How Ireland can best benefit from its

digital dividend

Consultancy Report

Report by Europe Economics

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Europe Economics is an independent private sector consultancy, based in London, which specialises in the application of economics and econometrics to problems arising predominantly in the fields of public policy, regulation and competition. More detail about the firm and its work can be found at http://www.europe-economics.com.

1 EXECUTIVE SUMMARY

1.1 The “digital dividend” which forms the subject of our study is the benefit that may be derived when analogue broadcasting signals are switched off in favour of digital, and radio spectrum is thereby released. Because of its propagation characteristics such spectrum is very valuable. Digital broadcasting has already begun in a large number of jurisdictions; but in most it is taking place in parallel with the continuing transmission of analogue signals. The digital dividend arises only when all, or substantially all, analogue broadcasting has ceased.

1.2 The digital dividend may vary in size and can be used in a number of ways. It can be used to expand and/or enhance established and familiar services such as television broadcasting and mobile telephony. But other services may also have claims upon released spectrum: for example, mobile television, mobile broadband, or “fixed wireless services” such as the provision of broadband to remote communities. Furthermore, the electronic communications sector is nothing if not innovative: new applications and services will arise that are as yet unknown. National governments and regulators therefore have objectives to set and choices to make in the application of the digital dividend. International cooperation also has to figure prominently in national decision-making.

1.3 Against this complex background, ComReg commissioned this study as input to the contribution that it will have to make as the national regulatory agency for communications in Ireland. The report is structured as follows:

- The first part is represented by Sections 2 and 3 and comprises an analysis of experience in relation to the digital dividend in certain other jurisdictions, a comparison with the positions adopted by the European Commission, and some provisional implications for Ireland.

- The second part, consisting of Sections 4 and 5, sets out the Irish context, drawn from a variety of published documents and reinforced by interviews with principal stakeholders.

- The third part, made up of Sections 6 and 7, draws together the findings of Parts 1 and 2 into conclusions and recommendations for next steps.

1.4 Among the six EU and six non-EU jurisdictions that we have considered no common model emerges for dealing with the digital dividend, and certainly no single model that could simply be transplanted to Ireland. Most jurisdictions are at an early stage in their thinking and planning process, and two of the countries we have reviewed see no great merit in developing a prescriptive plan. Dates for analogue switch-off vary, as does the amount of spectrum available for release. Obligations on individual nations to avoid cross-border signal interference with those of adjoining nations result in different national constraints depending on how many adjoining nations there are. While there is general agreement that spectrum harmonisation facilitates economies of scale in equipment

production, at a detail level agreement may be hard to reach: within the EU some tension is discernible between the Commission's preference for uniformity on the one hand and the value placed upon national flexibility by the Parliament and Council on the other. Methods of awarding spectrum to rival claimants vary considerably: some frequencies have simply been gifted to specific applications, while in others the auctioning of spectrum has proceeded apace.

1.5 Social issues may arise too: extending digital services, for example broadband, may bring significant opportunities for the economic development of rural areas.

1.6 International comparison highlights a number of strategic issues which Ireland will need to address, including:

- the need to devise and implement a detailed digital dividend plan,
- reaching agreement with neighbouring administrations in relation to spectrum allocation,
- support for the principle of a harmonised sub-band at a European level for non-broadcasting services,
- the priorities to be applied to increased communications capacity,
- who should decide on spectrum allocation,
- what demands for spectrum may arise and whether demand will exceed supply.

1.7 In Ireland (as in other jurisdictions) the extent of the digital dividend is uncertain, yet Irish legislation has already reserved a large quantum of spectrum for television broadcasting. It remains to be seen how Irish consumers will react to this. This question acquires a sharper edge in Ireland than elsewhere because a majority of Irish households do not rely on free-to-air broadcasting: some 76 per cent (and rising) pay for satellite, cable or MMDS.

1.8 In relation to television, Ireland also needs to reach agreement with the UK on the question of "overspill" signals, which have become part of the norm on the island of Ireland. Traditionally, these issues have not proved problematic but they need fresh consideration as frequencies are allocated to digital services.

