

Study on Spectrum Management in the field of Broadcasting

FINAL REPORT

Implications of Digital Switchover for Spectrum Management

Prepared for the European Commission (DG Information Society)

Authors:

John Burns

Aegis Systems Ltd

Phillipa Marks

Indepen Consulting Ltd

Florence LeBorgne

IDATE

Richard Rudd

Aegis Systems Ltd

The opinions expressed in the Study are those of the authors and do not necessarily reflect the views of the European Commission.

© ECSC-EC-EACAE, Brussels – Luxembourg 2004

CONTENTS

1	INTRODUCTION / TERMS OF REFERENCE.....	1
2	BROADCASTING AND SPECTRUM MANAGEMENT IN THE EU: CURRENT SITUATION	4
2.1	Introduction	4
2.2	Radio Spectrum from a Regulatory and User Perspective.....	4
2.3	Use of Radio Spectrum for Broadcasting in the EU.....	12
2.4	Radio Spectrum and Broadcasting Policy in the EU.....	12
2.5	The Situation Elsewhere.....	13
3	OPPORTUNITIES AND CHALLENGES PRESENTED BY SWITCHOVER	17
3.1	Introduction	17
3.2	Estimating the Digital Dividend	18
3.3	Implication of the Analogue Legacy for Digital TV Planning.....	20
3.4	Use of Broadcast spectrum by non-broadcast services.....	22
3.5	Making the most of the spectrum dividend in an uncertain market environment.....	23
3.6	Potential Developments in Broadcasting and the Implications for Spectrum Management.....	24
3.7	Alternative Uses of Broadcasting Spectrum.....	35
3.8	Market Evolution and Convergence	37
3.9	Implications of Spectrum Refarming	40
3.10	Internet Protocol Datacasting (IPDC).....	42
3.11	Other Convergence Initiatives	46
4	POLICY ISSUES ARISING FROM SWITCHOVER.....	48
4.1	Introduction	48
4.2	Spectrum management and broadcasting objectives.....	49
4.3	Timing of Switchover Decisions.....	53
4.4	Developing the Digital Market.....	55
4.5	Incentivising Switchover	57
4.6	New Approaches to Spectrum Management.....	58
4.7	Future Use of Broadcasting Spectrum	68

4.8	Conclusions.....	73
5	SWITCHOVER AND THE SPECTRUM PLANNING PROCESS.....	74
5.1	Introduction	74
5.2	Building Flexibility in the Planning Process	74
5.3	The Regional Regulatory Conference 2004 (RRC-04)	77
5.4	Achieving Flexibility in Practice: Finland's experience	80
5.5	Looking to the Longer Term	81
6	CONCLUSIONS AND RECOMMENDATIONS.....	83
6.1	Introduction	83
6.2	Facilitating Switchover	84
6.3	Maximising Opportunities from Switchover and Convergence	87
Annex A: Glossary		
Annex B: Introduction to International Spectrum Management		
Annex C: Current Status of Digital Broadcasting in Europe and Elsewhere		
Annex D: Current use of Broadcasting Spectrum in EU Member States		
Annex E: Estimation of Spectrum Requirements for Digital TV		

1 INTRODUCTION / TERMS OF REFERENCE

The transition from analogue to digital television broadcasting will ultimately result in a significant increase in the capacity of the radio spectrum currently allocated to broadcasting to carry electronic communication services or content. This will both reduce the amount of spectrum required to deliver existing broadcast services and create an opportunity for the delivery of new content, services or applications. The extent of this “digital dividend” will depend on many factors, in particular the nature of the digital television services that are broadcast, for example picture quality, the number of programme channels and the extent to which mobile reception or regional services are required. During the transition period from analogue to digital TV services, the need to protect existing analogue transmissions from interference has the potential to constrain severely the spectrum available both for digital TV and for other, new services and it is therefore desirable to expedite the switchover process as far as possible.

Currently there is no consensus on how any digital dividend should be used, beyond a general presumption that the most economically and socially attractive use would entail some element of mobility and/or audiovisual content. This reflects the fact that the spectrum concerned is ideally suited to wide area, non-line of sight communication and that recent growth in demand for radio spectrum has mainly been for mobile and broadcast applications.

This document is the final report of a Study on Spectrum Management in the Field of Broadcasting, prepared for the European Commission (EC) Directorate for the Information Society (DG INFSOC) by Aegis Systems Ltd, Indepen Consulting Ltd and IDATE. The report focuses on the implications of digital switchover and the growing convergence between broadcast and telecommunications for radio spectrum management. In line with the EC’s stated terms of reference of the Study, the report addresses the following specific issues:

- i) **General Overview of broadcasting and radio spectrum management in Europe:** the report and annexes provide an overview of national approaches to digital television rollout and radio spectrum management in the context of migration from analogue to digital broadcasting. Technical and regulatory background on radio spectrum management and wireless communication is also provided, including references to relevant EU legislation and other regulatory instruments.
- ii) **Spectrum implications of the digitisation of broadcasting and convergence:** the report analyses the extent to which current approaches to radio spectrum management at national and international levels, which were established in an analogue, non-convergent environment, are challenged by digitisation and technology / service convergence.

- iii) **Possible new approaches for better spectrum management in the field of broadcasting:** the report considers possible new technical, administrative and market-based approaches to spectrum management that might support flexibility and innovation in the future. Examples of convergent services and technologies and how these might be catered for in a future spectrum management framework, are addressed, along with techniques for improving spectrum efficiency in a digital world.
- iv) **Possibilities for co-ordinated EU Action:** Finally, the report provides recommendations on potential roles for the EU with regard to spectrum and broadcasting policy that might help to maximise the benefits arising from digitalisation and convergence.

The structure of the report is as follows:

Chapter 2 provides a high level overview of the current status of radio spectrum management and broadcasting within the EU and in a broader international context. These topics are addressed in more detail the Annexes.

Chapter 3 examines the opportunities and challenges presented by the switchover from analogue to digital broadcasting, particularly in the context of how the greatest benefit might be derived from the increased transmission capacity and spectrum utilisation efficiency which digital technology provides.

Chapter 4 considers what national and international policymakers might do to ensure that the regulatory environment can best support the opportunities and overcome the challenges identified in Chapter 3.

Chapter 5 focuses specifically on the spectrum planning process and how this can provide the flexibility needed to maximise the benefit from switchover and convergence.

Chapter 6 summarises our key findings and conclusions, and considers potential roles for the EC in facilitating the switchover process and maximising stakeholder benefits.

Scope of the Study

Although the Study initially set out to address spectrum management issues relating to all broadcast services, the principal spectrum management issues identified by the authors relate to the impending switchover from analogue to digital television. The switchover process has already commenced in some EU countries and most are expected to complete the process within ten years, whereas there are not yet any definitive plans for such a process with regard to sound broadcasting. The main opportunities for flexibility in spectrum use relate to the UHF frequencies between 470 and 862 MHz, and it is this part of the spectrum upon which this report focuses.

The authors are aware of a number of longer term issues relating to digital sound broadcasting, including the status of the various digital standards (in particular the Eureka Digital Audio Broadcasting and Digital Radio Mondiale standards that are

currently being deployed in some EU countries) and the extent to which convergent services might be delivered using digital sound broadcast technology. The balance between spectrum designated for television and sound broadcasting in Band III (173 – 230 MHz) may also become an issue as these two services develop. These are issues that in the authors' opinion would merit consideration as part of a separate future study.

Disclaimer

Whilst every effort has been made to ensure the accuracy of the information contained in this report, the authors can not accept any responsibility for actions or decisions that may be taken as a result of the information herein.

The opinions expressed in this Report are those of the authors and do not necessarily reflect the views of the Commission, nor does the Commission accept responsibility for the accuracy of the information contained herein.

2 BROADCASTING AND SPECTRUM MANAGEMENT IN THE EU: CURRENT SITUATION

2.1 Introduction

Broadcasting is a major contributor to the European economy. The overall turnover of the TV broadcasting sector in the European Union in 2000 was estimated at about €53.9 billion with an annual growth rate of 8.5% for public and 13.7% for private TV broadcasters between 1995 and 2000¹. The use of radio spectrum also embraces many other electronic communication services, as we explore in Annex B, and this is reflected in the contribution that radiocommunication services make to national economies. For example, a recent study² estimated that in 2000 the value of radio spectrum to the UK economy was £20 billion (€28.6 billion). Scaling this pro-rata to GDP would suggest a total value across the EU of around €160 billion or approximately 2% of gross domestic product.

The significance of broadcasting and radio spectrum in economic terms is matched by their importance at a social level. Broadcasting provides the main source of news, information and entertainment for EU citizens and virtually everybody accesses sound or television broadcasts on a daily basis. Mobile communications, the other major consumer use of radio spectrum has also reached the mass market in the last decade, with penetration exceeding 80% in most EU countries. Hence decisions on how spectrum resources are used can have a significant impact at both an economic and social level.

2.2 Radio Spectrum from a Regulatory and User Perspective

The radio spectrum is a finite natural resource that caters for an increasingly diverse range of wireless electronic communication as well as other critical applications, for example in support of aeronautical or maritime navigation. Because the use of radio spectrum by one user can interfere with other users, even across national borders, it is necessary to regulate access to spectrum in order to keep such interference at a minimum whilst enabling effective use of the resource. The following sections provide a high level introduction to the management of radio spectrum, in the form of a “top-down” description of the international framework and from the “bottom-up” perspective of a potential user wishing to gain access to radio spectrum. A detailed description of the international framework for spectrum management, and the underlying technical rationale relating to avoidance of harmful interference, is presented in Annex B.

¹ “Cinema, TV and radio in the EU: statistics on audiovisual services, EC, 2003

² “The economic impact of radio”, Radiocommunications Agency, February 2001

2.2.1 International Framework for Spectrum Management

Essentially, there are three layers to the international regulatory framework, comprising global, regional (European) and national elements. Under this framework, individual countries retain control over who uses radio spectrum within their territories but they must ensure that such use does not compromise other legitimate users in other national territories.

At a global level, spectrum management is governed by the Radio Regulations (RR) under the auspices of the International Telecommunications Union's Radiocommunications Sector (ITU-R). The RR provide the overall global framework for spectrum use, including the International Frequency Allocation Table (Article S5), which allocates spectrum to broad categories of service such as fixed, mobile, broadcasting or radionavigation. Specific parts of the spectrum are allocated on a primary or secondary basis to the various services, with primary allocations enjoying the highest level of protection from interference. National administrations are required to comply with the terms of the RR, which have international treaty status. However, the RR includes provisions for administrations to allow spectrum use by services other than those specifically allocated in Article 5, so long as no interference is caused to any allocated service and no protection from any allocated service is sought.

The RR are updated on a periodic basis by means of World Radiocommunications Conferences (WRCs), which are held every two or three years. Regional Radiocommunications Conferences (RRCs) are also held from time to time to develop agreements concerning particular radiocommunication services or frequency bands within specific geographic areas or among specific groups of countries. Of particular relevance to this study is the RRC to address the planning requirements arising from the introduction of digital TV and audio services in the VHF and UHF bands, which is to be held in two stages in 2004 and 2006 (RRC-04 and RRC-06 respectively). This RRC is addressed in more detail in Section 5.3 of this report.

2.2.2 The Frequency Planning Process: Allocations, Assignments and Allotments

When discussing approaches to radio spectrum management it is important to differentiate between two distinct processes, namely the *allocation* of spectrum to particular service categories such as broadcasting or mobile (generally done at an international level) and the *assignment* of frequencies to individual users (generally done at a national level). The allocation process is intended primarily to ensure that only compatible systems share specific parts of the spectrum, thus minimising the risk of interference between users, whereas the assignment process involves deciding who may use the spectrum in accordance with national and international rules. An assignment typically includes details of the location of a radio transmitter and the key technical characteristics that relate to its interference potential, e.g. operating frequency, power level or height above ground.

In some cases, notably where very high power transmissions are involved whose coverage extends well beyond national boundaries, assignments may be planned internationally. Such is the case in the broadcast bands, where assignments have historically been planned at RRCs and subsequent changes agreed by multilateral international negotiations. These negotiations can be complex and protracted, particularly where large networks of transmitters are involved, and make it difficult to change the use of the spectrum substantially from that envisaged at the original RRC.

Allotment planning is an alternative approach to international frequency planning which is becoming increasingly popular where flexibility is required. Under allotment planning, rather than individual transmitters being considered, radio frequencies are allotted to specific geographic areas, the extent of which is based on the interference potential of a notional transmitter assignment within the area concerned. Rather than specifying the technical parameters of an individual transmitter, the allotment is defined in terms of specified interference limits at the boundary of the geographic area to which the allotment relates. These limits cover the amount of interference that the allotment may cause to other allotments or assignments outside the allotment area and the degree of protection from interference that a notional service within the allotment areas is entitled to receive. The notional transmitter and service on which the allotment is based will generally reflect the type of system to which the allotment currently relates, e.g. a high power broadcast transmitter serving rooftop-mounted receiving aerials. However, if a national administration or user decides to use the spectrum in a different manner, e.g. by installing a large number of low power transmitters rather than a single high power transmitter, this may be done without the need for international co-ordination so long as the boundary limits that apply to the allotment are not exceeded.

The allotment planning approach provides considerable additional flexibility in the use of radio spectrum, albeit at the cost of some loss of overall technical efficiency since a change of use is likely to mean that the original level of protection is greater than that required by the new use (it is unlikely that a change of use would result in an identical protection requirement and any increase in the requirement would require the same degree of co-ordination and negotiation as the assignment planning approach, negating the principal benefit of allotment planning). Allotment planning is being promoted by European participants in RRC-04. The role of allotment planning in facilitating flexible spectrum use is discussed further in Section 5.2.

2.2.3 Legacy and Liberalisation

The spectrum allocations defined in the RR largely reflect the historic (pre-liberalisation) situation where the principal spectrum users were state or public bodies, notably government (public safety / military), incumbent telecommunications operators and broadcasters. Each of these sectors acquired large amounts of spectrum over time, many of which were agreed internationally to facilitate cross-

border co-ordination. Even when spectrum was made available for private use, in many countries the regulation of this spectrum was initially vested in the same (monopoly) organisation that was responsible for providing public telecommunications services, providing little incentive to make spectrum available for new or innovative applications that might compete with the incumbent's services.

Since the liberalisation process initiated in the 1980s, governments have endeavoured to improve access to radio spectrum both for private users and for those wishing to provide competitive telecommunications or broadcast services to the public. However, access is still constrained to a significant extent by the historical legacy of established allocations to existing services. In particular, allocations to major civil uses such as mobile communications, fixed links, broadcasting and satellite services still largely reflect the pre-liberalisation situation, despite the massive growth in sectors such as mobile telephony.

Governments also continue to make extensive use of radio spectrum, primarily for military and public safety / law enforcement applications. Whilst spectrum scarcity has forced many commercial users to make increasingly intensive use of their available spectrum (witness the massive growth in mobile base stations for example), government users have not generally faced the same incentives. In some cases this places direct constraints on commercial users, for example in some EU Member States parts of the UHF TV bands and the GSM mobile bands continue to be used by government services, to the exclusion of commercial users. The result is additional costs for the commercial users and in extreme cases fewer market players can be supported.

2.2.4 National Approaches to Managing Spectrum

In theory, national administrations enjoy considerable latitude in determining how spectrum is used within their territories, so long as they ensure that harmful interference is not caused to allocated services operating beyond their borders. In practice, the extent of this latitude depends largely on a country's geographic location, in particular the number of other neighbouring countries with which co-ordination is required. Hence the situation in countries such as Australia or New Zealand, who have no land boundaries to consider, is very different from central European countries where as many as nine directly adjacent countries need to be considered (the extent of co-ordination required may be even greater since the distance travelled by radio waves can extend well into the territories of countries beyond immediate neighbours).

In some cases, individual countries' use of spectrum is recognised formally by the insertion of footnotes in the RR. For example, in the UK and a number of Eastern European countries parts of the UHF TV broadcast spectrum is also allocated on a primary basis to aeronautical radars; as a consequence one or more TV broadcast channels may not be available for broadcast use in these countries. Where one or more countries wish to introduce radiocommunication services which differ from existing allocated services and wish these services to enjoy similar protection from

interference to existing primary services, additional footnotes may be negotiated to create additional primary allocations in those countries. Such footnotes generally include the proviso that the additional allocation is not protected from, or entitled to interfere with, any future planned services operating under the existing RR allocation. An example is footnote 5.235 which relates to the use of the VHF Band III Broadcast band by mobile services in a number of European countries, and is worded thus:

“Additional Allocation: in Germany, Austria, Belgium, Denmark, Spain, Finland, France, Israel, Italy, Lichtenstein, Malta, Monaco, Norway, the Netherlands, the United Kingdom, Sweden and Switzerland, the band 174 – 223 MHz is also allocated to the land mobile service on a primary basis. However, the stations of the land mobile service shall not cause harmful interference to, or claim protection from, broadcasting stations, existing or planned, in countries other than those listed in this footnote”

This footnote enabled countries such as the UK to establish commercial mobile networks in this frequency band, once appropriate bilateral agreements were reached with neighbouring countries to protect the broadcasting service.

Frequency assignments are generally determined at a national level but are subject to the provisions of the new EU Framework for Electronic Communications. In some cases, specific harmonisation measures may constrain NRAs in how spectrum is used (e.g. certain spectrum is harmonised internationally for second or third generation mobile services), but not the manner in which the spectrum is assigned to individual users. The three main approaches for assigning spectrum are first-come first-served, comparative selection and auctions, the latter two being used where the demand for spectrum exceeds the available supply. A detailed discussion of these and other options is presented in Annex B.

2.2.5 The Legacy Approach to Broadcast Spectrum Management

From the perspective of a user or potential user of radio spectrum, a key concern is how readily access to the spectrum required to deliver services can be obtained. Most incumbent users, particularly in the broadcast sector, were awarded spectrum rights of use under “command and control” regimes under which the amount of spectrum was determined on the basis of technical estimates of what was needed to meet specific objectives, notably coverage and service quality. Recommendations were developed in international bodies such as the ITU that enabled the amount of spectrum required to provide specified coverage and quality levels to be determined, based on assumptions about how such services would be delivered (e.g. the use of high powered, hilltop transmitters to maximise coverage and minimise network costs).

This approach, when applied to interference-sensitive analogue technology, results in a large amount of spectrum being required to deliver each service. This in turn

limits the number of competing services that can be provided in the available radio spectrum.

2.2.6 The Need for a New Approach

At the time most analogue TV broadcasters were first granted rights of use there was no alternative to terrestrial transmission, hence there were strong arguments to support the universal availability of terrestrial services regardless of the spectrum implications. The situation today is very different, in that cable and satellite transmission is widely available and the latter in particular can provide virtually ubiquitous reception, at least to outdoor fixed aerials. Digitisation presents a further paradigm shift, in that there is much greater technical flexibility in how networks may be rolled out, with correspondingly greater flexibility in the spectrum that is required. As we will illustrate later in this report, simple replication of existing analogue services would produce a substantial spectrum dividend that could allow many new players or services into the market. On the other hand, incumbent broadcasters argue that they must provide more than the status quo to compete effectively with satellite and cable platforms, or to meet evolving customer expectations such as mobility or indoor reception.

Such arguments are used by some broadcasters as justification for retaining their entire existing spectrum, resulting in denial of spectrum to potential new users who may place a higher economic value on the spectrum than the incumbents. Such denial implies an opportunity cost. Opportunity cost is the value of goods and services that would have been produced had the resources used in carrying them out (in this case spectrum) been used instead in the best alternative way. At the social optimum, marginal opportunity cost (i.e. the opportunity cost of a unit of the resource in question) equals the marginal value or price of the resource in question. Under most current national regulatory regimes opportunity cost is not reflected in the price paid by the incumbents to use the spectrum.

NRAs are increasingly considering market-based approaches to spectrum management, such as auctions or trading, which enable the market to determine the appropriate price that should be paid for spectrum rights. Historically, broadcasters have argued that they should be exempt from such policies due to the unique general interest obligations that apply their services. It is questionable whether such an argument is valid for services beyond those to which general interest obligations currently apply, in which case it can be argued that any expansion of broadcast services should be subject to the same considerations as any other user of the spectrum. Such an approach would require broadcasters to base their future spectrum requirement on commercial considerations, such as the cost of alternative provision or the revenue that may be foregone by not providing a new service, rather than simply providing a technical justification for retaining their existing spectrum.

The implications of this move away from spectrum being awarded on the basis of a pre-defined service or content offering to a situation where users acquire only the

spectrum they are willing to pay raise some complex issues in relation to broadcasting, which are considered further in Chapter 4.

2.2.7 Gaining Access to Spectrum: a User's Guide

To aid understanding of the spectrum management process, it can be helpful to consider this from the point of view of a potential user who wishes to gain access to spectrum for a new service or application. The historical approach to accessing spectrum in Europe is essentially an administrative one involving dialogue with government and/or regulatory bodies, and is described in the box below. This is still the principal approach for most types of spectrum access where an individual right of use is required, although several Member States have introduced auctions as a means of awarding particularly valuable rights of use such as those for 3G mobile. Some Member States are currently considering further market-based approaches to spectrum access, such as the establishment of a secondary market in which spectrum could be traded directly between users with only peripheral involvement of the regulator. These new approaches are discussed in more detail in Section 4.6.2.

Generalised approach to gaining access to spectrum in EU Member States

Where the requirement relates to a service that is already allocated spectrum in the Member State concerned, established procedures will apply. Depending on whether the demand for spectrum exceeds the available supply, the process will either be first-come first served, in which case a standard application form should be available from the NRA, or by means of a competitive process (auction or comparative selection procedure). The latter will require an application to be made in response to a public call by the NRA, which will only be made as and when appropriate spectrum becomes available.

If the proposed application does not correspond to an existing national spectrum allocation, the following procedure will typically apply:

1. The applicant should develop an outline business plan and identify technology partners as appropriate (equipment vendors, venture capital agencies etc).
2. The applicant should then approach government or NRA representatives – depending on the country this may be a government department responsible for industrial development / innovation or the telecommunications regulator. It is likely that the applicant will subsequently be referred to the national organisation or department responsible for managing and licensing radio spectrum, however initial dialogue with other government / regulatory departments may often help to strengthen the case for spectrum access, e.g. where the proposed application is supportive of national government policy objectives such as improving availability of broadband services.
3. The spectrum management body will advise on the availability of spectrum that might meet the requirement of the applicant. This might be licence-exempt

spectrum in the case of systems that can tolerate interference, but if the applicant requires access to “protected” or exclusive spectrum (e.g. in order to guarantee a particular grade of service) it will be necessary either to identify spectrum that is not already being used or to investigate the feasibility of sharing with existing users. If the latter approach is taken, technical trials are likely to be necessary along with discussions with the existing users.

4. It will also be necessary to agree the technical parameters of the proposed system, to ensure that interference will not arise to other users in adjacent areas or frequency bands. This process will be simplified considerably if the proposed system is compliant with an existing publicly available standard, such as those produced by the European Telecommunications Standards Institute. Otherwise it will be necessary for the applicant to demonstrate compliance with the essential requirements defined in the Radio and Telecommunications Terminal Equipment (RTTE) Directive, including the avoidance of harmful interference.

4. The next step (assuming any trials are successful) will depend on whether the availability of spectrum for the new application is likely to be limited or not – if the number of licences is limited it will be necessary for the NRA to consult with potential stakeholders in order to satisfy the requirements of the EU Communications Framework. Depending on the outcome of the consultation, it may then be necessary to initiate a competitive application procedure; otherwise a spectrum right of use may be granted on a first come, first served basis. The right of use will include technical and other conditions as defined in Annex B of the Authorisation Directive.

A simplified overview of the process is presented in Figure 2.1 below.

