the only way of ensuring better coordination, but we believe it is the best way.

13.18 It might also make it easier to achieve the degree of continuity in staffing which is presently lacking, and ensure that expertise, once built up, is not wasted. From the point of view of radio regulation a new department should provide an environment in which the importance of this function is clearly recognised, and the benefits of devoting adequate resources to it are



perceived. Although the management of the spectrum is seen by many as an obscure area of work, it is important for the development of a high quality telecommunications infrastructure that it be done effectively and well. This inevitably means devoting resources to it. A Department of Telecommunications seems more likely to recognise that expenditure on this matter is an investment which should pay dividends in terms of securing efficient telecommunications and industrial competitiveness.

13.19 We envisage that the core of such a department would comprise the Telecommunications, Information Technology and Space and Post Office Divisions of the Department of Industry, and the Radio Regulatory and Broadcasting Departments of the Home Office (though see the next paragraph as regards the position of broadcasting policy). It might be appropriate to add to these the Radio Interference Service, which carries out interference control work for the RRD on an agency basis. It is at present a part of British Telecom, but BT has given notice of its wish to relinquish control of it in the near future. If an Office of Telecommunications (OFTEL) were to be created, this too, could be associated with a new Department.

13.20 The foregoing has assumed that a new department would be responsible also for broadcasting policy. The arguments in support of the inclusion of broadcasting are:

(i) Broadcasting seems to fit sensibly and happily with the other responsibilities and requires a high degree of coordination with other uses of the spectrum.

(ii) It is increasingly impracticable to isolate broadcasting and consider it separately. For the future its full potential may well emerge through a bewildering array of new forms of shared services and shared technologies. It has already moved far from its original association of one type of service with one form of technology.

(iii) A new Department would need to be as substantial as possible, in terms of staff numbers and policy responsibilities, in order to be viable.

We note that the Ministry of Posts and Telecommunications between 1969 and 1974 had responsibility for broadcasting policy. However, we recognise that the question of where responsibility for broadcasting policy should rest is a sensitive and difficult one, which involves wider considerations than those we have discussed here. We have quite deliberately avoided any consideration of broadcasting policy, but our working assumption that broadcasting should form part of the responsibility of a new department is based on the practical considerations set out above.

13.21 We do not suppose that the creation of a separate department is without problems of its own. Size may be a crucial factor here. A department which is too small, in terms of numbers and of responsibilities, is unlikely to be effective or viable. We noted in Chapter 6 that a separate Ministry of Posts and Telecommunications existed from 1969 to 1974; this was a very small department and was evidently felt not to be viable as a separate Ministry. However, the world of telecommunications has changed a good deal since 1974. There are many new developments: liberalisation, with the setting up of competitors to BT; cable TV; satellite broadcasting; information technology; and a general growth in telecommunications. It can be argued that there is now not merely a role for a Department of Telecommunications, but a positive need for one, that is well resourced and able to provide well developed strategies under the direction of a Minister without other responsibilities.



## Transfer to the Department of Industry

13.22 A considerable number of respondents argued for the transfer of the RRD to the Department of Industry. Others however argued explicitly against this, on the grounds that the Department of Industry, representing predominantly manufacturing interests, should not be asked to take decisions which involved balancing industrial against other interests. We see some force in this, though we note that the Home office is itself not totally disinterested, being the Department responsible for broadcasting policy.

13.23 The case for transfer to the Department of Industry rests mainly on the better coordination which could be achieved between regulatory and industrial and telecommunications policies. The Department of Industry is responsible for telecommunications policy as well as sponsoring the interests of the electronics manufacturing industries and Information Technology generally. We agree that greater coordination would be desirable, and we accept that a move to the Department of Industry would help considerably. We feel also that it might engender a more open relationship, and a greater degree of contact, between the Department and the user and manufacturer communities.

13.24 It is also possible that such a move would ease some of the problems of staff and resources. If the RRD were part of the Department of Industry, the adverse effects of under-resourcing the RRD, which bear particularly on industrial and commercial users and which are considered by some to have a serious impact on industrial policy, would be felt in that part of the Governmental machine which would be able to apply the remedy. As regards administrative staff, while the RRD would still be a specialised area, there would be some common background of industrial/commercial/technological matters, and the difference in work should be less marked than between the RRD and other Home Office posts.

13.25 Such a move would not make it any easier to sustain the engineering expertise needed by the RRD. The Department of Industry does not have, any more than does the Home Office, analogous areas of work employing professional and technical staff. Its staff does however have frequent and close contacts with professional and technical staff in Research and Development Establishments in Government and Industry. We note also a welcome and growing staff interchange between civil servants and industry.

13.26 We have already noted the argument that the Department of Industry is not disinterested. This is not, perhaps, an overriding objection: if it is not possible to create an independent department, any potential parent department is likely to have some degree of interest; and it is arguably very sensible to link the responsibility for radio regulation to responsibility for industrial policy, given the importance of telecommunications to Britain's industrial future. However, the objection has considerable substance. There are many other areas of activity greatly affected by spectrum use. It would be undesirable for industrial considerations to be given undue preference over wider questions of, for example, social and economic benefits or defence requirements in decisions on spectrum use. Moreover, there are areas of industry such as transport or energy whose interests are not covered by the Department of Industry.

13.27 We would be happier with this proposal if we felt confident that the industrial arguments which would be brought to bear on regulatory policy would be directed to securing the overall benefit of industry in the UK. However in considering the industrial implications of different uses of Bands I and III, in preparing our Interim Report, we found no evidence of any attempts to evaluate, by cost/benefit analysis, the rival options in relation to the UK's industrial well-being, considered as a whole. This experience, together with our more general perceptions, provides little evidence of the involvement of the Department of Industry in broad assessments of the costs and benefits of



alternative developments. The transfer of RRD to the Department of Industry might well be beneficial if it meant that regulatory decision making were to be under-pinned by critical assessments of what was best for UK industry; but there would be no merit in regulatory issues becoming the subject of a tug-of-war between rival interest groups.

#### A Department of Communications

13.28 The foregoing arguments could be developed still further into consideration of a Department with responsibility for all forms of communications and transportation, by physical as well as electronic means. Arguments in favour would be that intricate and complex issues of policy and practice are already emerging as, for example, electronic means of communication are substituted for the physical movement of people and information. Arguments against would include the already complex and intricate interrelations between the competing elements within the transportation industries and services. We regard substantive analysis of this matter as outside our terms of reference but would comment that the inclusion of a radio regulatory responsibility within the ambit of what would amount to a large and necessarily diverse Department could lead to criticisms of the type levelled by many of our witnesses against the present arrangements.

#### Conclusions

13.29 In view of the volume of evidence put to us regarding governmental structure, we feel bound to give some indication of our views. We believe that the creation of a separate department is the best course to take, in that it would offer the prospect of a coordinated policy for Britain on telecommunications. Such a department would have a much more significant role now than did the Ministry of Posts and Telecommunications in 1969 to 1974; the present spate of diverse developments in telecommunications appears to us to require greater coordination than exists at present. Further, all our evidence points to an increasing role in the UK economy for telecommunications and telecommunications-related industries. Therefore, while recognising fully that changes in the machinery of Government involve the consideration of wider issues than those we have discussed here, we recommend the creation of a separate ministerial department responsible for telecommunications, in order to achieve industrial and regulatory effectiveness for Britain.

13.30 If this is felt not to be desirable or feasible, we recommend the concentration of responsibility for telecommunications in a distinct unit, with its own Minister, within an existing Government department. The most appropriate parent department would appear to be the Department of Industry.

13.31 If no substantive changes to the machinery of Government are to be made, we would nevertheless recommend the transfer of the Radio Regulatory Department from the Home Office to the Department of Industry.



## CHAPTER 14

### SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

#### Land Mobile Bands

While the situation in the land mobile bands is likely to be manageable until the late 1980s, problems thereafter are likely to become acute unless significant use can be made of other bands and/or new technology (para 4.8).

#### Broadcasting

We recommend in relation to ancillary services that:

- (i) as a matter of some urgency, the demand emerging from the enlarged community of programme makers be taken into account in policy formulation;
- (ii) the broadcasting authorities be given every encouragement to make the maximum use of the existing broadcasting bands to accommodate their ancillary requirements; and
- (iii) any further requests for spectrum for these various services be given very close scrutiny in view of the many other competing claims for frequencies (para 4.12).

There is no justification for the provision of additional spectrum for terrestrial TV or sound services without very serious consideration of the frequency implications, in the light of the undoubted emergence of alternatives (para 4.13).

Within the timescales we are considering, there is no scope for any reduction in the use of spectrum for terrestrial broadcasting (para 4.14).

#### Defence Bands

There is little scope for the reductions in defence spectrum usage which some respondents have suggested (para 4.19).

#### Fixed Services

We recommend that early special arrangements be made with all parties concerned to review the policy and practice of frequency spectrum management in relation to fixed services so that overall strategies can be developed in the face of the saturation likely to be begin in the late 1980s (para 4.25).

#### General Growth

In respect of the processes of frequency management and the operational requirements of the major users:

- (i) there is no prospect of any significant reserves of unused or under-used spectrum being identified in the 30-960 MHz range and reallocated;
- (ii) the long timescale involved in bringing about major changes in the pattern of use means that fundamental decisions will have to be taken an an early date on the relative priorities to be accorded to different services (para 4.28).



## Frequency Spectrum Management

We recommend that:

- (i) an Annual Report be published by RRD reviewing spectrum policy and management (para 9.6);
- (ii) explanatory material be produced, to a high standard of presentation, for the user, potential user or general reader (para 9.9);
- (iii) regular reviews be instituted by the RRD at not less than five year intervals related to specific user groups or systems and covering growth in spectrum usage, technical and operational changes taking place or foreseen, and spectrum efficiency (para 9.8);
- (iv) the Frequency Allocation Table be published (para 9.10);
- (v) a high level Advisory Committee be established (para 9.14);
- (vi) the overall allocation of spectrum for defence purposes be reviewed periodically, perhaps every five to ten years, by a small committee of Privy Councillors or people of similar standing, to whom the appropriate classified details of defence arrangements could be disclosed (para 9.19);
- (vii) cost/benefit analysis or similar techniques be, wherever relevant, an element in spectrum management decisions; and that applicants be encouraged to submit supporting evidence of such analyses where available (para 9.23);
- (viii) more general techniques of costing spectrum use be progressively developed (para 9.23);
- (ix) in appropriate frequency bands, the basis for calculating licence fees be amended so as to further regulatory objectives and in particular to encourage by financial incentives both the use of less frequency-demanding equipment and the use of less congested frequency bands (para 9.27);
- (x) adequate resources be devoted to spectrum monitoring, particularly of the mobile and fixed bands, as an aid to efficient spectrum usage and effective management (para 9.30).

## Frequency Assignment Management

We recommend that:

- (i) responsibility for assignment be delegated, wherever practicable and defensible, to definable and responsible common interest groups, subject to two safeguards: the imposition of technical criteria where appropriate, and of a requirement to report annually to the RRD (paras 10.13 and 10.14);
- (ii) wherever practicable, preference be given to the establishment of further service-providing systems when spectrum is being re-allocated; and that long-term regulatory policy be directed to encouraging users to use such systems rather than to seek individual assignments (para 10.17);
- (iii) fixed-term assignments be adopted (para 10.23);



- (iv) short term provisional assignments be introduced to increase planning and development efficiency (para 10.26).

We make no formal recommendation on spectrum pricing. We incline to the view that it may well be impracticable. However, if Government believe that this matter should be further pursued we recommend that before any action is taken a detailed and critical feasibility study be commissioned (para 11.16).

#### Staffing and Resources

We recommend that:

- (i) a special grade structure be created, with appropriately increased salary levels, for the engineering staff in RRD (para 12.11);
- (ii) regular interchange of staff between the RRD and industry be introduced (para 12.12);
- (iii) RRD interests in the SERC "Specially Promoted Programme into Radio Communication Systems" be increased and adequately resourced (both in the programme and the RRD)(para 12.7);
- (iv) RRD experience, knowledge and guidance, not only at technical, but also at policy levels, be made available to SERC (para 12.7);
- (v) an annual review of the relevance and effectiveness of these programmes be made by the RRD and SERC and incorporated in the Annual Report of the RRD (para 12.7);
- (vi) system-oriented research, with the maximum practicable industrial participation, be increased (para 12.7).

#### The Place of Radio Regulation in the Governmental Structure

We recommend that:

- (i) radio regulation remains within Government rather than being made the responsibility of a non-governmental body (para 13.14);
- (ii) a separate ministerial department responsible for telecommunications be created (para 13.29);
- (iii) failing (ii), responsibility for telecommunications be concentrated in a distinct unit with its own Minister, within an existing Government department (para 13.30);
- (iv) failing (iii), the Radio Regulatory Department be transferred from the Home Office to the Department of Industry (para 13.31).



LIST OF ANNEXES

- A Letter of 12 January 1983 from the Home Secretary to the Chairman.
- B Consultative Questionnaire.
- C List of organisations and individuals who gave evidence.
- D Selective Summary of Responses to the Consultative Questionnaire.
- E Study of Radio Regulatory Practice Overseas.
- F Terms and Abbreviations.
- G Case Study on the Impact of Private Mobile Radio on the Road Haulage Industry.
- H Frequency Allocations between 30 MHz and 51.4 GHz.
- J Frequency Demand for Civil Land Mobile Services against Potential Frequency Availability, 30-960 MHz.
- K Estimates of Growth for Fixed Services above 1 GHz.
- L Organisational Structure of Relevant Sections of the Home Office.
- M Papers on Spectrum Pricing.
- N SERC Specially Promoted Programme in Radio Communication Systems: List of Possible Research Topics in Mobile Radio.



ANNEX A

Home Office  
50 Queen Anne's Gate  
LONDON SW1

12 January 1983

Dear Dr Merriman

I understand that in discussion with officials you have enquired whether, having regard to the terms of reference of your review of the radio spectrum, you and your colleagues are free to examine the adequacy of the existing machinery for consultation regarding the use of the frequency spectrum and for the assignment of frequencies in relation to bands above 960 MHz.

I recognise that in relation to these matters, to which paragraph 1(e) of your terms of reference refer, different considerations apply than to other matters I have asked you to examine. In particular, while your examination of the present and possible future pattern of spectrum occupancy was deliberately limited to the 30-960 MHz range your examination of some aspects of our present machinery will, I imagine, need to be related to individual radio services rather than to particular parts of the spectrum. I hope, therefore, that you and your colleagues will not hesitate to make recommendations on these matters that could be applied both below and above 960 MHz. I am sure that officials will be ready to give you such information as you may need in formulating such recommendations.

Yours sincerely

(signed)  
WILLIAM WHITELAW



## QUESTIONS

PART A

## REVIEW OF 30-960MHz (PARAGRAPHS 1(a) - 1(d) OF TERMS OF REFERENCE)

1. What type(s) of operational service, and operating in what frequency ranges, are of concern to you?
2. What pattern of demand for these services, or development of market opportunities for new services, do you foresee over the next 10-15 years?
3. What factors, in your judgement, generate this demand (eg general economic climate, technological development, social need etc)?
4. What changes in methods of operation, or in technology, do you foresee and plan to exploit in order to achieve progressive improvements in frequency spectrum economy?
5. What operational or technical alternatives are open to you if demand for spectrum outpaces availability? Has this situation arisen in relation to the service(s) which concern(s) you? If not, do you foresee it arising?
6. Is conformity with usage/standards/attitudes abroad, a relevant factor? If so, in what way?

PART B

## THE MACHINERY FOR CONSULTATION AND FREQUENCY ASSIGNMENT (PARAGRAPH 1(e) OF TERMS OF REFERENCE)

1. What has been your experience of the working of present procedures? What is your general view of them? If critical, what shortcomings do you see? What changes would you propose? Please assess the likely effect on the cost of the regulatory process (both to government and to others) of any proposals you make.
2. How should the machinery take account of the interests of the equipment manufacturing and the user communities?
3. "Management" of the spectrum implies the effective control of three distinct activities
  - allocation of frequency bands for types of service
  - assignment of individual frequencies to specific users
  - monitoring and regulation of the use of frequencies to ensure maximum efficiency.

How should overall management of the spectrum best be discharged?

- (i) What scope of any is there for delegation of elements of this overall management to users, groups of users or other "intermediaries"?
- (ii) Should spectrum allocation decisions reflect value judgements on the "worth" of the services in question? If so, how should such value judgements be arrived at?
- (iii) Should frequency assignment decisions incorporate an element of judgement of "worth"? or should they be determined or influenced by market forces, eg by charging a 'rent' representing what is judged to be the economic value of the frequency assignment in question rather than a licence fee reflecting (in part) the cost to government of administering the licensing



system; or by "auctioning" spectrum?

- (iv) Does the existing licensing practice tend to foster the impression that licensees have a prescriptive right to retain their frequencies? Should spectrum be assigned instead to some users or groups of users for a predetermined time with no presumption that the assignment will be renewed?

4. Are there acceptable measures of the effectiveness - in terms both of techniques and operational usage - of spectrum occupancy and if so should they be used in the assignment process?



The following organisations and individuals submitted written evidence;

\* Those marked with an asterisk also gave oral evidence.

Air Call Communications  
 Association of British Theatre Technicians  
 Association of Cinematograph Television and Allied Technicians  
 \*Association of County Councils  
 \*Association of District Councils  
 \*Association of Independent Radio Contractors Limited  
 \*Association of Metropolitan Authorities  
 Audio Engineering Limited.

British Airways  
 \*British Broadcasting Corporation  
 \*British Railways Board and British Transport Police  
 British Security Industry Association  
 \*British Telecom  
 Bus and Coach Council

Citizens Band Association  
 \*Civil Aviation Authority/National Air Traffic Services  
 Clinical Research Centre  
 Communications Working Group of the Conference of Socialist Economists  
 Consumers Association  
 Convention of Scottish Local Authorities

\*Department of Health and Social Security  
 \*Department of Industry  
 Department of Trade  
 \*Department of Transport

\*Electronic Engineering Association

General Council of British Shipping  
 Greater London Council

Professor M Harrison, Department of Politics, University of Keele  
 \*Home Office

\*Independent Broadcasting Authority and Independent Television Companies Association  
 \*Institution of Electrical Engineers  
 \*Institution of Electronic and Radio Engineers  
 Isle of Man Home Affairs Board

\*Joint Radio Committee of the Nationalised Power Industries



Dr R C V Macario, Department of Electrical and Electronic Engineering, University  
College of Swansea

- \*Mercury Communications Limited
- Mid-Somerset Breakers Club
- \*Ministry of Defence
- \*Mobile Radio Users Association
- Model Power Boat Association
- Model Yachting Club

- \*National Economic Development Office, Electronic Capital Equipment and Information  
Technology Sector Working Party
- National Union of Journalists
- \*National Water Council

Plessey Communications

Post Office

Pye Telecommunications Limited

Radio Society of Great Britain

Reuters

Professor J J Richardson, Department of Politics, University of Strathclyde, and  
Mr A G Jordan, Lecturer in Politics, University of Aberdeen

Science and Engineering Research Council

Selective Paging Committee

- \*Society of Model Aeronautical Engineers Limited
- States of Guernsey Broadcasting Committee and States Telecommunications Board
- Stock Exchange

- \*Telecommunication Engineering and Manufacturing Association
- Telephone Manufacturing Company (TMC) Limited

United Kingdom Atomic Energy Authority

Dr C Veljanovski, Centre for Socio-Legal Studies, Wolfson College, Oxford

"103 is Free" Campaign



## ANNEX D

### SUMMARY OF EVIDENCE

1. This paper is a selective summary of points made in evidence to the Review in relation to the questions raised in part B of the list attached to the consultative letter (Annex B). It does not attempt to summarise the whole of any respondent's evidence, but rather to extract relevant points.

Question 1: "What has been your experience of the working of present procedures? What is your general view of them? If critical, what shortcomings do you see? What changes would you propose? Please assess the likely effect on the cost of the regulatory process (both to government and to others) of any proposals you make."

2. A considerable volume of criticism was evoked by this question. The main defects perceived were slowness, the closed nature of the processes, and a lack of adequate consultation. The main changes proposed were more coordination of regulatory and other policies; more and better consultation; and the transfer of the radio regulatory function from the Home Office to another Government Department or non-Governmental body. Respondents did not accept our invitation to cost their proposals.

3. The Mobile Radio Users' Association argued that present procedures showed no concern for the user but showed preference to manufacturers. It argued that the RRD should be transferred to OFTEL and that a User Coordination Group should be set up to undertake channel assignment work on a delegated basis. This Group should have devolved authority to manage the non-governmental spectrum as regards assignment; recommendations on licensing, the resolution of disputes and interference control. Air Call Limited supported the MRUA, criticized what it saw as injustices in allocation policy, and argued for flexibility in allocation. The Stock Exchange commented on the "dictatorial" attitude of the Home Office. The Bus and Coach Council criticized procedures as slow, lacking in continuity and inaccurate, and unable to keep pace with users' needs. British Rail argued that users should be involved more closely, and criticized the lack of information from the Home Office. It did not feel that the Mobile Radio Committee represented users satisfactorily. The Society of Model Aeronautical Engineers and the Model Power Boat Association both commented on a general lack of consultation, though adding that the position had improved recently and that personal relations, once they had made contacts in the RRD, were good. Other respondents criticized delays, a lack of appreciation of users' needs and a generally reactive rather than customer-oriented approach; and argued for regular reviews of allocations, and a more open attitude on the part of the Home Office to explaining present usage of the spectrum and its problems.