1.9 Our key findings are:

1 Once the initial benefits associated with broadcasting are guaranteed there is little scope for increasing the value by assigning larger amounts of spectrum to it.

2 A mixed approach to the allocation of the digital dividend spectrum is central to Ireland's ability to achieve greatest benefit from its digital dividend.

3 The amount of spectrum assigned to alternative uses could be in the region of 80 MHz to 120 MHz.

4 Legislation and regulation will need to ensure that re-allocation can be implemented if needed.

1.10 Two subsidiary issues arise for Ireland. First, the question arises whether Ireland would benefit from the reservation of some spectrum (if it is available) for experimental purposes in order to encourage "inward innovation", with consequent potential gains to Irish intellectual capital and employment. Secondly, it may also prove beneficial to Ireland to make available three 8 MHz channels not currently used for broadcasting (nos. 36, 38 and 69) as part of its digital dividend.

1.11 There is thus a small number of important issues that need to be considered going forward:

- First and foremost is the debate about the amount of spectrum that should be reserved for DTT: can broadcasters show that they need it and can they assure the public that the capacity they will have (a potential six-fold increase over what they have now) will not result in spectrum remaining unused or being filled with material of questionable quality.

- Second, what can the non-broadcasting community (which at present is mainly the mobile network operators) show it will require for future services, and what will those services do for Ireland, economically and socially?

- Third, how should spectrum be awarded to rival claimants? Do auctions (which many commercial operators appear to favour) achieve the right result for Ireland, and what if any conditions would the government or ComReg wish to apply to the awards?

- It would also seem desirable to consider the lesser issues identified above – whether an "innovation reserve" should be established, and what should be done with channels 36, 38 and 69.

2 TECHNICAL AND REGULATORY ISSUES

Technical issues

2.1 We begin with a short explanation of what frequencies are currently in use in public broadcasting.

2.2 Very high frequency (VHF) is the radio frequency range from 30 MHz to 300 MHz. Common uses for VHF are radio and television broadcasting, but other important uses include mobile stations (emergency, business, and military), amateur radio, marine communications, air traffic control communications and air navigation systems.

2.3 The next higher frequencies are known as Ultra High Frequency (UHF), and run from 300 MHz to 3,000 MHz (3 GHz). UHF too is commonly used for the transmission of television signals. Modern mobile phones also use the UHF spectrum, as do public service agencies for two-way radio communication. Until recently there has traditionally been very little radio broadcasting in this band but digital audio broadcasting (DAB) is now present there. Finally, the Global Positioning System (GPS) also uses UHF.

2.4 The VHF and UHF television broadcast spectrum is divided into Bands. Bands I, III, IV and V (particularly IV and V) are of relevance to this study, and they cover the following frequencies:

Band I	47-68 MHz
Band III	174-230 MHz
Band IV	470-582 MHz
Band V	582-862 MHz in Europe, 582-962 MHz in the Americas

2.5 The frequencies to be released when analogue television broadcasting ceases lie mainly, though not only, between 470 MHz and 862 MHz, i.e. Band IV and Band V.[1] Propagation characteristics at these frequencies make them ideal for many applications requiring mobility and wide area coverage. As a consequence, spectrum released in this bracket – the digital dividend – has the potential to be the key enabler not only of future broadcasting services but also of future broadband and multimedia mobile services.

2.6 Following the cessation of analogue television broadcasting, spectrum in Bands III, IV and V can be used for several different kinds of services, including:

- standard definition (SD) television broadcasting in digital terrestrial format;

[1] Ireland also uses Band III (174 – 230 MHz) for analogue television broadcasting

- high definition (HD) television in digital terrestrial format;
- wireless broadband for reception at fixed locations;
- mobile television;
- mobile telephony;
- mobile broadband;
- enhanced public safety applications.

2.7 Other applications may be contemplated too. These may involve digital sound broadcasting, low-power transmissions not requiring a licence[2], military systems or as an innovation reserve for testing new spectrum-using applications.