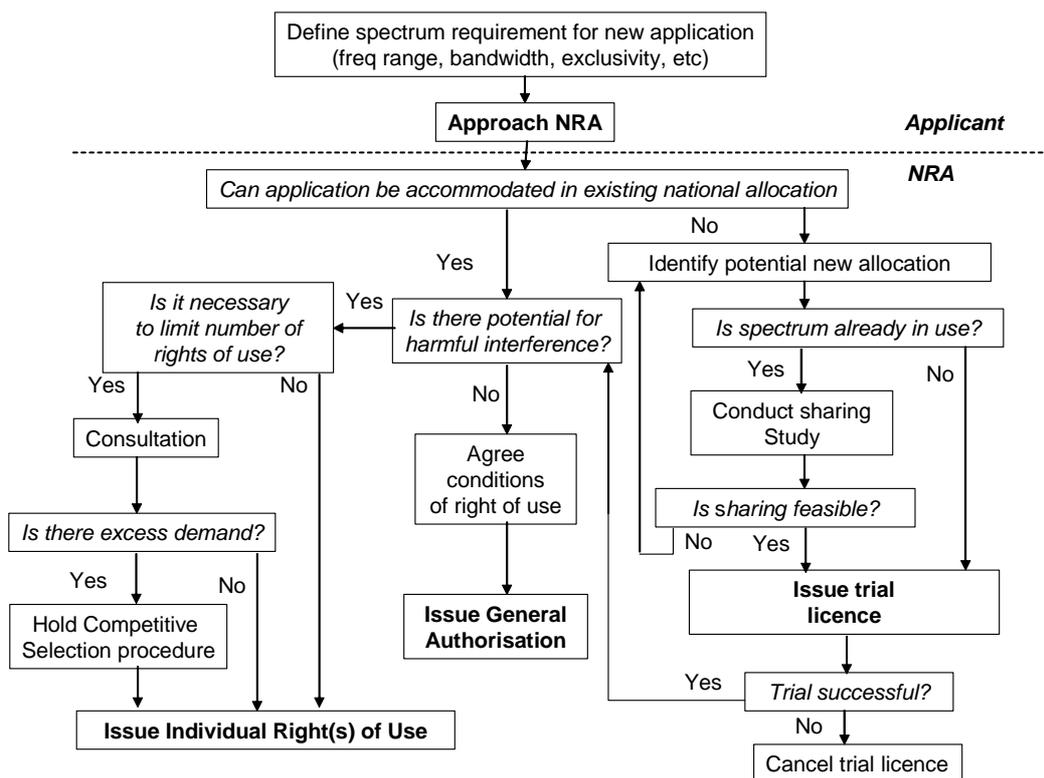


Figure 2.1: Typical process involved in gaining access to spectrum for new applications

2.3 Use of Radio Spectrum for Broadcasting in the EU

Most of the internationally allocated broadcast spectrum is intensively used within the EU, however in the TV broadcasting bands there are a number of national variations, whereby certain channels or in some cases entire bands have been allocated to other uses, either on an exclusive or shared basis. There are principally two reasons for this:

- i) Historical: in many countries there is a legacy of military or other government usage which pre-dates the introduction of broadcast services, particularly in parts of the UHF bands; and
- ii) New initiatives: in some countries, decisions have been made to re-allocate former broadcast spectrum (notably in the VHF bands below 230 MHz) to other uses, typically mobile radio.

A summary of the current use of the internationally allocated broadcast bands is presented in Annex E.

2.4 Radio Spectrum and Broadcasting Policy in the EU

There are four main areas of EU legislation which impact upon spectrum management and broadcasting, namely:

- The spectrum management policy framework (notably the Spectrum Policy Decision³ and Radio Spectrum Policy Group Decision⁴)
- The new regulatory framework for electronic communications and services (notably the Framework Directive⁵ and Authorisation Directive⁶)
- The “New Approach” Directives which govern the placing of electronic communications equipment onto the market (notably the Radio and Telecommunications Terminal Equipment Directive⁷)
- Audiovisual (AV) policy, including content regulation and general interest obligations (notably the Television Without Frontiers Directive⁸).

The first three of these fall within the remit of the DG INFOSOC, whereas AV policy is the responsibility of the DG for Education and Culture. It should be noted that EU competence does not extend to the assignment of frequencies to individual users. Assignment is a matter for individual Member States, although the principles of assignments and rights of use for radio frequencies are governed by the terms of the Authorisation Directive. Note that unlike ECC Decisions, EU Directives and Decisions are legally binding on all Member States.

A description of the main elements of the above four legislative areas and other aspects of EU policy that relate to spectrum management and broadcasting is presented in Annex B.

2.5 The Situation Elsewhere

Although the focus of this study is on developments within the EU, it is helpful for comparison purposes to review briefly the approaches being taken in other parts of the world. The following sections summarise the approaches to spectrum management and broadcast digitisation being taken in the USA, Australia and

³ Decision 676/2002/EC, on a regulatory framework for radio spectrum policy in the European Union, OJ L 108, p. 1

⁴ Decision 2002/622/EC, on establishing a Radio Spectrum Policy Group, OJ L 198, p.49

⁵ Directive 2002/21/EC, on a common regulatory framework for electronic communications networks and services, OJ L 108, p. 33

⁶ Directive 2002/20/EC, on the authorisation of electronic communications networks and services, OJ L 108, p. 21

⁷ Directive 1999/5/EC, on Radio Equipment and Telecommunications Terminal Equipment and the mutual recognition of their conformity, OJ L91, p. 10

⁸ Directive 97/36/EC of the European Parliament and of the Council of 30 June 1997 amending Council Directive 89/552/EEC on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the pursuit of television broadcasting activities, OJ L202 , 30/07/1997 P. 0060 - 0070

Japan. A more detailed discussion of developments in these countries is presented in Annex D.

2.5.1 USA

In the USA, both broadcasting and spectrum management are regulated by the Federal Communications Commission (FCC). Under impetus from the FCC, DTT began broadcasting in 1998, with 42 stations affiliated with the major networks and covering 25 cities across the country. Unlike the situation in Europe, the launch of DTT in the US is tied closely to the penetration of integrated digital TV sets and to high-definition TV broadcasting (HDTV).

As of May 2003, more than 1,000 stations were on the air with DTT signals, and every major TV market was served by at least one DTT station. The target date set by Congress for the completion of the transition to DTT is December 31, 2006. However, that date may be extended depending on whether most homes (85%) in an area are able to receive DTT programming. After the transition, analogue broadcasting will cease and the spectrum used by analogue services will be put to other uses.

The FCC has already re-allocated the upper part of the currently allocated TV broadcast spectrum to allow other wireless services, once analogue services have ceased. Under the FCC's scheme, the "core" spectrum for digital television services will be below 698 MHz, while frequencies above 698 MHz have been re-allocated to permit a variety of new fixed, mobile or broadcast services. During the transition to digital broadcasting, existing television services in the spectrum above 698 MHz would continue to be protected. Originally scheduled for 2001, successive postponements of the upper 700 MHz auction have taken place and a final date has still not been fixed for the auction. This is largely due to difficulties reaching agreement with incumbent broadcasters over release of the spectrum.

Unlike the European DVB-T standard, the technology adopted for DTT in the US will not support mobile reception. Any broadcaster wishing to provide mobile reception will therefore need to find other ways to realise this, for example delivering content over an existing mobile network or acquiring some of the re-allocated spectrum in the 700 MHz band. This distinction between fixed and mobile TV reception prompted the following comment by the Head of the FCC's Office of Technology and Engineering, in response to lobbying from some industry players to adopt the European DVB standard⁹:

⁹ From Oversight Hearing on High-Definition Digital Television and Related Matters before the Committee on Commerce, Subcommittee on Telecommunications, Trade and Consumer Protection, US House of Representatives, July 25, 2000

“...I am also concerned that one of the primary motivations behind this review of the DTV standard by some members of the broadcast industry appears to be a purported advantage of COFDM to provide portable and mobile services -- rather than any ability of COFDM to provide improved or enhanced television broadcast service. I believe that this raises fundamental issues regarding the intent of Congress and the Commission’s rules providing broadcasters with a free second channel for DTV operations..... To the extent that some broadcasters may desire to enter the market for the provision of mobile services, they can do so by acquiring licenses in the newly reallocated spectrum at 700 MHz or some other spectrum that is allocated for mobile services.”

It is important to bear this distinction in mind when considering the spectrum requirements for broadcast and mobile services in Europe and the USA, since several EU Member States consider mobile TV reception to be a standard digital broadcast offering.

2.5.2 Australia

The broadcasting landscape in Australia is similar to that in most European countries, with a mix of commercial and general interest broadcasters. There are three free to air commercial television networks, complemented by two national broadcasters (the Australian Broadcasting Corporation, ABC, and Special Broadcasting Service, SBS), a community television station in some areas, and three main subscription television providers. Terrestrial remains the dominant delivery platform for broadcasting.

Under the current regulatory regime, the licence that provides the right to broadcast content and regulates the behaviour of the broadcaster cannot be separated from the licence that grants access to the spectrum. The Australian Communications Authority (ACA) has overall responsibility for planning and licensing the radio frequency spectrum. However, under the Radiocommunications Act 1992, part of that responsibility is delegated to the ABA, which plans and licenses that part of the spectrum designated as the broadcasting services bands. Recently, the ACA has adopted the concept of “spectrum licences” for major users such as cellular telephony; however the concept has not yet been applied to broadcasting. In August 2002, The Minister for Communications, Information Technology and the Arts released a discussion paper on possible changes to the roles and responsibilities of the ABA and the ACA, including the most effective arrangements for the management of broadcasting and telecommunications spectrum.

The Federal Government has put in place a regulatory framework for the conversion of free to air television to digital mode, and has provided the free to air broadcasters with additional spectrum to simulcast programs in digital and analogue modes for at least eight years from the commencement of digital transmissions. Digital transmissions have commenced in all mainland State capital cities and a number of

regional areas. The rollout of digital services must commence in other metropolitan and regional licence areas before January 2004.

After considering the merits of the American and European standards, the ACA chose to adopt the DVB-T standard for its DTT services. A similar decision was subsequently made by the New Zealand government.

2.5.3 Japan

Both Spectrum Management and Broadcasting in Japan is the responsibility of the Department of the Telecommunications Bureau, which is part of the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPHPT). Broadcast services are provided by the licence-fee funded national broadcaster, Nippon Hoso Kyokai (NHK) and a number of commercial, advertising-funded broadcasters. NHK operates two national analogue terrestrial channels and three satellite channels, which are simulcast in analogue and digital format. At least four commercial terrestrial channels are available for 89% of the population. Japan has pioneered the delivery of HDTV, with commercial analogue HDTV services available over satellite.

The Japanese government plans to spend 180bn Yen over the next ten years to fund analogue to digital migration. The Government's objective is to achieve a total migration to digital by 2011, with simulcast continuing in the meantime. It will be necessary to change some of the frequency assignments used for terrestrial analogue services to facilitate the rollout of digital. Broadcasting legislation is being amended, to include a re-definition of TV broadcasting. In 2001, a National Council for the Promotion of Terrestrial Digital Broadcasting was created, to promote a smooth transition from analogue to digital services and to further the spread of digital broadcasting. Ten local DTT R&D facilities have been established by the trade body Telecommunications Advancement Organisation of Japan (TAO), to develop new content and applications for the digital platform. So far, 16 companies representing the three major broadcasting networks have applied for DTT licences, in addition to NHK. The Japanese ISDB standard has yet to be adopted anywhere outside Japan.

3 OPPORTUNITIES AND CHALLENGES PRESENTED BY SWITCHOVER

3.1 Introduction

The switchover from analogue to digital transmission will provide substantial benefits in terms of additional transmission capacity, allowing a wider range of content and services to be brought to the market. However, the process of switchover is immensely complex, involving the replacement or upgrading of hundreds of millions of TV receivers and the re-planning of thousands of transmitters. The relatively high powers used by many TV transmitters means that co-ordination is necessary over distances of hundreds of kilometres to avoid interference to distant receivers. Furthermore, the analogue services cannot be switched off until the overwhelming majority of users have acquired the means to receive a digital or non-terrestrial alternative. In most countries this entails the simultaneous transmission of analogue and digital services for a period of many years, further complicating the co-ordination process.

Another complicating factor is that the extent to which digital television has penetrated the market varies enormously among Member States, as does the projected timescale for analogue switchoff (see Figure 3.1).

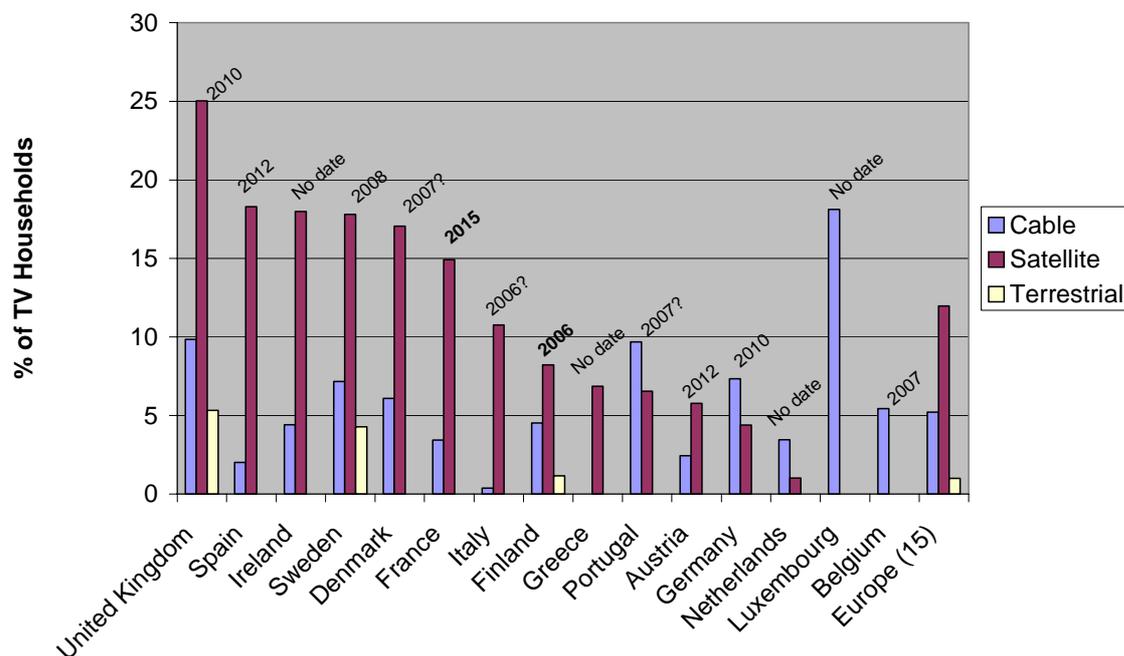


Figure 3.1: Market Penetration of Digital TV platforms and projected analogue switch-off dates in EU Member States (source: IDATE)

In this chapter, we consider the potential benefits that could arise from digitisation and the challenges that must be overcome in order to reap these benefits.

3.2 Estimating the Digital Dividend

3.2.1 Introduction

The increased capacity arising from digital transmission raises the prospect of a “digital dividend” that could lead to spectrum being made available for a range of applications beyond the simple replication of today’s analogue TV services. This digital dividend could be used to enhance the range, picture quality or reception capability of terrestrial TV services, or to facilitate new services which may or may not be based on broadcasting technology. In order to estimate the potential scale of this dividend we have considered the spectrum that might reasonably be required to replicate the current provision of national, free-to-air analogue TV services in a typical EU Member State.

In practice, this will depend on various factors, including:

- The number of programme channels involved
- The extent of coverage
- The degree of regionality
- Whether portable and/or mobile reception is catered for
- The required picture quality, in particular whether high definition TV broadcasts (HDTV) are planned
- The degree of cross-border co-ordination required.

The results presented here are intended to be territory-independent, and assume that all analogue television services have ceased. All services are assumed to be provided in UHF spectrum (470 – 862 MHz) and for fixed reception viewers are assumed to be using modest, directional rooftop aerials. It is assumed that these aerials have been tailored to the digital services (i.e. there is no analogue legacy in terms of pointing or aerial type), but that the transmitter network topology will be similar to that of the analogue network, i.e. with a pattern of high power main stations at elevated sites, supported by a somewhat larger population of lower-power relay sites.

Our detailed calculations and the underpinning technical considerations (including a description of the main technical parameters of DTT that affect spectrum utilisation) are presented in Annex F.

3.2.2 Results of Analysis

Our analysis concluded that national coverage of a single multiplex with regional programme variations and providing reception via rooftop-mounted aerials would require between 4 and 9 UHF frequency channels¹⁰, depending upon the choice of

¹⁰ The term “frequency channels” refers to the 49 channels in the range 470 – 862 MHz, each of 8 MHz bandwidth, as defined by the ITU in the 1961 Stockholm Plan.

technology (notably the modulation scheme and whether single frequency or multi-frequency networks are deployed) Providing high quality coverage to indoor portable receivers via set-top aerials or to mobile receivers would require significantly more spectrum – between 9 and 39 frequency channels per multiplex.

By comparison, most EU Member States have up to four analogue programme channels providing national coverage (98% or more of population), each requiring typically eleven frequency channels to deliver this coverage. However, analogue transmission conveys only one programme channel per frequency channel compared to as many as six for digital transmission based on current coding schemes. It is therefore helpful to compare the various digital technology options on the basis of how many frequency channels are required per national programme channel. This is illustrated in Figure 3.2 below.

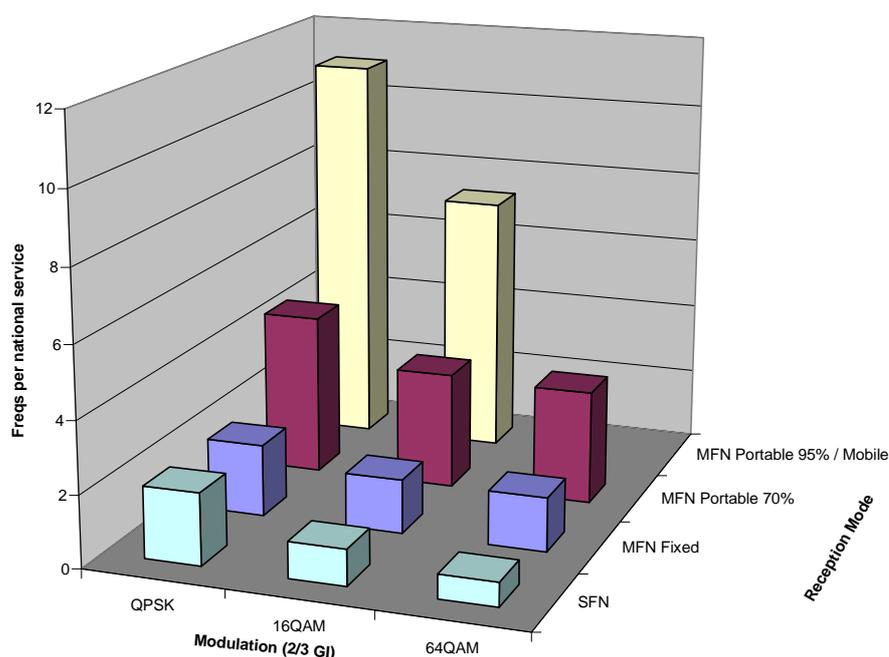


Figure 3.2: Spectrum Requirement per Programme Channel for analogue and digital terrestrial TV

Note that in the worst case (i.e. a multi-frequency network with widespread mobile and indoor reception capability) the spectrum requirement is the same as for analogue, whereas the best case represents over an order of magnitude reduction. If we assume that regionality and a reasonable degree of indoor portable coverage (corresponding to today’s analogue services) is required, it appears that between 3 and 4 frequency channels per programme channel are sufficient. This would suggest, for example, that up to 24 frequencies would be needed to deliver six national programme channels.

Although single frequency networks provide a significant reduction in the spectrum requirement nationally, the extent to which this can be achieved in practice will be

severely constrained where there is a need to co-ordinate with several neighbouring countries. To achieve this level of spectrum efficiency in practice would probably require the adoption of a radically different approach to broadcast network planning across Europe, based on a high-density cellular infrastructure at a considerably higher cost than today's high power transmitter networks.

Our calculations suggest that adoption of digital transmission based on the DVB-T standard would enable existing national terrestrial TV services to be delivered with typically between a third and a half of the existing spectrum requirement. This figure assumes that a high degree of regionality is required and that indoor coverage is available at 70% of locations, broadly comparable with today's analogue coverage (though in the analogue scenario much of this indoor coverage would suffer from degraded picture quality). Planning based on fixed, rooftop aerial reception only would provide a significant reduction in the spectrum requirement (to as little as 10% of the current analogue requirement), whereas providing for widespread mobile reception would increase the requirement to approximately the same level as the current analogue services.

In most scenarios, therefore, there is a substantial "digital dividend" if today's analogue services are broadly replicated in a digital environment. This dividend will however be largely or wholly offset if DTT in its present form is required to cater for enhancements such as mobile or high definition TV, or if the number of channels is expanded in an attempt to match the offerings of cable or satellite networks. As we will see in the later sections of this report, technology developments may have the potential to overcome this problem, providing a flexible approach to standards and frequency planning is adopted.

3.3 Implication of the Analogue Legacy for Digital TV Planning

Whilst it is clearly important to maintain existing terrestrial free-to-air services on general interest grounds, there may also be an economic case for doing so. A survey carried out by the UK Radiocommunications Agency¹¹ (now part of Ofcom) in 2001 estimated that the consumer surplus (i.e. the amount users are willing to pay less the amount they actually pay) from terrestrial TV services was about £146 (€204) per household per annum for analogue services and £176 (€246) for digital.¹²

These estimates do not take account of the opportunity cost of the spectrum i.e. its value in the best alternative use of the spectrum. For example, we note that by contrast users' consumer surplus from mobile phone services in the UK has been estimated at about £180 (€252)/annum for a private individual and £507 (€709) per

¹¹ The Economic Impact of Radio, February 2001 (<http://www.radio.gov.uk/topics/economic/eis-report.pdf>)

¹² The economic impact of radio 2001, Radiocommunications Agency, February 2001; The economic impact of radio, 2002 update. Radiocommunications Agency April 2002.

annum for a business user. Using data on the number of TV households and mobile users gives total consumer benefits of £4bn (€5.6bn) for TV and £7bn (€9.8bn) for cellular mobile services. As TV services occupy more spectrum than mobile services (roughly 300 MHz compared with 200 MHz respectively) this indicates a higher average economic value for mobile as compared with TV services. However, this does not necessarily mean that spectrum should be reallocated from TV to mobile services. Marginal rather than average values and general interest considerations should inform any such decision. Furthermore spectrum is not a homogenous resource and in this case the value of UHF spectrum to a mobile operator is likely to be less than the value of the 900 MHz and 1800 MHz spectrum that mobile operators currently occupy (because it can be less intensively used and there is currently no equipment available). And of course it should also be recognised that values may differ considerably between Member States as consumer attitudes and the services offered will differ.

Maintaining free to air broadcasting services in an all-digital broadcasting environment has a number of cost implications beyond the simple replacement of analogue transmitters and receivers by digital, especially if achieving spectrum efficiency is one of the goals. Transmitter networks are currently configured to reflect the interference characteristics of analogue reception. This requires large separation distances between transmitters using the same frequency channel (up to hundreds of km for the highest powers), even if the same material is being broadcast. Digital technology in some configurations has less stringent protection requirements and is better suited to high-density transmitter networks, enabling a more intensive re-use of frequencies to be achieved. Furthermore, DVB-T has the facility to deliver "single frequency networks" (SFNs) whereby the same frequency can be intensively re-used in the same area to enhance reception (see Annex).

A DVB-T transmission network that is planned for optimum spectrum efficiency can therefore deliver a significant reduction in the overall spectrum requirement compared to existing analogue networks - perhaps an order of magnitude in the spectrum required per programme channel. However this would be at the expense of wholesale re-planning of transmission networks, perhaps using a model more akin to cellular telephone networks with their many thousands of transmission sites rather than a conventional broadcasting approach where a hundred or fewer transmitters can provide substantially national coverage of large territories. This could have significant implications in terms of site acquisition costs, international co-ordination and potential public concern about proliferation of transmitter masts.

A further constraint is the need for viewers to be able to upgrade to digital at minimum costs. Any re-alignment or replacement of rooftop aerials to accommodate changes in transmission site or frequency represents significant additional cost and disruption which it will be necessary to take into account when the costs and benefits of different switchover options are compared.

In practice, achieving switchover in a reasonable timescale and at reasonable cost, whilst minimising disruption to existing analogue services in the interim, requires digital planning largely to reflect the configuration of analogue networks, at least for as long as they have to co-exist with analogue services and probably for some time thereafter if significant disruption is to be avoided.

3.4 Use of Broadcast spectrum by non-broadcast services

Another consequence of the analogue legacy is that broadcasting spectrum is used extensively on a secondary basis by broadcasters and others for services ancillary to broadcasting, public entertainment or other special events. Various terms are used to describe these applications, including Programme Making and Special Events services (PMSE), outside broadcasting, SAB and SAP. Activities include, for example, outside broadcast links used to report news or sports events and wireless microphones used in concerts and theatrical productions. SAB/SAP services are often able to use analogue channels that are unusable locally for broadcast transmission due the high protection requirements that apply (sometimes referred to as “taboo channels”).