4. The Joint Radio Committee of the Nationalised Power Industries commented on the administrative delays in producing frequency assignments and attributed this largely to under-staffing. It noted the poor relative pay of RRD engineers and recommended changing the grade structure. It was content with the existing machinery, given adequate staffing. The National Water Council had similar views - it felt that the Department should be staffed and organised to give a quick and responsive service to users.

5. The local authority associations in general felt that present procedures were haphazard, and wished to see more consultation with local authorities. The Association of District Councils also proposed a national representative body of radio users (which might undertake delegated assignment work).



6. The Telecommunications Engineering and Manufacturing Association criticized the slowness of the present machinery and the general lack of openness. It argued that as the Home Office had no direct concern for manufacturing industry, responsibility should pass to the Department of Industry, preferably in the form of a new joint authority for radio licensing and telecommunications. The EEA felt that the present system treated mobile radio unfairly as compared with other users; more openness, equity and consultation were required. The functions should be transferred to a separate department, or to the Department of Industry. The National Economic Development Office argued for more openness and for more weight to be given to economic and industrial considerations. It believed that more consultation and more "forward looks" were required, and suggested a new authority for telecommunications responsible to the Secretary of State for Industry (OFTEL might be appropriate); or, ideally, a new Telecommunications Ministry. The Institution of Electrical Engineers argued that whatever the organisational structure the proceedings should be more demonstrably open than at present. It recommended an advisory committee, of independent expert members. The Institution of Electronic and Radio Engineers recommended a revival of the Frequency Advisory Committee.

7. The Civil Aviation Authority, by contrast, was happy with the present machinery and did not wish to see any radical change. The BBC also expressed itself happy with its relations with the Home Office, and with the existing machinery; the IBA too appeared generally content.

8. British Telecom commended the international work of the RRD. As to national frequency management, it commented on the closed nature of the process: competing claims were judged "in camera" and it was not clear that the balance between civil and military or broadcasting and non-broadcasting allocations was fair. It believed that much more openness was needed. To improve the quality of allocation decisions and to increase their general acceptance, it proposed an advisory panel of experts from industry, Government, the armed forces and commerce. Mercury Communications Ltd criticized the slowness of the regulatory process, and the split between regulatory and telecommunications policy. It wished to see a single department, or failing that, the transfer of RRD to OFTEL.

Question 2: "How should the machinery take account of the interests of the equipment manufacturing and the user communities?"

9. Most of the responses to this were simply pleas for more and better consultation, and there was considerable uniformity in the replies.

10. The Mobile Radio Users' Association claimed that users had been neglected at the expense of manufacturers. It suggested that the new OFTEL-run authority it was recommending should have a consultative committee with representatives of all interests. The Selective Paging Committee supported consultation through trade associations, committees etc, and wished these consultations to result in fixed time-tables for action. Other responses included the suggestion that the Home Office learn more about clients' needs, and maintain greater stability of staffing in RRD, so that acquired expertise was not lost. Some groups argued that the interests of manufacturers were not relevant to the regulatory process, or that manufacturers' interests were already adequately covered. The National Water Council suggested a consultative committee, including manufacturers and users, to advise on the relative merits of applications. It also argued for provisional channel allocations. The Association of District Councils favoured consultation with a national body representing all users; the Association of Metropolitan Authorities felt that manufacturers' interests would be served by more advance notice of changes in allocations, etc, and users' interests by more advice from the Home Office.



11. The Telecommunications Engineering and Manufacturing Association recommended a consultative body representing Government, operators, manufacturers and users. This might have a technical sub-group and its procedure might include public hearings. Licensing decisions, it argued, should rest with the Department of Industry. The Electronic Engineering Association argued that committees should have a real consultative and representative role, and not merely rubber-stamp executive decisions; the membership of committees should be genuinely representative.

12. The Institution of Electrical Engineers argued for greater openness in the RRD's operations, and for an independent committee to provide expert technical advice, rather than a representative body for user and manufacturer interests. The National Economic Development Office recommended that responsibility for radio regulation should pass to the Department of Industry, or to a separate Department, to ensure that industrial interests were properly taken into account. The Institution of Electrical and Radio Engineers wished to see the Frequency Advisory Committee revived; it felt that consultation should be a continuing process, not the subject of ad hoc exercises.

13. The IBA and Independent Television Companies' Association argued for greater liaison between the regulatory authority and equipment manufacturers. They favoured in general informal rather than formal consultative arrangements. British Telecom suggested an advisory panel of experts to (inter alia) reflect industrial and user views. It also suggested that the Home Office should encourage competing applicants to argue their cases face to face instead of dealing with the applicants separately itself.

14. The paper by Professor Richardson (Strathclyde) and Mr Jordan (Aberdeen) suggested that the revival of the Frequency Advisory Committee might be useful. However, it suggested that there were dangers in attempting to consult too widely and comprehensively - over-refinement and extension of consultation might yield diminishing returns. It also suggested that a technical (and non-representative) advisory body might be helpful.

Question 3(i): "What scope if any is there for delegation of elements of this overall management to users, groups of users or other "intermediaries"?"

15. Of the bodies who commented on this proposals (about half of all respondents) the majority saw advantages in delegation, or at least regarded it as worthy of further thought.

16. Most users of the mobile radio bands were in favour. The Mobile Radio Users' Association proposed delegation to a User Coordination Group (which might also carry out monitoring and interference investigation). British Airways and the Nationalised Power Industries stressed that delegation was possible only to responsible bodies of proven competence. The Civil Aviation Authority favoured delegation in situations similar to its own, where the user had the necessary expertise. It felt that it might be feasible for smaller user groups to exercise assigned functions in sub-bands, subject to safeguards against the misuse of power. The Society of Model Aero Engineers also noted that safeguards were needed, such as transmission standards and type approval procedures. British Rail favoured delegation for larger users, and suggested that manufacturers might carry out assignments for smaller users. Others to support delegation were the Bus and Coach Council, the British Security Industries Association, the Stock Exchange and the Model Power Boat Association.

17. The Electronic Engineering Association was in favour and the Telecommunications Engineering and Manufacturing Association was content for more delegation, given adequate consultation and standards, and periodic reviews of assignments.



18. The local authority associations pointed out that they could take on delegated responsibility only if enough channels were assigned to them, and if the extra costs to them could be covered.

19. The IBA and Association of Independent Radio Companies favoured exclusive delegated bands for broadcast ancillary services, but the BBC preferred the existing arrangements. British Telecom saw delegation as appropriate only in exceptional cases, as at present.

Question 3(ii): "Should spectrum allocation decisions reflect value judgements on the "worth" of the services in question? If so, how should such value judgements be arrived at?"

20. The response to this was rather thin. Most respondents felt that it would be difficult to make explicit judgements of social worth, though some suggested that estimates of economic worth could and should be used. However, a significant number of users representing utilities, public services etc, felt that commercial criteria should not override considerations of social worth.

21. Of the mobile radio users, the Mobile Radio Users' Association noted that worth was difficult to quantify and British Airways felt that it was unrealistic to look for value judgements on the worth of services. The Bus and Coach Council suggested that judgements might be based on real or avoidable cost, supported by social benefit calculations. The Joint Radio Committee of the Nationalised Power Industries suggested that value judgements were inevitably implicit in the present procedure, and acknowledged that it would not be easy to make them more explicit, or to quantify them. The National Water Council suggested that worth to the community should be the criterion. The Association of County Councils said that safety-of-life considerations should predominate. The Association of Metropolitan Authorities pointed out the difficulties of comparing different types of service, and the Association of District Councils argued that spectrum management decisions must rest with Government.

22. A number of bodies including the Telecommunications Engineering and Manufacturing Association, the Electronic Engineering Association, the Institution of Electronic and Radio Engineers and British Telecom commented that the choice between competing services of different kinds must ultimately be a political or governmental one. The EEA added that "value judgement" decisions should not be needed as regards assignments, as there was no real shortage of spectrum if it was allocated equitably.

Question 3(iii): "Should frequency assignment decisions incorporate an element of judgement of "worth"?; or should they be determined or influenced by market forces, eg by charging a "rent" representing what is judged to be the economic value of the frequency assignment in question rather than a licence fee reflecting (in part) the cost to government of administering licensing system; or by "auctioning" spectrum?"

23. The majority of respondents who commented on this were firmly opposed to spectrum pricing or renting.

24. Most of the mobile radio users who commented were opposed. The Mobile Radio Users' Association said that fees should cover only administrative costs and added that there was in fact no shortage of spectrum if it was fairly divided. The Selective Paging Committee felt that a rental system would be very difficult to operate. The Bus and Coach Council and British Airways both opposed spectrum pricing. British Rail was not opposed, but stressed the need for equity between different users; it proposed that the level of charge might reflect the area covered and whether use was shared or exclusive.



25. The Joint Radio Committee of the Nationalised Power Industries was opposed to pricing and the National Water Council did not favour its application to such operations as theirs. The local authority associations also were opposed. The Association of County Councils argued that it was difficult to quantify the worth of a service, and that it was not in the community's interest that local authorities should have to bid against industry for the use of radio.

26. The Telecommunications Engineering and Manufacturing Association was opposed to spectrum auctions but felt there might be a case for pricing as a tool of spectrum management. The Electronic Engineering Association was opposed to pricing and argued that the use of spectrum was not price sensitive.

27. The IBA and Independent Television Companies' Association and the Association of Independent Radio Contractors were strongly against spectrum auctioning; they argued that the criterion for allocation should be need, not commercial considerations. British Telecom felt that charging would be quite inappropriate, and would lead to the entrenching of inefficient use. The Institution of Electrical Engineers argued that while charging might be reasonable in theory, it could not be put into practice fairly.

Question 3(iv): "Does the existing licensing practice tend to foster the impression that licensees have a prescriptive right to retain their frequencies? Should spectrum be assigned instead to some users or groups of users for a predetermined time with no presumption that the assignment will be renewed?"

28. The case for regular reviews of need was generally accepted. While many respondents emphasised the need of radio users for security of tenure as regards their assignments, a significant proportion were prepared to accept that a fixed period was reasonable, as long as it was related to the economic life of the equipment.

29. Mobile radio users in general emphasised the need for security of tenure but many acknowledged the need for periodic review, and were prepared to accept a limited term which was linked to equipment lifetime. The need for security of tenure was stressed by the British Security Industries Association, the Bus and Coach Council and by the Model Power Boat Association. British Rail were in favour of setting time limits to assignments, with periodic reviews.

30. The Joint Radio Committee of the Nationalised Power Industries accepted the argument for relinquishing bands which were underused, but saw problems in fixed periods of tenure. It argued that this would lead to a reluctance among users to invest in sophisticated equipment.

31. The Telecommunications Engineering and Manufacturing Association agreed with fixed period assignments, as long as the duration of the assignment reflected the size of the capital investment and the time needed to obtain an economic return. The Electronic Engineering Association was in favour of a modified version: it felt that a user should have a right to continue the use of radio, but that it would be reasonable, when synthesised equipment was in common use, for the regulatory authority to have the right to change users' assignments.

32. The IBA supported the need to rejustify the use of frequencies, say, every 10 years with an interim report-back at the 5 year point; this would include a critical examination of the proportions of spectrum devoted to military and civil use.

33. British Telecom acknowledged that as a last resort it might be necessary to withdraw from established users some or all of their allocation in order to provide for newcomers with a better claim; and stressed that in such cases appropriate notice - 10 to 20 years - should be given.



34. The Institution of Electrical Engineers was in favour of a fixed period "leasehold" system under which an assignment would be made for between 10 and 30 years depending on the user and the capital investment involved, but would be reviewed every 5 years to determine whether the "lease" should be extended, or the terms changed.

Questions 4: "Are there acceptable measures of the effectiveness - in terms both of techniques and operational usage - of spectrum occupancy and if so should they be used in the assignment process?"

35. Relatively few respondents replied on this point, and they were almost uniformly dismissive. A number made the point that while a comparison might be made between similar services, it was very difficult to conceive of any way of comparing the effectiveness of usage of different services. Others made the point that in some services a low rate of usage might be justified and any measurement would therefore have to take account of the type of user. One respondent argued that any attempted measure of efficiency was likely to be at best arbitrary and at worst would, if enforced, reduce the efficiency of some users. A number of respondents however argued that effectiveness should be checked by monitoring; the Electronic Engineering Association and the Selective Paging Committee, both argued for monitoring of spectrum use on efficiency grounds; and the Institution of Electrical Engineers argued for a radio spectrum version of the Clean Air Legislation. In addition, a number of respondents called for more active monitoring for, and suppression of, interference and illicit use of radio.



STUDY OF RADIO REGULATORY PRACTICE OVERSEAS

## A. UNITED STATES OF AMERICA

General Regulatory Structure

Responsibility for national spectrum allocation and management is divided, under the Communications Act of 1934, between the Federal Communications Commission (FCC) and the President, though Presidential authority is delegated to the National Telecommunications and Information Administration (NTIA) in the Department of Commerce. The NTIA is responsible for all federal government users of radio; the FCC is responsible for all other users, including state and local government.

Organisation of the Regulatory Authority(a) The NTIA

2. The NTIA exercises its delegated authority primarily through the activities of the Interdepartment Radio Advisory Committee (IRAC). This consists of representatives of the twenty or so federal departments and agencies that make extensive use of radio communications. It serves in an advisory capacity to the NTIA and assists that body in all matters relating to spectrum management. The IRAC has four permanent sub-committees, dealing with frequency assignment, technical matters, spectrum planning and international notifications respectively. The first of these has two sub-groups which handle aeronautical assignments and military assignments respectively. All sub-committees are chaired by NTIA officials with the exception of the international notification group which is chaired by the FCC.

(b) The FCC

3. The FCC is an independent agency, responsible to Congress. It comprises seven commissioners, appointed by the President, who also designates the Chairman. The majority party in government usually has the majority representation on the Commission in the ratio 4:3. It is supported by a staff of some 2200 in a number of offices and "operating bureaux". One of the offices - Science and Technology - is headed by the Chief Scientist and is responsible for broad frequency management policy, frequency allocation and advice on engineering, technical and scientific matters. Four operating bureaux - Broadcast, Common carrier, Private Radio, and Cable TV - carry out licensing and rule-making in their respective areas. A fifth bureau, Field Operations, is responsible for monitoring and enforcement.

4. The FCC is responsible for the management of the spectrum allocated to users other than federal government. Its operations are subject to the Administrative Procedure Act, which requires an extensive and open consultation process, including Notices of Inquiry, Notices of Proposed Rule-Making and, when necessary, public hearings, before it makes Rules - see paragraph 7.

Mechanism for the Allocation of Frequency Bands

5. The FCC and the NTIA are jointly responsible for the development of long range national spectrum planning and of the national table of frequency allocations. This joint planning effort is accomplished on a day to day basis by the staffs of the FCC and the NTIA and through the mechanisms of the IRAC and the FCC rule-making procedures. Requests for changes in the national table of



frequency allocations to meet non-government needs are submitted to the FCC by interested parties, and if a change would affect government operations, it is coordinated by the FCC with NTIA, usually through the FCC's IRAC liaison representative. Similarly, requirements originating from the federal government sector are coordinated by NTIA with the FCC. If changes to the table affect users other than federal government, the FCC will obtain the comments of the public through its Notice of Inquiry (NOI) procedures.

6. There is in practice much formalised sharing, and some degree of government usage of nominally exclusive non-government bands and vice versa. Thus most changes to the frequency spectrum will be considered within the IRAC machinery. It is worth stressing that IRAC's function is advisory, although in practice its recommendations are rarely rejected.

7. The FCC's allocation procedure is complex, but open. Since the allocation table is part of the FCC's formal Rules, any amendment to it is subject to the rule making procedures laid down in the Administrative Procedure Act. If for example a manufacturer is developing new equipment for which a new frequency allocation will be necessary, he first petitions the FCC and in response the FCC puts out a public notice - a Notice of Inquiry - inviting comments within a specified time. In the meantime, the FCC staff examine the petition to see if there is merit in the application, whether the public interest will be served in granting the request, whether the need is already provided for by other means etc. If the application seems valid on these grounds the spectrum need is determined taking into account re-use factors, economy of bandwidth, channel loadings etc. Consideration is also given to the place in the spectrum where the new application should be located. Having completed these steps and having taken into account the comments received, the FCC staff prepare a Notice of Proposed Rule-Making describing the technical limitations on the new application and describing the changes to the rules. If approved by the FCC Commissioners, the notice is then placed on the Federal Register with a date by which comments must be made, and also a deadline for further comments in reply. The latter provides an opportunity for public reactions to the responses to the proposed rule making. Once all these comments have been received a Report and Order is drafted and put to the Commission. The adoption of this Report and Order by the Commission implements the proposed rule change.

8. The procedure is described above in its simplest form. In practice it can be considerably complicated and lengthened by the need to repeat various steps of the process, and the FCC's decision can at any stage be challenged through the courts if anyone thinks his views have not been adequately taken into consideration. An extreme example of the problems and delays that can arise is that although the introduction of cellular radio at 900 MHz was agreed in principle in about 1970 the relevant rules have not yet been adopted.

9. It is also worth emphasising the role of the legal profession in these proceedings. Generally, on any major policy matter (that is on any matter other than routine requests for frequency assignments) it is the practice of manufacturers and radio users to make use of attorneys and lawyers as intermediaries in negotiations with the FCC. There are several reasons for this approach, which appears to be unique to the United States. First, the emphasis on openness and the freedom to challenge decisions either directly or through a court of law generates a demand for legal expertise and it is likely that the sheer volume of relevant legislation presents a formidable obstacle to those who would otherwise be involved. Second, the geography of the United States is such that many radio equipment manufacturers and major users of the spectrum are based a long way from Washington where the FCC has its headquarters. Since face-to-face contact with FCC officials is considered to be very important, these organisations feel the need for local representatives; there has thus grown up a body of Washington-based lawyers who act on behalf of users and manufacturers as professional negotiators with the FCC.



## Publication of the National Frequency Table

10. The NTIA publishes a national frequency table, which shows the allocations to services and user groups in the United States alongside a copy of the international frequency table. Government and non-government bands are identified; individual government departments are not identified although a distinction is drawn between military and non-military usage in several cases. The NTIA also publishes an annual report on the government use of the radio spectrum, reports on its Spectrum Resource Assessments (see paragraph 22) are freely available, and a biannual report on the activities of the interdepartmental committee IRAC is published. The Government frequency register listing individual federal frequency assignments is not however available except to government departments and to the FCC.

11. Unlike the NTIA, the FCC is obliged by virtue of the Administrative Procedure Act to make public its rules, opinions, orders, records and proceedings, subject to certain safeguards against breaches of security or personal privacy. The FCC's complete record of non-government frequency assignments is available in various forms such as microfilm and magnetic tape.

## Mechanism for Frequency Assignment

12. Most frequency assignments for government users are selected by the federal agency concerned, several departments having their own sub-allocations. The NTIA coordinates the assignment process through the frequency assignment sub-committee of the IRAC. The FCC is represented on this sub-committee to protect the interests of non government users in shared bands and the NTIA represents the interests of those federal agencies that are not directly represented.

13. All federal users have to review their frequency assignments every five years to check whether they are still required and whether the details as coordinated are still valid. It is not clear how effective this procedure is, since some users undoubtedly simply reconfirm the need for all their existing assignments but it is reported that many agencies, and in particular some of the smaller users of the spectrum, take the review seriously with the result that many unused assignments are relinquished.

14. For users other than federal government, and this category includes state police forces, broadcasters and major suppliers of public telecommunications services as well as the traditional "private" users, the onus is on the potential user to select a frequency and to submit it to the FCC for consideration. The FCC rules specify technical characteristics for the various services including power limits, frequency channel plans etc, and within the pmr bands specific sub-bands are set aside for different categories of user. Most pmr applicants use the services of frequency coordinators - commercial concerns set up (usually on the basis of one for each main user group and major centre of population) to select suitable frequencies for potential users. These frequency coordinators rely on comprehensive records of existing users, based on a combination of the publicly available FCC records and local knowledge built up in the course of carrying out their own business. Once a frequency has been chosen it is submitted to the FCC for licensing. Since the frequency coordinators make it their business to select the best possible assignment for the customer and at the same time comply with the FCC rules, the FCC part of the process is very much a formality. Thus the FCC is relieved of the burden of frequency assignment and the customer is given a good service at a moderate price. For relatively straightforward mobile radio licences, a frequency coordinator will generally be in a position to recommend an assignment within about two weeks and the FCC will generally issue a licence within a further three weeks or so.



## Liaison with other Bodies

15. The regulation of non-government bands is open, with all parties able to gain access to information and officials and to present their own cases. However, if the FCC has to approach the NTIA it may well be unable to disclose the details of the NTIA response. The requirement that non-government bodies deal only with the FCC means that the activities of the NTIA are not open to public scrutiny. The non-government sector has very little detailed knowledge, at least by US standards, of the government's use of the spectrum. It is not uncommon, it seems, for representatives of non-government spectrum users to make informal contact with the NTIA in order to assess (say) the feasibility of obtaining access to a government frequency band before making a formal approach to the FCC.