2.8 The release and reassignment of frequencies is a complex task. Because of differences in starting positions the issues are not exactly the same for every EU Member State, nor indeed for countries beyond the EU. Determining the most valuable uses of the spectrum (economically or socially or both) and devising the best way of awarding licences to use the spectrum are significant challenges in themselves. This is particularly so since future broadband and multimedia mobile services, although widely seen as important to the future of national economies and of the world economy, are technically dynamic and difficult to forecast.

The regulatory framework

The International Telecommunications Union

2.9 At the highest level, the use of radio spectrum is managed by the International Telecommunications Union (ITU), a United Nations specialized agency whose *raison d'être* is to promote international cooperation in communications and to define a framework covering the rights and obligations of nations in relation to spectrum.[3]

2.10 A basic ITU principle is that countries should generally have freedom in how they use spectrum, but must not interfere with legitimate uses in other countries.

2.11 In relation to analogue television, a fully coordinated spectrum plan was agreed for Europe at an ITU conference held in Stockholm as far back as 1961. The Stockholm Regional Agreement covered the use of VHF Bands I and III, and UHF Bands IV and V.

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[2] In this document we use the UK spelling convention, i.e. "licence" for the noun and "license" for the verb. The only exceptions are where we quote directly from a US document, where "license" is used for both.

[3] The origins of the ITU go back to 1865. It became a specialised agency of the UN in 1947, and is now based in Geneva. It currently embraces 191 member states.

2.12 The ITU holds a World Radio Communication Conference every three or four years in order to review, and if necessary amend, the Radiocommunications Regulations. The conference held in Geneva in 2006 (the Regional Radiocommunication Conference, RRC-06) agreed a plan, sometimes referred to as "Geneva 06" or "GE06", allowing for the transition from analogue to digital broadcasting in Europe and other regions.

2.13 The ITU's World Radiocommunications Conference of 2007 (WRC-07) considered spectrum allocations for new wireless services and particularly the future of International Mobile Telecommunications (IMT). The outcome of the conference included a co-primary allocation for mobile services with broadcasting services in the 790-862 MHz spectrum (channels 61-69) in Region 1, which includes Europe.[4] The WRC-07 allocation comes into effect on 17 June 2015.

The European Union

2.14 Within the prescriptions of RRC-06 and WRC-07 the European Union has established its own policy making structure and policies.

Structural arrangements

2.15 Under the Radio Spectrum Decision of 2002[5] the European Parliament and Council adopted a framework for radio spectrum policy in the European Union. The principal aims of the Decision were:

> "to establish a policy and legal framework in the Community in order to ensure the coordination of policy approaches and, where appropriate, harmonised conditions with regard to the availability and efficient use of the radio spectrum necessary for the establishment and functioning of the internal market" (Article 1.1)
>
> "to facilitate policy making with regard to the strategic planning and harmonisation of the use of radio spectrum in the Community taking into consideration inter alia economic, safety, health, public interest, freedom of expression, cultural, scientific, social and technical aspects of Community policies as well as the various interests of radio spectrum user communities with the aim of optimising the use of radio spectrum and of avoiding harmful interference;" (Article 2 (a))

2.16 Also under this Decision the Radio Spectrum Committee (RSC) was formed to "assist the Commission in the adoption of technical implementing measures in support of Community policies".

2.17 The Radio Spectrum Policy Group (RSPG) was set up at the same time to gather "high-level governmental experts from member States and to help the Commission in developing general radio spectrum policy at Community level".[6]

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[4] The other areas included are Africa, the Middle East west of the Persian Gulf, Iraq, the former Soviet Union and Mongolia.

[5] http://ec.europa.eu/information_society/policy/radio_spectrum/docs/policy_outline/decision_6762002/en.pdf

2.18 The RSPG and RSC work in parallel. The members of RSPG are representatives of the Member States and of the Commission. Representatives of the European Economic Area countries, the European Parliament, the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Telecommunications Standardisation Institute (ETSI) attend as observers.

2.19 The RSPG is required to consult extensively and to publish Opinions based on its work. Its opinions are intended to provide high-level strategic advice to the RSC and European Commission on radio spectrum policy issues. The RSC in turn, under the chairmanship of the Commission, develops technical implementation matters, i.e. legislative instruments including Commission Decisions and Recommendations.