ECC Report 002¹³ recognised SAB/SAP operations as an essential part of programme making, noting that the broadcasting bands III, IV and V were already used extensively by SAB/SAP services on a secondary basis and that this facility would need to be maintained, or even increased, in the future. In particular radio microphones and talkback production systems were used. Current frequency requirements for such applications are estimated at up to six 8 MHz TV channels and this is expected to rise to up to ten channels within the next 5 years. However, it was also noted in the report that SAB/SAP operations should not hamper the development of DVB-T or T-DAB.

The continuing availability of spectrum for SAB/SAP services may be affected by any long-term change of use in the broadcast bands. Whilst the broadcasting community is able to co-ordinate SAB/SAP services in a manner which avoids interference to primary broadcast services, this may be more difficult to achieve if new non-broadcast services are introduced. The ability of DVB-T to use spectrum more intensively is also likely to reduce the availability of “taboo channels” for SAB/SAP use.

Many EU member states have allocated parts of the broadcast spectrum to other services. The principal other use is for government and military services in the top part of the UHF band (above 792 MHz), although some countries (e.g. the Netherlands and UK) have allocated parts of VHF Band III to mobile services.

¹³ “SAP/SAB (Incl. ENG/OB) spectrum use and future requirements”, European Communications Committee (ECC), February 2002

These other services will be taken into account during the forthcoming regional regulatory conference (RRC) to re-plan the broadcasting bands for digital transmission (see Section 4.3) and may therefore continue to constrain the rollout of DTT or other new services in the spectrum even when analogue TV transmissions have ceased.

3.5 Making the most of the spectrum dividend in an uncertain market environment

There are a number of ways in which any spectrum released as a result of analogue switchoff might be used in the future. These include enhanced or expanded broadcasting services, mobile services, fixed wireless services, “converged” services combining elements of two or more of these services or even completely new applications that have not yet been thought of. This uncertainty presents a particular challenge to spectrum managers, since a decision to introduce a particular type of new service may constrain the ability to introduce other services or to maintain the quality of existing services. Regulators also need to balance the potential spectrum needs of new market players or services and the benefits such services may provide against the cost implications for incumbents of vacating spectrum and any loss of existing services in order to make way for such services. These trade-offs often need to be made in advance of technologies being fully developed and the deployment of services. There is therefore always a risk that demand for the new services will not materialise (e.g. because of competition from other services or changes in consumer preferences).

It might be argued that the prudent thing for regulators to do in these circumstances is to wait until technology and market developments become clearer. However, in some circumstances the decision to allocate the spectrum on a European basis is necessary to stimulate investment in technology. While this is not always the case, it will be particularly important in situations where scale economies are so large as to require a potential market the size of Europe as a whole and/or where international mobility is an important feature of the service.¹⁴ A case by case analysis is required to determine when decisions concerning spectrum allocations need to be made. In all cases – whether decisions are made early or late- there is a risk that demand will not materialise and spectrum will be left idle. It is important therefore that spectrum allocation or harmonisation measures can be changed or a framed with sufficient flexibility to allow the allocated use of spectrum to also change where necessary.

Access to spectrum for non-TV services post-switchover will depend on the regulatory approach taken to new broadcast services, including new programme

¹⁴ This is discussed further in “Costs and Benefits of International Frequency Harmonisation and Standardisation, Indepen and Aegis Systems, a Report for the UK NRA Ofcom, March 2004 (available on the Ofcom web site www.ofcom.org.uk).

channels and enhancements such as mobile or HDTV. In particular, it will depend on whether these services are subject to similar general interest considerations to those applied to existing analogue services or whether they are treated in the same manner as any other potential user of the spectrum. The latter approach, which we believe is justified by the increasing convergence between broadcasting and other communication services such as 3G mobile and the Internet, would ensure that new broadcast services face the same economic incentives to deliver services efficiently as other users of the spectrum. This can be achieved by employing market-based approaches to spectrum management, such as the ability to trade spectrum between different users and applications, or by administrative means such as the application of spectrum fees that take account of the economic value of the spectrum. These approaches are discussed in chapter 4.

3.6 Potential Developments in Broadcasting and the Implications for Spectrum Management

3.6.1 Background and Context

Historically, terrestrial free-to-air broadcasting has been constrained by the limited availability of radio spectrum and the relative inefficiency of delivering broadcast content using analogue technology. In practice, this has meant that in most EU Member States the number of television channels that can be delivered nationally over the terrestrial networks has been limited to no more than four or five (although sometimes several more channels may be available on a localised basis, e.g. to serve major population centres). Cable and satellite platforms are able to provide much greater capacity even using the same analogue technology. This enables delivery of an extensive array of both free-to-air and subscription-based channels to users that are within their service area and are willing to install the necessary reception equipment.

Unlike analogue terrestrial free-to-air services, access to satellite and cable services typically involves subscription to a single service provider, which acts as “gateway” to both its own services and those of third party providers who have negotiated access to the provider’s platform. Satellite services further benefit from having only a single transmission point. This lends itself much more readily to rapid upgrading of technology, with the result that satellite platforms have so far made much more progress in migration to digital transmission than terrestrial or cable broadcasters.

Digitisation has further enhanced the capacity advantage that cable and satellite already had, to the extent that these platforms can now deliver several hundred

television channels and are able to complement these with further services such as high speed internet access and “near-video on demand” (NVOD) services¹⁵.

The following sections consider how broadcasting services might evolve over the coming years, given the current state of markets and technologies, and the potential implications for radio spectrum management.

3.6.2 Portability and Mobility

3.6.2.1 Overview

Reception by mobile and portable receivers represent two significant and somewhat distinct segments of the television receiver market. There is a long-established and sizeable market for portable analogue receivers, typically used as second or third sets inside homes or by travellers in boats, caravans etc. Typically between a third and two thirds of households in EU countries have more than one TV set (see Figure 2.2 below). Portable sets are essentially smaller versions of large screen sets, capable of connection to either set-top or rooftop aerials. More recently, low cost, hand-held mobile receivers using LCD technology have become available, enabling limited (pedestrian) mobile reception of relatively low-resolution pictures in many areas by means of a built-in telescopic aerial.

The differences between these two reception modes are particularly significant in the context of digital television. Portable sets deliver high resolution pictures in fixed locations and generally connect to either mains or vehicle power supplies. The only fundamental difference from large screen TV sets is that portables are less likely to have access to an external rooftop aerial feed. Mobile receivers on the other hand have much lower resolution (a consequence of the much smaller screen size) but are required to operate at potentially high speeds and in highly variable reception conditions. This places different requirements on the transmitted signal which may be incompatible with optimising reception by fixed receivers. These issues and the possible implications for spectrum management are considered further in the following sections.

¹⁵ i.e. the delivery of the same material on multiple channels but time-shifted to allow the viewer a choice of when to view

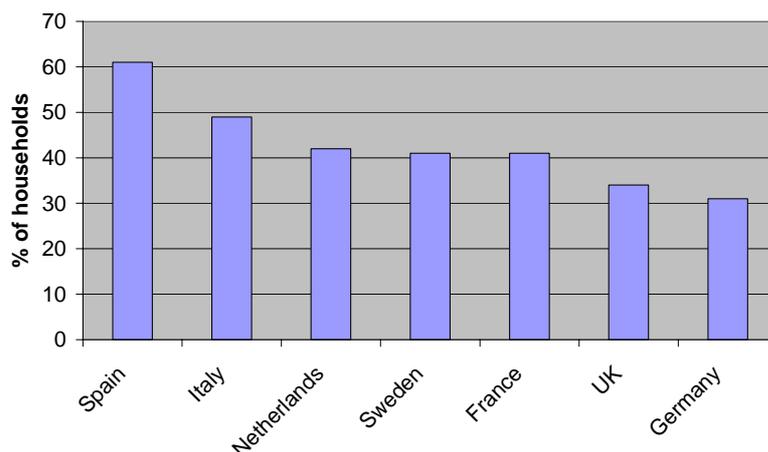


Figure 3.3: Proportion of households with two or more TV sets:

Definitions

Indoor and outdoor **portable** reception is defined in the following manner:

- **outdoor:** reception where a portable receiver with an attached antenna is used at no less than 1.5m above ground level;
- **indoor:** reception where a portable receiver with an attached antenna is used at no less than 1.5m above floor level in ground floor rooms with a window in an external wall.

Mobile reception is defined by the EBU as “reception while in motion, covering speeds from walking to motorway driving”.

3.6.2.2 *Portable Reception*

In many Member States 40% or more of the households are equipped with two or more sets (Figure 3.3). A significant proportion of these sets rely on indoor “set top” aerials. Maintaining this “indoor portable” reception capability in a digital transmission environment presents a challenge, especially during the transition period when digital services must be provided alongside analogue. Part of the problem is the “all or nothing” nature of digital reception: whereas an analogue TV signal experiences gradual degradation in the presence of interference or insufficient signal strength, digital reception tends to be either perfect or non-existent. Whilst viewers may be willing to tolerate imperfect analogue reception they are likely to be less tolerant of a complete loss of service. Hence matching the current availability of analogue TV services by portable receivers may require enhancements to network coverage and/or improvements in receiver sensitivity, incurring additional costs in each case. The cost in terms of spectrum utilisation could also be significant, as we saw in Section 2.2.

The economic case for delivering universal portable reception is at best questionable and at worst non-existent. For example, we estimate that extending indoor portable coverage from 80% to 99% in France would require an increase from 300 to over 3,000 transmitters, incurring an additional cost of billions of euros. In many cases, in-home distribution networks are likely to provide an acceptable and more cost-effective alternative for second sets used in the home, whilst it is generally feasible to install an external antenna on boats, caravans and vehicles (some have even installed satellite receivers). It should be noted that current analogue networks are not designed to provide ubiquitous indoor coverage hence any move to do so with DTT would represent a significant change from the status quo.

The EBU has suggested that for indoor portable reception, planning for 70% locations would be sufficient and seems to be the best way to reduce the spectrum requirements.

3.6.2.3 *Mobile Reception*

Effective mobile reception of DVB-T presents a different challenge, particularly if reception is required in fast moving vehicles. Such reception incurs two significant problems, namely the Doppler Effect¹⁶ and multipath interference¹⁷. The DVB-T standard can be optimised for resilience against either one of these effects but not currently for both. The 2k mode of DVB-T is significantly more resilient to Doppler effects than 8k, whilst the 8k mode is more resilient to multipath interference, at least in a static environment and is currently the only mode capable of being deployed in single frequency networks (SFNs). Apart from the spectrum saving demonstrated in Section 2.2, SFNs offer advantages in network cost and planning, enhanced signal strength in transmitter overlap areas and provide seamless handover from one transmitter to another, which is a significant advantage for mobile reception.

Planning parameters for DVB-T mobile reception at high speeds are under development. Several European broadcasters are interested in mobile reception and have actively contributed with detailed test measurements results. A large improvement has been observed by using antenna diversity (i.e. providing two physically separate antennae, either on the device itself or externally, e.g. attached to the roof of a vehicle). Diversity is likely to be essential for mobile reception of DTT using the 8k transmission mode.

¹⁶ Doppler effect causes an increase or decrease in the apparent frequency of the received signal as the transmitter and receiver move towards or away from each other

¹⁷ Multipath is due to the received signal being reflected off objects or surfaces between the transmitter and receiver, resulting in multiple versions of the transmitted signal being received, each with a different delay

Reception by handheld terminals is more challenging than reception by in-vehicle receivers using external antennae. The very small antenna sizes required for handheld devices implies low antenna gains and correspondingly high field strength values. This would require either a big increase in transmitter powers or a much denser network infrastructure, akin to cellular telephone networks. Interference and health and safety concerns limit the scope for power increases whereas adoption of a cellular approach could give rise to both cost and environmental problems.

A further problem associated with DVB-T reception on handheld devices is the digital processing overhead in the receiver. This increases power consumption to the extent that a hand-held DTV receiver would be unlikely to have a battery life of more than one or two hours with current technology. Whilst technology enhancements are likely to improve this performance, it will remain the case that a transmission format that is optimised for reception on high-resolution, large screen receivers at fixed locations is unlikely to be best suited to mobile reception on small hand-held terminals.

The most promising solution to the delivery of mobile TV or other audiovisual services to small handheld devices is likely to involve the use of a transmission mode that is optimised for such reception, although the success of this will depend on the availability of spectrum for such transmission. The next section reviews the work that is currently underway to develop such mobile-optimised standards.

3.6.2.4 *Mobile TV Standards*

Mobile digital TV is likely to benefit from the introduction of new standards such as DVB-H (Handheld), which are optimised for reception by small, low power devices. Work started on a mobile-optimised DVB standard in 2002, then referred to as DVB-M (mobile). This subsequently evolved into DVB-X and more recently still into DVB-H.

The new standard is based on DVB-T but takes into account the need for low power consumption in the terminal, reliable network coverage in a handheld or indoor reception environment and resilience to interference. DVB-H technical requirements include power consumption of less than 100 milliwatts, a data rate of 15 Mbit/s, operation via large, single-frequency networks and reception at high driving speeds. DVB-H devices may also be capable of receiving conventional DVB-T signals where coverage is configured to provide good indoor portable reception, but the degree of DVB-T/DVB-H interoperability has yet to be defined by DVB.

Commercial implementation of the DVB-H standard is targeted for around 2006. Technology trials are planned in a number of EU Member States, including Finland, Germany and the UK (see Section 3.10.2).

3.6.2.5 *Demand for Mobile TV*

The Technical Research Centre of Finland (VTT) has carried out a study to assess consumer attitudes and habits with regard to mobile digital television, as part of

Finland's plans to develop mobile DTT services. The study investigated users' reactions to a variety of mobile TV applications. Two types of terminal device were used in the study, based on a laptop computer and a personal digital assistant (PDA). The devices were tested in various transport modes (train, bus, boat and car) and in public places such as cafés, railway stations and a university entrance hall, as well as in users' private homes or gardens.

The study indicated positive attitudes to mobile TV. Those participating in the study were willing to pay an average of €0.50 per programme or €20 for a monthly subscription. The most popular types of programme in the study were news, children's programmes, entertainment and films. Of the ancillary services, the search and TV guide functions were the most popular. The devices tended to be used mainly while waiting or killing time. Mobile TV services are currently being trialled in Finland as part of a wider initiative relating to mobile IP datacasting (see Section 3.10.2.1).

3.6.3 Multi-Platform Delivery

Digital television can be delivered to fixed receivers by three principal means, namely cable, satellite and DTT. Cable networks incur substantial infrastructure costs and are best suited to urban or suburban areas with a highly concentrated residential population. Cable is near-ubiquitous in some EU Member States but almost non-existent in others. Satellite enables 100% geographic coverage to be provided, so long as line of sight visibility of the satellite can be achieved at the viewer's premises. This may be difficult at certain locations, e.g. urban centres with a preponderance of high buildings or in mountainous areas. The latter present a particular problem as they are unlikely to be served by cable networks. For example, research commissioned by the UK Independent Television Commission (now part of Ofcom) indicated that up to 4% of UK households would not have satellite coverage.

The existence of multiple platforms means that it is not necessary to rely exclusively on terrestrial networks to achieve universal access to TV services, at least for the provision of reception to a fixed point in the home. A multi-platform approach is consistent with the technology-neutral nature of the new EU Regulatory Framework but may have implications for content, which would need to be delivered transparently and not be dependent on the transmission platform. This is a particular challenge for enhanced services such as interactivity.

One argument that is sometimes put forward in support of ubiquitous terrestrial coverage is that it is the only way to deliver reception to mobile and portable receivers. However, as we have seen, the higher transmitter powers required to deliver mobility and portability from a DTT network primarily intended for fixed reception leads to a significantly higher spectrum demand even in an all-digital environment. Hence alternative approaches to achieving mobility based on technology optimised for this reception mode may be preferable if overall spectrum efficiency is an objective.

Another argument for universal terrestrial coverage is the difficulty in achieving truly ubiquitous satellite coverage in practice, for example due to terrain or planning restrictions on satellite dishes. A recent EU Communication¹⁸ limits public authorities' possibilities to hinder erection of dishes, however there may still be problems with private law agreements affecting apartment blocks etc. In such cases low power "self-help" relay stations, perhaps re-transmitting the signal from a nearby satellite reception facility may provide an effective solution.

It should be remembered that, depending on the technology, coverage may not be a significant driver of DTT spectrum demand. Within a given region the use of localised single frequency networks (SFNs) means that there is essentially no difference in the spectrum required whether a single transmitter or several are deployed, so long as the exported interference limit is not exceeded. Hence any decision on what constitutes an acceptable level of coverage for DVB-T may be driven by cost / practicality constraints rather than spectrum constraints, at least where SFNs are deployed. This is likely to be particularly relevant in the case of commercially funded services.

The existence of established cable or satellite networks in some countries may ease the transition to DTT, since it becomes necessary to migrate only a minority of the population to digital via DTT. In Berlin for example, only 8.9% of analogue viewers relied on terrestrial reception prior to the switch off which took place earlier this year¹⁶. There may also be a strong incentive for some cable and satellite viewers to switch to free-to-air DTT services if they currently pay for analogue cable or satellite services with a limited number of channels. In Berlin 40% of the households that acquired terrestrial set top boxes were existing subscribers to cable or satellite¹⁹.

Conversely, in those countries where analogue terrestrial broadcasting still predominates it is necessary to offer a credible alternative that will provide an incentive for this majority to make a swift transition to digital, while not penalising them in terms of coverage or access cost.

Care needs to be taken in a multi-platform environment to ensure that undue preference is not given to any particular option. In Germany, the offering of free-to-air DTT multiplexes has prompted allegations from the cable sector that DTT has been a beneficiary of state aid, in the form of subsidies via the state broadcasting licence fees. A formal complaint has been lodged with the European Commission

¹⁸ EU Communication on the Application of the General Principles of Free Movement of Goods and Services – Articles 28 and 49 EC – Concerning the use of Satellite Dishes, available on the EU web site at http://europa.eu.int/comm/internal_market/en/media/satdish/antenna_en.htm

¹⁹ Source: "DVB-T in Europe, Dr Chris Weck, IRT, presentation to CISMUNDUS Project Final Workshop, 10th February 2004

(DG COMP) by the cable operator ANGA and an investigation into the complaint is currently underway. Depending on the outcome, this could have implications for the future financing of DT T rollout in Germany and elsewhere.

3.6.4 HDTV / Wide Screen

The recent history of broadcasting in Europe has been one of massive growth in the number of channels available in most Member States, principally delivered by cable and satellite platforms. However the fundamental nature of TV receivers has changed relatively little over the last three decades. Whilst there have been some enhancements such as the introduction of stereo sound and widescreen pictures, picture resolution still reflects the 625-line standard established in the 1950s. This also applies to all the current European digital services, with the exception of the recently launched Euro 1080 satellite service (see box below).

Elsewhere, notably North America, Japan and Australia, the transition to digital television is linked to the introduction of high definition television (HDTV)²⁰, which is seen as a key differentiator for digital services. Until recently the prevailing view in Europe has been that there is little demand for HDTV, however the increasing popularity of DVD players and wide screen standard definition TV sets suggests that consumers are becoming more aware of picture quality and are increasingly willing to pay a premium for enhancements. The anticipated launch of HD DVD players in the European market and the recent launch of the first HDTV satellite service may stimulate demand for HDTV sets which in turn could encourage broadcasters to develop further HDTV services.

HDTV in Europe.

On 1 January, 2004, Euro1080, operated by Alfacam in Belgium launched Europe's first HDTV service, broadcasting from the Astra 1H satellite. There are two channels – a main channel serving households across continental Europe and an event channel serving public venues with coverage of major sporting or cultural events. The newsletter Satcoms Insider reports that HDTV set-top boxes will start appearing in electrical stores towards the end of the year priced at around €500, from manufacturers like Thomson, Pioneer and Panasonic. A smart card will be included in every box, valued at €100 which will be Euro1080's total fee for the service.

HDTV provides increased horizontal and vertical resolution within the picture, providing a viewing experience more akin to the cinema. In the USA, where HDTV has been promoted by the regulator and industry as a key selling point for digital TV, the resolution increases from 486 x 720 pixels to as many as 1,080 x 1,920 pixels, more than doubling the resolution and increasing the aspect ratio (width to height)

²⁰ Analogue HDTV services are already available in Japan but only via satellite

from 4:3 to 16:9. This is the same format that has been chosen by the Euro 1080 service.

In the US, HDTV prices have fallen considerably since HD services were introduced by broadcasters as part of their digital offering. At the time of writing, the cheapest wide-screen HDTV compatible model was retailing at \$799. According to the US Consumer Electronics Association (CEA), HDTV sets accounted for 87% of DTV sales (over half a million units at a value of \$800 million) in September 2003. The CEA expects 9 million households to purchase HDTV products over the next 18 months and has said that another 30 million consumers consider themselves likely purchasers within the next three years.

According to the Yankee Group, about 7 million homes in the US already have televisions capable of displaying HDTV images, but fewer than 2 million of those homes are actually watching high-definition signals. One reason for the gap is that after buying a HDTV set, consumers must often purchase an additional HDTV decoder or rent one from a cable company to display HDTV signals. HDTV makers are beginning to deliver sets that can automatically decipher high-definition signals transmitted over cable, without an external decoder. The FCC has recently extended the "plug and play" rules that require TV receivers to be capable of direct connection to cable networks to include digital as well as analogue services, including HDTV services where the TV is capable of displaying HDTV pictures.

Other administrations around the world have included HDTV as part of the rollout requirement for digital TV. For example, the Canadian regulator has stipulated that all Canadian digital programs aired by licensees between 6 p.m. and 12 p.m. must be available in HD format, where such a version exists. Broadcasters must also ensure that, by the end of December 2007, two thirds of their schedules are available in the HD format. In Japan, Government guidelines state that HDTV should be transmitted for more than half of DTT output, whilst in Australia broadcasters are required to provide an average 20 hours per week of HDTV programming in each mainland capital city.

In the medium term it seems likely that HDTV demand will be addressed by satellite or cable services, however if these offerings are successful the likelihood of its longer term introduction over terrestrial networks must be considered. This raises issues in relation to coding and compression standards, which are addressed in the next section.

In Europe, HDTV may emerge as a logical extension to the development of wide screen standard definition TV, which the EU has endeavoured to promote as a service differentiator for digital TV. In 1993 the EU launched a 4 year action plan to ensure wide screen reached the market. The aim was to achieve a critical mass of wide screen TV services and programming, supported by EU contributions and matching industry funding. However, the plan suffered mixed fortunes depending on the degree of support from broadcasters in individual Member States. With the exception of the UK where an agreement was reached between all the major

broadcasters to migrate to widescreen²¹, almost no free-to-air commercial broadcasters participated in the plan. Consequently, the take-up of wide screen sets varies enormously and bears little correlation with the take-up of digital, as illustrated in Figure 3.4 below.

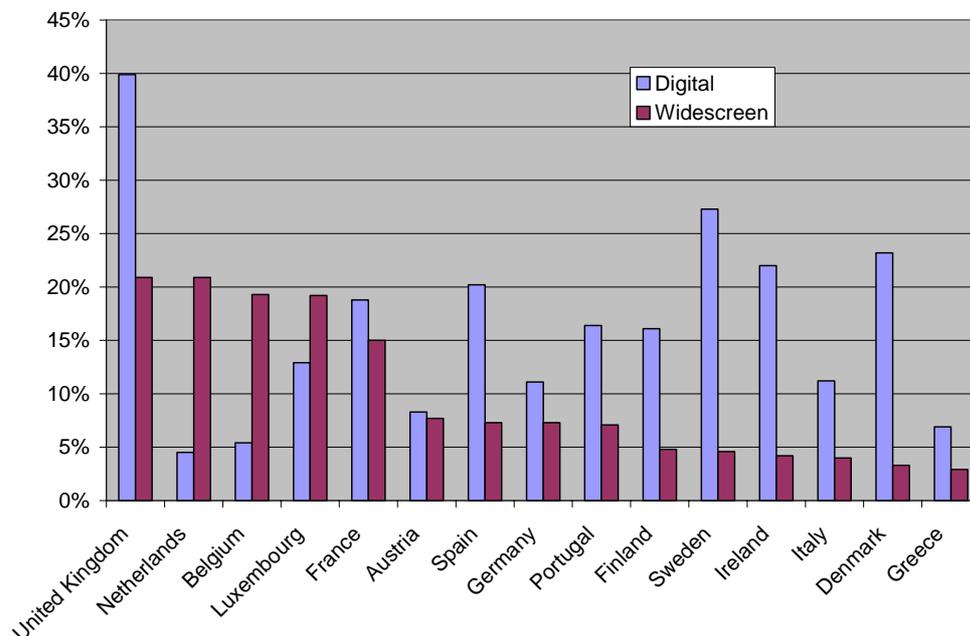


Figure 3.4: Penetration of wide screen and digital television in EU Member States (sources: Widescreen - OMSYC, the World Audiovisual Market 2002, p.134; Digital - IDATE)

3.6.5 Coding and Compression Standards

Currently digital TV transmission is based exclusively on the MPEG2 standard. Provision of HDTV services over terrestrial networks using current MPEG-2 coding would have a significant impact on spectrum requirements, since only a single programme channel could be carried per multiplex. HDTV using MPEG-2 requires 15-20 Mbit/s whereas MPEG4/AVC reduces this by around 50% and the proprietary Windows Media 9 (WM9) platform claims to reduce this even further to around 6 Mbit/s, comparable to existing standard definition services using MPEG-2.