16. The NTIA has formal and direct contact with non-government interests only through the Frequency Management Advisory Council (FMAC). The membership of FMAC consists mainly of representatives of industry, but also includes user representatives and academics. It meets four times a year and its deliberations are open to the public. Although there is no restriction on the matters that may be discussed, the Council tends to be involved only with major policy issues such as those concerned with international conference preparations, US involvement in the ITU etc, and it does not concern itself with day to day domestic matters.

## Licensing

17. Federal government use of the spectrum is exempt from licensing but requires authorisation by the NTIA. As mentioned above there is a five-yearly review of each government assignment to check whether use of the frequency is still required.

18. With the exception of certain low powered devices, all non-government use of radio requires an FCC licence. Licences are issued for periods of several years, the precise figure depending on the service concerned: for example, broadcasting stations are licensed for three years and mobile radio for five years. There is considerable pressure to modify the three year restriction in the broadcast service. At the end of each licensing period there is much activity, with competitors in the broadcasting field challenging the renewal application. Most of the issues raised revolve around broadcasting policy matters, the financial liability of the broadcasting company etc rather than radio regulatory matters. As there are virtually no refusals to renew broadcast licences the broadcasters themselves would like to see a longer licence period or even an open-ended commitment.

19. In order to prevent assignments from being authorised and then not taken into use there is a requirement in the mobile radio service that at the time of application the radio equipment must already be available or a firm order must have been placed with a guarantee of delivery of equipment within eight months.

20. Licences are now issued by the FCC free of charge. Until 1977 a charge was made to cover the administrative costs, as in the UK. However, the basis on which the broadcasters were charged a much higher fee than other radio users was challenged in the courts and the FCC's response was judged to be unsatisfactory. It therefore felt obliged to abandon charging altogether. Although there are many in the FCC who would wish to see a realistic licence fee covering at least some of the FCC's expenses the experience of the court decision and the administrative burden of returning many thousands of licence fees have been sufficient to discourage a move in that direction for the time being.



## Pressures on the Spectrum and Means of Control - Governmental Spectrum

21. Although it is difficult to obtain data quantifying the extent of the pressures on government bands it is clear from the various studies carried out, from the number of compatibility problems and from the need continually to exploit higher and higher frequency bands that there is considerable pressure on most government frequency bands.

22. To assist in frequency assignment, the NTIA carries out "Spectrum Resource Assessments". Each assessment examines a particular part of the spectrum allocated on a shared or exclusive basis to government use, with the aim of reviewing all such spectrum over a seven year period. The object of these studies is to assess current spectrum utilisation, to identify existing and/or potential compatibility problems between the systems of various departments and agencies, to provide recommendations for resolving any compatibility conflicts and to recommend changes to improve spectrum management procedures. They are carried out by reviewing records of current usage, by comparing this information with the results of extensive field monitoring exercises, by consulting users and manufacturers and by in-house compatibility studies. By means of these assessments, the results of which are published, the NTIA obtains a clear picture, for a particular part of the spectrum, of the existing pressures and potential problems and also identifies any under-utilised spectrum for future use.

23. Also of interest is the System Review procedure, sometimes referred to as the Circular 11 procedure. This is designed to avoid government departments developing or procuring communications equipment before ensuring that frequencies are available for the system. It requires consultation between the federal agency concerned and the NTIA at all stages of equipment development: conceptual, design and acquisition. The NTIA believes that through this procedure it has avoided many major incompatibility problems in the radio spectrum and has prevented departments from wasting considerable sums of money on abortive developments.

## Monitoring - Governmental Spectrum

24. NTIA monitors government use of the spectrum by means of vehicle-mounted monitoring stations. Although only a small percentage of government usage is checked in this way the fact that such steps are taken encourages users to act responsibly.

## Pressures on the Spectrum and Means of Control - Non-Governmental Spectrum

25. In the non-government bands there is no doubt that congestion is serious. With all applicants effectively having a right of access to the spectrum it is difficult for the FCC to reject serious applications and as a result of overcrowding the quality of service in (eg) the pmr bands has progressively deteriorated. Despite a relatively high level of mobile radio usage per capita compared with other countries, there is little sign of demand diminishing within the foreseeable future. The widespread use of citizens' band radio giving smaller business users access to a cheap mobile radio service does not appear to have reduced demand for conventional pmr. Indeed there is some suggestion that by introducing businesses to the benefits of mobile radio, citizens' band radio has generated a further demand for better quality professional radio systems. An interim report on future land mobile telecommunications requirements recently produced by the FCC concludes that private mobile radio growth will continue through to the end of the century. As expected, demand will be highest in the major cities; it is estimated that in New York and Los Angeles, more than 275 MHz of spectrum would be required by the year 2000 for private mobile radio, if existing technology were to be used. This demand will have to be met through more spectrum efficient techniques and/or new technology, since the FCC is in effect unable to regulate demand.



26. Any changes in the FCC's approach to spectrum management are likely to be in the direction of deregulation. Various radical alternatives to conventional spectrum management have been or are under consideration including regulation by pricing, auctioning, lotteries etc. The FCC's experience of having its licence fees successfully challenged in court (see paragraph 20, above) makes a move towards market pricing unlikely for the present. At the moment, the only firm proposal is for a lottery system for selecting the licensee in certain categories of service: low power television, the multipoint distribution service and possibly some categories of land mobile radio. Where there are many mutually exclusive applicants for a limited number of licences, the normal procedure would be to consider the merits of each application and then to hold hearings to decide on the outcome. This is very costly and time-consuming and it is suggested that a lottery would be quicker, cheaper and probably as fair.

#### Monitoring - Non-Governmental Spectrum

27. The FCC monitors the non-government use of the spectrum by means of a fleet of mobile monitoring stations (together with a network of fixed monitoring stations which operate mainly in the bands below 30 MHz). There is also said to be an element of self-policing among the licensees themselves.



## B. FEDERAL REPUBLIC OF GERMANY

### General Regulatory Structure

1. Posts and Telecommunications services in the Federal Republic of Germany (FRG) are the sole responsibility of the Federation and not of the "Lander". The Ministry, the Deutsches Bundespost, is the responsibility of the Federal Minister of Posts and Telecommunications, who is assisted by an Administrative Council.
2. The main piece of legislation, the Telecommunications Installation Act, gives the Federation the exclusive right to set up and operate telecommunications (including radio) installations and grants responsibility to exercise this right to the Minister of Posts and Telecommunications, and to the Minister of Defence for installations intended for the defence of the FRG. The Ministry of Posts and Telecommunications (MPT) has the right to operate telecommunications installations itself or to authorise others to do so under specified conditions and terms. In addition, following an agreement with the Ministry of Defence about twenty years ago, the Ministry of Posts and Telecommunications has responsibility for all general work on frequency matters, international coordination of assignments including military assignments and representation of the FRG at international meetings.
3. Other laws concern the regulation of equipment which uses radio frequency energy for purposes other than telecommunications (Industrial, Scientific and Medical (ISM) in UK terminology) and the regulation of amateur radio, which is for historical reasons the subject of separate legislation.

### Organisation of the Regulatory Authority

4. The Ministry of Posts and Telecommunications is organised on the conventional lines of a government department. The radio regulatory division falls within the Telecommunications Networks Department. Subordinate to the central administration there are eighteen regional directorates and three central offices at the intermediate level and a large number of local offices. One of the central offices, the Telecommunications Engineering Centre (the abbreviation of which in German is FTZ) has responsibility for, inter alia, the technical aspects of frequency management, frequency coordination, monitoring and interference investigation. The local telecommunications offices have a part to play in the regulatory process in that they handle radio licence applications and some basic assignment work.

### Mechanism for the Allocation of Frequency Bands

5. Following a world conference a national frequency table is drawn up by the MPT. Although there is a formal interdepartmental machinery for the discussion of such matters it would appear that at ministry level the preferred method of working is for the ministry to consult individual government departments and others separately on a bilateral basis. There is particularly close cooperation between the MPT and the Ministry of Defence and the authority of the latter is obtained before finalising a revised national frequency table.
6. It is of interest to note that in preparation for the 1979 WARC, the FTZ (the Telecommunications Engineering Centre) was given responsibility for discussions at interdepartmental level following which it submitted recommendations to the MPT. At the ministry level political and other considerations entered into the discussions before the national proposals to the conference were finalised. In all civil frequency allocation matters the MPT has the ultimate authority. When for example the Interior Ministry requires



additional spectrum for police and fire radio systems it must make an application to the MPT. If the MPT were to refuse such an application the Interior Ministry would in general simply accept the position, though it could in theory pursue the case through ministerial channels.

#### Publication of the National Frequency Table

7. A national frequency table, which shows the international allocations as well as the allocation to radio services in Germany has been published since 1965. It is felt that the publication of such a table helps to give users confidence in the system. Other publications include equipment specifications, technical parameters for licensing etc. Details of individual frequency assignments are not available to the public.

#### Mechanism for Frequency Assignment - Governmental

8. In general the Ministry of Defence plans its own bands independently of the MPT, and does not need a licence. The only MPT involvement is in shared bands, where there are compatibility problems between civil and military systems or where international coordination is required. Other government departments are allocated blocks of spectrum within which they are responsible for detailed planning. The MPT does however licence the civil government departments and it lays down technical characteristics for their systems, such as channel spacing. It carries out frequency planning in the broadcasting service, and installs and operates television transmitters, with the exception of the first of the three networks.

#### Mechanism for Frequency Assignment - Private

9. The majority of private radio systems are in the land mobile service and there are relatively few private fixed links. At least in the frequency range up to 1 GHz the MPT attempts to operate a policy of designating bands and sub-bands for various services and categories of user respectively on an exclusive basis. In the private land mobile radio service there are separate sub-bands for taxis, industrial users, port authorities etc and frequency planning is simplified by the adoption of lattice planning techniques. This approach, together with rigid and relatively severe restrictions on technical characteristics, enables frequency assignment work to be delegated to regional, and in some cases, local offices.

10. The decentralisation of frequency assignments for industrial users is taken a step further by involving user associations. There is one user association for each of the twelve or so principal private user categories, and their costs are met by one or more of the major users in each group. These associations which employ one or more experienced radio engineers, act as the link between the user and the MPT. They maintain detailed records of private radio usage within their own category, obtained from their own experiences rather than by access to MPT licence records, and assist potential users in applying for a licence. The user associations are not given any formal responsibility by the MPT but if their recommendations, which are usually submitted to a local office, meet all the MPT's regulations, the local office will almost always issue a licence. In general, user associations will be in a position to recommend a frequency assignment within a few weeks of the application being received and the MPT licensing process would add typically a further two weeks to this timescale. Nearly all private mobile radio users take advantage of the services offered by the user associations and the MPT estimates that more than 90% of routine assignment work in this field is delegated in this way.



### Liaison with Other Bodes

11. As indicated previously the MPT consults other government departments on a bilateral basis rather than by means of the formal interdepartmental machinery. The MPT exercises authority for the regulation of all civil radio usage and all the other civil departments are subordinate to the MPT.
12. Although there is no regular formal contact between the MPT and the private radio user associations, the associations take steps to familiarise Ministry officials with the activities of their customers and the Ministry is willing to hold discussions with the associations as and when necessary.
13. There appears to be little direct contact between the MPT and radio equipment manufacturers in the field of spectrum management and frequency assignment although discussions are held in connection with the preparation of equipment specifications and type approval.
14. In addition to direct contact between the MPT and the broadcasting companies there is a formal committee to advise the minister on broadcasting matters. This committee meets twice yearly and includes representatives of the MPT, the FTZ and the broadcasters.

### Licensing - Governmental Use

15. The radio systems of each government department are covered by a general licence. Each department has to submit details of its radio usage to the MPT annually and on the basis of this submission a licence fee is charged. For historical reasons the Ministry of the Interior is the only department apart from defence that does not have to pay a licence fee although it is still subject to the other requirements stipulated by the MPT. The actual fee charged is based on the standard licensing tariff as would be applied to a private system but the total figure is reduced by half in recognition of the fact that the departments conduct their own frequency assignment work and hence relieve the MPT of this burden. In the broadcasting service, the broadcasters must also pay the MPT for the provision and operation of the transmitter network.

### Licensing - Private Use

16. Licensing for private fixed links (which are generally restricted to public authorities) are issued for ten years at a time, as were those for private mobile radio until recently. Mobile radio licences are now open-ended but the MPT has the right to revoke a licence at any time. Private mobile radio licence fees are about £2.50 on issue plus £1.25 per mobile per month thereafter. Fees are collected monthly through the telephone accounting system. Some low power services, eg door operating devices, are covered by a general licence which for all practical purposes constitutes licence exemption. As long as the equipment is suitably marked as being type approved, an individual licence is not needed.
17. Citizens' band radio is licensed in two ways. The mobiles are covered by a general licence and there is no fee for their operation. However, stations operating from fixed sites require individual licences for which a fee is charged.
18. Experimental licences are issued to manufacturers wishing to develop equipment, but only if a potential user can be identified and if the MPT can foresee the possibility of granting a permanent licence for such an application in the future.



19. The funding of the regulatory organisation is met entirely through licence fees. Fixed stations in the citizens' band service make a particularly substantial contribution, partly to assist in providing the necessary interference investigation service. The licence fees cover such indirect costs as participation in international conferences, research etc. The licence fees are not accurately balanced between the various services, i.e. each service does not necessarily pay its "fair" share. Indeed, there is a deliberate policy to charge higher licence fees for private services to encourage use of the public service.

#### Pressures on the Spectrum and Means of Control

20. In some parts of the FRG the frequency congestion in the pmr field is such that users have had to accept a gradual deterioration in the quality of service or move to higher frequency bands or to public radio services. Private services are severely restricted in terms of the transmitter power (and hence operating range) and antenna height, antenna siting etc. If a commercial or industrial user wishes to have a mobile radio system covering a larger area than is permitted under the regulations then it has no alternative but to use the public radio telephone service. The number of mobiles permitted on each channel of a private radio service is also restricted although it appears that the user associations are prepared to exceed these limits with caution, using their first-hand experience to accommodate the maximum number of users whilst maintaining an adequate grade of service. In this way the user associations benefit both their customers and the MPT.

21. Although the FRG seems not to have the sort of problems which are normally associated with very large city areas, there is undoubtedly a growing demand for private radio spectrum which the MPT will not be able to satisfy. The general trend is to encourage users to take advantage of public services and in anticipation of the demand a new public radio telephone service is being introduced in the region of 450 MHz. In addition to the constraints of the licensing conditions, there is some attempt to discourage private systems through artificially high licence fees.

#### Monitoring and Inspection

22. Once licences have been issued the MPT imposes a very rigorous control to ensure that licence conditions are met. Every public installation is checked before it is put into operation. For private systems the MPT relies on spot checks which cover both operational requirements and technical specifications. Some 74 inspection stations are involved in such on-site inspections, and in addition the spectrum in various bands is regularly monitored using six fixed stations and some mobile stations.



## C. FRANCE

### General Regulatory Structure

1. French telecommunications law provides that no telecommunications equipment may be installed or used except with the authority of the Minister of Posts and Telecommunications. Although the Minister exercises complete control over at least the civil use of telecommunications equipment, the state does not have a monopoly in the provision of telecommunications facilities. Responsibility for radio regulation is located within the MPT, which is also the provider of the majority of the public telecommunications services.

2. Mention should be made of an Act passed in July 1982 which among other things broke the monopoly previously held by TDF, the French broadcasting authority, for the production of broadcast programmes (TDF however retains its distribution monopoly) and which established a new Audiovisual Communications Authority. This authority has rule-making powers and has authoritative powers in the cultural field. Although these powers do not extend to radio regulatory matters the authority, which has full ministerial support and is independent of the MPT, may make decisions which could have a very significant impact on spectrum utilisation.

### Organisation of the Regulatory Authority

3. The radio regulatory functions of the MPT are located in the Direction Generale des Telecommunications (DGT). The radio communications division, which is responsible for frequency planning, licensing and the coordination of frequency assignments between users, is contained within a department of the DGT responsible for international affairs (the DTRE). The MPT is responsible for the international coordination of all frequency assignments, including military, for services throughout France and its overseas territories.

4. Frequency planning and licensing for private mobile services, for the aeronautical and maritime services and for the amateur service are the responsibility of the DTRE, which is also involved in the planning of radio services in French overseas territories. All frequency assignment work within the MPT is conducted centrally in Paris. There have been proposals to decentralize some of these activities including frequency assignments and licensing for private mobile radio but no decision has been taken.

5. Coordination between various government users of the frequency spectrum is achieved through a committee structure, the principal committee of which is the Telecommunications Coordination Committee (CCT). This Committee, which has about 10 members including military and MPT officials, is chaired by a retired senior military man and reports formally to the Prime Minister. Its secretariat is provided by the MPT. Although the CCT is a permanent feature of the organisation it considers only the most important issues and most day-to-day decisions are taken in various permanent and ad hoc sub-committees.

6. Most of the sub-committees, which deal with such matters as international conference preparations, non-telecommunications use of radio frequencies (ISM), site clearance etc, are chaired by MPT officials. The sub-committee which is responsible for deciding on frequency allocation matters is the Mixed Frequency Committee (CMF). This is chaired by the MPT and its members include the Ministry itself, the Ministries of Education, Transport, Industry and the Interior (for the police and fire services), the Broadcasting Authority, the Defence Ministry and the armed forces. The presence of representatives of the three individual armed forces in addition to the Ministry of Defence in discussions on radio regulatory matters appears to be common practice in France. The CMF meets every two or three months depending on need.



7. Reporting to the CMF is a Frequency Assignment Committee (CAF) which is run by the MPT. Its membership is more extensive than that for the CMF and includes for example the Civil Aviation Authority and radio amateurs. The CAF meets every two weeks.

#### Mechanism for the Allocation of Frequency Bands

8. The mechanism for dealing with frequency allocation in France appears to be very similar to that in the UK, and indeed many features of the French approach to spectrum management, including the interdepartmental committee structure, have their counterpart in the United Kingdom. Major changes to the national frequency allocation table originate from preparations for, and the results of, international conferences of the ITU. Preparations for such conferences are the responsibility of one of the specialised sub-committees of the Telecommunications Coordination Committee (the CCT). All government users are represented indirectly through the MPT.

9. Between international conferences, most decisions on frequency allocation changes are taken within the Mixed Frequency Committee (CMF). If agreement cannot be reached in this forum the matter is referred to the CCT and ultimately, if necessary, to the Prime Minister.

#### Publication of the National Frequency Table

10. Since the mid 1970s, the French national frequency allocation table has been available publicly and it is circulated to other Western European countries, the United States and elsewhere. The table shows the detailed allocation of the spectrum to individual services and in most cases identifies the user - armed forces, private, TDF, Interior Ministry etc. Only a limited number of detailed annexes to the table are included in the publicly available version, the others being restricted to government departments and public authorities.

#### Mechanism for Frequency Assignment

11. Government departments, including the TDF, are given responsibility for making frequency assignments within the bands allocated to them. The Frequency Assignment Committee (CAF) is used as a clearing house to give other departments the opportunity to comment on band edge problems and other potential incompatibilities. Non-government users apply to the MPT for licences. DTRE has responsibility for licensing and frequency assignment work for all non-government land mobile and maritime mobile services and for the amateur radio service. The interests of non-government users are represented on the CAF by the MPT.

#### Liaison with Other Bodies

12. All government departments with a significant interest in the use of the radio spectrum are represented on the Mixed Frequency Committee (CMF). As mentioned earlier it is through this and the CCT that the requests of radio users are taken into account both in the preparation for WARC and in the interim periods. The MPT represents the interests of all non-government users and in order to carry out this duty it has frequent meetings with individual users' and manufacturers' associations. In general the formal relationship between the MPT and private radio users is on very similar lines to that in the UK.



## Licensing

13. Government users of the spectrum do not pay a licence fee. With the exception of certain low power services which are exempt from licensing, all non-government systems must be licensed and a fee is chargeable. In the mobile radio field at least, licences are issued without a time limit.

14. The licence fees are intended to cover all the day-to-day administrative costs of frequency assignment work and the issuing of licences. The licence fee structure is rather complex with different rates applying to different services and such factors as the transmitter power, the number of mobiles in the mobile service or the length of circuit in the fixed service all being taken into account in fixing the final fee. Some national public services pay a reduced fee. For example, the electricity authorities only pay about one third of the fee that would be payable if they were treated as private operators. Similarly the national health service radio schemes are subject to a lower fee although the frequency planning for such systems is done on the same basis as if they were private systems.

15. As an example of the costs, the fee for a mobile radio system with 20 mobiles, all having a transmitter power of between one and one hundred watts, would be about £325 per annum. For fixed links the fee ranges from about £35 for a link of less than 2 kilometers, to about £1,350 for 50 to 100 kilometers and over £8,500 for a distance of over 200 kilometers.

16. Some consideration has been given to the decentralisation and delegation of the frequency assignment and licensing functions in the land mobile service on the basis of the system in the Federal Republic of Germany but this has been rejected.

## Pressures on the Spectrum and Means of Control

17. The sub-division of the spectrum from 30-960 MHz in France between the major user groups, ie broadcasting, military, police etc, maritime, aeronautical and land mobile, follows very closely the pattern in the UK. For example, the amount of spectrum for land mobile services, excluding military, police and other security services, is about 5.5% of the total; the figure in the UK is about 6%. With the concentration of population in the major cities, the private mobile radio service has become very congested and complaints about the standard of service and the lack of further spectrum are frequent.