2.20 Member States are legally bound to implement Commission Decisions at national level, and the Commission regularly requests detailed information on implementation from Member States.

The Council's current thinking

2.21 Most recently, the EU Council of Ministers has underlined that Member States:[7]

- need to make best use of the digital dividend, taking into account social, cultural and economic benefits, while considering also the different national circumstances;
- should take digital dividend as an opportunity to extend broadcasting, both terrestrial and non-terrestrial, and to encourage new communications services such as wireless broadband communications and mobile multimedia;
- should have the right to determine the amount of spectrum to be used for general interest objectives;
- should coordinate spectrum usage in the EU in order to enhance efficient use and avoid cross-border signal interference;
- should allocate parts of the UHF spectrum for (non-mandatory) use by uni-directional and bi-directional networks in order to achieve more efficient spectrum use;
- should coordinate spectrum usage in the EU to provide benefits of economies of scale;

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6 See http://ec.europa.eu/information_society/policy/radio_spectrum/activities/index_en.htm for references to RSC and RSPG.

7 "Reaping the full benefits of the Digital Dividend in Europe: A common approach to the use of the spectrum released by the digital switchover" – Council of Ministers, 12 June 2008

- should ensure flexibility of usage with the exception of services of general interest;
- should consider differences in national plans and digital switchover across other Member States when coordinating the usage of the spectrum;
- should release the digital dividend as quickly as possible once digital switch-over (DSO) has occurred.

The Commission's current thinking

2.22 The Commission sees the digital dividend as a unique opportunity for Member States to meet growing demand for wireless services, to allow broadcasters to develop and expand their services, and to address social and economic problems – for example, the so-called "digital divide" (the adverse effects that arise when some groups in society do not have reasonable access to modern communications services).

2.23 The Commission focuses on the possibilities of releasing spectrum in a harmonised way by promoting the clustering of services. In this way, the Commission believes, the greatest economic value from DSO may be achieved, on the grounds that European businesses should be able to benefit from opportunities to develop goods and services for a single market rather than for separate national markets.

2.24 If harmonisation is one plank of the Commission's thinking on the digital dividend, the other is that spectrum should be distributed in a manner that is technology- and service-neutral. The Commission is quite ambitious as to how much spectrum should be released for non-broadcasting services. On June 12th 2008 the DG Information Society Commissioner, Ms Viviane Reding, proposed by 2010 that half the digital dividend should be allocated to new mobile and wireless services:

> "Let us agree to allocate by 2010, 50 per cent of this digital dividend to new mobile and wireless services. This would allow us to turn the dream of 'broadband for all Europeans' into reality, while at the same time allowing enough space for commercial and public broadcasters to develop and offer new and more modern TV services."

2.25 However, although CEPT is examining conditions under which the upper part of Band V could be harmonised for non-broadcasting services, there appears to be little consensus within Member States, and several appear unlikely to implement any such harmonisation if it is proposed.[8]

[8] See "Breakthrough on mobile services in Digital Dividend", Policy Tracker, 20 June 2008, www.policytracker.com

2.26 The Commission's push towards harmonisation is especially noticeable in a recently published invitation to tender to consulting firms entitled "Exploiting the Digital Dividend, a European Approach".[9] The study is to:

> "assist the Commission in identifying and assessing the options and possible scenarios to achieve the required EU coordination of the digital dividend as outlined in the Commission Communication COM(2007) 799 on 'Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover'."

2.27 Two of the tasks in the study are to assist in:

> "identifying and assessing external constraints affecting the process of a coordinated usage of the dividend in Europe" [and] "developing the main options and scenarios for the EU coordinated approach".

[9] http://ec.europa.eu/information_society/policy/ecomm/library/calls_tenders/index_en.htm

3 THE DIGITAL DIVIDEND IN THE EU AND BEYOND

3.1 This study firstly considers what experiences other countries have had in relation to realising their respective digital dividends. In so doing it focuses on eleven countries plus Ireland, plus the European Commission as a supra-national body. [10] The selected countries, together with our reasoning for their inclusion, were as follows.