It is therefore questionable whether a single default compression standard (MPEG2) should continue to apply to DTV transmission or whether multiple systems could be accommodated in the future. The latest chip sets support delivery of MPEG4 coded content over an MPEG2 transport stream, allowing at least twice as many programmes to be transmitted within a given bandwidth, yet retaining compatibility with most existing DVB infrastructure and head-end equipment. Vendors claim that MPEG-4 video quality meets or exceeds that of MPEG-2.

²¹ Commission Staff WP on widescreen, , p.20 (sec 3.4.1)

IPR royalties could however be a potential barrier to the adoption of MPEG4. Whereas MPEG2 licensing is based on a fixed charge per receiver, the planned regime for MPEG4 is per hour of use, which broadcasters see as a deterrent to its take-up. Microsoft has announced that it will not charge per use with WM9, raising the possibility that this format could emerge as a de-facto standard for HD coding. From the perspective of spectrum policy, new compression schemes merit policy makers' attention, broadcasters should be encouraged to use them and IPR holders encouraged to make them available on reasonable terms.

3.6.6 Value-Added services

Digital broadcasting allows more than just audio and video to be conveyed. The medium can also be used to provide access to a range of other material in digital form. For example, in the US recently enacted Homeland Security measures include the ability to broadcast emergency information over DTT channels. In Finland, from the beginning of 2004, a trial to deliver real-time public transport information on digital television will be conducted. The services will eventually cover timetables, routes, on-line traffic data, and weather and road conditions and will be the first of a range of value added services to be provided, based on the MHP standard. Finnish broadcasters have committed to use MHP in providing value added services in connection with their own transmissions.

The popularity of existing teletext services delivered over analogue TV networks demonstrates the demand for such add-on services. Although there is as yet little evidence that users are willing to pay for such services, they can provide a worthwhile source of advertising revenue and a useful conduit for public information distribution (as in the US and Finnish examples cited above).

3.6.7 Social / Cultural Diversity

The additional capacity afforded by digital television relative to analogue could be used to support general interest objectives such as cultural or linguistic diversity, enabling minority content to be provided either on a commercial basis (e.g. where there is a high local demand), a not-for-profit basis or as part of an extended general interest remit. Cable platforms already carry some local content and some offer specialist premium channels for particular ethnic groups. Satellite and cable are also used to deliver a growing range of international channels that originate from inside or outside the EU, or to deliver the national services of other Member States. DTT could prove particularly attractive for the delivery of localised services, although as previously noted this tends to increase the overall spectrum requirement.

3.6.8 Interactivity

Interactivity is a further enhancement that can be provided by digital television (to a limited extent this can also be provided by analogue transmission, e.g. by linking telephone or SMS voting to live programmes, but digital provides for a much richer interactive multimedia experience combining attributes of the Internet with conventional TV broadcasts). Interactivity implies that a "return path" is needed and

to date this has been provided by means of a telephone modem. Work has been underway within the DVB standards group on an in-band return path facility that would use the same radio frequencies as the DTT transmissions, however currently there appears to be little support for this initiative among the broadcast community. The regulatory and technical implications of operating bi-directional services in broadcast spectrum are discussed further in Section 3.7.3.

3.7 Alternative Uses of Broadcasting Spectrum

3.7.1 Introduction

The increased efficiency brought about by digital transmission implies that, depending on the broadcasting scenario that emerges, a substantial amount of spectrum could become available for other uses. It is important therefore to consider what these other uses might be, and how attractive the released spectrum might be compared to other options that currently or might in the future exist.

The characteristics of terrestrial broadcast spectrum are particularly well suited to applications requiring wide area, non-line of sight coverage. Two applications immediately spring to mind, namely mobile communications and fixed wireless access, although other more specialised applications such as location tracking or even radar systems can also be envisaged. However by far the most economically attractive option is likely to be some form of mobile or broadcast offering, or a combination of the two. The following sections consider the potential deployment of conventional mobile and hybrid mobile / broadcast services in the broadcast spectrum post-switchover.

3.7.2 Regulatory implications of non-broadcast services operating in broadcast spectrum

Other non-broadcast services providing area coverage (e.g. two-way mobile communications) can be operated in broadcast spectrum even where broadcasting is the sole primary allocation, but only on a non-protected, non-interference basis. In practice, the use of the spectrum to deliver convergent services such as the delivery of multimedia content to mobile phones is likely to be compatible with the current ITU-R definition of broadcast services and hence such services would enjoy protection within the limits defined for broadcast services at the forthcoming RRC. These limits are likely to be expressed in terms of a protected field strength at the edge of the coverage area applicable to the assignment or allotment under consideration.

Increasing convergence between broadcast and telecommunications services has led to moves within the ITU to revisit traditional service definitions. A new service concept referred to as "Terrestrial Wireless Interactive Multimedia Services" (TWIMS) was discussed at the 2003 WRC and will be further considered in 2010, when it will be clearer how emerging markets such as DTT and 3G mobile are

developing. The TWIMS concept and related issues are addressed further in Section 5.2.3.

3.7.3 Mobile Services

Market demand for mobile telephony services has grown to the extent where the penetration of such devices exceeds that of fixed line telephones in most EU Member States, although traffic levels per subscriber are generally much lower. It is conceivable that in the future mobile networks will increasingly compete with fixed line networks for voice traffic and that call tariffs and traffic profiles will converge. This could lead to pressure for further spectrum allocations to facilitate network expansion.

The UMTS Forum, which represents European 3G mobile operators and equipment suppliers, has recently reiterated that the long-term spectrum requirement for 3G mobile services beyond the already-available 2G and 3G spectrum would be of the order of 190 MHz²². Of this, 155 MHz is currently available in the 2.6 GHz band, which was identified at WRC-2000 as future expansion spectrum for IMT-2000 services, along with the band 806 – 880 MHz immediately below the current GSM 900 band. The latter includes the upper seven channels in the UHF TV broadcast band (Band V).

Discussion with mobile industry representatives has indicated that there is currently little or no demand in Europe for conventional two-way mobile services in the broadcast bands; this is also borne out by responses to recent consultations on the future use of the UHF and VHF broadcast bands conducted by the UK regulator. This situation may change in the longer term: we note for example that the UMTS Forum has suggested that harmonised spectrum in the UHF broadcast band could be attractive for extending 3G mobile services into remote areas²³. This presents a significant technical challenge, since it would be necessary to define two fixed, contiguous blocks of spectrum to cater for uplink and downlink traffic. Agreement would need to be reached on the amount of spectrum required, the size of any guard bands to protect the adjacent mobile and broadcast services and the optimum location of the spectrum within the UHF bands. Reaching such agreements internationally would involve protracted negotiation and would also be contingent on the complete removal of analogue TV services, at least from the uplink frequencies, since these high power signals would interfere with reception of much lower power mobile transmissions.

The UHF band provides greater coverage than 2.6 GHz, but does not allow such intensive re-use of available frequencies. Interest among key stakeholders in the

²² "Frequency Spectrum for Mobile Services", Joseph Huber, ANRT & ETSI Conference, Casablanca, April 2003

²³ Document FM(04)99, input to ECC FM meeting on 26th – 30th April 2004.

mobile industry is currently focussed on the 2.6 GHz band. For example Nokia's response to a recent UK consultation stated a clear preference for spectrum above 2.5 GHz and that Nokia did not see a requirement for any refarmed analogue TV spectrum to be used for cellular systems, arguing that any refarmed spectrum should continue to be used for digital broadcast technologies²⁴.

Nevertheless, the interest recently expressed by the UMTS Forum suggests that there would be merit in considering further allocations to the mobile service below 860 MHz and it would seem appropriate to pursue this at the 2007 World Radio Conference if the objective is to cater for such services when analogue services cease. The potential refarming of broadcast spectrum should also be considered alongside the future refarming 2G mobile services to 3G, which is expected to take place once the latter have become fully established.

In the meantime, there is a growing consensus that any mobile or convergent services deployed in the UHF broadcast bands should use frequencies below 806 MHz, to avoid interference from GSM900 mobile transmissions which would require the addition of bulky and expensive additional filtering in terminal devices.

Should such demand arise in the longer term, it seems likely that this could be accommodated within the currently proposed planning framework. The possibility of spectrum sharing between DVB and mobile services has been explored as part of the CEPT preparations for RRC-04. For example, work by Ericsson has suggested that a CDMA network could be deployed in the current TV broadcast spectrum alongside DTT services and that it would be feasible to accommodate two CDMA carriers within a single 8 MHz TV channel²⁵.

3.8 Market Evolution and Convergence

3.8.1 Introduction

Convergence refers to the increasing deployment of multiple digital media such as broadcasting, telecommunications and information technology to deliver integrated multimedia content and services. These may include textual, audio (speech or music) and/or video material. Radio spectrum in general and broadcasting spectrum in particular has considerable potential for the mobile delivery of convergent services and content. The market for mobile multimedia services is far from mature, but is showing signs of accelerating growth. For example, camera-

²⁴ Nokia response to UK Government consultation on the use of the analogue TV spectrum, April 2002

²⁵ "Contribution on possible example sharing scenarios between upstream and downstream applications using CDMA schemes and public broadcasting video (DVB-T) applications and improving the total spectrum efficiency in the band 470 – 862 MHz", ECC Joint ad-hoc group between CPG/PT1 and FM WG, December 2002

enabled phones already outsell conventional digital cameras, despite having been introduced only two years ago²⁶.

The first 3G mobile services were launched recently, bringing mobile video services to the market for the first time. These services include one-to-one video telephony and access to video clips of premium content such as sports highlights or adult material. They do not currently provide any access to off-air broadcast material; however in Japan Vodafone will shortly be launching a phone that includes a built-in TV receiver.

A logical consequence of converging technologies is that broadcast and “one to one” audiovisual material could be received and viewed on the same device; indeed the characteristics of the two may be virtually identical in terms of bit rate, coding, etc. Depending on how the market for mobile multimedia evolves, in particular the balance between broadcast or streamed material and one to one communication, broadcast technologies could play a significant role in facilitating the economic delivery of such services.

3.8.2 Combining the Benefits of Broadcasting and Telecommunications

Broadcasting involves the simultaneous real-time transmission of content to multiple recipients, whereas telecommunications involves the flow of information between two or more specific parties, either by means of physical connections between those users or by routing packets of data through a distribution network such as the Internet. Broadcasting is highly efficient where a large number of users wish to access the same material at the same time, but is not best suited to delivering individual content on a large scale. It is also unsuitable for delivery of critical content such as data files where there is an appreciable risk of interruption to the transmission. Hence a broadcast medium is unlikely to be a viable substitute for a packet data network such as UMTS where data integrity is critical.

On the other hand, using a cellular data network to distribute live video material to a mass audience would require an enormous overhead in network infrastructure, since each individual recipient would be utilising network resources for the duration of the transmission. Hence there is an attraction in combining these two transmission technologies to enable delivery of content in the most appropriate manner.

The potential synergies between digital broadcasting and mobile technologies and services were highlighted by the UMTS Forum, which represents the major players in the mobile industry, in a recent presentation²⁷. According to the Forum, UMTS

²⁶ Strategy Analytics report “Camera Phones Outsell Digital Still Cameras in H1 2003 and Beyond”, October 2003

²⁷ “Actual Situation of UMTS, presentation by Bosco Fernandes to CISMUNDUS final project workshop, February 2004.

and DVB will complement each other, DVB offering a useful multicast extension for UMTS and UMTS providing both a return path and an additional delivery path for DVB.

Another important factor which is likely to have a major impact on the quality and economic viability of mobile multimedia services is the capacity of storage media. In keeping with "Moore's Law"²⁸, the capacity of digital storage media has continued to double roughly every two years, while costs per megabyte have fallen at a similar rate. Combined with parallel developments in data compression, this means it is already possible to accommodate up to four hours of video material onto a storage device no larger than a postage stamp and costing no more than €100²⁹.

The prospect of low-cost mass storage may on the one hand largely negate the need to access on-line material whilst on the move (the material could be downloaded via a high-speed connection prior to departing), but could also make datacasting more attractive by enabling "live" material to be buffered locally so that any short breaks in transmission can be recovered and re-inserted by a conventional IP connection before the viewer becomes aware of the problem.

3.8.3 Potential overlap between 3G mobile and digital broadcast services

We have observed that broadcast technologies can provide a useful complement to existing mobile services, by providing a cost-effective platform for delivery of content to mobile terminals. However, technologies such as UMTS already include the capability to deliver "broadcast" content, including audiovisual material, to mobile phones. This blurring of the distinction between broadcasters and mobile networks strengthens the argument for treating new broadcast services in the same regulatory manner as other wireless content delivery platforms such as 3G mobile, particularly in relation to rights of use for radio spectrum.

3.8.4 Research Activities on converged services

There are a number of ongoing research programmes under the EU 5th Framework initiative addressing the potential for combining mobile and broadcast technologies to deliver converged multimedia services. One example of particular interest is the *CISMUNDUS* Project - Convergence of IP-based Services for Mobile Users and Networks in DVB-T and UMTS Systems.

The goal of the *CISMUNDUS* Project is to achieve co-operation between two complementary wireless access networks, namely a "point-to-point" mobile network (typically UMTS, but also GSM/GPRS) and a "point-to-multipoint" broadcast network (DVB-T or DAB). The ultimate goal is to ensure a seamless and wireless interactive connection to various multimedia converging services for people on the move.

²⁸ "Cramming More Components Onto Integrated Circuits", Electronics, April 1965
(<ftp://download.intel.com/research/silicon/moorespaper.pdf>)

²⁹Based on coding at 256 kbit/s and storage on a 512 MByte Smart Media storage card

The Project envisages requested content being sent to users via DVB-T or UMTS/GPRS, depending on its characteristics. Inside a "hot spot", fixed or mobile, the signal may be received by the "hot spot" gateway and can be transposed to a local WLAN using wireless transmission technology (if needed), or just repeated by means of an indoor DVB-T gap-filler and/or a UMTS/GPRS replicator in certain cases. The DVB-T terminal and the UMTS/GPRS handset may be combined in one device or linked, wirelessly, via Bluetooth or other interfaces.

3.8.4.1 *Facilitating convergence through the spectrum management process*

We believe that innovation is best supported by a technologically neutral regulatory framework, where technology is mandated only to the extent necessary to ensure technical co-existence. We also believe that a European market for such innovations can only develop if there is assurance that at least some spectrum will be available to support them if they prove to be successful. We believe that this can be done in the context of the planning process that is being developed in the current ITU Regional Regulatory Conference, providing European proposals for flexible planning are adopted. The long-term evolution of convergent services would be further facilitated by extending the primary allocation of the spectrum to embrace mobile as well as broadcast services, and we recommend that this initiative be pursued at the 2007 World Radio Conference (WRC 07).

In the longer term, when digital broadcasting and other new services such as 3G mobile are established and a clearer picture of future spectrum demand emerges, there may be benefit in a more flexible approach to spectrum allocation. For example, it may be preferable to replace the existing service based definitions with alternatives that reflect the physical characteristics of radio transmissions, such as whether they serve an entire geographic area or merely connect two fixed points. Such deliberations should be pursued within the CEPT in the context of preparations for future WRCs.

3.9 Implications of Spectrum Refarming

"Refarming" refers to changing the allocation status of spectrum, for example from broadcast to mobile services. As we have already noted, there is nothing to stop individual national administrations from doing this on a national basis. However, radio equipment manufacturers are increasingly seeking global allocations to allow the economies of scale that result from a global market. However, introducing bidirectional mobile services into spectrum currently used for broadcasting presents a number of challenges in terms interference management and frequency planning which make it difficult for the two services to co-exist within the same spectrum. The main issues affecting compatibility are discussed below.

3.9.1 Effect of high power broadcast transmissions on reception of low power mobile signals

Mobile networks involve the reception by network base stations of relatively low power signals from mobile terminals. The base stations employ sensitive antennae and receivers and it is important that the received mobile signals are not overwhelmed by high levels of interference. This is relatively straightforward where the spectrum is exclusively used for mobile, since interference only arises from other mobile transmitters that are generally more distant from the base station than the “wanted” mobile. Broadcast networks on the other hand generate very high power signals, as much as a million times more powerful than the signals emitted by mobile phones. Under certain atmospheric conditions these signals can travel very long distances (a thousand km or more) beyond the intended coverage area, resulting in occasional interference to TV reception in neighbouring countries.

The effect of such interference on a mobile network could be catastrophic, resulting in prolonged outages over much of the network. Consequently, the deployment of a reliable “return path” on a broadcast frequency would be dependent on the complete absence of high power broadcast transmissions on that frequency. This would effectively rule out the deployment of a return path until switchover is complete and could have implications for the cost of delivering mobile or convergent services that do not require a return path within this spectrum, since any spectrum designated for a return path would be denied to such services.

3.9.2 The need for paired “duplex” spectrum for wide area mobility

Broadcasting spectrum is planned on the basis of unidirectional services, where there is no need to sub-divide the spectrum into forward and return paths. Mobile services require separation of the forward and return paths, either in the time or frequency domains. These two approaches are known as time division duplex (TDD) and frequency division duplex (FDD) respectively. Where FDD is deployed, it is necessary to define specific frequency bands for the forward and return paths. This is the situation for all GSM bands and most of the currently allocated 3G mobile spectrum, for example.

Some mobile standards, such as UMTS, can operate in either TDD or FDD mode, however TDD does not allow large propagation delays between mobile terminals and base stations as this would cause a collision between transmit- and receive timeslots. Therefore TDD can only be used over relatively short paths, typically no more than a few km. Since the main advantage of the UHF broadcast bands over alternative mobile frequencies such as 2.6 GHz is the greater coverage distance that can be obtained (due to the lower free space loss at lower frequencies), the use of TDD would be self-defeating, hence any re-farming of the TV bands to facilitate mobile services would require two contiguous frequency bands to be defined within the existing broadcast band, one to cater for upstream traffic and the other for downstream.

This raises two issues. Firstly it is necessary to determine the required amount of spectrum for upstream and downstream traffic and to harmonise these sub-bands on an international basis, so that manufacturers do not have to tailor equipment to individual national markets. Secondly, as observed in the previous section, it will not be possible to operate high power downlink transmissions in the uplink spectrum. Hence before making a refarming decision that involves designation of uplink spectrum for mobile services, it will be important to assess the potential costs and benefits in terms of the new mobile services that might be accommodated and the broadcast or convergent services that would be denied spectrum as a result.

3.10 Internet Protocol Datacasting (IPDC)

3.10.1 Introduction

IPDC is a new application that is being developed by a number of major players in the telecommunications and broadcast sectors, whereby audiovisual material can be delivered to fixed or mobile terminals using IP over a DVB carrier. IPDC can be transmitted using spare capacity on existing DVB multiplexes or via dedicated networks using either DVB or mobile (GPRS / UMTS) technologies, depending on the nature of the material. The service is essentially unidirectional, although a return path is necessary to cater for interactive services. This can be provided by means of a conventional 2G or 3G mobile network.

IPDC is not suitable for the downloading of critical data files in a mobile environment since a temporary loss of transmission would lead to file corruption, however it could be used as an economic means of downloading carouselled data files to large numbers of users, for example software or operating system updates could be downloaded in this way. In the event of the datacast transmission being interrupted the terminal could initiate a request to download the file by conventional means.

3.10.2 IPDC Trials

IPDC trials are currently underway in Finland and Germany. Further trials to take place in the UK have recently been announced.

3.10.2.1 Finland

Following the recommendation of a working group set up by the Ministry of Transport and Communications in March 2002 to investigate possible uses for the fourth Finnish DTT multiplex, technical trials have commenced of an IP datacast network in Helsinki. Services delivered over the network include news services, information society services, video clips and television programmes. The test network covers most of the central Helsinki area within a few km radius. There is one main transmitter and four 'gap-fillers' placed around Helsinki.

The trials are led by Finnish research company RTT Oy and supported by a number of IT, media and communications companies including Nokia and the Finnish

national broadcaster YLE. A key challenge for the trial participants is to overcome the limitations of DVB-T in a mobile environment, notably the conflict between achieving reception at high speed and maximising data throughput. The current trial network allows reception at speeds in excess of 100 km/hr whilst delivering up to 80 video broadcasts designed for small screen displays or up to 5.8 GB of data per hour. Although the current trial is using the DVB-T standard, in the longer term, it is likely that DVB-H will be deployed.

3.10.2.2 Germany

In Berlin, to coincide with the switchover to an all-digital terrestrial broadcast environment, a joint IPDC trial is being undertaken by Nokia, Philips, Universal Studios GmbH and Vodafone. The project involves a hybrid network services platform, combining IPDC and a conventional mobile network to deliver content to both fixed and mobile users. Services involved include:

- Mobile TV content
- Local guides
- Electronic Newspapers
- Games
- Music
- Business- to-business services
- Machine-to-machine / telematics services

The trial is currently making use of spare capacity on an existing DVB-T broadcast multiplex but there are plans to trial DVB-H on a dedicated multiplex later this year.

3.10.3 The Economics of IP Datacasting

As part of its plans for the current Helsinki trial, Finland's Ministry of Transport and Communications (MTC) made the following estimate of the potential costs associated with rolling out a dedicated IP datacast network³⁰.

In technical and economic terms, the Ministry considered that a sensible option for a national IPDC network would require about 200-300 medium-sized 1-5 kW transmitters. This could be supplemented with lower power gap-fillers numbering somewhere between several hundred and perhaps a couple of thousand, the actual number depending on the required quality of indoor coverage. For coverage equivalent to that of the current GSM networks, the total number of transmitters and gap-fillers would approach the number of GSM base stations, at least in towns and cities. Therefore to build a network covering 70 % of the Finnish population with

³⁰ "A fourth digital broadcasting network: creating a market for mobile media services in Finland", MCT working group report available from the MTC web site

comprehensive indoor coverage in these areas would require about 1,500 transmitters, most of which (perhaps up to 80%) would be low-power gap-fillers.

At current costs, the Ministry estimated that the necessary investment in main transmitters would be about €60,000-100,000 per site, whilst the investment in gap-fillers would be about €40,000 per site. The average annual transmitter site maintenance costs were estimated to be €10,000 per site. Based on the above, the overall network investment would be approximately €60-70 million, and the annual maintenance costs €15-20 million. These costs would be lower for sites that are already in use by the operator, e.g. as part of a GSM network.

This was estimated to be about half of the cost of a GSM network with the same coverage area. There would also be further savings in comparison with a GSM network, because the IPDC network investment in centralized technical elements would be considerably less, amounting to only 10% of the cost of the cellular network elements. In making this assessment, the Ministry notes that a direct comparison of network costs is not straightforward. An IPDC network is unidirectional and provides a cost-effective solution for media distribution. By contrast, mobile networks such as GSM are bidirectional and can provide telephone and text messaging services as well as forming a bidirectional data link for the individual user, for instance for access to the Internet. Thus, the Ministry does not consider IPDC and mobile networks to be substitutes for each other, but rather to be complementary systems.

3.10.4 Spectrum Requirement for IPDC

IPDC may typically be delivered by means of single frequency networks (SFNs), each of diameter around 20 km and comprising up to 3 main transmitters with up to 10 – 15 low power fill-in stations (see Figure 2.4). This approach would enable a four-frequency repeat pattern to be deployed, with up to 10 Mbit/s of data capacity available in each SFN. Hence a national IPDC network could be configured with four DVB frequency channels.

In principle, these channels could be located anywhere within the UHF broadcast bands, however in practice it would be preferable for them to be located away from the 900 MHz GSM band to avoid potential interference between GSM return path transmissions and reception of IPDC content.