18. The MPT is currently carrying out an exercise to examine the potential growth in the mobile radio field and to examine ways of meeting the demand. Some preliminary results of this exercise show that the number of mobiles in the private radio services is expected to grow from the present figure of 250,000 to about 600,000 in 1990. These figures exclude paging systems but, from 1984, include mobiles in a new PTT-operated trunked system in which there are expected to be 150,000 mobiles in operation by 1990. Predictions for the car radio telephone service show even greater growth, from 7,200 mobiles at present to about 80,000 in 1990.

## Monitoring and Inspection

19. It is not clear to what extent the French MPT carry out routine monitoring of the spectrum but individual installations are checked for compliance with licence conditions before a licence is issued.



## D. JAPAN

### General Regulatory Structure

1. The General Radio Law of Japan, which dates from 1950, provides for the licensing of radio stations, radio equipment, radio operators and the operations of radio equipment. It gives the Ministry of Posts and Telecommunications (MPT) absolute authority over the management of the radio spectrum. Prior to 1949 a single Ministry of Communications provided and regulated all postal and telecommunications services. After that date separate Ministries of Posts and of Telecommunications existed until 1952 when the operational side of the Ministry of Telecommunications was turned into a public corporation, the Nippon Telegraph and Telephone Public Corporation (NTT). In 1953 international telecommunications services were transferred to a separate organisation (KDD).

### Organisation of the Regulatory Authority

2. The present Ministry of Posts and Telecommunications operates postal services and regulates telecommunications activities. The telecommunications side of the MPT comprises a telecommunications policy bureau and a radio regulatory bureau. The latter, in addition to having a general division on frequency matters, contains the broadcasting, radio communications and monitoring departments. It is perhaps significant that the monitoring department has the same status as the broadcasting department within the radio regulatory bureau. Some of the radio regulatory functions of frequency assignment, licensing etc are delegated to eleven regional radio regulatory bureaux.

3. Independent of the main administration of the MPT, there are a number of advisory councils which report direct to the Minister. One of these, the Radio Regulatory Council, has wide ranging powers. The Radio Law requires that the Minister "shall consult the Council and then have a regard for the draft decision of the Council" on a range of subjects from modifications to the Radio Laws and conditions for licensing etc, to individual frequency assignments. The Council may authorise the Ministry to deal with the less important assignment and licensing cases without consultation; eg in the broadcasting service, frequency assignments for stations of less than 100 watts are dealt with without reference to the Council, but all others are referred to it. The Council also acts as an adjudicatory body with regard to any appeals against Ministry action under the Radio Laws. Although its findings are only in the form of recommendations, it is very unusual for the Minister not to act on the Council's decisions. The Council comprises five members, appointed by the Minister with the consent of the House of Representatives and Councillors.

### Mechanism for the Allocation of Frequency Bands

4. Responsibility for the national frequency allocation table for Japan, which closely follows the international regulations, rests with the Ministry of Posts and Telecommunications. Since the MPT carries out all frequency assignment work for all government and non-government users except the military, proposals for changes to the allocation table tend to originate from within the various departments of the MPT itself. These individual departments, in response no doubt to pressures from the users concerned (for example NTT and NHK) submit their requirements to the Radio Regulatory Bureau which does what it can to accommodate the demand. There is close liaison between the MPT and the Defence Ministry and the latter provides information on its spectrum needs direct to the MPT. Thus the MPT has responsibility for deciding on the sub-division of frequency bands between the civil and military authorities. In practice the military requirements are given a high priority and their demands are usually



met. (In this context it should be noted that the total expenditure on defence in Japan is about 1% of the gross national product and although no figures are available it can be assumed that the military use of the spectrum is correspondingly small in comparison with many other countries.)

5. Through its consultations and negotiations with other departments, the Radio Regulatory Bureau builds up a picture of the long term needs of each user group and it prepares a provisional frequency allocation plan for the next ten to fifteen years. Unlike the current frequency allocation table, this long term version is not made public.

#### Publications including National Frequency Table

6. The Radio Laws of Japan require that the Minister of Posts and Telecommunications "shall prepare and offer for public perusal a list indicating the present situation of the frequencies available for future assignment as well as those already assigned". This requirement is fulfilled by the publication of a national frequency table which shows the radio services authorised in each frequency band in Japan together with, in some cases, additional qualifications. This frequency table does not identify which categories of user have access to the various services. The MPT also publishes a list of frequency assignments giving such basic details as category of use (ie fixed, mobile etc), power and location. Military services are excluded from the list as are other security services, assignments authorised for short periods of time and certain HF assignments subject to seasonal changes. For those services which are licensed at local level, including most private mobile radio, the list does not show every individual assignment but merely gives typical characteristics for each frequency. The composite list is issued annually and up-dates are available every two months.

#### Mechanism for Frequency Assignment

7. The MPT has absolute authority to assign frequencies for all services except the military. A potential user must make an application to the MPT; if the relevant regulations are met and there are frequencies available then the Ministry will issue what is referred to as a pre-permit. This gives assignment details, including operating frequency, bandwidth etc, and authorises the user to obtain and install the necessary equipment. Before operating the equipment the Ministry conducts an inspection and only then will a licence be issued. As mentioned earlier the issue of licences and pre-permits to the more important services are scrutinized by the Radio Regulatory Council which, in the case of (eg) broadcasting appears to consider both technical and social factors in its deliberations.

8. The frequency table is subdivided (at least in part) into various services and user groups and the frequency planning parameters are described in some detail in MPT ordinances. This makes it possible for some frequency assignment work to be delegated to local offices and the majority of assignments for relatively low power services are made in this way.

9. The public broadcasting authority, the NHK, carries out much of the frequency assignment work for the broadcasting service and this includes giving technical assistance to the private broadcasting companies. Frequency assignment proposals are submitted to the MPT where they are checked for compatibility with other services before being submitted to the Council and then licenced.



10. For public telecommunication services the NTT is not given complete freedom to plan the relevant frequency bands itself even though in most cases the NTT will be the only user in the band. The NTT may make assignment proposals to the MPT but all spectrum usage must be fully justified. The MPT would appear to assign frequencies to the NTT very sparingly, the NTT having to demonstrate that existing channels are fully loaded before further frequencies are made available.

#### Licensing

11. With the exception of certain low power devices all radio systems are subject to licensing. Licences are generally issued for periods of five years, or three years in the case of broadcasting stations. The majority of licences are issued by local MPT offices even where the assignment work is carried out at regional level. The MPT maintains central control however for all broadcasting services, multichannel fixed services, experimental services and the space services.

12. Those systems which are exempt from licensing are defined by the radiated field strength at a specified distance from the transmitter. This category includes model control. The 27 MHz CB service, which is very restricted in terms of the number of channels available and the transmitter power, was subject to licensing but has been exempted with effect from the start of 1983.

13. Licence fees are designed to cover direct costs, ie those associated with the administration of frequency assignment and the issue of the licences themselves. A fee is payable on application; for broadcasting stations it is approximately £340; for other services £75. Licence renewals cost £3 per licence and this cost is incurred only every three or five years depending on the service. In addition the user is obliged to pay for the compulsory inspection of the station when first installed and this amounts to some £1,800 for a broadcasting station and £175 to £450 for other stations. The Radio Laws require that inspections are carried out annually although some services may be exempted from this requirement and in practice the MPT does not have sufficient staff to meet this obligation in full. Such intermediate inspections are charged for at about one half of the cost of the initial inspection.

#### Liaison with other Bodies

14. The Public Telecommunications and Broadcasting Authorities, NTT and NHK respectively, maintain informal contacts with the MPT at official level but it is clear that the Ministry maintains a tight control on spectrum usage and carefully guards its authority in the radio regulatory field. Both authorities attempt to reach informal agreements with the Ministry before formal submissions are made. The NHK, but not the NTT, also appears to make some use of the Radio Regulatory Council, submitting its views direct to the Council. Neither the NTT nor the NHK have any significant contact with other users of the spectrum and the MPT appears to conduct most of its business with the radio users on a bilateral basis.

15. There appears to be no significant contact between private radio users and the Ministry, except in connection with the processing of licence applications, and there is no evidence of any form of user association. Neither is there much direct contact between individual manufacturers and the Ministry although there are radio equipment manufacturers' associations and discussions are held between the MPT and these organisations.



## Pressures on the Spectrum and Means of Control

16. With a high population density, especially in the Tokyo area, Japan undoubtedly has a serious congestion problem in most radio bands. At present there are some 2.15 million licensed radio stations in Japan of which over 600,000 are land mobile stations, over 500,000 are amateur stations and over 700,000 are in the so-called simplified service which includes citizens' band radio. The total number of stations has doubled since the early 1970s and there are predictions that the number of land mobile stations will increase to between ten and twenty times the present level within a decade.

17. Within the broadcasting service the difficulties of finding sufficient channels are exacerbated by the large number of services offered (there are seven television channels in the Tokyo area) and a determination to give virtually 100% coverage. Loss of coverage through shielding by large buildings imposes further demands for more relay stations and hence for operating frequencies. The Radio Laws require that such loss of coverage must be compensated for by the constructor of the building. These pressures have led the NHK to use the 12 GHz satellite broadcasting band for terrestrial television broadcasting and so far two small areas of Tokyo have such services.

18. In the mobile radio field the limited use of the spectrum by the military has undoubtedly eased the situation but nevertheless the VHF and lower UHF bands are very congested and extensive use is planned for the 800-900 MHz bands. Some years ago there was a serious proposal to make the broadcasting service relinquish the VHF television bands so that they could be made available for mobile radio. With the availability of proven technology for mobile radio operations in the region 800 MHz, this proposal was dropped. However, the broadcasters still feel somewhat vulnerable in that they are no longer faced with the problem of accommodating all television services at UHF and hence they do not have such a strong claim to the whole of the UHF broadcasting spectrum as before. At present however it would appear that the spectrum immediately above the UHF television bands will be adequate to cope with at least the short term growth in mobile radio requirements.

19. At around 800-900 MHz there is a six hundred channel cellular radio system operated by the NTT which provides a high quality public car radio telephone service in the Tokyo area. This has been in operation for about three years. In addition there is a four hundred channel multiple access system which offers a cheaper but poorer quality service and is in effect a common base station system for private users. Third party communications and connection with the public network are not permitted. In December 1982 an eighty channel personal radio system was opened at 900 MHz. This offers a high grade citizens' band type service which appears to be aimed primarily at the small business user.

20. Although there are suggestions that the use of private radio is discouraged in favour of the public services it is not clear how this is achieved in practice since the MPT is obliged to licence all applications, as long as they meet the licensing conditions and a frequency can be found. Since the shortage of frequencies in the major cities is likely to be a very real problem it is probably this fact alone that turns potential private users to the public services.

## Monitoring and Inspection

21. The emphasis on equipment inspection has already been noted. The MPT also operates a policy of regular monitoring of the spectrum and of individual users to confirm compliance with licence conditions as well as to investigate irregularities and interference complaints. For these purposes there are five fixed monitoring stations and a number of mobile units.



Terms and AbbreviationsNational and International Bodies concerned with Radio  
Spectrum regulation or usage

|                |   |
|----------------|---|
| ITU            | International Telecommunications Union: a Special Agency of the United Nations.                 |
| CCIR           | Acronym (in French): International Consultative Committee of ITU on Radio.                      |
| CCITT          | Acronym (In French): International Consultative Committee of ITU on Telephony and Telegraphy.   |
| WARC           | World Administrative Radio Conference of ITU.   |
| CEPT           | Acronym (in French): Conference of European Posts and Telecommunications Administrations.       |
| FCC            | Federal Communications Commission of the USA.   |
| NTIA           | National Telecommunications and Information Agency of the USA.                                  |
| FTZ            | Acronym (in German): Telecommunications Engineering Centre.                                     |
| ICAO           | International Civil Aviation Organisation.  |
| IMCO (now IMO) | Intergovernmental Maritime Consultative Organisation (now International Maritime Organisation). |

Terms used in Radio Spectrum Regulation

|            |   |
|------------|---|
| Allocation | Designation of a segment of the spectrum to a class of users or usage (eg broadcasting, aeronautical navigation, fixed links etc).          |
| Assignment | Designation of specific frequencies for use by specified persons or groups of persons, for specified types of usage in specified locations. |
| Licence    | Authority to install and operate specified apparatus, on specified assignments, in specified places.  |

Units of definition or measurement used inRadio Spectrum Regulation

|               |  |
|---------------|--|
| Hz            | Unit of frequency, 1 cycle/second (named after the physicist H Hertz). |
| kHz, MHz, GHz | thousand (kilo -), million (Mega-), thousand million (Giga -), Hertz.  |
| HF            | High frequency, 3-30 MHz.  |
| VHF           | Very high frequency, 30-300 MHz.                                       |
| UHF           | Ultra high frequency, 300-3000 MHz.                                    |
| SHF           | Super high frequency, above 3000 MHz.                                  |



CASE STUDY ON THE IMPACT OF PRIVATE MOBILE RADIO ON THE ROAD HAULAGE INDUSTRY

Department of Industry

On the basis of submissions made to the Review by the road haulage industry prior to the publication of the Interim Report, it is possible to make an assessment of the prospective costs and benefits of the introduction of a vehicle radio communication system offering national coverage to the commercial road transport industry.

2. The calculations below are based on information contained in the submission put forward jointly by the National Freight Consortium p.l.c. and Phillips (UK) Limited, a study undertaken by Pactel commissioned by the Mobile Radio Committee for the Electronic Engineering Association and a study undertaken by Industrial Market Research Limited for British Road Services Limited.

3. The results of the market research show that there is a viable potential market for a national mobile radio scheme amongst commercial vehicle operators and coach operators. Even on the basis of fairly conservative assumptions about market size, it can be shown that benefits to the national economy exceeds costs by a substantial margin.

4. We have attempted to identify and, where possible, to measure the benefits to users of a national private mobile radio (PMR) system. Primary benefits to road haulage users consist of:

- savings in capital expenditure on vehicles;
- savings in fuel and other operating costs;
- improvements in the level of service provided to customers for a given level of expenditure.

Other benefits which can be identified but which are difficult to quantify include:

- reduced traffic congestion and pollution;
- improved security for vehicles, loads and drivers;
- operational benefits from direct contact with rescue services.

5. The costs of a PMR system for road haulage users will include



the capital and operating costs of the base and control stations required and the cost of equipping and servicing mobile sets in vehicles.

6. The two market research reports have examined potential market penetration of a scheme involving national coverage of PMR. The Pactel report considered heavy goods vehicles, of which there are an estimated 1.2 million in the UK. They considered that there was a definite market for 25,000 mobile radio units with a potential market of at least 100,000 units. Industrial Market Research Limited identified a potential market of between 30,000 and 57,000 units amongst commercial vehicle and coach operators. For the purposes of this assessment we have taken a fairly conservative initial estimate of the market of 30,000, but have assumed that the market grows by 15% per annum so that the total market reaches 100,000 after 10 years.

7. The estimates of demand derived by Industrial Market Research Limited were based on an equipment cost per vehicle per week of £15. We have assumed that this charge is sufficient to cover the cost of installing a national PMR system for road communications including base station costs as well as the cost of equipping vehicles. Since this study was conducted in 1980, this cost has been converted to 1983 prices (£19 per week). For a market of 30,000, these amount to about £30m per year. There are likely to be substantial economies of scale and these unit costs can be expected to fall as usage increases. For a market of 100,000 we have assumed an annual charge of £12 per week giving a total annual cost of about £60m.

8. The Pactel report, completed in 1982, estimated vehicle operating cost savings resulting from the installation of mobile radio in 25,000 HGVs of £50m per annum including fuel cost savings of £15m per annum. In 1983 prices these total some £53m per annum. The submission from the National Freight Consortium indicated operating cost savings of about £65m per annum from an assumed 10% saving in vehicle mileage by 25,000 vehicles (about £70m in 1983 prices). In assessing benefits we have used a central estimate of annual operating cost savings of £60m per 25,000 vehicles. For a market of 30,000 these total £72m per annum. With a total market of 100,000 vehicles after 10 years, these annual savings increase to £240m. It should be noted that it has not been possible to quantify any of the other benefits described in paragraph 4 and that to this extent,



these figures will underestimate the size of the benefits to the national economy.

9. The calculations described above indicate that for a market of 30,000, the annual costs to road users of a national system of PMR would amount to £30m and that the corresponding annual benefits would total £72m. Thus for a initial market of this size costs would outweigh benefits by the considerable margin of over £40m per annum; for a market of 100,000 forecast after 10 years, benefits would exceed costs by £180m per annum. For a market of 30,000 the ratio of benefits to costs is slightly under 2:5:1 but this rises to almost 4:1 for the larger potential market of 100,000.

10. Although uncertainty surrounding some of the assumptions means that these figures are imprecise, the large difference between benefits and costs and the fact that there are a number of benefits that we have been unable to quantify makes us confident that there are significant national benefits to be gained from the introduction of a national mobile radio scheme. The size of the net benefits provides a strong case for allocating additional spectrum to enable this service to be provided to road haulage users.

Department of Industry



## FREQUENCY ALLOCATIONS ABOVE 30 MHz

The block diagrams on the following pages show, in simplified form, the frequency allocations in the 30-960 MHz range and the 960 MHz - 51.4 GHz range.

30-960 MHz

Annex D to the Review's Interim Report gave the proportions of spectrum in this range allocated to the major user groups. As a result of the change of use of Bands I and III, and certain other changes, these proportions will change as follows by 1989:

|   | July 1982 | January 1989 |
|---|-----------|--------------|
|   | %         | %            |
| Broadcasting  | 45        | 39           |
| Defence   | 36        | 29           |
| Police and Fire services                                      | 2         | 2            |
| Other Civil   | 6         | 19           |
| Civil Aviation Authority and<br>National Air Traffic Services | 6         | 5            |
| Space Services )  |           |              |
| Radio Astronomy )   | 1         | 1            |
| Radio Amateurs )  |           |              |
| Shared use  | 4         | 5            |

960 MHz - 51.4 GHz

Primary allocations to different users are as follows:

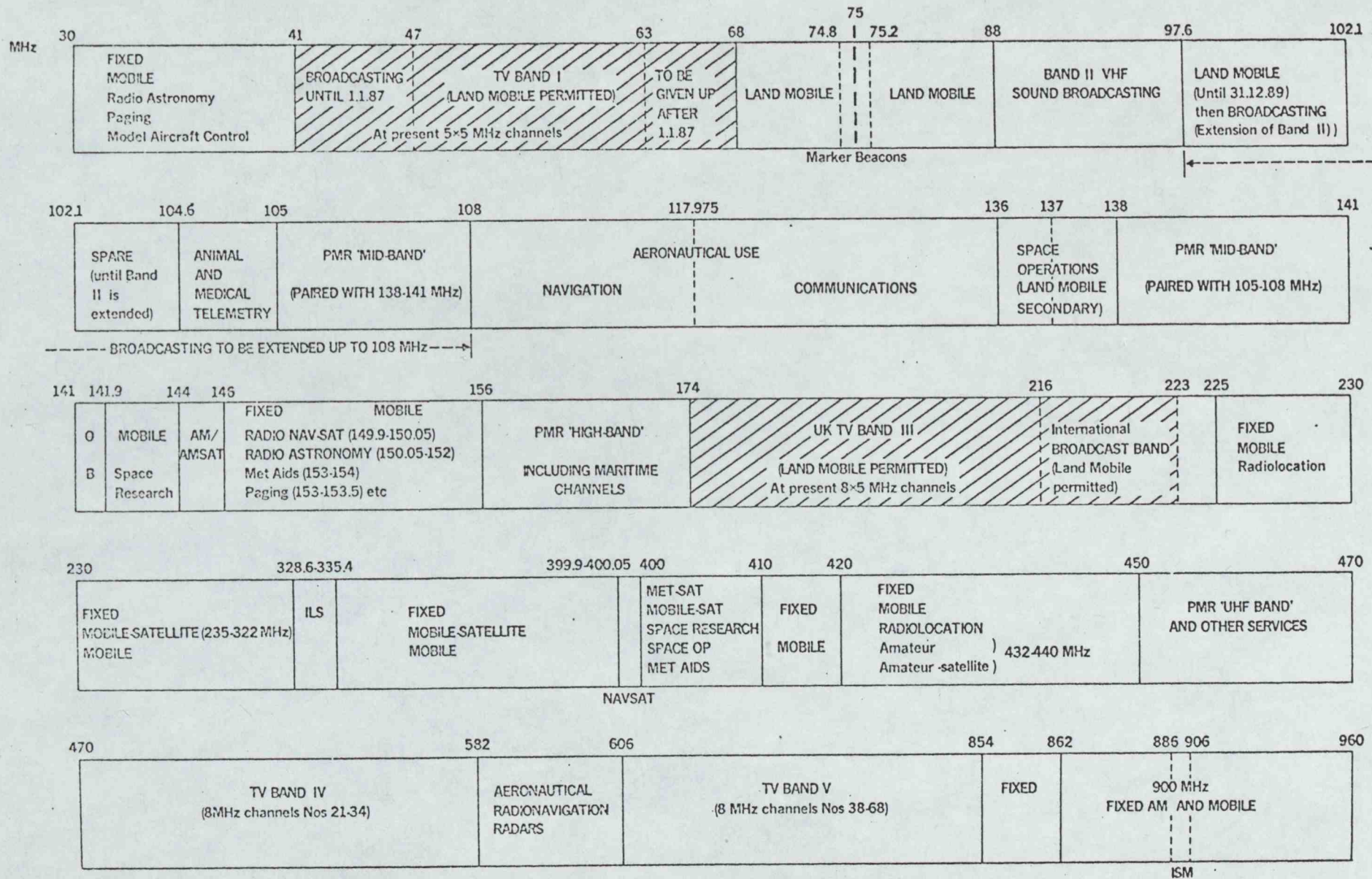
|  | %    |
|--|------|
| Civil Aviation Authority and<br>National Air Traffic Services                                | 4    |
| Defence  | 32   |
| Common Carrier fixed links   | 17   |
| Broadcasting ancillary/outside<br>broadcast links  | 2    |
| Private fixed links  | 2.5  |
| Amateurs, Earth Exploration-Satellite<br>Radio Astronomy, Space Operation,<br>Space Research | 2.5  |
| Other civil  | 18.5 |
| Shared between different users   | 21.5 |



In general the figures relate to available allocations from 960 MHz to 51.4 GHz and not to current usage. The figures for common carrier, broadcasting and private fixed links, however, relate to current and future planned usage. The figures above give a broad picture of allocations to different users but no attempt has been made to weight the figures to take account of the differing values of spectrum (eg allocations higher up the spectrum are, in general, less desirable and more bandwidth is required for similar purpose than lower down in the spectrum).