Countries selected for comparison

EU Member States (in alphabetical order)

3.2 **Finland** has a population roughly comparable with that of Ireland (5 million and 4.42[11] million respectively) together with issues arising from the fact that both countries have some densely populated areas and a scattered rural population. In addition, Finland was the first EU Member State to achieve DSO in television broadcasting, and it might thus have more experience to offer than Member States which have not yet done so.

3.3 **France** was chosen as a large-population Member State with broad-based and competitive broadcasting and telephony sectors, and also with issues arising from needing to avoid signal interference with a significant number of neighbouring countries: Belgium, Luxembourg, Germany, Switzerland, Italy, and Spain (and, arguably, Andorra and Monaco). Conversely, potential issues arise for France in possibly catering to the French-speaking population in Belgium, Switzerland and of course *vice versa*.

3.4 **Italy** was chosen as a second large-population Member State, and one which, on the face of it, is proceeding more slowly with its decision-making than some other larger Member States. We were keen to explore what issues remain open in Italy, and why.

3.5 **Sweden** was our choice for an EU Member State with a medium-size population. It is bounded on one side by an EU Member State, Finland, which has proceeded somewhat more quickly with digitalisation, and by a non-EU jurisdiction, Norway. Its "neighbourhood" issues are thus of interest.

3.6 The **United Kingdom** has substantially developed, and has documented well, its thinking in relation to DSO and the digital dividend. The publications of Ofcom (the UK equivalent of ComReg) are a rich source of analysis and ideas. The UK has highly competitive broadcasting and telephony markets. And it has border issues to deal with in relation to Ireland: because signals from Wales currently spill over to the east coast of Ireland, and because of the land border between Northern Ireland and the Republic of Ireland.

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[10] We encountered some difficulties in obtaining adequate material in English in respect of Japan. However, and for completeness we do present a brief summary.

[11] Central Statistics Office Ireland: Population and Migration Estimates, August 2008.

Non-EU member states (in alphabetical order)

3.7 **Australia** was chosen for a combination of reasons: a highly-developed regulatory régime, population dispersed between a few large cities and immense rural areas, and competitive communications sectors. Australia does not have border issues to contend with, so that its ability to exploit spectrum without regard to interference with or from neighbours may have something useful to tell us.

3.8 **Canada** was chosen partly to provide a comparison with the neighbouring United States and partly because it has most of its population distributed across a relatively small number of towns and cities, with the remainder widely dispersed. In principle, though not in scale, Canada has some issues in common with Ireland and Australia.

3.9 **Japan** suffers extreme spectrum congestion, and is therefore not immediately comparable to Ireland. However, its exploration into different uses of the digital dividend is relatively advanced and this, together with its high level of technology adoption in the communication sector, may provide useful indications of future possible uses for the dividend in Ireland.

3.10 **New Zealand,** like Australia, has a highly-developed regulatory régime, a population resident largely in towns and cities, with the rest distributed across rural areas, and no problems of signal interference with or from neighbours. Its population (5 million) is broadly comparable with that of Ireland.

3.11 **Switzerland** seemed to us to offer a potentially interesting comparison with EU Member States, in that it is part of Europe but not of the EU. It has significant issues of borders and topology, and it needs to serve multiple language groups.

3.12 We chose the **United States** because of its overwhelming importance in the world economy, and its advanced thinking and practices in regulatory matters in general and in communications in particular. It is remarkably well documented: the Federal Communications Commission (FCC) website in particular is extraordinarily informative. Like Australia and Canada the US has both densely and thinly populated areas.

The six EU Member States

3.13 We adopt a broadly common form of analysis: what progress has been made or is intended towards DSO; how much spectrum is to be released and when; what strategies (if any) have been announced; and what reasoning lies behind such strategies.

Digital timetable

3.14 The positions of the six EU Member States are set out in Table 1 below. Here we show when digital television transmission (DTT) started and when final DSO is planned.