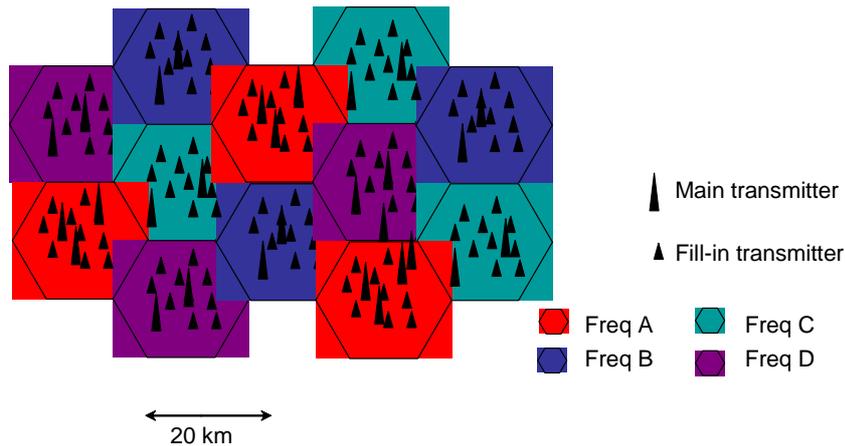


Figure 3.5: Idealised IPDC network with 4-frequency repeat pattern

3.10.5 Standardisation Issues

Standardisation activity for IPDC services is underway in various bodies, including the Internet Engineering Task Force (IETF), IEC and DVB Group. The European Multimedia Home Platform (MHP) standard also supports IPDC services. The aim is to standardize the minimum requirements for terminals capable of using the necessary (software-based) applications for receiving datacast services. Work is also underway on mobility optimised radio transmission for datacast service reception (i.e. the DVB-H standard described in Section 3.6.2.4).

An IPDC Forum was established by industry in January 2002 and currently has fifteen members, including broadcasters, transmission network operators and equipment vendors. The Forum's work to date has included studies into the IPDC business case, technology requirements and spectrum issues³¹. The work has embraced both DVB and DAB but with an emphasis on DVB. The Forum is developing an "IPDC Baseline Specification", the purpose of which is to define the minimum requirements for the interface of a terminal device to the IPDC access network. The latter may be either a unidirectional broadcast network, a bidirectional mobile telephony channel, or both.

3.10.6 Time to Market

IPDC is still at an embryonic stage and it is difficult to predict with any certainty whether or when such services might reach commercial fruition.

According to Nokia³², there is already considerable industry interest and tested, standardised solutions are anticipated by 2004. Receiver availability should follow by the end of 2004 but establishing appropriate national regulatory frameworks (e.g.

³¹ "IP Datacasting: the Road to Converged Services?", K L Hayer, IPDC Forum, presented at IBC2003

³² "Mobile Broadcast Services", J. Kamarainen, presented at the 11th CEPT conference, Nice, October 2003 (www.ero.dk/conference)

relating to media regulation and spectrum assignment) is likely to take longer. Nokia also emphasised the importance of the forthcoming RRC (see Section 5.3) in facilitating mobile TV and IPDC services, particularly with regard to flexible network planning principles.

Finnish network operator Sonera³³ has suggested that it will take two to five years to evaluate the technology and a further two to six years to have services up and running and to change consumer habits. It may be ten years before it is clear whether the technique is successful in establishing itself in the market. This timescale suggests that access to spectrum, or at least to capacity on existing multiplexes, may be required within the next five years, which is likely to be incompatible with the switchover timescale in many Member States. One way round this may be to ensure that capacity is available on commercial DVB-T multiplexes to enable technology and market trials to be undertaken prior to switchover.

3.11 Other Convergence Initiatives

3.11.1 DVB Ad-Hoc Group on UMTS

This Group has been working on concepts for terminals in co-operative networks – in particular, dual-mode terminals using both DVB-T and cellular radio services such as GSM, GPRS and UMTS. Among the commercial scenarios being addressed within the Group are:

- IP services co-ordinated on UMTS and DVB networks: a service provider uses a (part of a) DVB-T multiplex (e.g. leased from a broadcast network operator) to provide a portal for an Online service. It may use a data carousel as above to transmit the most relevant pages or files to the users. A control channel may be needed to provide signalling for the use and allocation of these channels (e.g. handover or roaming for DVB-T and UMTS).
- DVB-T integrated into a mobile operator's network: The DVB-T downlink, as part of the UMTS network, is now used as an extension pipe to the UMTS air interface (UTRA) to increase the downlink capacity. The DVB-T transmitter can be collocated with the UMTS base station.

3.11.2 UMTS Multimedia Broadcast and Multicast Service (MBMS)

MBMS is part of the latest UMTS standard set being developed within the 3rd Generation Partnership Project. MBMS enables broadcast and multicast (streamed) content to be delivered using Internet Protocol over GSM and UMTS networks.

³³ IP Datacasting content services white paper, Sonera MediaLab, May 2003
(<http://www.medialab.sonera.fi/workspace/IPDCContentServicesWP.pdf>)

MMBS is seen as complementary to DVB-T as part of a hybrid service platform. Services could include news, traffic information, entertainment (e.g. music or video clips).

4 POLICY ISSUES ARISING FROM SWITCHOVER

4.1 Introduction

The previous chapter highlighted some of the potential benefits and opportunities arising from switchover. The extent to which these are realised in practice will depend in part on decisions made in regard of the following policy areas:

- The approach to planning spectrum for DTT at a European level;
- The approach to transition, including the method of achieving switchover (e.g. simulcast versus forced switch-off) and the timing of switchover in each MS;
- The services that are allocated spectrum after switchover and the manner in which spectrum is assigned.

The first issue is to be addressed at this year's Regional Regulatory Conference (RRC-04), which is discussed in chapter 5. The key issue during the transition phase is the scarcity of available frequencies required to maintain universal access to analogue services, provide spectrum for new digital services (to stimulate take-up of DTT receiver equipment) and where necessary to accommodate existing non-broadcasting services. The RRC will address these issues and seek to ensure equitable access to frequencies for all countries during the transition. The method of achieving switchover, its timing and the assignment of spectrum to specific services or users post-switchover will however depend on national policy priorities.

The optimal use of radio frequencies is a key objective under the New EU Framework for electronic communications ("New Framework") but there is no established consensus amongst Member States as to what constitutes optimal use. The diversity of Member States' situations in respect of objectives for DTT, penetration of cable and satellite platforms and the costs of achieving universal provision of TV services could mean that a single approach to achieving switchover and use of the spectrum released in the EU would not be economically beneficial overall. This chapter discusses the trade-offs that arise in deciding the optimal use of spectrum.

The concept of optimal spectrum use should take account of economic, social and technical factors. As we observed in chapter 2, the additional capacity provided by digital migration creates potential benefits in all of these areas. Furthermore, the availability of alternative delivery platforms that were not available when analogue networks were rolled out creates additional opportunities to review the effectiveness with which terrestrial broadcasting spectrum is being used.

In this chapter we do not attempt to reach conclusions on the switchover and spectrum release decisions Member States should make, as this is a matter for national governments. Rather we discuss how decisions about these matters might be made. Decisions concerning the timing of switchover and which services should

be assigned spectrum could be made by governments using administrative processes, market processes or a mix of the two. For example, governments could determine the switchover date based on certain criteria being met (e.g. coverage and take-up of digital services) or decisions could be taken by spectrum licensees based on commercial criteria. The nature of TV broadcasting is likely to mean that some government intervention will be necessary to ensure universality and other general interest objectives are achieved and broadcasters' actions are co-ordinated in a way that allows efficient use of spectrum in a digital environment. The use of administrative and market based approaches to achieve spectrum management and broadcasting objectives are considered in the following sections, with particular regard to three key issues, namely:

- i) How might the timing of switchover be determined?
- ii) How should the future use of spectrum released at switchover be decided?
- iii) How might the spectrum be assigned?

We start by considering the objectives that need to be taken into account when making these decisions and suggest that a cost benefit framework is required to evaluate options.

4.2 Spectrum management and broadcasting objectives

In evaluating the approach to take to switchover decisions both spectrum management and broadcasting objectives need to be taken into account. These are discussed below.

4.2.1 Spectrum management objectives

The Radio Spectrum Decision refers to various policy dimensions that must be taken into account in spectrum policy, namely economic, safety, health, public interest, freedom of expression, cultural, scientific, social and technical aspects, with the aim of "optimising the use of radio spectrum and of avoiding harmful interference". How NRAs make trade-offs between all these policy aspects so as to optimise the use of radio spectrum or encourage efficient use is not specified, however the weight put on the different objectives and the way these trade-offs are made are crucial to decisions concerning the future use of spectrum post-switchover.

National differences in spectrum policy become a European issue if they result in such different patterns of spectrum use that opportunities to develop new European-wide services are foreclosed. For example, the use of the upper part of the UHF TV band by military applications in some countries could be a constraint on achieving pan-European availability of spectrum for new wireless multimedia services of the type discussed in chapter 3. The successful development of a European market for new radio-based applications or services is likely to depend on there being reasonable assurance that at least some radio spectrum would be available for the new service in each national market.

The high powers emitted by analogue TV transmitters and the sensitivity of domestic analogue receivers to interference mean that even the limited continuation of analogue services in a few Member States will constrain the introduction of new services. Any spectrum dividend will therefore only be fully realisable upon the complete cessation of analogue broadcasts within the EU and neighbouring countries. Hence the timing of switchover will be a key factor in determining the benefits derived.

4.2.2 Broadcasting policy objectives

Broadcasting policy has numerous objectives including:

- Diversity of content, including linguistic and cultural diversity;
- High quality content;
- Plurality of media ownership;
- Freedom of expression;
- Impartiality in the presentation of news;
- Consumer protection (from offensive or misleading material); and
- Universality in the provision of certain core services.

It is sometimes argued that government intervention is required to achieve these aims because they would not be delivered by a free market in broadcasting³⁴. Markets fail because broadcasting services have public goods characteristics and are often regarded as merit goods.

Free to air broadcasts are public goods in the sense that consumption by one individual does not deny consumption by another. In these circumstances private companies are only able to finance their services through advertising because consumption is non-excludable. Without advertiser financing government funding is required. It is well-known that advertiser financed services will over-supply content that is attractive to large audiences and therefore not provide the diversity of content that would be expected in a well-functioning market. This is one reason why content on advertising-financed broadcasting services is regulated.

Broadcasting is also often regarded as a merit good, i.e. a good that government (and sometimes society) deems is undervalued by consumers in normal market exchanges, and so government intervenes to promote the consumption of merit good aspects of broadcasting (e.g. by requiring specific types of programme to be broadcast or directly funding certain types of broadcasting).

Markets may also fail to deliver appropriate levels of consumer protection and impartiality in news services (because of transaction costs or consumers' lack of

³⁴ This argument typically ignores any costs associated with government intervention e.g. costs of over-regulation.

suitable information), so regulations are put in place to ensure their delivery. Finally plurality of ownership, freedom of expression and universal access to a minimum set of services are regarded as desirable aspects of a well-functioning democracy and regulations are put in place to ensure these are delivered.

Beyond this, it is argued that broadcasting is too important to be left to the market, even the market operated well, because of the impact of broadcasting on cultural identity and the functioning of democracy. Given this, it is argued that regulatory and institutional measures are required to ensure high quality and independent programming. This view can in principle be brought together with a more market oriented analysis, through consideration of those features of broadcasting that are important on general interest grounds and what the market may provide. Taking account of these two aspects one can come to a view about the interventions required to deliver general interest objectives informed by an analysis of the market.³⁵

Pay-TV and digitisation weaken the arguments for public intervention. Pay TV is not a public good and hence the arguments for regulating these services must rest on other market failures (e.g. consumer protection measures) or other policy objectives (e.g. promoting a European production industry).

In addition, as the number of services that can be provided over free to air broadcasting expands as result of digitisation the market will provide an increased diversity of services, because it becomes more economic to pursue niche audiences rather than seek to attract a small fraction of a mass audience. This development, which is already happening in pay and advertiser financed digital broadcasting, weakens the case for government intervention. The case for intervention is not entirely removed as there are various aspects of general interest broadcast services that cannot be fulfilled (e.g. localised programming) within the current spectrum constraints and there are aspects of general interest services (e.g. current affairs programming, high quality drama and programming aimed at minority language or cultural groups) which are unlikely to be delivered by a market because they are not economic.

4.2.3 Cost-benefit trade-off

As the discussion above shows, the objective of optimising spectrum use involves the consideration of a multitude of potentially conflicting objectives, including broadcasting policy objectives. Spectrum management is by no means a simple matter of optimising the technical or even economic efficiency of spectrum use, rather a plethora of social and other policy objectives need to be taken into account. The scarcity of spectrum means that fulfilment of these objectives through spectrum management decisions will come at the cost of other forgone opportunities and it is

³⁵ Such an approach has been developed by the UK NRA Ofcom for example. See "Measuring Public Service Broadcasting", R Foster, J Egan, J Simon, www.ofcom.org.uk

important that this cost is understood and compared with the benefits of meeting broadcasting policy objectives.

Cost-benefit appraisal of public policy decisions uses the concept of welfare to capture the economic and other benefits of a resource such as radio spectrum. Welfare is often measured as the total 'surplus' associated with the allocation of scarce resources. Surplus has two components: consumer surplus (CS) and producer surplus (PS). CS is the cumulative sum of the differences between the willingness to pay for a good and its price. PS is the cumulative sum of the differences between the price of a good and what firms are willing to be paid to produce a good (i.e. it comprises supernormal profits). This is illustrated in Figure 4.1. For example, to measure the net benefits arising from any alternative use of spectrum post-switchover we need to measure the CS and PS arising from the services that might use the spectrum. The sum of the CS and PS in the best alternative use of the TV spectrum comprise the opportunity cost of that spectrum.

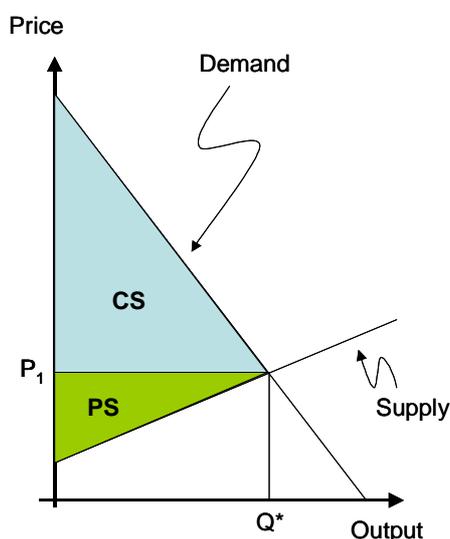


Figure 4.1: Economic welfare measured in terms of consumer surplus (CS) and producer surplus (PS) of a final good or service where spectrum is used as an input to production

The key challenge for policy makers is to quantify the consumer and producer surplus measures that apply when undertaking cost-benefit analysis of spectrum allocation decisions.

In the case of broadcasting there have been a number of recent studies that have sought to value general interest broadcasting using willingness to pay or contingent valuation techniques. For example, Finn, McFayden and Hoskins (2003) have estimated the value of the Canadian Broadcasting Corporation from an individual and society wide perspective. Delaney and O'Toole (2004) have estimated household willingness to pay for Irish general interest broadcasting and Foster, Egan and Simon (2004) report results of the relative costs and benefits of different

types of general interest programming.³⁶ These studies sought to capture not only individuals' value of the service in question, but also the value from a wider society viewpoint thereby seeking to capture the general interest benefits of broadcasting (including programming and universal service benefits).³⁷ We note that the consumer surplus estimates for UK TV services presented in Section 3.3 only capture individuals' private benefits from TV services. This is all ground breaking work and the authors all recognise that there are numerous issues still to be resolved; however, it does provide an evidence based way forward.

In summary, as with other public policy decision, spectrum allocation decisions should be information by cost benefit analysis. The key challenge in doing this is deriving robust estimates of the value of alternative uses of the spectrum. A number of quantitative research techniques have been developed, such as contingent valuation and stated preference analysis, that can be used to derive such estimates.

4.3 Timing of Switchover Decisions

4.3.1 Introduction

The European Commission and a number of Member State governments are keen to promote rapid take-up of digital TV because of the potential benefits to consumers arising from access to digital interactive services and enhanced picture quality and the potential benefits arising from use of the spectrum post-switchover to provide additional services or content.

Switchover is likely to involve significant economic costs arising from the need for a new transmission network and for consumers to acquire digital reception equipment (TV sets and video recorders) and in some cases to replace roof-top aerials. The size of these costs will depend on geography and the extent to which consumers already access digital TV over cable or satellite platforms. In countries where there is relatively low cable and satellite penetration the consumer costs in particular can be very large. BIPE³⁸ assessed the scale of the costs for a number of EC countries and concluded that the costs of digital conversion are likely to exceed any cost savings from moving to digital transmission in most Member States, with the exception of Germany and Sweden.

³⁶ "Valuing the Canadian Broadcasting Corporation, A Finn, S McFayden, and C Hoskins, *Journal of Cultural Economics*, 27, 20003; "Irish Public Service Broadcasting: A Contingent Valuation Analysis, L Delaney and F O'Toole, Trinity College, Dublin, February 2004; *Measuring Public Service Broadcasting*, R Foster, J Egan and J Simon, www.ofocm.org.uk

³⁷ These studies implicitly assume that value of general interest benefits from broadcasting is best derived from asking the population in general. It might alternatively be assumed that only politicians or certain senior decision makers' views on these matters should count in which case these could be elicited from a survey of such groups.

³⁸ Section 4.6, *Digital Switchover in Broadcasting*, BIPE for the European Commission, April 2002

In general the benefits are likely to be greatest in countries where there is a high penetration of digital satellite and/or cable platforms and relatively few viewers rely on terrestrial reception (see Section 3.6.3). In Berlin, for example, analogue services were recently switched off and less than 10% of homes were affected. Differences in the costs of switchover are likely to mean that switchover will happen at different times in different Member States.

Decisions about the timing of switchover could be made administratively and administrative measures could be used to incentivise broadcasters, manufacturers and consumers to take actions to speed up switchover. Alternatively decisions could be left to market measures with actions driven by financial incentives. Whichever route is chosen, the date chosen for switchover should ideally be that where the net benefits are maximised. The next sections discuss briefly the factors that should be considered in assessing the costs and benefits associated with switchover.

4.3.2 Costs and Benefits of Switchover

As with most policy decisions made by governments, the costs and benefits of switchover at different dates need to be assessed. The costs and benefits that should be counted have been discussed by BIPE. A summary is given in Table 4.1.

Costs	Benefits
1. Cost of new consumer receiver equipment – TV receivers, VCRs and roof-top new aerials	1. Consumer and producer benefits from extending DTT coverage
2. Capital costs of new transmission infrastructure	2. Consumer and producer benefits from use of spectrum released at switchover for services other than DTT
3. Planning and management costs of switchover	3. Savings in annual transmission costs
4. Marketing and communications costs	4. Stimulus to productivity from use of digital services
	5. Social benefits from wider access to digital services
	6. Stimulus to competition in the provision of TV and other new services

Table 4.1: Costs and Benefits of Switchover

The costs of switchover can be quantified using market information and forecasts of digital take-up, use of analogue equipment and the prices of digital equipment. Quantifying the benefits is more problematic as these depend importantly on options for future use of the spectrum which may be uncertain and on how much these options will be valued in future which is even more uncertain. Nevertheless, because consumers need to be given advance warning of the changes, many planning decisions need to be taken well in advance of switchover and so must be made based on available information, however limited.

The UK government has recently undertaken a cost-benefit analysis of switchover at different dates, starting in 2010, from which it was concluded that the net benefit from switchover was probably maximised in 2010, though uncertainties in the data meant that the estimated scale of the loss from waiting a year or two was not very robust³⁹. The cost benefit analysis does not take account of items 4, 5 and 6 in Table 4.1 in the benefits calculation. Data on the consumer benefits/consumer surplus of different uses of UHF TV spectrum was collected by the UK Radiocommunications Agency (now part of Ofcom) through surveys of consumers' willingness to pay for various dimensions of digital TV services (such as number of services, picture quality (high definition or not), interactivity, portability or mobility) and alternative services that may use the spectrum such as various high speed mobile data services. It was assumed that producer benefits (i.e. supernormal profits) were zero i.e. surplus profits were competed away. This seems a reasonable approach given the uncertainties. Note that if in time the spectrum is auctioned then the sums paid by the winning bidders should in principle equal their producer surplus⁴⁰.

While there are clearly considerable uncertainties associated with the results of such analyses they allow a more informed debate concerning switchover decisions than would occur without the information and thereby aids transparency.

4.4 Developing the Digital Market

4.4.1 Introduction

A number of obstacles need to be overcome in order for switchover to proceed in a timely manner and for the full potential benefits of switchover to be realised. The principal challenge is to persuade viewers that the cost of upgrading to digital is justified in terms of the benefits provided. For example, recent research carried out on behalf of the UK government found that 13% of householders do not want digital television and have no intention of getting it at any point in the future, while a further 30% have no plans to switch but remain open to persuasion⁴¹. Given that the average replacement cycle for main household TV sets is around eight years⁴² and that the overwhelming majority of TV sets currently on sale do not have integral digital tuners, it could be many years before digital reception achieves universality unless a way can be found to persuade remaining analogue users to migrate.

³⁹ Cost Benefit Analysis (CBA) of Digital Switchover, September 2003, www.digitaltelevision.gov.uk

⁴⁰ In Section 3 of BIPE (2002) it is suggested that operators' values could be revealed through an option mechanism. This mechanism is not explained sufficiently for us to understand how it might work. As a general rule, operators will have strong incentives to hide the value they place on spectrum for fear that they may be opportunistically taxed by governments.

⁴¹ Media Guardian, January 7th 2004

⁴² source: Intellect (UK trade body representing receiver manufacturers)

4.4.2 Equipment considerations

The increasing availability of lower price wide screen and flat panel receivers could well encourage users to replace their current sets to benefit from improved picture quality. This could provide a catalyst for at least some users to upgrade to digital, particularly if they also replace their existing video recorders with DVD equipment. This raises the question of whether steps should be taken to encourage the vendors of such equipment to include an integral digital reception capability. Whilst it can be argued that integral digital tuners would hasten the penetration of digital services, any attempt by governments or regulators to mandate or explicitly promote such provision may run counter to the technologically neutral basis of the EU Regulatory Framework.

An alternative may be to consider the TV set as a “monitor” that can be connected to any external source, whether DTT, satellite, cable, DVD or other digital storage medium. Such monitors could be promoted as “digital ready” in that they provide access to the full range of functionality of digital TV when connected to a compatible set top box. There is perhaps a stronger case for the integration of digital tuners into video recorders to avoid the additional complexity that would result from having to rely on a second set-top-box.

Whichever approach is taken, it is important that consumers are made aware of the benefits of digital at the point of sale and that the various options (integrated digital tuners, “plug and play” set-top boxes, etc) are also clearly explained.

4.4.3 Should digital platforms compete with or complement each other?

We have already observed (Section 3.6.3) that the realisation of universal digital coverage may entail a multi-platform solution. But to what extent do the three available delivery platforms compete in the market (and to what extent should they if the goal is to optimise the use of scarce spectrum resources)? Some EU countries (e.g. Germany) have argued that the success of DTT depends on its ability to compete effectively with cable and satellite, using this argument to justify the long-term retention of all existing analogue broadcasting spectrum for DTT. However, in reality, it is unlikely that DTT can develop as a direct competitor as its broadcasting capacity is far too limited.

As noted above, DTT’s attractiveness is likely to be enhanced as viewers acquire higher resolution displays, however this advantage could be compromised if broadcasters attempt to maximise the number of programmes at the expense of signal quality. DTT appears to be best placed to serve those who currently are content with the reception of analogue free-to-air services, since it involves the minimum up-front cost and disruption. This tends to favour the free-to-air business model rather than pay-TV model, which is best suited to a platform that can deliver a wider range of premium material. The experience of the UK and Spain, where pay-TV terrestrial offerings were launched and subsequently failed, tends to support this view.

A key differentiator of DTT relative to satellite (and to a lesser extent cable) is its suitability for broadcasting local or regional content⁴³, though as discussed in chapter 3 this does tend to increase the spectrum requirement. Similarly, only DTT can provide direct reception by portable or mobile receivers, although as we have seen this can lead to a significant increase in the spectrum requirement under some scenarios. Whilst we have reservations about the use of the DVB-T standard in its current form to support widespread mobile reception, we agree that the delivery of mobile audiovisual services (including TV) is likely to be an important application in the UHF TV spectrum and one that cannot be effectively replicated by cable or satellite platforms.