# SIMPLIFIED DIAGRAM OF SPECTRUM OCCUPANCY 30-960 MHz



**KEY:-**

|                                     |                                   |  |
|-------------------------------------|-----------------------------------|--|
| AM/AMST - Amateur/Amateur Satellite | ILS - Instrument Landing Systems  | ISM - Industrial, Scientific and Medical Equipment |
| MET/SAT - Meteorological Satellites | NAV/SAT - Navigational Satellites | OB - Outside Broadcasting                          |
| SPACE OP - Space Operations         |                                   |  |



SIMPLIFIED DIAGRAM OF FREQUENCY ALLOCATIONS 960 MHz – 51.4 GHz

|  |  |   |  |                                   |   |  |   |   |   |  |   |          |
|--|--|---|--|-----------------------------------|---|--|---|---|---|--|---|----------|
| 60   | 1215   | 1365  | 1400   | 1427                              | 1429  | 1450                                     | 1535  | 1545  | 1559 MHz  |  |   |          |
| AERONAUTICAL<br>RADIONAVIGATION                      | RADIOLOCATION<br><br>Amateur<br>Amateur-Sat              | FIXED<br>MOBILE<br>Radio<br>Astronomy               | RADIO<br>ASTRONOMY<br>E.EXP-SAT<br>SPACE<br>RESEARCH<br><br>-----<br>SPACE OP ---> | FIXED<br>MOBILE                   | PRIVATE FIXED<br>LINKS<br>OB LINKS<br><br>E.Exp-Sat<br>Space Op | MARITIME<br>MOBILE-SATELLITE             | AERONAUTICAL<br>MOBILE-SATELLITE  |   |   |  |   |          |
| 659  | 1610   | 1626.5  | 1646.5   | 1660.5                            | 1670  | 1690                                     | 1710  | 2310  | 2450  | 2690 MHz                               |   |          |
| AERONAUTICAL<br>RADIONAV                             | AERO-<br>NAUTICAL<br>RADIONAV                            | MARITIME<br>MOBILE-SAT                              | AERO-<br>NAUTICAL<br>MOBILE-SAT  | RADIO<br>ASTRONOMY<br>FIXED       | MET.AIDS<br><br>MOBILE<br>PRIVATE<br>FIXED<br>LINKS             | MET-SAT<br>FIXED                         | FIXED (mainly<br>COMMON CARRIER)<br><br>E.Exp-Sat<br>Space Op<br>Space Research | FIXED<br>MOBILE<br><br>Amateur<br>Amateur-Sat | FIXED<br>OB LINKS<br><br>Radio<br>Astronomy         |  |   |          |
|  |  |   |  |                                   |   |  |   |   |   | 2400                                   | ISM   | 2500     |
| 690  | 2700   | 2900  | 3100   | 3300                              | 3600  | 4200                                     | 4400  | 5000  | 5250  | 5350                                   | 5460  | 5470 MHz |
| RADIO<br>ASTRONOMY<br>E.EXP-SAT<br>SPACE<br>RESEARCH | AERO-<br>NAUTICAL<br>RADIONAV                            | AERO-<br>NAUTICAL &<br>MARITIME<br>RADIONAV         | RADIO-<br>LOCATION   | RADIO-<br>LOCATION<br><br>Amateur | FIXED<br>(COMMON<br>CARRIER)<br><br>FIXED-<br>SATELLITE         | AERO-<br>NAUTICAL<br>RADIONAV            | FIXED<br>MOBILE<br>RADIO<br>ASTRONOMY   | AERO-<br>NAUTICAL<br>RADIONAV                 | RADIOLOC<br><br>Space<br>Research                   | AERO-<br>NAUT-<br>ICAL<br>RADIO<br>NAV | AERO-<br>NAUT-<br>ICAL<br>MARI-<br>TIME<br>RADIO<br>NAV |          |
| 7470   | 5650   | 5850  | 7100   | 7250                              | 7300  | 7900                                     | 8400  | 8500  | 8750  | 8850                                   | 9000  | 9200 MHz |
| RADIO-<br>LOCATION<br>MARITIME<br>RADIONAV           | RADIO-<br>LOCATION<br>OB LINKS<br>Amateur<br>Amateur-Sat | FIXED<br>(COMMON<br>CARRIER)<br>FIXED-<br>SATELLITE | OB<br>LINKS  | SATELLITE<br>SERVICES             | SAT-<br>SERVICES<br>OB LINKS<br>PRIVATE<br>FIXED LINKS          | FIXED<br>MOBILE<br>SATELLITE<br>SERVICES | FIXED<br>RADIO-<br>LOCATION<br>SPACE<br>RESEARCH                                | RADIO-<br>LOCATION                            | RADIO-<br>LOCATION<br>AERO-<br>NAUTICAL<br>RADIONAV | RADIO<br>LOC                           | AERONAUTICAL<br>RADIONAV                                |          |



|   |   |  |   |   |  |  |  |                              |               |          |
|---|---|--|---|---|--|--|--|------------------------------|---------------|----------|
| 9200  | 9300  | 9500   | 10.0  | 10.5  | 10.68  | 10.7   | 11.7   | 12.5                         | 12.75 GHz     |          |
| RADIO-<br>LOCATION<br><br>MARITIME<br>RADIONAV                  | AERONAUTICAL &<br>MARITIME RADIONAV<br><br>Radioloc | RADIO-<br>LOCATION                                     | RADIO-<br>LOCATION<br><br>FIXED<br>MOBILE<br>Amateur<br>Amateur-Sat | FIXED (mainly<br>COMMON CARRIER)<br><br>RADIO ASTRONOMY | RADIO<br>ASTRONOMY<br><br>E.EXP-SAT<br><br>SPACE<br>RESEARCH                   | FIXED<br>(COMMON<br>CARRIER)<br>FIXED<br>SATELLITE   | OB LINKS<br><br>BROAD-<br>CASTING<br>SATELLITE | FIXED-SATELLITE              |               |          |
| 12.75   | 13.25   | 13.4   | 14.0  | 14.25   | 14.5   | 15.35  | 15.4   | 15.7 GHz                     |               |          |
| PRIVATE FIXED<br>LINKS (INC<br>COMMON CARRIER)<br><br>FIXED-SAT | AERO-<br>NAUTICAL<br>RADIONAV                       | RADIOLOCATION<br>RADIONAVIGATION<br><br>Space Research | FIXED-SAT   | FIXED-SAT<br>FIXED<br>MOBILE<br>Space<br>Research       | FIXED<br>MOBILE  | RADIO<br>ASTRONOMY<br>E.EXP-SAT<br>SPACE<br>RESEARCH | AERONAUTICAL<br>RADIONAV                       |                              |               |          |
| 15.7  | 17.3  | 17.7   | 19.7  | 20.2  | 21.2   | 23.6   | 24.0   | 24.05                        | 24.25 GHz     |          |
| RADIOLOCATION   | FIXED-<br>SAT INC<br>B-SAT<br>FEEDER<br>LINKS       | FIXED<br>(COMMON<br>CARRIER)                           | FIXED-<br>SATELLITE   | SATELLITE-<br>SERVICES                                  | FIXED (mainly<br>COMMON CARRIER<br>with some<br>PRIVATE)<br>Radio<br>Astronomy | RADIO<br>ASTRONOMY<br>E.EXP-SAT<br>SPACE<br>RESEARCH | AMATEUR<br>AMATEUR-<br>SATELLITE               | RADIOLOCATION<br><br>amateur |               |          |
| 24.25   | 25.25   | 27.5   | 29.5  | 30.0  | 31.0   | 31.3   | 31.5   | 31.9                         | 33.4          | 36.0 GHz |
| RADIONAV<br><br>Radioloc  | FIXED<br>MOBILE                                     | FIXED (COMMON<br>CARRIER)<br>FIXED-SAT                 | FIXED-SAT   | SAT<br>SERVICES   | FIXED<br>MOBILE  | RADIO<br>ASTRONOMY<br>E.EXP-SAT<br>SPACE<br>RESEARCH | FIXED<br>MOBILE                                | RADIONAV                     | RADIOLOCATION |          |



|  |  |  |  |                       |   |                             |          |
|--|--|--|--|-----------------------|---|-----------------------------|----------|
| 6.0  | 37.5   | 40.5                                       | 42.5   | 43.5                  | 45.5  | 47.0                        | 47.2 GHz |
| FIXED<br>MOBILE                                  | FIXED<br>FIXED & MOBILE--<br>SAT<br>MOBILE         | BROADCASTING--<br>SAT                      | FIXED<br>FIXED--SAT<br>MOBILE<br>RADIO ASTRONOMY | MOBILE<br>MOBILE--SAT | MOBILE<br>MOBILE &<br>RADIONAV--<br>SATELLITE<br>RADIONAV | AMATEUR<br>AMATEUR--<br>SAT |          |
| 47.2   | 50.2   | 50.4                                       | 51.4 GHz   |                       |   |                             |          |
| FIXED<br>FIXED--SAT<br>MOBILE<br>RADIO ASTRONOMY | E.EXP--SAT<br>FIXED<br>MOBILE<br>SPACE<br>RESEARCH | FIXED & MOBILE--SAT<br><br>FIXED<br>MOBILE |  |                       |   |                             |          |

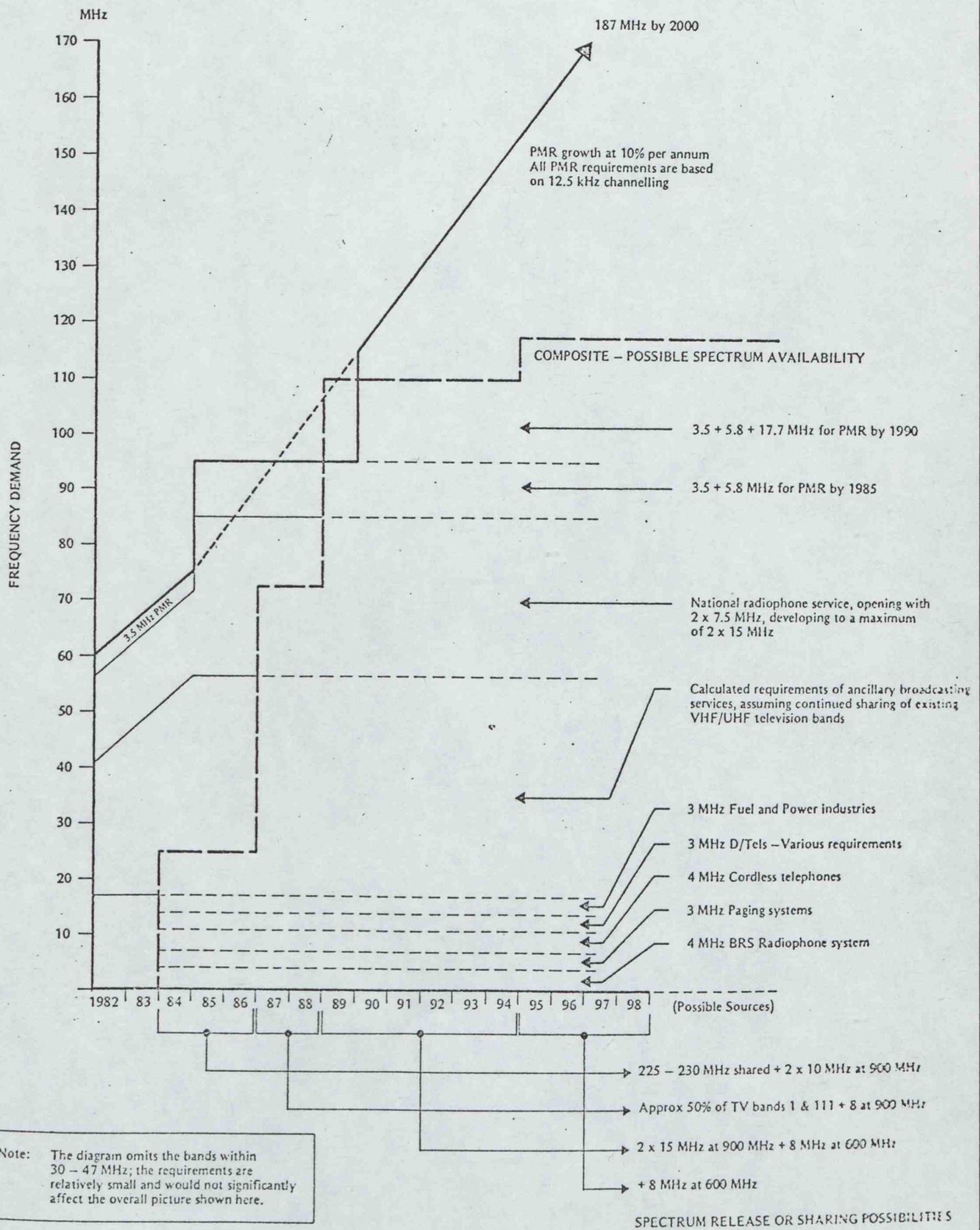
Key: E.EXP--SAT :- EARTH EXPLORATION--SATELLITE  
 MET:- METEOROLOGICAL      OB:- ANCILLARY/OUTSIDE BROADCASTING  
 RADIOLOC:- RADIOLOCATION      RADIONAV:- RADIONAVIGATION  
 SAT:- SATELLITE      B--SAT:- BROADCASTING--SATELLITE  
 SPACE OP:- SPACE OPERATION

Editorial Notes:

1. This diagram is not to scale and shows frequency allocations in broad outlines only.
2. Upper case denotes PRIMARY allocations
3. Upper case initial letter, remainder lower case denotes SECONDARY allocations.



FREQUENCY DEMAND FOR CIVIL LAND MOBILE SERVICES  
AGAINST  
POTENTIAL FREQUENCY AVAILABILITY





## ESTIMATES OF GROWTH FOR FIXED SERVICES ABOVE 1 GHz

The following paragraphs give, for each frequency band, an estimate of the date by which it is expected to be unable to accommodate any further significant increase in demand in those geographical areas where congestion is likely to peak. In other less congested areas it should be possible to continue to accommodate further demand after the forecast dates. The diagrams show the present growth pattern in some of the fixed links sub-bands.

## PRIVATE USER FIXED POINT-TO-POINT LINKS ABOVE 1 GHz

(i) 1450-1530 MHz (the 1.5 GHz band)

The band 1450-1530 MHz is divided into three sub-bands providing for a wide range of services, including inter alia single channel, multi-channel telephony, telemetry and telecontrol.

The sub-band accommodating single channel links is expected to reach saturation in the South East of England around 1995.

The two sub-bands providing for 8 channel and 36 channel links are expected to be fully utilised by the late 1980s and mid 1990s based on annual rates of growth of 30% and 20% respectively (see figure).

The above projections assume that the sub-bands will continue to be used for analogue systems but if future use includes the introduction of digital, low capacity systems then congestion could occur at an earlier date.

(ii) 7.5 GHz

The two sub-bands at this frequency provide for 300 channel telephony systems and wideband links used mainly for broadcasting ancillary services. The annual rate of growth is approximately 18% (see figure) and requirements can probably be met until around 1990 in the South East, and into the mid 1990s for the less congested areas.

(iii) 13 GHz

This band accommodates both analogue and digital systems. The portion allocated to digital systems is likely to become fully occupied in the South East of England by the late 1980s. The sub-band allocated for conventional wideband analogue systems has only been available for use since January of this year and sufficient capacity is available to meet demand until about mid 1990s.



(iv) 22 GHz

The above band is used to accommodate short range wideband analogue and medium and high capacity digital links. On present estimates saturation is perceived within the next 10 years.

COMMON CARRIER BANDS ABOVE 1 GHz

(i) British Telecom provide services using both analogue and digital technology in the frequency bands 2, 4, 6, 11, 19 and 29 GHz. On present estimates saturation is likely to occur in the 2, 4, and 6 GHz bands by the late 1980's. The 19 and 29 GHz bands have only recently been made available with a view to accommodating growth markets such as multi-point distribution systems and wideband links for television; saturation is expected by the early 1990s.

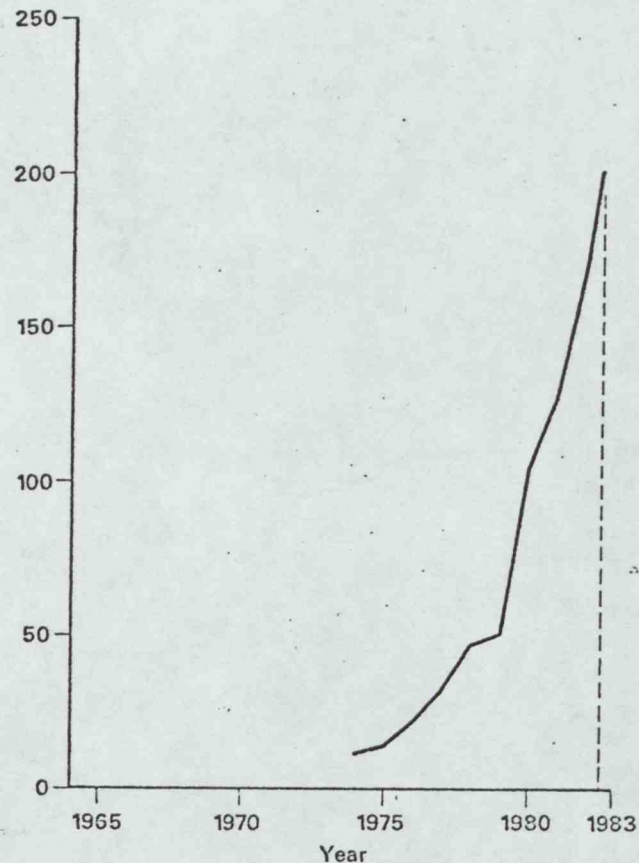
(ii) Mercury Communications Ltd utilise the 10.5, 13 and 22 GHz frequency band for the provision of multi-point distribution and medium and high capacity digital links. If forecast demand is realised then the bands will be totally utilised towards the late 1980s. However latest developments indicate that Mercury may need additional frequencies if their full requirements are to be met.