Table 1: DTT start and DSO dates in six EU Member States

Member State	DTT start date	DSO date
Finland	2002	2007
France	2005	2011
Italy	2003	2012
Sweden	1999	2008
United Kingdom	1998	2012
Ireland	**2008**	**2012**[12]

Source: Europe Economics compilation from NRA websites

3.15 Although the sample size is small, Table 1 reveals notable differences in how long Member States reckon to take between their DTT start date and their final DSO. Finland took five years and France is expecting to take six. Italy had deferred its DSO date from 2006 to 2008 and has just deferred again to 2012; if it achieves that it will have taken nine years – the same period of time as Sweden. And if the UK achieves DSO in 2012 it will have taken fully fourteen years from DTT start, having twice abandoned earlier DSO dates of 2006 and 2010.

3.16 If Ireland achieves DSO in 2012 from a DTT start in 2008, it will thus have managed one of the shortest implementation periods in our sample of Member States.[13]

[12] Strictly speaking, the 2012 date has yet to be announced by the Minister under a process set out in the Broadcasting Act 2007.

[13] To broaden the base of comparison, Denmark will have achieved DSO in three years, and Austria in four; while Belgium and Spain will have taken nine or ten years.

The size of the digital dividend

3.17 Table 2 summarises the amount of spectrum that the five Member States are planning to release after allocations to DTT. The total represents the digital dividend.

Table 2: The digital dividend in six EU Member States

Member State	Breakdown of digital dividend Spectrum Bands (MHz)	Total digital dividend (MHz)
Finland	112 UHF 77 VHF	189
France	180 UHF 49 VHF	229
Italy	Yet to be finalised	Yet to be finalised
Sweden	112 UHF 77 VHF	189
United Kingdom	112+16 UHF[1]	128

Note 1: 16 MHz is to be released from radar and radio-astronomy use

Source: Europe Economics from NRA websites

3.18 The extent of digital dividend available in Ireland is not yet clear. Much will depend on how many television broadcasting multiplexes are taken up.

Strategies adopted by the EU Member States

3.19 Although, as we have acknowledged, our sample size is small, the diversity of strategies adopted by Member States is remarkably wide. If there is any common thread, it is that governments want minimum disruption to consumers' television habits during and immediately after the transition. Thus, television tends to dominate spectrum allocations.

Finland

3.20 In summary, Finland has focused largely on using its digital dividend for television services and has been silent on the allocation of spectrum to other services (save for a decision to deploy the 450 MHz frequency band for broadband use) and on the achievement of commercial as distinct from public service or public safety objectives.

3.21 The principal official document published in 2007 is a working group document proposing Finland's planning for the digital dividend (in English *The Use of Analogue Television Spectrum after the Digital Switchover*). This document makes no mention of how spectrum is to be paid for. Since demand for spectrum for broadcasting is for the foreseeable future less than supply, no question of beauty contests or auctions arises.

3.22 Under GE06 Finland may allocate seven multiplexes in the UHF band and two in the VHF. The government has already allocated four to digital terrestrial television (DVB-T)

and one to mobile television (DVB-H), with the remaining two as yet unallocated. DVB-H service began in three cities in December 2006. Furthermore, Finland has shown close interest in the promotion of regional television programming and has planned extensive coverage for it.

3.23 No further specific allocations are proposed, except that

> "Finland has taken the decision to deploy the 450 MHz frequency band for broadband use. …this band is ideally suited in terms of its radio-technical characteristics for building broadband connections in this sparsely populated country…" (*op.cit*. para. 8.4)

3.24 Finland also has to attach weight to actions by its neighbours, principally Sweden and Russia:

> ".. the release of spectrum is dependent not only on decisions taken in Finland; the timetables for the digital switchover in neighbouring countries also come into play… Sweden will be shutting down its last analogue transmitters in November 2007, but based on current knowledge analogue broadcasts in Estonia will continue through to the end of 2012. Information on the situation in Russia is variable, but one realistic assessment suggests that analogue transmitters there will shut down in 2015." (*op.cit.* para. 6.5)

Sweden

3.25 To summarise, Sweden is vocal in support of EU coordination of spectrum use as regards the digital dividend. The Swedish communications regulator, Post & Telestyrelsen (PTS), supports the notion of auctioning spectrum where demand exceeds supply[14], and also supports spectrum trading (i.e. the transfer of licences) subject to PTS consent.