Our conclusion is that DTT should not be regarded as a direct alternative or competitor to cable or satellite services, and where broadcasters decide that this is the case a distinction should be made between the additional spectrum requirement that ensues and the “core” spectrum required to fulfil any general interest broadcasting objectives. That is to say the additional spectrum should be assigned on the basis of a competitive process that is service and technology neutral.

4.5 Incentivising Switchover

The announcement of a switchover date will itself provide households with incentives to purchase digital receivers and manufacturers with incentives to make equipment with digital tuners – TVs, VCRs and DVDs – as they will then be certain that analogue equipment will have a limited life.

Incentives to take-up digital TV can also be provided by the following administrative actions:

- The labelling of receivers either positively as being digital or negatively as not being digital or analogue only (the concept of “digital ready” monitors as discussed in Section 4.4.2 above could also be accommodated within such a scheme);
- Marketing and communication campaigns to raise public awareness of digital TV and thereby assist the “bandwagon” effect, whereby adoption is stimulated through knowing others who have taken up the service;

⁴³ Although there have been recent claims relating to the launch of satellite based mobile broadcast services, these are dependent on a line-of-sight path between the satellite and receiver, which is unachievable in indoor or many urban outdoor environments. The proponents of such systems acknowledge that their viability is likely to depend on extensive networks of terrestrial “fill-in” stations. Local satellite broadcasting, although technically feasible, is inherently wasteful of spectrum in that the satellite footprint will be much larger than the local area and the ability to re-use the spectrum in different localities is much lower than for terrestrial broadcasting.

- Making decisions about spectrum release, so that potential new users of the spectrum have incentives to invest in the research and development required to launch new products and services;
- Enhancing the functionality of digital services relative to analogue and ensuring that all existing analogue functionality (e.g. teletext) is replicated as seamlessly as possible;
- Subsidising broadcasters' costs of switching to digital transmission (as is happening in Japan for example);
- At a point close to switchover, subsidising certainly consumers' costs of purchasing digital equipment.

We are not lawyers and so cannot advise on whether the last two actions would fall foul of EC rules on state aids. We note that Germany has already adopted the approach of subsidising the broadcasters' digital rollout costs and that this has been challenged by existing cable operators (see Section 3.6.3). Certain Member States already provide subsidised TV licences to certain social groups (e.g. in the UK free licences are available to those over 75 years of age) and there would seem to be a reasonable case to make similar provisions for digital receivers. The first four actions should not face any such problems and could all be regarded as enabling or supporting the market based approaches discussed in Section 4.6.2 below.

The initiatives already taken by Member States to promote digitisation include:

- **Belgium:** the Flemish government has set aside €12.4 million with the objective that all households will be covered by DTT by the beginning of 2005.
- **France:** the Government said that it will finance up to €32 million for frequency replanning, to be paid back by broadcasters over 5 years.
- **Austria:** the Government proposes allocating up to 25% of license fees to DTT development.
- **Italy:** the Government plans to allocate up to €130 million on consumer subsidies for DTT in 2004 – each household will receive a one-off rebate of €150 on its licence fee if it decides to buy a digital receiver.
- **Spain:** The government has called on DTT manufacturers to agree to commit to launching digital terrestrial TV set-top boxes, while digital terrestrial TV operators will be required to produce specific content for digital channels, by the end of 2004.

4.6 New Approaches to Spectrum Management

A number of new approaches to spectrum management, which aim to take account of the economic value of radio spectrum, have been pioneered in recent years. Some of these could play a role in facilitating switchover and ensuring the optimal

use of spectrum in the longer term. The three main examples, administrative incentive pricing, auctions and trading, are discussed in the following sections.

4.6.1 Administrative incentive pricing (AIP)

4.6.1.1 Background to AIP

Administered incentive prices (AIP) are fees charged to spectrum licensees that are set by the regulator and are intended to reflect the marginal opportunity cost of spectrum use. They will reflect the marginal opportunity cost if they are set at a market clearing price and will then provide incentives for efficient use of spectrum⁴⁴. Figure 4.2 (below) shows the demand for spectrum as downward sloping, reflecting the fact that the marginal value of spectrum to a user declines as the amount of spectrum available increases, and a vertical supply curve reflecting a fixed amount of spectrum Q^* for the service in question. P^* is the market clearing price of spectrum and it is P^* that one is trying to estimate when setting AIP. As spectrum is scarce it generates a rent for society which is given by the shaded area in Figure 4.2.

It is important to note that the AIP is not intended to be an estimate of amount that might be raised by an auction of the spectrum. Referring again to Figure 4.2, a first price auction would (in theory) yield revenues in excess of $P^* \times Q^*$ as bidders would be prepared to pay up to all the area under the demand curve and left of the supply curve to obtain the spectrum (i.e. some of the area of the triangle above P^* in addition to $P^* \times Q^*$).

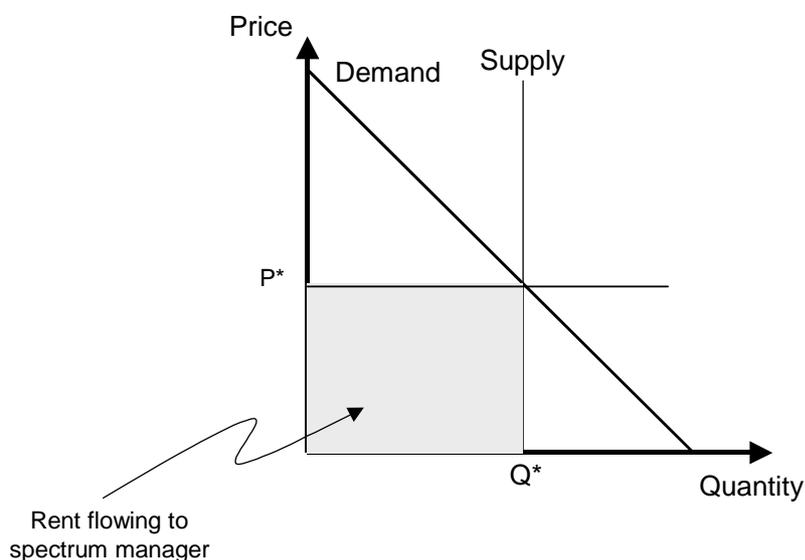


Figure 4.2: Supply, demand and market clearing price for constrained spectrum

⁴⁴ Review of Radio Spectrum Management, Professor Martin Cave for the UK Department of Trade and Industry and UK Treasury, March 2002

In practice, it is not possible to estimate P^* precisely because this is the price that would apply if the allocation of spectrum between different uses and different users was economically optimal (i.e. welfare maximising). The reality is that we are likely to be far from any kind of optimum as the allocation of spectrum to different uses and users is the result of a historical process governed primarily by technical and political considerations and not economic factors. AIP are set so that one moves towards P^* , but should be set iteratively taking account of any impacts on spectrum use and technology and demand changes over time.

A methodology for estimating the marginal opportunity cost of spectrum (i.e. P^*) has been developed in the UK and is based on the least cost alternative to using a marginal unit of spectrum. The additional cost (or cost saving) to an average or reasonably efficient user as a result of being denied access to a small amount of spectrum (or being given access to an additional small amount of spectrum) is calculated. The additional cost (or cost saving) depends on the application and is calculated as the estimated minimum cost of the alternative actions facing the user. These alternatives may include:

- investing in more or less network infrastructure to achieve the same quantity and quality of output with less or more spectrum
- adopting narrower bandwidth equipment
- switching to an alternative frequency band
- switching to an alternative service (e.g. a public service rather than private communications) or technology (e.g. fibre or leased line rather than fixed radio link)⁴⁵.

If there are other uses that could use the spectrum, then their marginal values also need to be taken into account when determining the AIP.

This approach has been applied in the UK to the following services: defence, fixed links, maritime business radio, private business radio, programme making and special events, public mobile networks, public safety services (police, fire, ambulance services), satellite uplinks (permanent and transportable earth stations and VSATs) and scanning telemetry. In the case of broadcasting services, the UK Government has stated that⁴⁶:

“Broadcasting is a major user of spectrum that is increasingly overlapping and competing with telecommunications services. We agree that

⁴⁵ Note that this approach overstates the value of spectrum for reductions in spectrum and understates the value for increases in spectrum. An average of the values obtained from an increase and a decrease in spectrum gives a reasonable approximation to the value.

⁴⁶ Government Response to the Independent Review of Radio Spectrum Management. Department of Trade and Industry and Her Majesty's Treasury, 2002

broadcasters should pay for spectrum but that the introduction of spectrum pricing for television and its timing should be linked to digital switchover as the main spectrum efficiency gain will come from the move to digital-only broadcasting of television programmes. Incentive pricing for analogue television spectrum will be implemented after full consultation, but not before 2006, in a way that demonstrably provides an additional incentive for the broadcasters to do what they can to achieve the switchover conditions. We also envisage applying incentive pricing to digital television but not before 2010.”

4.6.1.2 Application of AIP to broadcasting

The spectrum currently occupied by analogue TV broadcasting could be used for additional analogue TV services, digital TV services, SAB/SAP services, mobile datacasting and possibly also conventional mobile services. Hence marginal values need to be calculated for these services and a judgement made about how much spectrum might be demanded by each service so that the marginal service can be identified.

Broadcasters often argue that they should not be subject to AIP or any other pricing on the grounds that they pay for their spectrum through the content and other obligations they must fulfil. Eurostrategies (2003) for example have estimated the cost of obligations to provide coverage beyond commercially viable levels⁴⁷. However, as we discussed earlier in this chapter these obligations are in place to address general interest objectives and not spectrum efficiency. To promote spectrum efficiency broadcasters should face the marginal opportunity cost of their use of spectrum, just as for example they pay an unsubsidised price for electricity and other inputs they use.⁴⁸ At a minimum there is merit in estimating the marginal opportunity cost of spectrum used by broadcasters so that decision makers are aware of the cost of reserving spectrum for broadcasting purposes. Such an exercise could indicate for example that it would be economically advantageous for broadcasting operators to use a mix of platforms rather than just terrestrial transmission to meet their obligations.

Separation of content and infrastructure authorisations⁴⁹ may be helpful in this context: the pricing of the content authorisation could reflect any general interest

⁴⁷ Assessment of Measures linked to Broadcasting with the Context of the New Regulatory Framework, Eurostrategies for the European Commission, April 2003

⁴⁸ The efficiency arguments are set out in detail in Chapter 2 in An Economic Study to Review Spectrum Pricing, Indepen, Aegis Systems and Warwick Business School, February 2004.

⁴⁹ i.e. authorisations relating to the provision of specific broadcast content, which may be subject to general interest considerations, and authorisations to operate transmission networks that would be

obligations on the broadcaster whereas the transmission authorisation would incur the marginal opportunity cost associated with the spectrum.

4.6.1.3 *Estimating the Marginal Opportunity Cost of Spectrum to Broadcast Services*

The marginal benefit of spectrum to TV services has been estimated in a recent study for the UK NRA. This obtained values in the range £1M - £1.2M (€1.5 - €1.8M) per MHz.⁵⁰ These estimates were based on the impact on coverage of having less spectrum and then calculating the cost of replicating that coverage using other transmission platforms (i.e. satellite and cable).

The same study estimated the marginal opportunity cost of 900 MHz spectrum in the UK at £1.68M (€2.5M) per MHz. This is the value of a small amount of additional mobile spectrum at either 900 MHz or 1800 MHz. This is not the marginal value of UHF spectrum to a mobile operator, as it does not take account of the different propagation properties of UHF as compared with higher frequencies or the additional costs of producing handsets that can operate at UHF frequencies. Also in practice the marginal value of UHF spectrum to a mobile operator will depend very much on how an operator might use the spectrum. For example, if the spectrum were to be used primarily to serve rural areas, operators may find it more cost-effective to expand coverage by installing more base stations than by acquiring additional spectrum. It may also be the case that mobile operators may derive greater value from the spectrum by using broadcast technology (such as DVB-H) to deliver mobile content. These options were not explored in the study.

While the estimates may suggest that an additional unit of UHF spectrum could have a greater value to a mobile operator than a TV broadcaster, the other factors just mentioned need to be taken into account before coming to this conclusion. Nevertheless, the marginal opportunity cost estimates do raise the question of whether the general benefits of general interest broadcasting are sufficient to justify allocating the spectrum exclusively to this use.

4.6.2 **Market Based Approaches**

4.6.2.1 *Introduction*

Broadcasters have a financial incentive to move from simulcasting to digital only transmission, in terms of reduced transmission costs, however, this incentive is weak whilst digital penetration is low. Broadcasters may need to capture more than just the savings in analogue transmission costs if they are to promote rapid switchover (e.g. through providing services on other platforms, marketing DTT and possibly even subsidising digital receivers). Application of AIP is one way in which a

regulated in the same way as other electronic communication networks under the new regulatory framework.

⁵⁰ The methodology for calculating these values is set out in "An Economic Study to Review Spectrum Pricing", Indepen, Aegis Systems and Warwick Business School, February 2004.

further financial incentive to migrate can be provided, but market-based mechanisms such as auctions or spectrum trading may also be effective. These are discussed below.

Competition issues are often raised in the context of market approaches to spectrum because the latter typically involve less government intervention in licensing decisions. There is a choice between relying on competition policy or using existing administrative controls on the ownership of licences to the extent that this is feasible. For example, administrative rules involve an element of discretion, often involving a judgement about whether a user “needs” the spectrum it has requested. This would be difficult to sustain in an environment where spectrum is traded unless there is to be considerable government intervention. The choice of approach depends on the effectiveness and speed of the competition authorities in reaching decisions versus the extent to which clear administrative rules can be developed.

4.6.2.2 *Overlay Licences and Auctions*

It may be feasible to auction existing analogue TV spectrum in advance of switchover with incumbent broadcasters as sitting tenants that may be bought out – a process known as “overlay licensing”. The purchaser of the spectrum would have an incentive to promote DTT as a means of bringing forward the date at which spectrum will be released for other services. Issues that need to be considered in granting overlay licences are:

- The incumbents’ rights to interference protection
- The duration of incumbents’ licences
- The new entrants’ rights to interference protection
- The grounds on which the new entrant may ask the incumbent to vacate the spectrum

To avoid disputes over rights to interference protection incumbents’ and new users’ rights need to be defined unambiguously.

Giving new entrants a right to move incumbents with compensation, and/or giving incumbents a time limited right to stay has been shown to be more efficient than simply giving incumbents a perpetual right to stay⁵¹. This is because the new entrant is not “held up” in indefinite negotiations with incumbents who will seek to extract the full value of the spectrum. Encumbered spectrum is likely to be valued less than unencumbered spectrum, but the discount can be limited by giving incumbents time limited rights. The creation and auctioning of overlay rights

⁵¹ Efficient Relocation of Incumbents, P Cramton, E Kwerel, J Williams; University of Maryland and the FCC. October 1996.

provides a pragmatic response to the issue of migrating incumbents and so would seem to offer potential for refarming the TV spectrum from analogue to digital use.

Overlay licences have been created in a number of frequency bands in Australia, Canada, New Zealand and the United States. They have the following common features:

- Incumbents' rights are time limited (2-5 years)
- Incumbents have a right to compensation from the new entrant if asked to leave before their licences have expired
- New entrants must offer incumbents the same interference protection as they had originally
- New entrants are similarly given the same level of protection from interference as other site licensees in the band.

4.6.2.3 *Application of Overlay Licensing to Broadcasting*

This approach is similar to that being taken by the US government to switchover. In the US, the FCC has auctioned spectrum currently occupied by TV broadcasters (in the lower 700 MHz band) for flexible fixed, mobile and broadcast uses. New licensees must protect incumbent broadcasters from harmful interference. Incumbents may be required to vacate the band by the end of 2006 but only if less than 15% of households in their market do not have access to digital TV. Similar arrangements are proposed for the upper 700 MHz band but the auction has been postponed a number of times because of difficulties in reaching agreement with incumbent broadcasters over spectrum release.

Overlay licences have the following potential advantages relative to making broadcasters' spectrum licences tradable (see below):

- "Free rider" issues are internalised to some extent. Free rider problems arise when several parties benefit from the actions of one party but do not pay for this benefit – the other beneficiaries are then said to be free riders. For example if a new user of broadcast spectrum clears an incumbent high powered transmitter then this will give benefits to neighbouring spectrum users because the likelihood of interference in neighbouring areas and/or frequencies is reduced. These issues are internalised with overlay licences because the new user has access to a contiguous block of spectrum. However, new users of the spectrum may need to co-ordinate their actions to accelerate switchover, if broadcast frequencies used in a given area are distributed over a wide frequency range.
- Co-ordination issues may be reduced if the buyers of the overlay licences can plan how best to accommodate the incumbents in a digital environment – this issue is largely avoided for those broadcasters who are simulcasting as they simply move over to their digital frequencies.
- Windfall gain issues are avoided and revenues are raised for government.

4.6.3 Spectrum Trading

Spectrum trading is a process whereby licensees may transfer some or all of their spectrum rights and obligations to another entity. A number of different forms of trading can be envisaged including:

- Leasing of rights to a third party for a specified period of time
- Change of ownership
- Change of ownership and reconfiguration of rights, e.g. partitioning or aggregation of rights
- Change of ownership, reconfiguration and change of use

Spectrum trading would allow broadcasters to trade the spectrum they are currently assigned. This would give them an incentive to bring forward the switchover date and to take actions that might support this outcome (e.g. marketing DTT, subsidising receiver equipment, putting their services on digital cable and satellite platforms).

The main argument for introducing spectrum trading is similar to that justifying the use of markets for trading other rights of access to scarce resources (such as land, oil and minerals), namely that it promotes economic efficiency. In particular, it is argued that by making rights tradable users have financial incentives to economise on spectrum use, spectrum will be reassigned to the highest value users and, if change of use is permitted, spectrum will be reallocated to the highest value use of spectrum in a timely manner. The efficiency benefits from trading are unlikely to be fully realised unless:

- tradable rights of access to spectrum are defined clearly and users are given adequate protection against harmful interference;
- transaction costs associated with undertaking trades are low relative to the value of trades. This requires current or potential users to be able to easily access information on the existing assignment of spectrum rights and any restrictions on those rights, and information on spectrum trades;
- costs associated with enforcing rights are relatively low;
- there are some safeguards against anti-competitive behaviour;
- NRAs provide sufficient information about their intentions concerning the future release of spectrum, as their actions can have a major impact on market prices and confidence in trading.

Establishing a system of tradable licences potentially involves a number of fundamental changes to the spectrum management regime that involve transferring decisions over spectrum use and enforcement from the NRA to users and moving the role of the NRA towards that of a market facilitator. In particular, users have primary responsibility for ensuring they operate free from harmful interference and for deciding amount of spectrum they use.

Few countries have implemented all the forms of trading listed above, except perhaps for simple change of ownership⁵². In the US the FCC has recently adopted spectrum leasing rules⁵³ under which licensees may lease part or the entirety of their spectrum rights to third parties. *De jure* responsibility for the licences sits with the licensee and *de facto* control may sit with either the licensee or the lessee, though FCC approval is required if the lessee has *de facto* control. These rules apply to some but not all broadcasting services – local TV services are included but local programme distribution services are not.

In Canada and Guatemala auctioned licences may be divided and transferred and in New Zealand and Australia all forms of spectrum trading are permitted for holders of spectrum licences⁵⁴, subject to compliance with the International Radio Regulations. Only in New Zealand is the trading regime fully applied to broadcasting services. This has resulted in numerous changes of ownership in radio broadcasting but few other changes. This lack of trading activity is not limited just to broadcasting services and reasons for this have recently been reviewed in a report for the New Zealand Government⁵⁵. Key issues have included the ready availability of spectrum, uncertainty over future spectrum releases by government and problems with the infrastructure required for a spectrum market (e.g. publicly available, up to date information on spectrum assignments).

The UK regulator has recently undertaken its second consultation on spectrum trading which included a proposal to extend trading to broadcasting services. The EU is currently carrying out its own separate study into spectrum trading.

4.6.4 Application of Spectrum Trading to Broadcasting

At present in Europe trading of radio and TV broadcasting generally only involves changes in ownership of broadcast licences, although there have been some instances where broadcasters have leased unused capacity in the broadcast signal for teletext or other data services.

⁵² Reviews of experience with trading are given in Implementing Spectrum Trading, Consultation Document, UK Radiocommunications Agency, July 2002; Implications of international regulation and technical considerations on market mechanisms in spectrum management, Aegis and Indepen for the Independent Spectrum Review, November 2001

⁵³ FCC Adopts Spectrum Rules and Streamlined processing for Licence Transfer and Assignment Applications, and Proposes Further Steps to Increase Access to Spectrum through Secondary Markets, FCC, May 15 2003. Report and Order and Further Notice of Proposed Rulemaking, FCC, October 6, 2003.

⁵⁴ In Australia apparatus licences are also tradable.

⁵⁵ Allocation and Acquisition of Radio Spectrum, Market Dynamics and Moore Wright Associates for the Ministry of Economic Development, April 2003.

Trading will only provide further potential benefits if broadcasters have some flexibility in their spectrum use. While this flexibility is limited in an analogue environment – partly by regulation and partly by international agreements on the location of high powered transmitters – this need not be as restrictive in a digital context where there is potentially more technical flexibility. However, an effective trading environment will depend on a reasonable degree of flexibility in the planning process, such as the use of the “spectrum mask” concept and allotment rather than assignment planning (see Section 5.2).

It may also be the case that for many non-core general interest services coverage obligations may be relaxed or removed altogether – more like the situation for satellite services – in which case broadcasters will have freedom to configure their services to meet their commercial objectives and to change this configuration over time in response to changes in market demand.

Trading of broadcasting licences could also offer benefits in the context of the migration from analogue to digital TV broadcasting if broadcasters’ current spectrum assignments were made tradable and had a duration that extended well beyond switchover. If current assignments were made tradable then broadcasters would have an incentive to speed up the transition process so that they could free up spectrum for trade with third parties post-switchover⁵⁶. To be of value the licences would need to have a duration that extended at least 5 and probably 10 years beyond switchover.

There are a number of issues with implementing tradable licences including:

- “Free rider” problems – switchover will only be accelerated if all broadcasters in an area work together. If one broadcaster in an area subsidised set top boxes as a means of promoting switchover and thereby releasing spectrum for trade, then other broadcasters in the area will also benefit as they will be able to release spectrum for trade earlier than would otherwise be the case. Each individual broadcaster benefits from the actions of others to promote digital take-up and so will wait for others to make the first move. The way to overcome this problem would be for the broadcasters to club together to jointly take actions that will accelerate switchover and so enable them to trade their spectrum earlier than would otherwise be the case.
- Interleaved analogue assignments - the spectrum currently occupied by broadcasters is designed to avoid interference in an analogue broadcasting environment and this may not be an appropriate configuration for providing digital TV or other services. An intermediary, say government or the broadcasting industry acting collectively, may need to repackage the spectrum for trading purposes as a means of reducing transaction costs.

⁵⁶ This assumes, as seems likely, that broadcasters’ current assignments would be sufficient to meet their obligations in a digital environment.

- Release of unassigned analogue spectrum – interference between analogue services means that it is not possible to assign all frequencies to TV services. Some of the spectrum is idle while other parts are used by SAB/SAP services. Interference constraints are less severe in a digital environment and so more of the spectrum can be used in more locations. Plans for the release of this spectrum that is currently held by government/used by SAB/SAP services would need to be publicised well in advance of their release so that they did not undermine broadcasters' trades.
- Windfalls – broadcasters may make large windfall gains from trading spectrum and this may not be politically acceptable. This could be addressed through the application of capital gains taxes to spectrum trades.

On balance it seems likely that trading by broadcasters would need to take place within a spectrum use framework set by government and broadcasters may need to co-ordinate their spectrum release and migration plans if large transaction and consumer costs are to be avoided.

Comment

It is argued by economists that as a general rule market participants have better information about likely future market developments than governments. This suggests that a market approach to switchover, with suitable constraints to reflect universality objectives, may be more appropriate than one based on government decision making. However, as we have discussed, in this case markets may fail to provide the best outcome because of free rider and transaction cost issues unless broadcasters in an area club together to co-ordinate their actions to promote switchover and to clear spectrum and repackage spectrum into tradable blocks.