# Growth in usage of Fixed Link Bands at 1.5 and 7.5 GHz

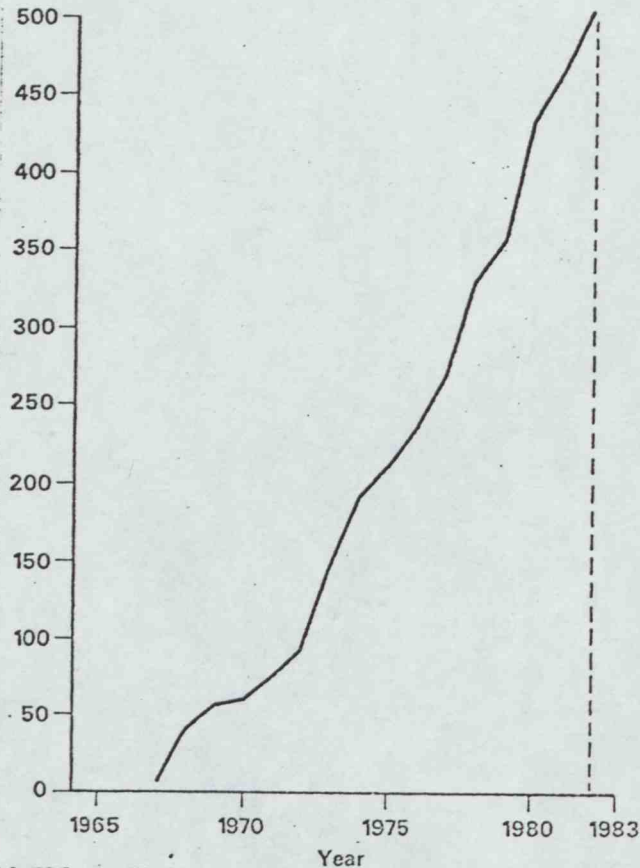
1.5 GHz Sub-BAND 'E' 8 CHANNEL

Number of links



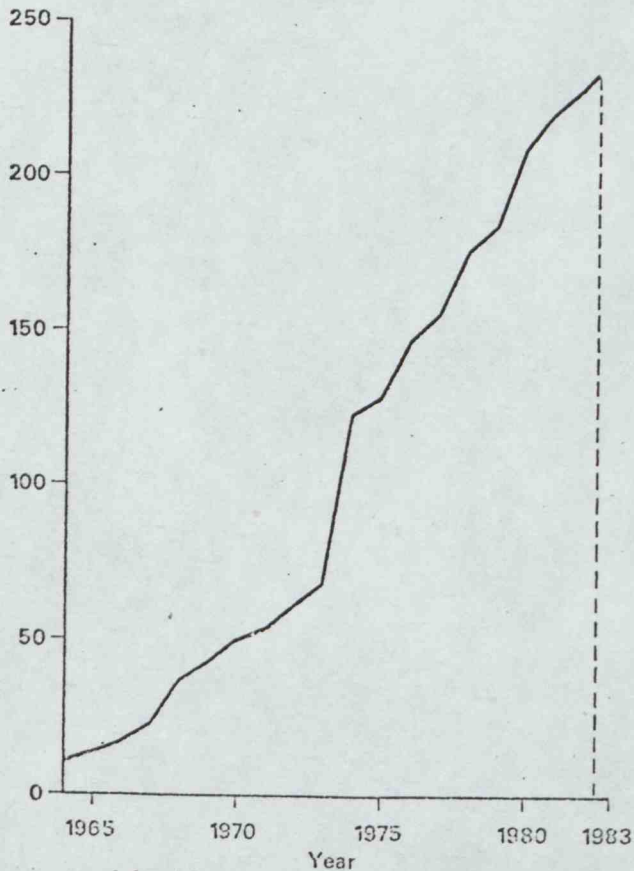
1.5 GHz Sub-BAND 'B' 36 CHANNEL

Number of links



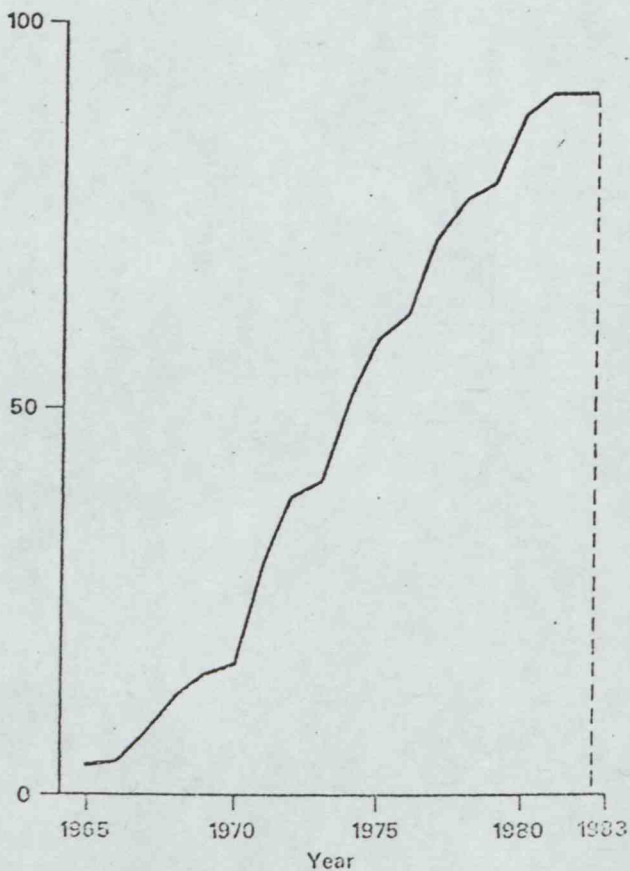
7.5 GHz BI-DIRECTIONAL Sub-BAND

Number of links



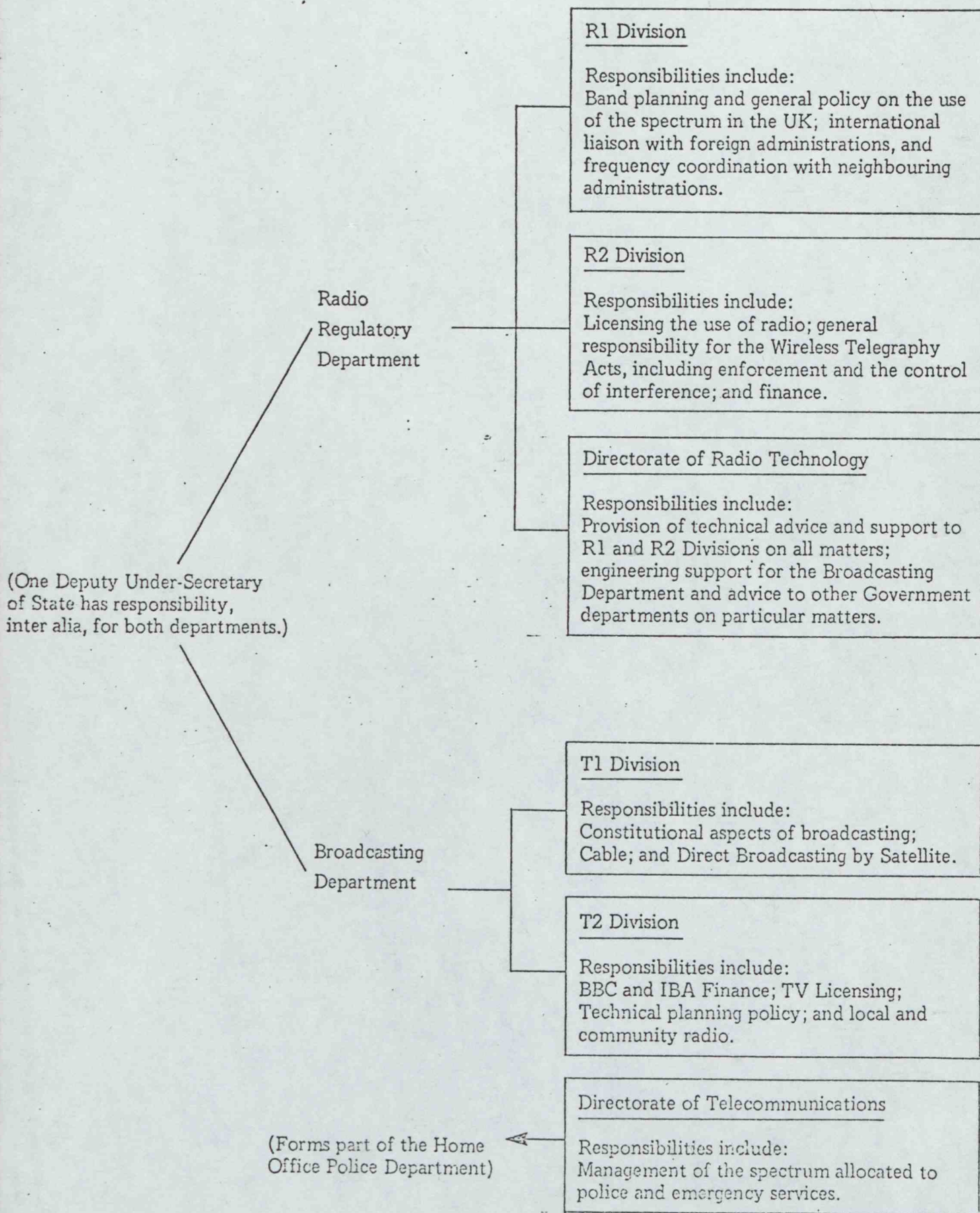
7.5 GHz UNI-DIRECTIONAL Sub-BAND

Number of links





THE OFFICE DEPARTMENTS CONCERNED WITH THE USE OF THE RADIO SPECTRUM





## SPECTRUM PRICING

We reproduce below three papers from the material submitted to us on this question: "The Use of Price Mechanisms in Spectrum Management" from the Radio Regulatory Department (Home Office); "A Renting System for Radio Spectrum" from the Transport Science Policy Unit (Department of Transport); and "Economic Aspects of the Allocation of the Radio Spectrum", by economists in the Department of Industry.



### Introduction

1. Frequency management involves a series of judgements about the best use of available spectrum in particular circumstances. Priorities between services are decided within the inter-departmental Committee structure. The regulatory authority - the Home Office - has the responsibility for judging how best to administer the bands allocated to private users. The question which this paper seeks to address is whether, and to what extent, the judgements of the market could be substituted for or supplement the judgements of the bureaucratic machine. A mechanism based on the pricing of spectrum use should be, at least theoretically, capable of providing a common currency for the evaluation of competing claims for spectrum use, and a basis for selecting spectrum uses to the greatest economic benefit of the community.

2. The use of price mechanisms must not however be considered in isolation from other frequency management techniques aimed at extracting the maximum value from the use of the spectrum: for example the setting of equipment standards to minimise interference; the careful engineering of frequency assignments to facilitate the maximum re-use of frequencies; and the encouragement of the use of common, shared, base stations in the private land mobile service.

### Background

3. The present basis for the determination of licence fees charged to spectrum users rests on the principle that the fee income should meet the cost of administering the licensing system, together with that proportion of RRD's other administrative costs which can, on a fairly broad view of spectrum occupancy, be ascribed to the requirements of licensed radio users, as distinct from Crown use of the spectrum. The licence fee does not therefore represent a rent or royalty on the use of spectrum. It bears no detailed relationship to the amount of spectrum occupied by the individual user, and the licence fee is not used as a spectrum management tool, eg, to regulate demand or to channel frequency use into particular directions. The determination of licence fees is therefore a fairly straightforward calculation in which the costs attributable to each category of licence are divided by the expected number of applicants. The only substantial question of judgement comes in distributing the administrative costs of RRD which are not directly related to licensing (eg attendance at international Conferences) between Crown and non-Crown users. This recovery



of administrative costs not directly attributable to the licensing system was introduced in 1981 as a result of a Rayner scrutiny of RRD, and employs a formula which apportions the costs concerned between Crown and non-Crown use in accordance with a fairly crude estimate of the relative proportions of the spectrum occupied by each. The proportion of unallocated overheads recovered is 50%; for 1982/3 the total cost of unallocated overheads is estimated to be £4.9 m. Thus whilst a notion of spectrum occupancy influences one element of the process for determining licence fees, this is done simply in order to provide a basis for increasing the revenue derived from the licensing system, and is not done with spectrum management objectives in view.

4. The broadcast receiving licence fee is determined quite differently from other radio licence fees. An element of the fees is related to licensing and radio regulatory costs (eg the cost of investigation of complaints of interference to broadcast reception), but the bulk of the fee raises revenue to support the BBC.

5. There has been a considerable amount of interest for some years in this country and elsewhere (particularly the USA) in departing from this conventional licence fee basis and in seeking a method of charging for the use of spectrum which more adequately reflected the economic value to the user of the spectrum occupied and which supported radio regulatory policy by regulating demand for radio frequencies in some way. The lack of a spectrum pricing policy may distort competition, particularly in cases where the licensees in effect re-sell spectrum which they have acquired at insignificant cost. Competition between British Telecom and Mercury, for instance, proceeds on the assumption that the cost of microwave fixed links is intrinsically less, at least in the short term, than that of the equivalent land line connexions, since the spectrum resource consumed is undervalued in each company's calculations. But difficulties have regularly been encountered in finding a secure and consistent basis on which to found a pricing policy. The remainder of this paper will attempt to identify and discuss the different options which may be suggested in this area. An underlying assumption is made that a requirement would remain under any new system to recover in fees at least that proportion of RRD costs recovered under present arrangements.



## Uses of a price mechanism

6. Before any sensible discussion of spectrum pricing concepts can take place it is necessary to define as clearly as possible what the possible roles of pricing mechanisms might be in spectrum management, and what policy objectives the introduction of such mechanisms might be expected to achieve.

7. The most frequently postulated objective of spectrum pricing is as a tool for rationing access to the spectrum in a situation where the demand for access exceeded the supply of available spectrum. This assumes a situation in which the only available means to reconcile supply and demand was to repress demand, and takes no account of more positive approaches, such as those mentioned in paragraph 2, by which the supply of spectrum may in effect be increased and which may thus avert the need for rationing.

7.1. It is possible to conceive of essentially three kinds of procedure (other than the use of a pricing mechanism) which might be employed in a situation where it became necessary to ration by repressing demand:

(i) on a first-come first-served basis. This is by and large the method used up to now in the UK in dealing, for instance, with land mobile assignments. It works reasonably well so long as it remains possible, by careful engineering, to fit newcomers into the existing pattern of use without excessive delays. Where, however, long queues build up, and there is no effective mechanism for removing sitting tenants who may be making less effective use of spectrum than applicants in the queue, the first-come first-served mechanism becomes less able to meet the demand;

(ii) by some form of judgement about the comparative worth of different applications to use spectrum. Such a judgement might be exercised by government, or by a quasi-governmental regulatory body (the Federal Communications Commission in the American model). This process brings with it the danger of increased politicisation of spectrum allocation issues and, in the American model, of the introduction of slow, cumbersome and expensive bureaucratic procedures involving quasi-judicial comparative hearings. Whilst economic judgements might form part of the comparative evaluation of competing claims perhaps through some form of cost/benefit analysis, there is still no guarantee that the licence will go to the applicant who has the best economic case, or that in many cases the claimants are sufficiently similar in nature for the comparisons to be meaningful;



iii) by lottery. This would be a completely arbitrary way of allocating licences, would take no account of economic considerations and would probably be politically unacceptable in the UK, but is being seriously considered in the United States for some classes of licence.

7.2. All of the foregoing forms of spectrum rationing are to some extent arbitrary, and none necessarily ensures that the spectrum is used in the most economically-efficient way. In an attempt to meet these difficulties two further rationing mechanisms might therefore be added to those listed in paragraph 7.1, both based on the use of a price mechanism:

iv) the setting by government of prices for the use of spectrum such that the number of applications for access to spectrum was brought into line with spectrum availability;

v) the creation of as free a market as possible in radio frequencies, with spectrum prices determined by market forces as frequency assignments were traded among potential users.

The application of either of these two spectrum rationing methods would seek to ensure that spectrum would be allocated to the users who stood to make an economic return on the use of the spectrum sufficient to justify the payment of the going rent for the spectrum concerned. Coupled with a concept of fixed terms of tenure of frequency assignments (on a similar basis to leasehold property tenure) spectrum pricing would also, it is argued, squeeze out of the spectrum those users who were not making the best potential economic use of it.

8. A second, and more limited, objective of a price mechanism might be to influence applicants' decisions about their use of spectrum in directions which supported spectrum management policy. Here it may be argued that individuals or companies operating in a market economy will have an incentive to make the most economic use of the resources which they consume only if those resources have a price which reflects their scarcity. Thus a company which is considering the establishment of a radio system must decide whether it can make a sufficient return on its investment in various resources whose price takes into account the operation of market forces and therefore reflects, if only imperfectly, their scarcity - eg, radio equipment, land on which to site transmitters, labour costs



to operate the equipment. But the company has no basis on which to put a monetary value on the spectrum which it occupies, and therefore has no direct economic incentive to use spectrum as efficiently as it will be induced to use the other resources which it will consume. A price mechanism might therefore aim to provide economic incentives to spectrum efficiency by encouraging, for example:

- the use of lightly-loaded, rather than congested, bands
- the use of spectrum efficient technology, even if the cost of the equipment was greater than that for less spectrum-efficient technology
- the use of radiocommunications options which are less frequency demanding (eg paging or message-handling instead of full two-way radio).

9. A third aim of a pricing policy might simply be to raise revenue for the exchequer and to prevent radio users from making an excessive return from the privilege of access to the frequency spectrum. This aim need not necessarily have anything to do with spectrum management policy, and there is a danger that a pricing policy introduced for spectrum management purposes might be seen by those who had to pay more for spectrum as simply another form of taxation. A pricing policy applied in order to raise revenue might have some justification if it were seen to be related to the provision of a better standard of service to radio users in such matters as spectrum monitoring and the improvement of protection standards. Indeed it would have to be accepted that whatever justification was advanced for a spectrum pricing policy, spectrum users would probably come to demand a better quality of service from RRD in return for their money: this would mean more resources and more public sector expenditure. Further, any raising of interference standards would mean, in the end, fewer users being accommodated within a given number of available radio channels. Moreover if the licence fee (or some other pricing mechanism) were to become a form of rent for spectrum occupancy, users would no doubt expect refunds for early surrender of licences, which would add further administrative complication

#### How and where a price mechanism might be introduced

10. Paragraph 7.2 suggested two principal avenues by which a price mechanism might be brought into spectrum management. One would be to create as free a market as possible in radio frequencies and allow the price of frequencies to



be set by market forces. One could, for instance, envisage a market modelled on the housing market, under which frequencies, held perhaps on some kind of leasehold basis, could be traded freely between individuals and companies with the minimum of government intervention and at prices determined by market forces. As will be seen however there are serious difficulties in creating the free market conditions needed for this kind of approach. The other principal avenue would be for government (or some agency of government) to set and adjust spectrum prices in accordance with its judgement of the value of the spectrum and in furtherance of its radio regulatory objectives. Apart from being theoretically less economically efficient this approach exposes government to criticism of the prices which it may set, and would therefore require a clear and defensible price basis to be identified if the attempt to introduce pricing were not to be seen as an arbitrary device to raise revenue at the expense of spectrum users.

11. It is against this background that the possible application of price mechanisms need to be considered in relation to the objectives described in paragraphs 7 to 9 and a first distinction needs to be drawn between the application of pricing at the allocation level (here taken to mean decisions about the categories of user given access to different parts of the spectrum - eg, broadcasting, private mobile, defence), and at the assignment level (here taken to mean decisions about individual applications for frequencies).

12. At the allocation level whilst it is theoretically conceivable to see different user groups (eg defence, broadcasters) bidding against one another for access to the spectrum, there are in practice severe constraints:-

i) the international framework makes it impossible to create anything approaching a free market in frequency allocations. International frequency allocations are made and revised at World Administrative Radio Conferences held at approximately 20-year intervals, so that changes in allocations are a long-term process in which the requirements of a large number of countries have to be reconciled. Thus for example the transfer of Bands I and III from broadcasting to mobile and other uses, which the Review recommended in its interim report, was made possible by changes to the international allocations which were agreed at the 1979 WARC. It is only by conforming to the international allocations that gross incompatibilities between different radio services across national frontiers are avoided, and that full protection can be obtained for UK services from the effects of potential interference caused by stations in other countries. Thus, to take a hypothetical example, private land mobile users might be able collectively to outbid maritime users for spectrum allocated to the



maritime service. Internationally, however, the maritime service would still enjoy priority and land mobile users would be vulnerable to interference from foreign maritime stations. If, in the foregoing example, land mobile users were still willing to pay more for the use of the spectrum concerned than maritime users, the economic value of that spectrum could thereby be held to have been increased, notwithstanding the international allocation. But all practical experience suggests that users are not willing to invest in the establishment of services which could not be offered protection from interference. Moreover, in the situation envisaged, the user who was not in conformity with the international allocation would be required to protect from interference any foreign station which was in conformity with the international allocation, even if the foreign station concerned came onto the air at a later date. It needs also to be recognised that, in addition to the constraints of the ITU framework, there are other equally important international agreements governing frequency use in certain services. Civil aeronautical communications, for example, are subject to relevant agreements in ICAO (International Civil Aviation Organisation). Allied military frequency use is coordinated within the NATO structure, and if the UK were to depart from common NATO allocations there would be serious implications for defence interests;

ii) the extent of government use of the spectrum is a further impediment to the creation of a free market in spectrum allocation. As an illustration it is assumed for the purpose of calculating licence fees (see paragraph 3) that 50% of the spectrum is occupied by Crown users, such as the Ministry of Defence and Civil Aviation Authority. An attempt to make, say, the Ministry of Defence pay an economic rent for the spectrum it uses would simply result in a paper transfer of funds from the Ministry of Defence to the regulatory authority. Such transfers would differ from other transfers between departments (eg for HMSO supplies) in that the amount of the transfer would not be related to resources expended by the department receiving the transferred funds. There would be no net effect on public expenditure and the artificiality of the transaction would be heightened by the governments position as, in effect, the monopoly supplier of a commodity of which it was also a major user. Thus it would be practically impossible to conceive of private users being able to bid against government for the use of spectrum. The sums of money which the private



sector would need to raise in order to compete in the market against government would be beyond all save possibly the largest consortia, and the artificiality of the transactions within government would make the competition an unequal one. On the other hand there is no doubt that government use of the spectrum has a cost in terms of the opportunities which it denies to other potential users of the spectrum concerned. There is therefore a strong case for an economic evaluation of cost to be taken into account as a factor in frequency allocation decisions (see paragraph 18(i)).

iii) broadcasting is another large user of frequency spectrum (occupying some 45%\* of the spectrum between 30 and 960 MHz). The key consideration here is that the applicability of a spectrum pricing policy depends on the ability of the user to make do with less, and the ability of some other claimant to put it to his own use. Broadcasting occupies bands which are almost all allocated exclusively to broadcasting under the International Radio Regulations, and thus have limited use for anything except broadcasting. Second, the amount of spectrum required by the broadcasters for transmitting their signals is very largely determined by Government. It is Government which decides the number, scope and nature of the broadcasting networks, both television and radio, whether transmitted off-air, by cable or by satellite; and it is hardly possible to foresee a Government policy which left such socially significant developments to be determined simply by market forces. Broadcasting is thus an area where the freedom to conduct a practical spectrum pricing policy hardly exists. The same arguments apply even at the margins of the broadcasting bands; and indeed, because of the lattice planning involved, efforts to make even slight reductions in that area would have a quite disproportionate effect on the national coverage of terrestrial services;

(iv) there are a number of areas of spectrum use where it is impracticable, for one reason or another, to exert direct economic pressure on licensees. In some areas such as maritime communications, there is a strong safety of life element, and even the present comparatively modest licence fee charges are represented by users as being a "tax on safety". Similarly the emergency services provide a safety of life service, and in the case of the police and fire services there would be practical difficulties in devising a spectrum cost element which had the desired effect within a quite complicated funding arrangement involving sources of finance within

---

\* 40% when Bands I and III are relinquished.



and without central government, and with the Home Secretary himself the police authority for the Metropolitan Police. Radioastronomy and amateur radio are examples of services which occupy spectrum for little or no economic return, but which are intrinsically dependent on access to the spectrum for their very existence. To allow them to be displaced by other services, whatever the economic benefits, would be a highly contentious matter. These services also operate in internationally-agreed allocations and their displacement would have international repercussions. As with government use of the spectrum it could be instructive to make a study of the economic cost of allocating spectrum for these services, so that the degree to which their use of spectrum is in effect subsidised could be assessed and taken into account in allocation judgements; but actually to exact full economic rents would probably be politically impossible;

(v) a final consideration is that if the UK were to charge for spectrum when other countries did not a range of UK industries could be put at a commercial disadvantage. For example charging for aeronautical spectrum would probably mean that the costs would have to be passed on to the airlines who are users of the aeronautical services concerned. Some traffic could then be lost to neighbouring countries at a cost to the industries servicing civil aviation.

13. It therefore seems that the direct application of economic charging for spectrum use would not be an effective way of regulating competition at the allocation level between the various user groups: there would be so many factors to distort whatever pricing structure might be set either by government or by market forces that it could not function efficiently as a distributor of market forces. The rest of this paper therefore considers how, within these constraints, economic forces might nevertheless be better brought to bear on spectrum management decisions.

14. In a given service - of which the private land mobile service is the most obvious example - one could conceive of competition among potential users being settled by a kind of auction under which assignments went to the highest bidder. Finding the right level of fee or rent to balance supply and demand would however be a complex and probably contentious business. One way would be for the regulatory authority to introduce successive licence fee increases until



the point was reached where all the remaining applicants' requirements could be met (possibly combined with positive action to weed out unproductive existing users). However, uniform price increases across the country would mean that the fees charged in an area where there was little frequency congestion would have to be raised along with those in other areas where a very high fee was needed to balance supply and demand. To overcome this and similar problems a complicated scale of fees would be needed to regulate demand according to the degree of congestion in the particular area and other factors such as the degree of channel sharing which the applicant was willing to accept. The administration of the system would be burdensome, and the fees charged would be the subject of perpetual contention as one user compared his fee with that charged to another user in the same or a different service.

15. The alternative would be to try to foster a market for frequency assignments in particular frequency bands and allow assignments to be freely transferred from user to user at a price to be determined by the market. This avoids some of the complications of the regulatory authority's setting prices, but it would still be doubtful whether even in a limited frequency band an effective market could be created. This is because, in order to make the most efficient use of the spectrum, frequency assignments are individually engineered to satisfy the applicant's particular needs with the minimum impact on other users or potential users. Whilst therefore an assignment may exactly satisfy the original applicant's requirements, it is less likely to satisfy another user's potential requirements so exactly (unless the second applicant has taken over the original licensee's whole business). If potential purchasers of frequencies find themselves having to apply to the regulatory authority for modifications to their assignments, the notion collapses of a free market operating without government intervention.

16. In any scheme for the use of pricing to regulate demand in certain bands and services but not in others, the users affected by the price increases (which might have to be quite substantial to have any real effect on demand) would be inclined to resent the policy and to see it as unfairly discriminating against them in comparison with the bands and services to which the full rigours of pricing were not applied. A key determinant of the price of spectrum within a band would be the allocation decision which had prescribed the bandwidth



available for the service concerned. Pricing in particular bands would thus lead almost inevitably to increased questioning of frequency allocation decisions. It is also necessary to recognise that it is quite probable that the only service in which pricing might in practice be applied as a rationing mechanism is the private land mobile service, and it would be very difficult to present the policy as being other than a discriminatory tax on this vocal group of users. This service is also characterised by a mixture of large undertakings with huge investment funds, and very much smaller ones. Thus within the private mobile service such a policy could act against equitable access by smaller undertakings, and favour instead the acquisition of spectrum, perhaps speculatively, by large monopolistic concerns. If applied rigorously in other services (such as point-to-point fixed services) it could also make it more difficult for newcomers to establish themselves against entrenched and possibly monopolistic spectrum users - eg Mercury against BT.

17. A further difficulty that would have to be faced is that of enforcement. The licence fee increases introduced in 1981 in the light of the Rayner scrutiny of RRD (see paragraph 3) were most unpopular with many radio users, and the imposition of further charges unrelated to RRD administrative costs would no doubt be fiercely resisted by those who would have to pay (as some of the evidence to the Merriman enquiry has already indicated). Experience suggests that a substantial increase in charges would lead to an increase in illicit use of radio, with a real danger of entering a vicious circle of deteriorating enforcement: that increased fees could encourage the growth of illicit operation; that illicit operation would result in more interference to licensed users; and that licensed users would in turn be unwilling to go on paying for a deteriorating standard of service. In theory this could be countered by an increase in enforcement but if the broad consent of users to licensing control were to be forfeited draconian, and probably unacceptable, powers of enforcement would be needed to maintain order in the spectrum. There would also be a need for additional resources which revenue from spectrum pricing might not necessarily ensure.

18. Since spectrum pricing is likely to be so ineffective as a spectrum rationing mechanism are there any other ways in which economic factors might be brought to bear on spectrum management more directly than they do now? There are two possibilities:



(i) a clear need has been identified for the judgements which must inevitably be made within government about the use of spectrum to be informed by the best possible appreciation of the economic consequences of different courses of action. At one level this might involve the regulatory authority in conducting cost/benefit analyses of competing applications. For this applicants would have to supply whatever economic evidence was required to support their claims, and the regulatory authority would need to have the resources to assess that evidence. At the strategic level of frequency management, some form of economic analysis seems needed to enable proper account to be taken of the opportunity cost of spectrum use. This might take the form of a national costing concept which sought to put a monetary value on the occupation of spectrum for particular purposes, and which could be taken into account in spectrum management decisions. Given the diversity of frequency uses and the radically different characteristics of different parts of the spectrum, the development of the national costings would be a complex and difficult task, and its results would have to be applied with caution, at least until a degree of confidence in their validity had been established. This would seem a more promising avenue for bringing economic reality to bear on spectrum decisions than the application of direct pressure through a price mechanism.

(ii) limited manipulation of licence fees within the existing system of licensing controls might in some circumstances be applied as a spectrum management tool in the context of providing economic incentives, rather than as a device for repressing demand. In the circumstances in which it was used the fees that were set should be demonstrably related to the incentive which it was intended to provide, so as to provide a charging basis that was not open to question. Such a policy would be an extension of, and would build upon, the existing mechanism for determining licence fees, and would seek to identify and act upon areas where, for spectrum management reasons, it was desired to encourage certain forms of spectrum use and to discourage others. Thus, if an applicant had a choice between two technologies, one of which was more expensive in equipment costs, but was more spectrum-economical, different licence fees could be charged for the two technologies such that over the period in which the equipment costs were amortised, the more spectrum economic equipments would represent the better investment. (For example, technology A offers spectrum savings compared with technology B, but would cost the applicant £1000 more in equipment costs, amortised over 10 years. The annual licence fee for spectrum A therefore needs to be at least £100 less than that for technology B before an economic incentive is provided to choose technology A rather than technology B.) Of course if the difference in equipment costs between



technology options were too great, an unacceptably large licence fee differential might be needed to compensate. Thus any economic incentive provided through the licence fee would have to be supplemented by other incentives (eg a better standard of service). Indeed, the type of change envisaged here can be and has in the past been achieved through the application of the normal licensing controls (eg the progressive reduction of VHF land mobile channel widths from 100 kHz to 12.5 kHz), though the application of a licence fee differential might in some circumstances serve to ease a transition of this nature. A policy based on the provision of economic incentives would be useful only if it were capable of reinforcing the positive measures mentioned in paragraph 2 for extracting maximum use from the spectrum and would have to be seen as a spectrum management tool to be applied selectively, and possibly in combination with other tools, in specific circumstances - if any arose - where it was judged capable of making a useful contribution to the application of spectrum management policy.

#### Summary

19. Spectrum pricing is likely to be an ineffective and contentious method of rationing spectrum at either the allocation or the assignment levels. This does not however exclude a role for economic judgements in spectrum management, nor the adjustment of licence fees in certain circumstances to provide economic incentives to users to satisfy their communications needs in ways which support radio regulatory policy.

Radio Regulatory Department



## A RENTING SYSTEM FOR RADIO SPECTRUM

### Summary

1. There is now a serious and persistent shortage of radio spectrum in the bands which are most suitable for land mobile services, of which transport applications are an important part. The shortage has arisen from a rapid expansion of the general demand for spectrum following developments in electronics. The Interim Report of the Independent Review of the Radio Spectrum recommended that the TV Bands I and III should be used for land mobile services when the 405-line TV service is closed down. That will alleviate the present shortage but it will not provide any mechanism to moderate the general demand so as to prevent a recurrence of the problem.

2. In this paper it is proposed to introduce gradually a system of charging rents for allocations of spectrum wherever the unrestricted demand for frequencies exceeds the supply, thus invoking the price mechanism to induce users and potential users to moderate their demands in a manner which will derive the greatest practicable total net benefit to all users. No additional body would be required to collect the rents.

3. Some problems are to be expected in introducing such a system, notably the socially undesirable effects of increasing the costs of the broadcasting services. A possible method of reducing that problem without jeopardising the benefits of the renting system is suggested, but it is improbable that all the problems could be solved without some public debate.

### Introduction

4. Rapid technological progress in electronics over the last decade or two has greatly reduced the cost and increased the capability and reliability of radio transmitters and receivers. In so doing, the development has opened up a wide range of new applications and increased the number of sets in previous applications. One rapidly expanding class of application is civil land mobile services, which includes (but is not restricted to) land transport services. The demand for licences to use such radios has correspondingly increased and the rate of increase is expected to persist and possibly to grow in the next decade.

5. The potential benefits of transport mobile services are reductions in the operators' and public costs of transport, accidents, energy consumption, traffic



congestion, noise and environmental pollution, all stemming from fewer and shorter journeys due to the exchange of up-to-the-minute information between the occupants of the vehicles and their bases of operation. Or, in some cases, the information leads to more or longer journeys for which the perceived benefits exceed the perceived costs (otherwise they would not be made). Other benefits are the better use of vehicles and infrastructure, direct reductions of capital costs and direct improvements in security. Transport services differ from most other inland applications in that radios offer the only feasible means of communicating substantial quantities of up-to-the-minute transport information, ie the only means by which the occupants of a moving vehicle can be called and by which they can call others without stopping and leaving the vehicle.

6. However the realisation of these benefits is threatened because the other demands on the spectrum are also growing as a result of the same technological progress, so that an acute shortage of unallocated spectrum has now developed. The spectrum which is most suitable for land mobile radios lies between 30 and 960 MHz, of which only about 3% is allocated to civil land mobile services. The 1982 review by the Home Office Mobile Radio Committee concluded that insufficient spectrum is allocated to these services and that the position is rapidly worsening as the demand grows while spectrum is actually withdrawn, mainly as the result of international commitments.

#### A Finite Resource

7. Historically, although national and international restrictions on radio transmissions have evolved to eliminate or mitigate interference between transmitters, technological progress has increased the available supply of spectrum by enabling higher and higher frequencies to be used. But there is now an upper as well as lower boundary to the frequencies which it is technically practicable to use for mobile radios, so the finiteness of the resource is apparent. The problem can be summarised as a conflict between the demands for that resource of a few large users on one hand and a multitude of small users, including civil land mobile services, on the other. The problem will be alleviated when the TV Bands I and III are used for land mobile services, as recommended by the Interim Report of the Independent Review of the Radio Spectrum, when the obsolete 405-line TV service is closed down. But that re-allocation will not of itself provide any mechanism to moderate the future growth of the general demand for spectrum so as to prevent a recurrence of the problem.

#### Invoking the Price Mechanism

8. The investigation of the Mobile Radio Committee and other studies have



revealed or confirmed that the necessary band width for any service is affected by the degree of technical sophistication - and hence the cost - of the transmitting and receiving equipment and by the quality of service. In other words, for a given service there is a possible three-way trade-off between equipment cost, service quality and bandwidth. Trunking, single side band and cellular systems are examples.

9. In general the present method of allocating frequencies tends inherently to favour established users at the expense of new users and it does not automatically induce users to moderate their demands so as to make the best use of the total spectrum. But the possibility of trade-offs appears to offer a method of introducing such inducement, and of alleviating the shortages - or apparent shortages - of spectrum in the process. The method is to treat the spectrum, or at least the band between 30 and 960 MHz, as a scarce resource and charge an economic rent for it. The rent would depend on the band width and its position in the spectrum, and also on the geographical locations of the base stations and their effective power, which primarily determines their territorial coverage.

10. If such a rent were charged over the whole spectrum it would be a pure economic rent in the sense that the total quantity of radio spectrum, like the total quantity of land in most countries, cannot be increased by human effort. In both cases the utility of any portion of the resource depends on its size, location and use. Thus some parts of the spectrum have a higher utility than others for many purposes, but the location is less important for some users than others and some users prefer the less crowded regions.

11. The theoretical basis of the benefit of charging an economic rent for a wide band of the radio spectrum is that it would invoke the price mechanism to induce all users and potential users to make better use of the spectrum so as to reduce their aggregate costs. Each user would be able to balance the extra cost of more sophisticated transmitting and receiving equipment to reduce his band width against the lower rent for a smaller allocation; or he could modify his operating procedures to require less effective power and/or share an allocation with other users to the same end; or again he could weigh the pros and cons of moving to a different part of the spectrum with lower rent, or using another means of communication, or abandoning or not starting his activity. Sub-letting would extend the mechanism down to the actual users where they are not the primary lessees from the central authority. The extensive cable system which will probably be installed in the next few years will offer just another means of communication for radio links between fixed points. A rent for radio spectrum might therefore induce the transfer to cable by such radio users who might not otherwise consider it.



12. There are thousand of users and potential users and only they have the information which can enable them to perform the necessary calculations and assessments - which may be largely subjective - of the benefits and costs of their individual options. That is why the price mechanism is theoretically better than any other mechanism, eg cost/benefit analysis by a central body, for deriving the greatest practicable total net benefit to all users of the spectrum. More technology or more sophisticated technology is not invariably advantageous; it depends on the balance of supply and demand.

13. Since the objective is not to bring in revenue but to induce an optimum allocation of resources, the rent should reflect the scarcity of spectrum, not the value to the users, some but not all of whom may enjoy a considerable consumer surplus of economic benefit. That is to say the rent for any band of the spectrum would have to be set at the level which matched the demand in that band to the supply, not at the level which would maximise the revenue. Ideally it would always be possible for a user to get an allocation in that band at the going rent, but the rent would be no higher than necessary to maintain that equilibrium. If the rent were appreciably higher than that equilibrium rent, the allocation of resources would be to that extent sub-optimal. The necessity for renting would not arise if there were no scarcity of spectrum.

#### Methods of Introducing a Renting System

14. The best use of the spectrum in the above sense depends on all the users being subjected to the same economic disciplines and basing their demands on the foregoing trade-off calculations. Because some frequencies are less suitable than others for some purposes, or the equipment is difficult to manufacture and so expensive, the rent which would match the demand to the supply may be so low in some bands as not to be worth charging. But if substantial bands in the 'crowded' parts of the spectrum, where the rent would be high, were occupied by protected users who did not pay any rent, those users would not be induced to make the best use of technology and operating methods. Consequently the rent of the adjoining bands would be pushed up by the pressure of demand and the adjoining users would be induced to use more expensive equipment than would otherwise be necessary, or move to less convenient bands or means of communication, or even not communicate - thus reducing the total net benefit to all users. For that reason an ideal renting system should ultimately cover the whole spectrum, rather than only a small part of it or only the small users.

15. However, it would not be feasible to introduce any renting system suddenly on a large scale, not solely because of the administrative problems but also



because there is at present no means of estimating the equilibrium rent in any part of the spectrum. A gradual introduction is therefore essential and it might be feasible to do that band by band or service by service. Either method would probably appear unfair to the occupants of the bands or users of the services first affected but presumably the service-by-service approach would be easier to administer.

16. For the selected services the channels might be auctioned to the highest bidder for a specified period, based on the economic life of the equipment. Alternatively an initially low rent might be charged for all new services in the crowded bands and, at the same time, the existing users in those bands notified that their allocations would be subject to the payment of rent after a further period. Anomalies would inevitably arise, but they would be minimised if:

- i. the rents were introduced while a low rent would still be enough to abate the present excessive demand by inducing some applicants to reconsider their options;
- ii. the rents - and the movement of rents - were published;
- iii. the further period were short - 3 years rather than 5 years.

17. If these conditions were met, it would seem reasonable to expect that a sufficiently stable and increasingly equitable situation would emerge without an intolerable delay. Moreover the published rents for the bands of the spectrum adjoining the bands occupied by protected users would provide evidence on which the pros and cons of requiring the protected users to pay rents could be debated.

#### Problems and Disadvantages

18. The problems and disadvantages - or putative disadvantages - of charging economic rent for radio spectrum can be classified as technical and general. The technical problems are peculiar to the radio spectrum. The licensing authority would still have to understand them and have power to regulate the classes of use and operating standards in any band - much as a local government authority can regulate the class of land use and building standards in any area. The authority would have to ensure that the renting system fitted in with the international system of allocating radio frequencies and the obligations of the UK in that system. Some additional technical problems, not mentioned in these notes, might be found on detailed investigation, but there is no obvious reason



why any technical problem should be exacerbated by charging an economic rent for a transmitting licence instead of merely a fee to cover its administrative costs. Combining the two functions of regulating the users and charging the rents would avoid the necessity for any additional - and possibly bureaucratic - body to perform the latter function. Some non-commercial small users, eg 'ham' amateurs and radio astronomers, might be given 'charitable' status, entitling them to free access to specified bands.

19. The principal non-technical problem appears to be that of the rents payable by the larger users, notably the broadcasting authorities and MoD. The MoD rent would constitute a circulation of funds within government, although the cost of additional equipment or measures to reduce the demand for spectrum would represent a change in net Government expenditure on resources. But the broadcasting authorities' rents would come from the general public, ultimately from television licences and the cost of goods and services advertised on commercial television. The size of the problem cannot be judged until the renting is inaugurated and enables the equilibrium rent to be gauged, but it merits serious consideration in advance because:

- i. a significant increase in TV licence fees would be a burden on those with low incomes, eg state pensioners (cheaper licences for old people would suffer from the disadvantage that many old people live with younger, wealthier people who could easily afford the total cost);
- ii. the increased cost of goods and services might be seen as inflationary - again bearing heavily on people with low incomes - and as a restriction on commerce tending to inhibit economic growth.

20. In as much as the rents would be a revenue gain to the Exchequer, they would reduce the Public Sector Borrowing Requirement and help control the money supply, which would be disinflationary in the longer term. If revenue neutral policies were adopted, this effect could neutralise the impact on the Retail Price Index, depending on how the funds were used. The micro-economic argument is that a renting system would concentrate radio use into those applications where the greatest economies could be obtained, so lowering costs, helping to reduce prices and stimulating economic growth. However, it is doubtful that any large rise in TV licence fees, even if fully offset in the RPI by a more general easing of prices elsewhere, would be politically attractive.

21. A possible method of reducing these effects, and reducing the circulation of funds within government, might be to charge rent to the large users only at



the margins of their allocated bands of spectrum. For example each broadcasting authority might be charged rent at the same rate per unit of band width as the neighbouring users but only on an agreed proportion of its whole allocation; any increase or reduction of bandwidth would be charged or credited at that marginal rate; the proportion of the spectrum on which rents would be payable would have to be large enough to give the large users an economic incentive to moderate their demands.

22. If a larger user responded by reducing his demand by the whole of that portion of the spectrum on which rent was payable, it would probably be necessary to re-assess the situation, but such a reduction would of course ease the pressure of demand and so reduce the equilibrium rent, especially if all the large users responded in that way. The reactions of large and small users cannot be estimated in advance of an announcement of intention to introduce a renting scheme, but it seems reasonable to suppose the most painful effects could be mitigated in such a way without jeopardising the benefits of the system.

Department of Transport  
Transport Science Policy Unit



## ECONOMIC ASPECTS OF THE ALLOCATION OF THE RADIO SPECTRUM

The radio spectrum is a common resource with unique and complex characteristics. To obtain the most from it has required close attention to technical factors and cooperation among users. In all countries, the allocation of spectrum among broadcasting, telecommunication, mobile radio and other uses is made by a national administrative process, working within a framework of international agreements. In recent years, these arrangements have been placed under some strain by the rapid expansion in demand for radio frequencies which has accompanied the electronics revolution. Recognition of the strategic importance of spectrum availability has prompted concern that the present pattern of allocation may not reflect changing economic and industrial priorities. In this paper, various ways are explored in which economic factors might be given more explicit consideration in the management of the radio spectrum in this country.