4.7 Future Use of Broadcasting Spectrum

4.7.1 Introduction

In Section 3.7, we described a number of services that might make use of broadcast spectrum post-switchover. The key point is that the demand for each of these services at the time that switchover is likely to occur – probably beyond 2010 in most Member States - is highly uncertain. The most promising new application currently is probably IP datacasting (see Section 3.10), which could be readily accommodated within the DVB planning process.

It has been argued by some that all of the spectrum currently allocated to analogue broadcasting services should in future be allocated to digital broadcasting services on public interest grounds. While it is certainly the case that consumers derive significant benefits from existing TV services, it is not obvious that the benefits from assigning the spectrum to additional terrestrial TV services in say 2010 exceed those that may derive from other services. For example, in the UK it has been

found that consumer surplus values are higher for future mobile services than future TV services⁵⁷. The answers may however vary between Member States depending on the current state of the TV market (notably cable and/or satellite penetration), service demands (e.g. mobility or portability) and policy priorities.

The spectrum planning framework will need to be highly flexible to cater for the many variants of the DVB-T standard (as much flexibility is required for effective delivery of mobile digital TV services as for delivery of other multimedia services such as IP datacasting). It is possible that other communications services, such as bi-directional fixed or mobile telecommunications could be deployed in the released spectrum so long as emissions were within the interference parameters prescribed by the DTT planning process. There appears to be little if any commercial interest in using broadcasting spectrum directly for bi-directional applications, however its value in support of these applications where the return link is in other bands (e.g. by providing greater capacity for the downloading of material to mobile terminals) could be significant.

Decisions concerning spectrum use post-switchover should in principle be made several years in advance of switchover to enable the market to respond accordingly. The timing decision involves a number of trade-offs. The longer one waits the more information will be available about consumer demands and new technologies and so it is more likely that the services chosen will be those that maximise the benefits from use of the spectrum. However, it is also important that manufacturers and service providers are given clear signals concerning the allocation of the spectrum so that they have sufficient time to develop equipment and services and have sufficient certainty concerning spectrum availability in different Member States to make the associated investments. For example, the example of IPDC given in Section 3.10.6 illustrates that there can be up to a 10 year lead-time on service development and that spectrum needs to be available to undertake trial services at an early date.

As with the timing of switchover, choices concerning the use of spectrum post-switchover could be made through administrative processes or through the market. The cost/benefit approach to government decision-making outlined in Section 4.2.3 could be applied to decide which services might be assigned spectrum post-switchover. Alternatively, spectrum use decisions could be made by the holders of spectrum licences subject to constraints implied by the emission parameters defined by the DTT planning process.

4.7.2 How might the spectrum be assigned post-switchover?

There are three sets of interrelated choices that need to be made concerning the assignment of the spectrum released at switchover. These are:

⁵⁷ Cost Benefit Analysis (CBA) of Digital Switchover, September 2003 op cit

- i) Whether the services that will use the spectrum should be specified in advance;
- ii) Whether a competitive assignment process is used to assign the spectrum; and
- iii) If a competitive process is used, whether it is a beauty contest or an auction.

These are addressed in the following sections.

4.7.2.1 Services

Whether the nature of services will be prescribed depends on the general approach to making spectrum management decisions. Market based approaches are typically less prescriptive than those directed by administrative decisions. We have already noted that there may be advantages in not being too prescriptive because of the uncertainty concerning which uses of the band may offer the most value. However, some certainty over the interference and any other regulatory constraints within which future services will have to operate will be necessary so that technology and service developers can start to invest in the development of equipment and services. This should be provided by the planning framework agreed at RRC-04/06.

Examples of less prescriptive approaches can be seen in the UK and the US. In the UK the concept of *general multiplexes* has been introduced into the Communications Act 2003. The Act defines a general multiplex in the following way:

*“...a wireless telegraphy [i.e. spectrum] licence containing terms, provisions or limitations by virtue of which the services for the purposes of which the use of the licensed station or apparatus is authorised are confined to, or are allowed to include, one or more multiplex services; and [where...] there is no licence under Part 1 or 2 of the 1996 [Broadcasting] Act in force in respect of a multiplex service to be broadcast using that station or apparatus”.*⁵⁸

This effectively means that the multiplex could be used to deliver services or content that fall outside the scope of broadcasting regulation.

In the US, the upper part of the UHF TV spectrum has been designated for “generalised wireless services” which may include fixed, mobile and broadcast services. In Europe, many such services could be delivered by means of DVB technology, ensuring compatibility with broadcast services, however the US digital broadcast standard does not provide this flexibility and it is unlikely the US broadcast community would acquiesce to the use of an alternative broadcast standard.

⁵⁸ Section 175(5)

Over the longer term, international moves towards more flexible allocations may also take place; these are addressed in the next chapter.

4.7.2.2 *Whether to use a Competitive Assignment Process*

With the exception of general interest broadcasting where special public interest considerations arise, a non-competitive assignment process is unlikely to be consistent with “encouraging efficient use of radio frequencies” as there is no way of ensuring that the spectrum has been assigned to a user that will make efficient use of the spectrum in either a technical or an economic sense. Furthermore such an approach could be said to be discriminatory and so contrary to the requirements of Article 5 of the Authorisation Directive. It is therefore assumed that rights for commercial users must be assigned competitively.

There are two main competitive approaches that may be adopted – beauty contests and auctions. The pros and cons of these are discussed in Annex B. The approach taken will depend to some extent on the flexibility in spectrum use. If a very flexible approach to the use of the spectrum is adopted then beauty contests are likely to be difficult to implement as there is unlikely to be a common basis for comparison between tenders. In these circumstances auctions provide a common, financial basis for comparing bids to use the spectrum for different services and provide an incentive for successful bidders to use spectrum in an economically efficient way.

4.7.2.3 *Catering for Innovation*

The approaches to assigning radio spectrum described in Annex B (auctions, beauty contests, first-come first served) apply where there is an established allocation or designation of spectrum for a particular application, such as mobile telephony, private mobile radio or microwave links. As we have already seen, the approach to gaining access to spectrum for new, innovative applications is less straightforward (see Section 2.2.5).

In principle, innovation could be encouraged by administrative decisions such as making available spectrum for experimentation with non-operational systems or offering preferential access to spectrum for companies with innovative service ideas. Most NRAs have some provision for licensing spectrum for test and development purposes; however these do not generally permit the provision of commercial services. Some NRAs are willing however to convert such licences into full operational licences once the feasibility of the proposed application has been demonstrated.

Whilst test licences may be useful to demonstrate technical feasibility, offering licences to market-test innovative services may be problematic. Competition issues need to be carefully considered – is the administration giving fair and non-discriminatory access to spectrum? Similarly, careful consideration needs to be given to the consequences of the service either succeeding, and so potentially requiring additional spectrum, or being a lukewarm success, and so occupying spectrum that might be more productively used by others.

From 1991-1998, the US FCC offered preferential treatment in its licensing process to parties developing spectrum using new communications services and technologies through what were called *pioneer's preference* licences. In 1994 the scheme was modified in a number of ways, including the addition of a requirement to demonstrate that the applicant could not capture the benefits of innovation other than through being awarded a pioneer's preference licence. Of the 140 applications for these licences only 5 were granted. The scheme was terminated in 1998 because of conflicts with domestic implementation of GATT legislation.

An example of a similar approach in Europe was the recent licensing of 10 GHz fixed wireless access networks in Denmark. In this case, an operator approached the NRA with a proposal to trial a system for providing rural broadband communications, using spectrum already allocated internationally to the fixed service but not at that time being used in Denmark. The regulator was invited to observe the trials and after three months agreed to grant the operator a full licence. Further licences have since been offered on a first come, first served basis.

Although a "one-stop-shop" facility has been established in Europe for certain existing categories of spectrum licence (notably satellite), no such facility exists for an applicant seeking an opportunity to access spectrum for a new application on a pan-European basis. However, many potential new applications are likely to fall within the scope of existing initiatives by CEPT, such as the designation of potential bands for fixed wireless access which include the 10 GHz band referred to above. ITU allocations and the CEPT common allocation table provide the basic framework within which individual NRAs can seek to accommodate new services and, if these services are successful on a national basis, provide scope to develop the services in other European countries subject to co-existence with other services.

Developments such as spectrum trading may provide a further route to the acquisition of spectrum on a national basis but the application of different approaches to spectrum management in different Member States mean it is unlikely that this would enable a common allocation to be obtained throughout Europe. Such allocations are likely to fall into two main categories in the future, i.e. spectrum designated for specific licensed applications, such as UMTS or multimedia wireless services (MWS), and licence-exempt applications such as wireless local area networks and short range devices. There are signs currently of increasing growth in the latter, since the costs involved in gaining access to spectrum and rolling out network infrastructure are relatively low and only a general authorisation is required.

Care must be taken by NRAs to ensure that when granting individual rights of use for spectrum the requirements of the Authorisation Directive are complied with. This is particularly important where there is a possibility that the number of rights of use that can be made available will have to be limited. Article 7 of the Directive requires Member States who are considering limiting the number of rights of use to consult all interested parties and to grant rights of use on the basis of selection criteria that are objective, transparent, non-discriminatory and proportionate. This effectively

prevents the application of a “pioneers’ preference” approach to spectrum access where there is a spectrum scarcity, although such an approach could be followed where there is not considered to be a likelihood of such scarcity. This is effectively the route taken by Denmark in the example referred to above.

4.8 Conclusions

In Europe governments have so far adopted an administrative approach to determining the timing and mechanism for switchover in consultation with broadcasters. We have suggested that this should involve an assessment of the costs and benefits of switchover at different dates and attempts should be made to quantify these costs and benefits. The costs and benefits should be the subject of public consultation. This will ensure all options are considered fully and as far as is possible decisions are informed by objective information.

A more market-based approach has been adopted in the US. This in effect passes the cost/benefit trade-offs to third parties subject to the constraint that switchover cannot occur before certain digital TV access criteria (which are not platform specific) have been met. Such an approach could be applied in European Member states once the pan-European interference environment in which services will operate has been clarified at the RRC. Of course governments may have specific policy objectives they wish to achieve through specifying the spectrum use (e.g. expanding the scope of general interest broadcast services) in which case the role for market approaches will be more limited. In addition, some degree of government intervention may be required so that common frequencies are available throughout Europe for new services.

To the extent that these policy objectives are achieved through targeted policies, such as universal service and content obligations and government funding of public broadcasters (e.g. through taxes or licence fees) then the role of spectrum management in achieving these objectives could be reduced. This is not the approach that is taken at present where broadcasters’ access to spectrum is coupled with the award of broadcasting licences, each of which may have different coverage and content obligations. In a digital environment in which many new commercial services may be provided there is potentially the scope to decouple broadcasting and spectrum licences. In this situation broadcasting licences would be subject to common conditions (e.g. a required percentage of European content and negative content regulation) and any coverage obligations would attach to the spectrum licence.

5 SWITCHOVER AND THE SPECTRUM PLANNING PROCESS

5.1 Introduction

The EU is keen to ensure that flexibility and support of innovation are catered for in the spectrum planning process. The aim should be to achieve a horizontal, multi-sector approach to the future planning of broadcast spectrum. This should not favour the interests of any specific sector with regard to spectrum access, beyond the extent that may be justified by general interest objectives.

The detailed planning procedures for the broadcast frequency bands post-switchover will not be determined until the completion of the Regional Regulatory Conference (RRC-04). However, regardless of the approach adopted, the band will continue to be planned on the basis of the existing 8 MHz channel raster used for analogue television broadcasts and will involve the assignment or allotment of channels to cover specific geographic areas within Member States' territories. It will remain feasible to accommodate non-broadcast radio transmissions within this plan if this does not cause interference to broadcast services in neighbouring countries. It is also feasible in the longer term (once analogue services have ceased) to consider allocating part of the spectrum to other services: indeed the possibility of allocating the spectrum above 806 MHz to mobile services is already a draft agenda item for the 2010 World Radio Conference.

The definition of broadcasting in international regulatory terms is broad: according to Radio Regulations Article 1.38 the broadcasting service is defined as:

“A radiocommunication service in which the transmissions are intended for direct reception by the general public. This may include sound transmissions, television transmissions or other types of transmission”.

This definition would allow for future converged services like datacasting.

5.2 Building Flexibility in the Planning Process

As we have seen there is growing interest in the potential to deploy new, converged services in broadcast frequency bands, but there is also considerable uncertainty about how and when such applications might reach the market. A flexible approach to spectrum planning is therefore essential in terms of facilitating rather than constraining development in such a dynamic market place. The planning processes being considered in preparation for the forthcoming RRC include measures intended to provide such flexibility. Two key measures are described in the following sections. An update on preparations for the RRC itself is presented in Section 5.3 below.

5.2.1 “Spectrum Mask” concept

Considerable flexibility can be achieved through the use of the spectrum mask concept in which, although the spectrum is nominally planned on the basis of DVB-T use, other services may be implemented providing:

- i) they cause no more interference than would have been caused by a DVB-T transmission; and
- ii) they demand no greater protection than would be afforded to a DVB-T receiver.

The masks used for planning purposes will take into account the transmitted spectrum of the DVB-T signal, as well as the filter characteristics of the receiver. An example is shown below.

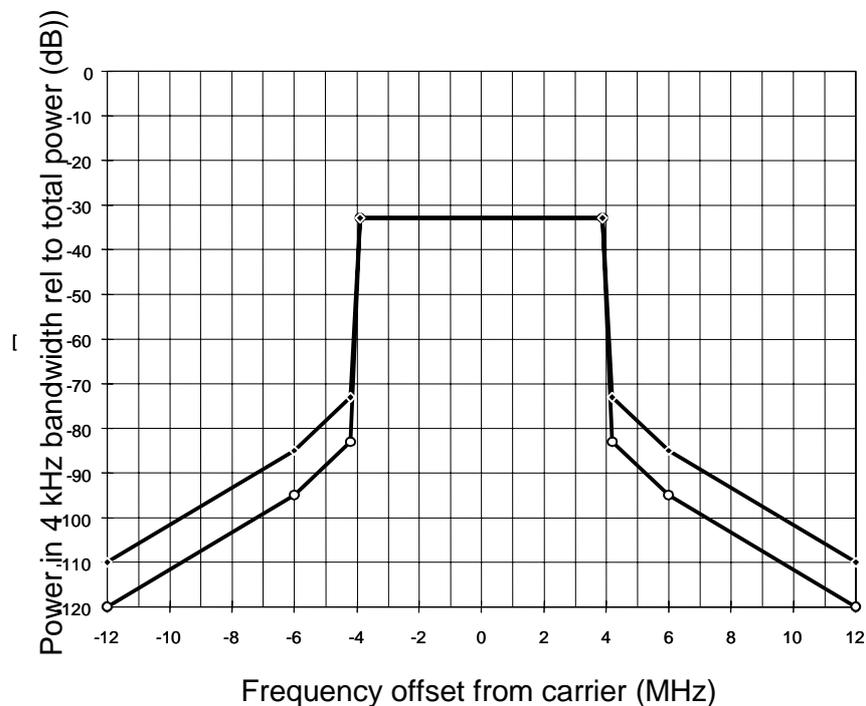


Figure 5.1: Example of a DVB-T “Spectrum mask”

5.2.2 Assignment and Allotment Planning⁵⁹

The assignment planning approach which was used historically for analogue TV services can be simplified by assuming that the protected area around each transmitter is a circle of constant radius and that interfering transmitters all have similar characteristics and must be located at a minimum distance to ensure that interference does not arise. This results in a “lattice” pattern (see diagram), in which

⁵⁹ For a more detailed discourse on allotment and assignment planning, see “Revision of ST61”, by Nigel Laflin, in the EBU Technical Review, April 2002 (http://www.ebu.ch/trev_290-laflin.html)

the individual transmitters are then shifted to the locations actually required and the transmission parameters tailored to the required service area. After negotiation with neighbouring countries, the data pertaining to the actual locations forms the basis of an agreed assignment plan. This process requires detailed knowledge of the actual network configuration (locations, powers etc) during preparation of the plan. Any subsequent change to an assignment requires negotiation with neighbouring countries to ensure that interference is not caused to other assignments. In practice, this negotiation can be a lengthy and complex process and would be particularly unwieldy if a single high power assignment were to be replaced by a network of low power transmitters.

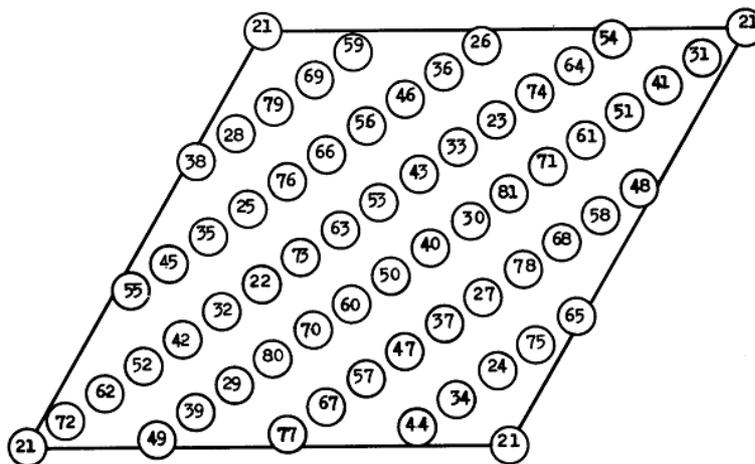


Figure 5.2: Geographical Lattice pattern used for planning analogue TV assignments (from the Stockholm Agreement 1961)

The allotment of a radio frequency channel is defined in the Radio Regulations (S1.17) as:

“Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions.”

The allotment plan provides a frequency for each allotment area. At the allotment planning stage, in general nothing is known of the actual location of the transmitter sites, or of the specific transmission characteristics to be used. The only parameters available are a definition of the area to be covered and the channel to be used. For planning purposes, it is necessary to define some reasonably realistic reference transmission conditions so that any necessary compatibility calculations can be made. These reference conditions may take the form of a “spectrum mask” as described above. To implement networks within an allotment it is necessary to convert the allotments into individual transmitter assignments, but these do not need to be co-ordinated with other countries unless the pre-defined interference limits for the allotment are exceeded.

Allotment Planning essentially involves defining a hypothetical reference network which is used to specify the interference limits (imported and exported) at the boundary of each allotment area. A typical reference network has a regular geometric structure, for example a hexagon or a square, within which are located reference transmitters with specified reference parameters, such as radiated power, antenna height, etc. These parameters are chosen to provide coverage meeting the expected quality, data rate, location probability, etc, within the allotment area, whilst minimising the overall interference potential.

Reference networks are typically a compromise between the density of the transmitters required to support the desired coverage and the potential to re-use the same frequency in other geographic areas. Once the complete reference network is defined its interference potential is calculated, using appropriate software models. The reference network does not dictate how the allotment is used in practice other than by defining the interference limits that must apply.

5.2.3 Terrestrial Wireless Interactive Multimedia Services (TWIMS)

TWIMS is a concept that is currently being addressed within the ITU reflecting a Resolution (No. 737) generated at WRC-2000, which sought to “review spectrum and regulatory requirements to facilitate worldwide harmonisation of emerging TWIM applications. A joint working group set up by the ITU concluded that there were no regulatory impediments to the introduction of such services. TWIM services have been included on the preliminary agenda for WRC-2010 and a Recommendation was adopted at WRC-2003 for ITU-R to “continue its studies on the technical, operational and frequency issues and identify any regulatory impediments that may arise in relation to the introduction of TWIM applications on a global basis”.

5.3 The Regional Regulatory Conference 2004 (RRC-04)

5.3.1 Background to RRC-04

The ITU is holding an RRC in two stages in 2004 and 2006 to address the re-planning of the existing “Stockholm plan” which underlies the planning of radio services in the VHF and UHF TV broadcasting bands (III, IV and V). According to the Chairman of ECC Project Team FM24, which is co-ordinating European Common Positions for the RRC, the new plan adopted by the RRC must be sufficiently forward-looking and sufficiently flexible to cover developments in digital technology in future years⁶⁰. A number of planning approaches are being pursued by PT FM24 to ensure that such flexibility is achieved in practice and include the spectrum mask and allotment planning approaches described in the previous

⁶⁰ These points were made by the PT Chairman in a contribution from the PT to ECC ad-hoc group WGF/CPG-PT1 in November 2002

sections. It should be noted however that the area covered by the plan is not just Europe but also includes Middle East, Africa and former Soviet Union.

The RRC is essentially a technical forum that will focus on planning criteria for digital broadcasting and any other services that participating administrations have identified as requiring protection within the relevant frequency bands. It is not intended to address policy issues nor has it been tasked with considering any changes to the status of the frequency allocations in the Radio Regulations. Such considerations are the remit of the World Radiocommunication Conferences to be held in 2007 and 2010. Nevertheless, the RRC has required national administrations and other stakeholders to focus on their plans for digitisation and therefore provides a timely opportunity for the Commission to develop a policy position on broadcast spectrum management. The Commission may also wish to use its influence to ensure that the technical planning approaches developed at the RRC provide maximum flexibility within the existing allocation framework and do not unduly constrain the application of market mechanisms in the frequency assignment process.

The next section provides an update on the latest European proposals, as addressed at the ECC FM-PT 24 meeting held in Zagreb in October 2003.

5.3.2 Update on European RRC Proposals

The CEPT has agreed a number of European Common Proposals (ECPs) that will be put forward at the RRC. These are summarised in Table 5.1 below.

ECP	ECP Title	Summary
1	Frequency planning for the digital terrestrial broadcasting service for RRC 04/05	Plan to include DVB and DAB in Band III, DVB only at UHF (bands IV/V). 8 MHz channels to be used at UHF.
2	Time schedule	Requirements to be submitted at least 3 months before second session of RRC, which should take place in early 2006. The new plan should enter force within 6 months of the RRC 06.
3	Basis for the report to the second session of the Conference	The ITU Task Group 6/8 report should form the basis for the report of the by RRC 04 to RRC 06.
4	Plans connected to the Agreement	The agreement will embrace new plans for DVB and DAB in Band III, DVB at UHF and existing Stockholm 61/ Geneva 89 analogue plans.
5	Planning scenarios	The principle of 'equitable access' shall be adopted. Systems other than T-DAB & DVB-T may be used provided they cause no more interference than systems in the plan. Both allotments & assignments catered for. Different planning scenarios to be used in different areas.
6	Consideration of planning methods	The planning method should be able to cater for, record and convert between allotments and assignments. The method will include 'compatibility analysis' and 'plan synthesis' phases. Mutual compatibilities may be agreed on a bilateral basis.
7	Coexistence of T-DAB and DVB-T in Band III	The whole band is available to both services, but preference may be given to DAB in the 216-230 MHz band.
8	Transition from Analogue to Digital Terrestrial Broadcasting	Existing analogue assignments (GE89/ST61 or MIFR) may form the basis for requirements. Procedures shall be developed for the interim protection of analogue services.
9	DVB-T network structures and reception modes to be used in frequency planning for RRC 04/05	Planning shall allow for the use of MFN, SFN or a mix of the two. Planning shall allow for fixed, portable (outdoor/indoor) and mobile reception modes.
10	T-DAB network structures and	Planning shall assume SFNs and a location probability of 99%.

	reception modes to be used in frequency planning for RRC-04/05	
11	Channel bandwidth and channelling plan for T-DAB in Band III	Channelling shall be as defined in the relevant ITU-R Recommendation.
12	Technical criteria for DVB-T and T-DAB allotment planning	Defines the parameters and criteria to be used in planning.
13	Field strength prediction method for Band III	Propagation model for Band III should be based on ITU Recommendation P.370 (for compatibility with Wiesbaden 95 plan)
14	Protection of analogue and digital broadcasting in the preparation of the digital plan	Existing & planned assignments need not be taken into account in developing the new plan.
15	Data related to broadcasting required for the RRC	Defines the input required from administrations when submitting requirements (fixed/mobile, coverage, SFN / MFN, etc).
16	Consideration of Other Services	Services with primary status, and radio astronomy should be considered in planning. Data on other services shall be submitted at least 9 months before RRC 06.

Table 5.1: European Common Positions for RRC-04 (as at October 2003)

By allowing for the full range of DVB transmission modes and allowing for the use of allotment planning, a high degree of flexibility is anticipated which would extend not only to the use of the band for broadcasting but also for the deployment of other point-to-area or point to multipoint systems such as mobile or fixed wireless access should these be required in the longer term.