### The aims of spectrum management

2 It must be acknowledged that the objectives of radio spectrum management are not clearly defined. The main rationale for regulation is to prevent congestion of the available spectrum by minimizing signal interference among users. In addition, some priority among alternative users is established by dividing the spectrum into frequency bands which are allocated to particular types of service. New services are accommodated by extending spectrum use to progressively higher frequencies and by technical adjustments within existing allocations. This, it will be noted, is a statement of the method of working, rather than of the aims of the exercise. The procedure accords effective priority to incumbents and contains no means of ensuring that allocation decisions conform with broader economic objectives.

3 It is presumably desirable that spectrum be allocated to uses which offer the greatest net benefit to society. Ordinarily, competing claims for a scarce resource would be settled by allowing a price to be determined for it, the payment of which would serve to balance prospective demand and available supply. An efficient market should, subject to technical and international constraints, produce an allocation consistent with this aim. However, to the extent that radio regulation is expected to give priority to more specific objectives - the maintenance of certain broadcasting values, accommodation of the programme of liberalisation in telecommunications, support of developments in information technology and provision for national defence are some obvious examples - the operation of a market mechanism could be circumscribed and its effectiveness diminished. The potential for conflict among objectives could be diminished the greater the reliance on market forces generally within the domestic and the international economy.

### The problem of signal interference

4 Price determination might be secured through a number of market forms, such as open sale, periodic auction or rental arrangements of one kind or another. which would be most



suitable depends upon the scope for defining property rights in radio spectrum and the extent to which continuing management of the resource is unavoidable. The spectrum is not depleted by use. Its scarcity derives ultimately from the potential for interference between signals. The circumstances under which interference may occur are technically complex, variable and to some extent unpredictable. For these reasons, rights to spectrum - in effect the right to exclude others from particular frequencies - could only be maintained by active regulation of users.

5 Technical aspects of spectrum management, such as the spacing between channels to secure an acceptable degree of freedom from interference, have an economic significance that could itself be judged by potential users. If left to be resolved by market forces then perhaps each use could enjoy the optimum technical specifications, balancing reduction of interference against the costs that must be incurred, rather than accepting regulatory guidance on the minimum attainable. However, voluntary cooperation among users (as distinct from producers) on technical standards is not commonly found in competitive markets. Moreover, the costs to users of arriving at mutually consistent methods of working, defending their own practices or seeking compromises with others, and of responding to shifting demands from final customers, would be substantial and uncertain. In the absence of a regulatory framework, the resolution of disputes would, in the last resort, be a matter for the courts.

#### Minimising transactions costs

6 Transactions in all markets have a cost and an efficient market is one in which not only are resources allocated to their best use, but also the costs of achieving this result are minimised. If, as with the radio spectrum, there are evident gains from agreement on technical standards, users can be expected to cooperate rather than compete. However, the enforcement of agreed standards and their adaptation to changing technological conditions would appear to present formidable difficulties for any voluntary arrangements. In short, the foundation of the case for administrative decision making may be its cost effectiveness.

7 The granting of property rights to existing users, essential to the creation of a market in spectrum, may add significantly to the costs of transferring frequencies from one use to another. A price structure that closely reflected the economic worth of spectrum would not necessarily be sufficient inducement to call forth extra supplies. Existing users would have to incur costs in making suitable alternative arrangements and perhaps face disruption of their services. Compensation may be sought to recover these costs as well as the value of the frequencies given up. If, as seems likely, some major users habitually hold on to spectrum in excess of their immediate requirements. As with the sale of land, a substantial premium may be needed to overcome the reluctance of existing users to give up their property. Intervention by a regulatory authority, to enforce transfers or to penalise hoarding, might be necessary to ensure continued development of the resource.



## The scope for a market mechanism

8 While a market in spectrum would be a possible solution to the problem of scarcity, as a practical matter, such a market would need to be set up and sustained by regulatory action. In order to minimize the costs of operating the market, the regulatory authority would need to determine the property rights of users and probably to intervene to ensure or encourage an appropriate allocation of the resource. The relevant question, then, is not whether regulation can or should be replaced by reliance on market forces but how far regulation needs to extend. If it is provisionally concluded that a regulated market is feasible, what might be its structure? Would it be competitive - that is, would it produce an efficient or even an improved allocation of the spectrum among alternative uses?

9 Suppose that the radio regulatory authorities were charged with setting technical standards and operating a market in which channel capacity was offered to the highest bidder, with use subject to the constraints set by international agreements. For such an auction process to work, it would probably be necessary to define units or blocks of spectrum defined in terms of bandwidth and coverage for which bids were invited. Under the present licensing system, users are assigned specific frequencies in response to their individual application. While some use is made of standard allocations, to a great extent the frequencies assigned are tailored to their requirements. This service is valued by many licensees, who are charged for the direct cost of the work done, but could probably not continue in the same way in a market environment. The absence of a standard 'unit' of spectrum that could be used for trade would not, in itself be a limitation on the effectiveness of the market, provided users were free to group, subdivide and resell the blocks initially defined by the regulatory authority. Indeed, there is a case for permitting resale on commercial terms within any allocation procedure, including the present licensing system, as a means of providing temporary access and some flexibility.

10 The expectation, if not the requirement, that in certain bands particular types of service will have priority, in order to conform with the table of frequency allocations agreed among all countries, may well fragment the market. To the extent that trade is confined within broadcasting or private mobile radio (PMR) segments, the primary benefit of seeking to balance one use of spectrum is largely foregone. The auction of spectrum can then perform only the function of frequency assignment among competing applicants who intend the same type of use. The scale of the bids received within each band, that is differences in the price of spectrum allocated to particular types of service, might indicate whether the bands were about large enough or in need of adjustment (although such changes might have to await revisions to the international agreements). In any case, this use of the prices revealed at auction could only be justified if the final markets in which users of spectrum operated were themselves competitive. In general, this is not the case.



## Monopoly

11 The amount that potential users would be prepared to bid for spectrum would depend upon the expected profitability per unit of radio frequency of the service they intended to supply (the costs of economising on spectrum and of alternative methods of signal transmission would set limits to bids). Users that had a monopoly in the markets they served could use their profits to appropriate excessive spectrum, squeezing out not only their smaller rivals but also bidders in markets which were competitive. In the UK, the strength of British Telecom in all telecommunication markets could be translated into a monopoly of the frequency bandwidth most suited to such services. The BBC and commercial TV companies would also be in a strong position and, it may be noted, are extensive users of land mobile radio. In consequence, the small PMR companies would be unlikely to obtain as good an allocation of spectrum by bidding for it in open competition as they might hope to get from an informed appeal to a regulatory authority.

## Regulation in other markets

12 Both telecommunication and broadcasting services are subject to regulations which limit the number of firms allowed to operate and so sustain the monopoly positions referred to. To be effective, the licences or franchises that are granted to provide these services must convey also the right to install such facilities as are necessary for transmission. No necessary rights to spectrum are conveyed, if alternative means of transmission exist, but it would undermine an auction if only a strictly limited number of licence holders were able to take part. The prices revealed would serve no useful purpose in allocating spectrum or in frequency assignment.

13 Regulation of radio and TV broadcasting is itself founded on spectrum scarcity. The number of national TV programmes in the UK is limited to four in the UHF range by the size of TV Bands IV and V. Commercial TV companies with a franchise from the IBA are usually able to make excess profits from advertisers and are subject to a levy. In this situation, any additional costs to acquire frequencies could be met by the companies and largely be offset by lower levy payments. Even if additional frequencies became available, the established TV companies might well seek to defend their position by hoarding the extra spectrum. When TV franchises are renewed, unsuccessful companies could auction their frequencies to appropriate the excess profits expected by their successors.

14 In any event, the IBA would continue to be concerned with the structure of the broadcasting industry. In particular, it would not necessarily be willing to simply award the greatest number of franchises possible with available spectrum. The point can be illustrated by reference to commercial radio, where it is acknowledged that the number of stations is restricted. A small increase in the number of channels might result in more stations specializing in popular music, which is at present the the most profitable option. If greater diversity of programming



was desired, but insufficient frequencies were available for this to occur through the operation of market forces, the terms of franchises could restrict popular music stations and encourage news, sport or minority interests. Dividing up the market would lessen competition but give more choice to listeners. In general, the close interaction between spectrum management and broadcasting regulation would seem to leave little scope for a separate market in spectrum, unless there could be a substantial increment in frequencies available, sufficient to enable a diversified range of programming to be offered by competitive radio and TV stations.

#### Non-commercial users

15 The BBC would be constrained in paying for spectrum by the licence fee, which is subject to regulatory control. Indeed, much of the spectrum is allocated to non-commercial organisations, including over 50% in the range under consideration (30-960 MHz). In principle, organisations such as the armed forces should be both willing and able to pay for spectrum as for other resources they require. Public sector bodies, particularly if they are subject to effective expenditure constraints, should not produce distortions in the markets in which they make purchases. The problem is partly one of the scale to which the government is involved. Another dimension is that many of the services provided are considered essential, such as the emergency services, so that there would be a tendency to pay whatever is necessary to secure their access to the spectrum. The absence of sound means of valuing the full range of uses of spectrum is a general difficulty that affects any scheme of allocation, not just market mechanisms and is considered further below.

#### Effects on consumers

16 Ordinarily, final consumers take no direct interest in radio spectrum questions (with the exception of CB and other amateur radio users). Their interests would be taken into account by the providers of services, who would wish to be assured that their transmissions could be received. Bids for spectrum would need to be coordinated with the suppliers of equipment, particularly in areas such as broadcasting where sales of equipment are direct to consumers (in telecommunications and mobile radio renting or leasing is the norm). Apart from the inherent complexity of the coordination that is required, it is not certain that there would always be a community of interest between those seeking extra sales and those wishing to extend the useful life of equipment already purchased.

#### Impact on technical innovation

17 Technical innovation has been particularly stimulated in mobile communication services that have been starved of spectrum, notably mobile radio applications. The forced exploration of ways to economise on bandwidth through, for example, reducing the spacing between channels, sharing capacity and re-using frequencies



has permitted some expansion of these services and stimulated the market in equipment. However, the logic of the proposition that mobile radio has been squeezed excessively is that a fairer allocation could render some advanced techniques unnecessary or uneconomic at projected levels of demand, especially outside the conurbations. Companies that were able to purchase additional capacity would have less incentive to seek technical solutions to the problem of scarcity. Greatly increased spectrum availability would not favour enterprises that have invested in spectrum efficient but relatively high cost technologies.

#### Charging for spectrum

18 The attempt to to allocate spectrum through a market mechanism, it would seem, would be subject to many constraints, might well generate considerable costs and difficulties for users and might not produce in practice the desired result of reflecting the economic worth of the services provided by means of radio frequencies. A more modest aim than creating a market would be to institute a system of charges for spectrum based upon an estimate, necessarily approximate, of the value of a unit of frequency bandwidth and proportional to the quantity assigned. While not offering a means of allocating spectrum among the broad range of potential uses, economic charges would help to ensure that existing licence holders did not retain spectrum that they did not need, so increasing supply, and to discourage applications for bandwidth where cheaper alternatives existed, so reducing demand. All users would have an incentive to seek ways of reducing the bandwidth required to offer service, although again the incentive would only be really effective in competitive services. The outcome could represent an improvement upon the present situation, where charges are well below the scarcity value of the frequencies assigned.

19 The general issue of determining the economic worth of a unit of spectrum in the absence of a market is addressed below. It can be a formidable undertaking, particularly where final markets are subject to distortion - the objective is not to draw off excess profits - or where there is no price paid by final consumers as in broadcasting. Moreover, it could prove a cumbersome undertaking; considerable expense would arise from a requirement to regularly revalue all actual and potential uses in order to ensure that charges were fair and achieving their purpose. Such problems could be circumvented by establishing unit values only in uses where there was a competitive market and generalising to all users. Since, by historical coincidence, it is by and large the services that are provided competitively that are most concerned to obtain more spectrum, this procedure might produce, at least in the near future, quite a close approximation to the true marginal worth of spectrum.

20 There is a strong argument that priority in spectrum allocation should be given to services that could not exist without it over other applications for which alternative technologies of transmission are feasible. This is not, however, an economic proposition as it takes no account of the cost of alternatives and is not necessarily the result towards which a system of economic charges would lead. Instead, higher charges might well produce the result that small scale or marginal providers of mobile services are obliged to withdraw. A further point worth noting is that, provided access to



the spectrum can be secured, refraining from charging does encourage market entrants and experimentation with new types of service.

21 Charging for spectrum could raise useful sums for the Exchequer. Indeed, there would be the risk that this would become its primary purpose, particularly if the empirical basis of the charge was not very secure. In the circumstances, it is not obvious that a regulatory authority with the power to withhold or retract licences, to impose strict conditions on licensees and to reorganise assignments would welcome or make effective use of the additional power to levy charges. Charges that were not related directly to the valuation placed on spectrum would be simply a form of tax. If the aim is to manage the spectrum more efficiently then the problem of hoarding spectrum, in particular, could be tackled by present administrative methods.

#### Cost benefit analysis

22 Leaving users in possession of a resource for which they have not been required to pay the true value would sustain overbidding and complicate the task of regulation. The authority might gain from having available a reasonably objective estimation of the value of utilising spectrum to provide a range of services compared to the alternatives, using such valuations to counter overbidding and to guide individual allocation and assignment decisions. It would not be sufficient to require applicants to prove that their case had merit. Once it became known that regulatory decisions were influenced by considerations of demand and the costs of alternatives, applicants would have the incentive to offer optimistic projections of the viability of the proposed service. In any event, the range of economic factors to be taken into account extends beyond the commercial prospects of a particular enterprise. The regulatory authority would need to place individual applications in the context of more general development of demand and of technology. The authority may not be well placed itself to carry out such assessments. There is, however, a thriving market in consultancy in which both the authority and applicants for spectrum could purchase the respective information they require.

23 The technique of cost benefit analysis as a guide to economic choices in the absence of an efficient market or adequate methods of price determination is, by now, well established, for example in the planning of land use and the design of transport systems. Both the potential and the limitations of the technique have been fairly thoroughly explored, although there have been few attempts to apply it in the context of the radio spectrum. The case for a greater allocation to PMR has been put in cost benefit terms and some illustrative case studies have been prepared for the Review. A reason for the dearth of studies may have been the cost of compiling the information. Many of the well known studies have been undertaken for single projects where the length of the planning period and the scale of investment potentially at risk has permitted and justified a thorough examination of the costs and returns involved. Realistically, the same care cannot be devoted to recurring, small scale decisions of the kind entailed in spectrum management without producing delay and a substantial increase in the cost of regulation.



24 The aim of cost benefit appraisal of applications for spectrum would be to maximise the net benefit to society from exploitation of the resource - that is, the same general aim as that served by an efficient market. Moreover, at least in principle, the technique can accommodate some of the problems identified with possible market mechanisms, for example monopoly in final markets or the existence of independent regulatory objectives in these markets. In practice, it may be doubted whether it is feasible to envisage a cost benefit approach substituting in full for an efficient market.

25 The method of working is to value in monetary terms all costs and all benefits that can be identified. The task is not as daunting as it might appear at first glance, in that the focus of decision making is presumed to be on the margin between alternative uses, as in the Interim Report in which PMR and broadcast teletext services were compared. Broad value judgements on the merits of broadcasting compared to other types of service are not needed, nor is a serious purpose served by simply quantifying the economic importance of particular uses of spectrum. Indeed, it may be doubted whether at such a level of aggregation meaningful questions can be formulated for analysis. Cost benefit studies need practical alternatives to bite on. Inevitably, uncertain or improbable outcomes will tend to be given less weight.

#### The valuation of benefits

26 In many areas of potential applications, generating estimates of benefits is likely to be difficult or even impossible. Normally, industry sources can offer data of the costs entailed or these can be constructed from engineering studies. Where the principal benefits take the form of expected reductions in costs, as in the use of mobile radio to reduce the operating costs of transport fleets, equally robust estimates should be obtainable on the benefit side. Where the service to be provided is sold to final consumers, benefits will be measurable by market research methods, even for new services. In broadcasting, however, the benefits are not only diffused very widely among the population, but they are not paid for directly. As a minimum, considerable ingenuity is needed to quantify and to compare alternatives.

27 Broadcasters themselves cope with the absence of financial feedback from customers by undertaking extensive audience research, so that the preferences and viewing and listening habits of the public are studied in detail. If desired, such data can be converted into monetary terms by employing techniques for the valuation of leisure time, or by inferring the valuation of additional or different kinds of broadcasting services from behaviour. Companies engaged in testing the market for cable TV and for DBs will be directing their studies along similar lines. When such services commence, the revealed demand for them will provide confirmation - or the contrary! - of the estimates produced.

28 A short cut, deployed in the DoI submission on the use of TV Bands I and III, is to assume that the output from a service is worth at least what people are prepared to pay to offer and receive it (avoiding double counting costs recovered from revenue). Such an approximation, which represents a minimum estimate, may suffice, particularly if it reveals an order of magnitude difference between alternatives or if the formal exercise of establishing willingness



to pay exposes the absence of significant demand for, or of real intentions to invest in, some of the alternatives being studied.

29 Valuing the contribution to national defence or public safety of additional spectrum presents problems of a different kind. The valuation of life and limb, or more accurately of changes in the probability of injury or death, is considered in transport applications of cost benefit analysis, though rarely is it a factor of crucial importance. It must also be acknowledged that different approaches to the topic seem to produce inconsistent results. In any event, it is hard to resist the conclusion that such refinements of valuation are likely to prove unnecessary. The opening up of new services is not likely to change the priority currently placed by society on defence, public safety and so on. It should normally be sufficient to consider how the same standard of service could be secured by other means, for example, by moving to a different frequency band and whether the costs of the move are more than compensated for by the net benefits of the potential for new applications thereby created. Formally, this is a kind of cost effectiveness study, in which benefits are taken as given and the minimum cost of obtaining them is sought.

### Conclusions

30 There appears to be no simple method of taking full account of economic factors in the management of the radio spectrum. Resolving the problem of scarcity by creating a market in frequencies is a feasible solution, but a free market would generate substantial costs to users in seeking to protect themselves from interference and in seeking to effect transfers of frequencies. Even a market would require active regulation to minimize these costs. In current circumstances, where there is significant regulation and monopoly profits in telecommunications and broadcasting, it is not at all probable that the outcome would significantly improve the position of new services or mobile radio applications. For similar reasons, charging an economic rent for spectrum does not appear an attractive second best solution. If and when the relevant markets can be deregulated as a result of an extension of competition, these options could be reconsidered.

31 The quantitative economic basis of allocative decisions could be improved by the consistent comparison of proposed alternative uses of spectrum within a cost benefit framework. The information requirements of such an approach appear almost forbiddingly large. Moreover, the conclusions of cost benefit or cost effectiveness studies could only be considered tentative with regard to many services, contributing to final decisions but not determining them. Despite these deficiencies, it is evident that applications for frequencies are strengthened by indications of unsatisfied demands that could be met or of potential gains in the efficiency with which the radio spectrum could be utilised. There would be merit in making provision for a continuing capability to undertake systematic assessments of information of these kinds.



SCIENCE & ENGINEERING RESEARCH COUNCIL  
Specially Promoted Programme in Radio Communication Systems  
Possible Research Topics suggested by  
Mobile Radio Consultant

- 1 Investigation of new communication organisations.
- 2 System design of networks.
- 3 Investigation of Radiotelephone systems ( analysis).
- 4 Radiotelephone systems Cellular:
  - 4a Mobile Control Centre Software.
  - 4b Overall system software; provision of adequate capacity for information flow inside network.
  - 4c Control of base station with associated software.
- 5 Investigation of new equipment architectures to allow integration.
- 6 Frequency assignment strategies and techniques.
- 7 Propagation modelling, particularly of heavily built-up areas and inside buildings and structures.
- 8 Investigation of novel methods of modulating and coding.
- 9 Definition of equality and grade of service.
- 10 Determination of protection ratios for different systems.
- 11 Design of paging services.
- 12 Improvement of point to point services.
- 13 Automatic vehicle monitoring and location.
- 14 Analysis of data transmission over paths subject to fading, shadowing and interference. Investigation of means to improve BER by diversity.
- 15 Investigation of Spread Spectrum methods of transmission.
- 16 Guided Radiation.
- 17 Electro-Magnetic Compatibility.
- 18 Design of good linearity receivers and transmitters.
- 19 Filter techniques - switched capacitor etc.
- 20 Saw devices.
- 21 Large area coverage systems.
- 22 Communication services operating within TV or sound broadcasting systems (paging, data transmission).
- 23 "White meter" switching.
- 24 The establishment of centre of excellence for sub-micron technology. This to be part of interdisciplinary activity.
- 25 Sensor monitoring by radio - Telemetry.
- 26 Adaptive modems for use in HF Skywave transmission, on VHF and UHF at speeds of travel up to Mach 3.



- 27 Suppressed and concealed antennas for use on HF, VHF and UHF for portable equipment and vehicles.
- 28 Use of diversity between "E" and "H" wave.
- 29 Guided radiation.
- 30 Simulation of complete communication systems, including paths, interference, effect on signalling etc.
- 31 Use of signal processing in digital radio equipment.
- 32 C A D programme to analyse behaviour of complex radio apparatus, including secondary and tertiary effects like EMC, non linearities, screening, interaction etc.
- 33 Investigation of methods for avoiding distortion of FM signals due to multipath effects (broadcast and voice).