5.3.3 Equitable Access

A key objective of the RRC is to ensure “equitable” access to spectrum resources for individual countries (see ECP 5). The approach being taken to achieve this is to ensure that each country has sufficient “protected” spectrum to cater for a specified minimum number of “national coverages” of DTT, where each “national coverage” refers to a single DVB-T multiplex that can be received substantially throughout the national territory using a typical network of high power broadcast transmitters. Whether all of these national coverages are used for digital television is for each national administration to decide – some of the spectrum may be used for other applications so long as this does not lead to greater interference being produced or a higher level of protection being required.

The WGFM meeting in Bratislava had considered equitable access, and the ways in which this might be ensured. Two groups of opinion were apparent:

- i) All administrations should be allowed the same number of coverages (i.e. the lowest number of possible coverages available in the planning area), with more negotiated on a bilateral basis where possible.
- ii) Number of coverages to be agreed bi- or multilaterally, with administrations urged to reduce or modify their requirements where necessary (i.e. on obligation).

EBU Report BPN 038 illustrates the spectrum requirements for a wide range of different planning scenarios, noting that:

- Rooftop reception requires less spectrum than portable reception
- Spectrum requirements for portable reception can be reduced by accepting
 - lower location percentage
 - lower pixel coverage
 - use of SFNs
- MFNs require a similar amount of spectrum compared to small SFNs (less than about 50 km diameter)
- Larger SFNs require less spectrum than MFNs
- Larger SFNs show better spectrum usage than small SFNs
- Modulation 64QAM and 16QAM require a similar amount of spectrum expressed in total bit rate of all multiplexes in most practical cases.

If an administration requires that other services be protected, it must accept that fewer coverages will be possible.

CEPT's Working Group on Frequency Management (WGFM) suggested that a compromise might be to adopt option (i) above, but with the change that the default number of coverages is a mean not a minimum. To determine such a default number, a common basis for planning must be assumed: it was proposed that rooftop reception with 64 QAM in an MFN might be appropriate.

5.4 Achieving Flexibility in Practice: Finland's experience

In 2002 the Ministry of Transport and Communications in Helsinki decided to reserve a DTT multiplex specifically for mobile transmissions and initiated trials of an IP Datacast network in Helsinki. Frequency planning for the network began in Spring 2002. Frequency negotiations with Sweden were concluded in December 2002 and at the time of writing negotiations with other neighbouring countries (principally Russia, Estonia and Norway) were still underway but were expected to be concluded by early 2004.

Currently, international coordination is based on the use of transmitters that are as powerful as possible (the traditional approach to wide area broadcasting). Coordination criteria and calculation methods have not yet been internationally adopted for other types of network in the broadcast bands. This means that any subsequent modifications, such as the addition of low-power gap-fillers to enhance coverage would require coordination with Finland's neighbours. This should not give rise to any particular problems, provided that the interference levels now agreed are not exceeded.

However, this would be administratively burdensome if an alternative approach to planning a DVB network (e.g. a cellular plan) were to be adopted, since every transmitter would require individual co-ordination. This should be alleviated by the adoption at the forthcoming RRC of an allotment based approach to planning,

whereby a particular geographical area is allotted a frequency band that can be used comparatively freely within certain technical limits.

The current trial network under coordination is based on a broadcasting-type approach using high-power transmitters complemented with gap-fillers. Such a network can reach only about 70% of the population due to the lack of frequencies while analogue services remain, but if necessary FICORA believes it would be possible to complement the network with low-power transmitter cells in areas where it is not possible to coordinate frequencies for high power transmitters.

FICORA's view is that IP datacast does not need any special consideration in the forthcoming RRC. However, they confirm that allotment planning would give much more flexibility in establishing any new kind of services in DVB-T / DVB-H networks. It would be laborious to coordinate at least IP datacast-type networks assignment by assignment as the number of gap-fillers (or in a small-cell approach low-power main transmitters) is expected to get quite large.

The Ministry considered that a DVB-T network based on high-power transmitters alone would not be sufficient to ensure adequate coverage for mobile devices. A hybrid network is therefore proposed, based on regional SFNs. In each SFN, high-power transmitters will be supplemented with gap-fillers using the same frequency. The same broadcast received from several different sources in an SFN area can be added together using 'diversity enhancement' to achieve a sufficiently good signal level.

The working group envisages a future system of personal wireless handsets that would also function as mobile phones, making use of the existing mobile phone networks to do so. The development work needed to bring about such a system would be investigated by the terminal manufacturers once the conditions are in place for the infrastructure to be established. No plans have yet been published for bringing such devices to market.

5.5 Looking to the Longer Term

The continuing presence of analogue broadcast services and current market uncertainty over how broadcast and other wireless communication services will evolve over the next few years necessitates a flexible approach to the management and use of existing broadcast spectrum. Over the longer term, once analogue services have ceased in a number of Member States and when the new 3G mobile networks have reached maturity, it may be appropriate to reconsider the international status of this spectrum, perhaps with a view to the harmonised introduction of new mobile or convergent multimedia services. It may even be concluded that the current service definitions such as mobile, broadcast etc are no longer appropriate and should be replaced by alternative definitions that reflect the physical characteristics of spectrum use, e.g. whether point to point or point to

area⁶¹. Such deliberations should be pursued within the CEPT in the context of preparations for future WRCs.

Work is already underway within CEPT to develop positions for the 2007 WRC, whose agenda includes an item "to consider frequency-related matters for the future development of IMT 2000 and systems beyond IMT 2000 taking into account the results of ITU R studies". This provides an opportunity, as part of the preparations for the WRC, to consider potential future requirements for 3G mobile frequencies below those currently allocated (i.e. below 806 MHz). In particular, industry and regulators should consider whether there is likely to be a requirement for paired, duplex spectrum to support wide area mobility using FDD technology. If such a need is identified, technical and market studies should be initiated to determine the amount of spectrum that would be required to cater for upstream and downstream services and where this should be located in the spectrum. In the meantime, in order to maximise long-term flexibility within the broadcast bands, the EU should work with CEPT and other like-minded international bodies to promote the adoption of a global co-primary allocation to the mobile service in these bands at the WRC.

The draft agenda for WRC 2010 includes two specific items of interest to the current study, which would be more appropriately addressed in the context of preparations for WRC 2007, namely:

- i) consideration of allocations to the mobile service in the band 806-862 MHz in Region 1 (including Europe) following the transition of analogue to digital TV; and
- ii) reviewing ITU-R studies concerning the development and regulatory requirements of terrestrial wireless interactive multimedia applications and taking any appropriate action on this subject.

The latter item could include a review of the allocation definitions, to reflect service evolution and convergence, as discussed above.

⁶¹ Such a distinction would reflect different technical criteria such as the use of highly directional antennae for point to point services which make them unsuitable for sharing spectrum with point to area services such as mobile or broadcast.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

Switchover and convergence provide an opportunity for European economic growth, job creation and social development. Regulatory policies need to create and maintain the right conditions to let this happen. In its recent Communication on Switchover⁶², the Commission concluded that:

- i) Market forces and consumer demand must drive broadcasting digitisation
- ii) Member State policy interventions should be transparent, justified, proportionate, non-discriminatory and technologically neutral.

The Commission considers that policy intervention should take place firstly at national level, but that a role exists for the EU in relation to internal market aspects of switchover. Possible EU contributions highlighted in the Communication include benchmarking, equipment standards, consumer information, facilitating and promoting access to value added services. The Commission notes that intervention by public authorities is justified under two premises, namely⁶³:

- a) where general interests are at stake (social, cultural, political, economic, etc) or
- b) in the case of market failure (i.e. where market forces alone fail to deliver in terms of collective welfare).

A role for the EU could also arise because of need to promote European objectives (e.g. stimulating the internal market), to reduce uncertainty or to deal with co-ordination issues arising from complementarities between transmission and content and externalities such as cross-border interference. In the following sections we consider the potential roles that the EU might play in shaping switchover and spectrum management policies within Europe. Two broad policy areas are considered, namely facilitating switchover and helping Member States and the market to make the most of the opportunities offered by switchover, spectrum release and convergence.

In developing the following recommendations, we have recognised that Member States' national policies with regard to issues such as pluralism and diversity are likely to differ widely, as is the state of development of the television market (especially cable and satellite penetration). However, we believe there are broad policy areas that are relevant throughout the EU and that opportunities may exist for

⁶² "Communication...on the transition from analogue to digital broadcasting (from digital switchover to analogue switch-off), COM(2003)541, 17/9/03

⁶³ COM(2003)541, page 9

the Commission to support Member States in achieving the maximum benefit from the switchover process.

6.2 Facilitating Switchover

The potential benefits of switchover need to be balanced against the associated costs and any general interest objectives related to expansion of DTT services in individual Member States. Early switchover will inevitably incur higher costs and if there is no immediate demand for spectrum the benefits may be limited.

Recommendation 1: Benchmarking

There is a clear role for the EC in benchmarking progress in Member States, both against themselves and other industrialised countries such as Japan and the USA. Benchmarking could serve a number of purposes including:

- Providing information to Member States on different approaches to stimulating take-up of digital TV;
- Indicating where markets are failing to provide the relevant equipment and services at a reasonable cost (and possibly also reasons for this);
- Providing information to industry on new opportunities for equipment and services based on experience in other countries;
- Providing information that the EC could use in developing best practice guidance and to inform policies on DVB.

Information that could usefully be collected includes:

- Digital broadcasting take-up by platform;
- Digital receiver/STB sales, both in absolute terms and as a percentage of all receiver sales;
- Number of suppliers of digital receivers and the price/size range for which digital equipment is offered;
- Number, type and cost of services offered – pay TV, free-to-air TV, mobile TV, DAB, data etc;
- Key drivers of take-up.

This would require common information requirements to be specified for Member States and then this would be compared with information that can be obtained from the US and Japan. Benchmarking could be done as part of the e-Europe monitoring process and we suggest that a useful starting point would be assessing Member States' compliance with the eEurope Action Plan requirement to publish by the end of 2003 their intentions regarding switchover. We note that the Commission is already committed to continue gathering data on the EU digital TV market on a

yearly basis, as it did in 2001 and 2002 as part of its annual implementation reports on the communications regulatory package⁶⁴.

Recommendation 2: Costs Benefits Analysis

The costs and benefits associated with switchover are likely to vary significantly between Member States, depending on factors such as:

- Penetration of cable and satellite platforms
- Geographic terrain
- Extent of network reconfiguration required
- Service requirements (e.g. coverage, portability, mobility).

The date chosen for switchover should ideally be that when the net benefits are maximised. Member States should be encouraged to undertake cost-benefit analyses, which should be informed by market research to establish user preferences and willingness to pay for particular service attributes, e.g. in relation to choice of platform for universal service or introduction of new services like mobile TV. The recent Communication on Switchover noted the current uncertainty regarding consumers' willingness to pay for new features such as interactivity or convergent services⁶⁵.

Since both attitudes to digital TV and the associated transmission and reception costs are likely to change significantly as the market develops it will be important to update these analyses on a regular basis (at least every 2 – 3 years). While there are clearly considerable uncertainties associated with the results of such analyses they allow a more informed debate concerning switchover decisions than would occur without the information and thereby aid transparency.

Recommendation 3: Promoting Consumer Awareness

We referred in Section 4.4 to the challenge faced by broadcasters and regulators in achieving universal migration to digital, in particular the reluctance of some viewers to migrate on the grounds that they do not perceive there to be sufficient benefit. The problem is compounded by the limited availability of integrated digital TV receivers and a lack of information about future switchover and the impact it might have on the long term utility of analogue TV receivers at the point of sale. There are two potential approaches to dealing with this issue, namely to take action to require manufacturers to incorporate digital receivers in the future, or to ensure that consumers are made fully aware at the point of purchase whether the set does or does not have an integral digital tuner, and the implication of this in terms of the need for additional equipment when analogue services cease.

⁶⁴ COM(2003)541, page 13

⁶⁵ COM(2003)541, page 7

In August 2002, the US Federal Communications Commission (FCC) ruled that digital tuners must be installed in new sets sold in the US, starting with large screen models. At the time of writing, this decision had just been upheld by the US Court of Appeal following a legal challenge by the industry-backed Consumer Electronics Association. According to the appeal court judge, the ruling will make the purchasing of DTV equipment more appealing for consumers.

The more fragmented nature of the European market may make such an interventionist approach inappropriate and may also run counter to ensuring a technologically neutral approach to switchover. The Commission has already stated that it does not consider it appropriate, taking account of subsidiarity and the specificities of national broadcasting markets, for the EU to mandate digital receivers⁶⁶.

We would therefore favour the implementation of a universal labelling scheme making clear to consumers at the time of purchase whether or not the TV set was already digital enabled and if not stating clearly what the options available to upgrade are (e.g. plug-in module, set-top box etc). The scheme should also extend to other receiving equipment such as video recorders. Similar schemes have been successfully applied to support other EU policy initiatives relating to consumer goods, such as the promotion of energy efficiency for washing machines and refrigerators.

This would increase consumer awareness of digital services and be likely to spur manufacturers to incorporate digital tuners, or at least provide optional “plug and play” upgrades. The information provided at the point of sale could also be used to highlight the benefits of digital reception, such as enhanced picture quality, additional channels and interactive services. Such a policy should be subject to a cost benefit analysis before being implemented.

We note in this regard the comment in the recent switchover communication that, where necessary, a degree of Community harmonisation could be envisaged in this regard and that labelling specifications could be approved by European consumer and standardisation bodies.

Recommendation 4: New Approaches to Spectrum Management

Judicious application of new approaches to spectrum management, such as those described in Section 4.6, could help to facilitate switchover process. The application of such techniques as administrative incentive pricing (AIP), auctions and spectrum trading is explicitly catered for in the New Regulatory Framework and NRAs should be encouraged to examine how such approaches might support their own objectives with regard to switchover. In particular, consideration should be given to the use of financial incentives to speed up the transition process and the use of trading to give

⁶⁶ COM(2003)541, page 13

flexibility concerning the future use of the spectrum. We note in this context that the Commission intends to initiate a discussion on new approaches to spectrum valuation and spectrum trading as part of the eEurope 2005 initiative⁶⁷.

6.3 Maximising Opportunities from Switchover and Convergence

Recommendation 5: Access to transmission capacity

A key requirement in opening the market for new broadcast or convergent applications is access either to radio spectrum or transmission capacity. Spectrum access can be addressed by the mechanisms referred to in the previous section or by administrative decisions, however in many cases there may simply not be any possibility to make spectrum available for new services during the transition phase. As noted in Section 3.10.6, the time to market for new applications is uncertain but there could well be demand (for trial services at least) during the transition phase.

One way to address this demand for trial services may be to ensure that access is available on non-discriminatory terms to transmission capacity on new commercial multiplexes. Setting aside a minimum of, for example, 20% of capacity on one or more multiplexes for trialling of new applications or services may be one route to achieve this. Consultation may be required to establish an appropriate level of capacity provision for new services. In the longer term, a viable secondary market in DVB transmission capacity can be envisaged, akin to the market for satellite transponder capacity.

Recommendation 6: Differentiating between “General Interest” and other broadcast services

With regard to licensing policy for broadcast services, a key question is whether it is necessary for general interest objectives to extend to transmission networks (as opposed to content which falls outside the new Regulatory Framework). For example, if Member States were to include mobile reception within their digital coverage obligations (which seems to be the current thinking of some NRAs and Governments) this would have significant implications for spectrum demand and management. However, universal service in the telecommunications world does not currently extend to mobile provision and it is questionable whether this should be the case for broadcasting.

We suggest there is a case for the separate treatment of existing general interest broadcast services and purely commercial content provision. The latter should have no greater claim to access limited spectrum resources than any other commercial application (e.g. mobile telephony or datacasting). Hence broadcast spectrum beyond that required to maintain existing general interest services post-switchover should be made available on a service and technology neutral basis. Such

⁶⁷ COM(2002)263,page 17

spectrum could be freely traded (either wholly or partially) between operators allowing services to evolve over time and to reflect market demand.

This approach implies that content and infrastructure regulation must be separate. The current situation in most EU Member States is that coverage requirements are linked to particular kinds of content and this will continue to be the case for some general interest services post-switchover (though the coverage obligation may not be as onerous). These services would be carried on broadcast multiplexes. However, for other digital services this situation should not apply in which case content obligations and access to infrastructure can be decoupled by issuing a general authorisation to provide any programme services and separately granting spectrum rights of use to transmission network operators, It is then up to the operator to go to the market and buy transmission capacity.

Recommendation 7: Spectrum Refarming

The EC is an active participant in the preparations for the forthcoming WRCs, through the medium of the CEPT Conference Preparatory Group (CPG). In a recent submission to the CPG⁶⁸, the Commission explained that it will “accompany the WRC-07 process as it has done before, by co-ordinating EU positions and interests at the Conference while relying on the competent work of European experts organised within CEPT to prepare the technical approaches of Europe at the Conference and to negotiate them successfully”.

At the regional level (i.e. within the EU), we believe the approach being taken at RRC04 will provide sufficient flexibility to cater for new mobile / converged services such as datacasting should a market demand for these arise. Future flexibility in the evolution of broadcast, mobile and convergent services would be enhanced by extending the primary allocation status of the current broadcast spectrum to include all these services. We therefore recommend that the EU’s Radio Spectrum Committee works with CEPT to develop a European Common Position to support this objective at the 2007 World Radiocommunications Conference (WRC 07).

Refarming with the specific objective of accommodating wide area, bidirectional mobile services such as UMTS in the broadcast spectrum would require further extensive technical studies to establish appropriate duplex spacings to cater for wide area, bidirectional services using FDD technology (see Section 3.9). We are not currently convinced that there is any significant demand in Europe for such an approach to refarming in the short to medium term, however in view of the timescale likely to be required for the technical studies we recommend that industry and regulators consider the potential long term requirement for duplex spectrum in the current broadcast bands as part of the preparations for WRC 07.

⁶⁸ Communication from the Commission -Results of the World Radiocommunication Conference 2003, document ECC/CPG(2004)006

In its CPG submission, the Commission also argued that policy-makers should direct more attention to complex technical-regulatory negotiations that take place in the radio spectrum domain, not only at WRCs but also at RRCs such as the forthcoming one on digital switchover broadcasting. As noted previously, we believe that WRCs provide the most appropriate forum for the pursuit of policy objectives in a global context, however it is important for the Commission to be fully acquainted with the planning rules that emerge from the RRC and to ensure that their implementation by Member States takes due account of broader policy objectives.

We note that the Commission has already requested the Radio Spectrum Policy Group to establish clear EU policy goals for WRC-07 that will feed into the CEPT technical preparatory work. We suggest that the RSPG should also seek to develop a position with regard to longer term deliberations on terrestrial wireless interactive multimedia services, including the possible need for a more flexible allocation framework.

Recommendation 8: Catering for New Services under the existing planning regime

It is apparent from our research that there is immediate interest in the potential of the broadcast bands to deliver mobile multimedia content using unidirectional technologies such as DVB-H. Such technologies can be readily accommodated in broadcast spectrum, but as we noted in Section 4.2.1, the successful development of a European market for such services is likely to depend on there being reasonable assurance that at least some radio spectrum would be available in each national market.

It is important to emphasize that we are not advocating spectrum being reserved for any particular application or technology. Although DVB-H appears to be gaining momentum as preferred technology for broadcast delivery of mobile content it is conceivable that other approaches, such as deployment of additional UMTS downlink carriers in the band, could prove more successful over time. Rather, we recommend that spectrum be made available as far as possible on a technologically and service neutral basis, subject only to compliance with the technical planning requirements determined at the RRC. The “general multiplex” concept described above could meet this objective, so long as such multiplexes are licensed according to the principles of the New Regulatory Framework for Electronic Communication Networks and Services, by an open, competitive procedure.

The amount of spectrum that would be required to support the introduction of new services or applications is as yet unclear, and will for example depend on the size of the market and the nature of the services that are to be provided. However, we suggest that four frequency channels would be sufficient to provide substantially national coverage using spectrally efficient mobile or broadcast transmission technology, and taking account of the need to co-ordinate with broadcast services in

neighbouring countries. In order to facilitate competition, sufficient spectrum should be available initially to cater for at least two competing operators.

We therefore suggest that the EU's Radio Spectrum Committee, in conjunction with the ECC, initiates a process to develop an ECC Decision that would require signatories to commit to identify a minimum of eight frequency channels from within the UHF broadcast band, post-switchover, to be made available on a service and technology neutral basis. These multiplexes could for example comprise mobile television, mobile IP datacast services, expanded 3G mobile downlink capacity or other services according to market demand, and should be licensed on a technology-neutral basis subject only to compliance with the interference limits defined at RRC-04/06.

In addition, Member States should be encouraged to adopt market based mechanisms such as overlay auctions and trading, along with the application of administrative incentive pricing, to encourage incumbent spectrum users to release spectrum beyond their core requirements⁶⁹ where there is demand from other, more economically attractive services. The ability to trade spectrum in the future would provide broadcasters with an incentive to minimise their spectrum utilisation, making further spectrum available for new, innovative services should this be required.

Further technical studies may be required to identify the most suitable portions of the broadcast bands for such applications. For example it is likely that frequencies below 800 MHz would be favoured to ensure compatibility with GSM terminals. We suggest that the ECC would provide a suitable forum to pursue such studies.

Recommendation 9: Dealing with existing non-broadcast use of spectrum

Apart from TV broadcasting, there are two other substantial uses of the TV broadcast bands, namely SAB/SAP and government / military services (see Section 3.4). SAB/SAP operates throughout the VHF and UHF bands whereas the latter tend to have exclusive allocations at the top end of band V (above 790 MHz). SAB / SAP are generally linked to broadcast use and are often able to co-exist with broadcast services in a way that would not be feasible for other services. However where the presence of SAB / SAP services denies the opportunity of spectrum access to other users, this opportunity cost should be reflected in the price paid for the spectrum concerned.

In the case of government / military use, we recognise that some of these applications may have national security implications that would militate against their removal from the band, however we would also suggest that where possible and where there is a scarcity of spectrum in the UHF bands Member States should seek to identify alternative bands for these uses. The transition period from analogue to digital broadcasting provides an opportunity for NRAs to review these allocations

⁶⁹ by "core requirement" we refer to the spectrum required to maintain existing general interest obligations

and the terms and conditions associated with them with other relevant national bodies, to identify alternative bands and to establish a plan for migration of these other services where there is excess demand for commercial spectrum use.

Such dialogue should address potential market based solutions to migration, such as overlay licensing and should take account of the opportunity cost arising from the denial of spectrum to commercial operators. Member States should be encouraged to consider the application of AIP, based on these opportunity costs, to non-commercial users. The UK, for example, applies AIP to military use of spectrum based on the price that would be paid by civil users for an equivalent assignment.

Recommendation 10: International and Cross-Sector Co-operation

The development of convergent technologies and their role in furthering the information society can be enhanced by co-operation with like-minded nations and organisations elsewhere in the world. For example, one area that is particularly relevant to the current study is the development of mobile television and related applications, which is attracting considerable interest both in the EU and Japan. We suggest that co-operation in this area be encouraged, for example by including co-operation in the development and exploitation of convergent technologies within the remit of the existing Action Plan for EU-Japan co-operation⁷⁰. This could also prove useful in addressing the potential market for other audiovisual developments such as HDTV.

We note that an active policy dialogue is already underway between the Japanese MPHPT and Finland's MTC on a number of ITC and eEurope related issues, including digitisation of broadcasting⁷¹. The UK Government, which also maintains regular bilateral dialogue on ICT policy with MPHPT, has observed that

“the development of incompatible standards for digital TV in Europe and Japan represents a wasted opportunity and we should work hard to ensure that later generations of multimedia broadcasting standards are developed collaboratively for the global market”⁷².

Finally, we note the reference to facilitating co-operation between industry players at various levels in the value chain in the recent switchover communication⁷³. This is increasingly important in a convergent world, as established trade bodies (such as

⁷⁰ “Shaping our common future”, an action plan for EU-Japan co-operation, 2001 (<http://jpn.cec.eu.int/frame.asp?frame=/english/eu-relations/actionplan.pdf>)

⁷¹ MPHPT Communications News, 21st November 2002 (www.soumu.go.jp/joho_tsusin/eng/Releases/NewsLetter/Vol13/Vol13_16/Vol13_16.pdf)

⁷² “UK Online - the British Government's approach to e-business”, Patricia Hewitt, speech to Japanese business organisation Keidanren, Jan 2001 (www.dti.gov.uk/ministers/archived/hewitt190101.html)

⁷³ COM(2003)541, page 14

the EBU or ECTA) tend to be sector-specific. The EU may wish to consider hosting periodic workshops to encourage cross-sector participation between content providers, transmission network operators, equipment vendors and other key stakeholders to ensure that the full potential of convergence can be realised.