3.26 Finland and Sweden have in common a desire to avoid taking spectrum decisions in haste, despite their both having achieved early DSO. In other important respects, however, they take differing views on exploiting the digital dividend. Sweden recognises that spectrum has great potential value commercially and to society. In a recent report, PTS stated that:

> "PTS is of the view that it must be considered whether other applications, for example those described in this report, can bring greater value to society and the consumer, than the usage for more television services can." (*op.cit*. p.13)

3.27 Indeed, Sweden has already decided that Bands I and III will not be used for future television broadcasting. Band I has attracted little commercial interest but is of interest to the Armed Forces and radio amateurs. Parts of Band III are also of interest to the Armed Forces.

[14] Indeed, PTS auctioned 2.6 GHz spectrum in May of this year, raising the equivalent of roughly €230 million for the Swedish Treasury.

3.28 Sweden is strongly in support of EU coordination of spectrum use rather than in going its own way. A 2006 report by PTS entitled "The use of radio spectrum following the switchover to digital terrestrial television broadcasting" records that:

> "PTS considers that it would be of great value if the European countries can through coordination reach agreement on how the entire or parts of the spectrum that is released as of the switch-off of analogue television broadcasting shall be used. Therefore, Sweden should, in the opinion of PTS, not make decisions regarding the use of spectrum in the bands III, IV and V which in practice would be irrevocable before the European countries have made a joint decision on the matter." (*op.cit.* p.13)

France

3.29 Summary: France estimates its digital dividend at about 230 MHz (a quite substantial figure relative to other EU Member States) and a report commissioned by the national regulator, ARCEP, strongly recommends a shared allocation of the digital dividend across the audiovisual and electronic communications sectors, with the majority share going to television.

3.30 A report by the Commission for the Digital Dividend to the President of France in July 2008 suggested that the digital dividend in France is around 230 MHz (180 MHz for the UHF stream and an additional 49 MHz or so for most of the VHF Band III). This Commission favoured reallocation of this spectrum so as to avoid causing inconvenience to viewers and to obtain the maximum possible range of channels and services for consumers by the end of 2011. The licensing of new broadcasters to ensure the extension of DTT coverage would also need to be undertaken in a consistent and coherent manner.

3.31 The report also notes that two distinct approaches often clash when it comes to the question of utilising the dividend, the one emphasising pluralism and cultural diversity, the other focusing on the optimising the national economic interest. It positioned itself in favour of attaining a golden mean of these two perspectives.

3.32 In a review conducted for the French communications regulator, ARCEP, consultants Analysys Mason used two approaches to evaluate alternative allocations of the digital dividend. The first, which they called the "sharing approach", envisaged allocation of a minority of spectrum frequencies to electronic communications services, with the majority to go to audiovisual services. The second, in contrast, proposed that the entire digital dividend be allocated to audiovisual services alone and was therefore referred to as the "audiovisual only" approach.

3.33 The study estimated that opting for the sharing approach would increase social gain (also referred to in some reports as social welfare) by greater than €25 billion between 2012 and 2024 over and above the benefits offered by the audiovisual-only option. Furthermore, the sharing scenario was estimated to lead to a rise in GDP of €7.1 billion over the 2012-2024 period, as compared with a rise of €2.3 billion with the audiovisual only approach.

3.34 The report concludes that the digital dividend cannot be viewed merely from an economic standpoint, but needs also to be analysed for externalities. The result appears to point strongly towards a shared allocation of the freed spectrum across the audiovisual and electronic communications sectors, which would satisfy Parliamentary objectives more effectively than an audiovisual-only mandate. (Parliament had already required that most of the freed spectrum be reallocated to audiovisual (television) services.

3.35 However, the precise allocations of spectrum to different types of services remain to be seen.

3.36 France is silent on the question of mechanisms whereby an excess of demand over supply for the freed spectrum should be dealt with. It does, however, have experience of spectrum auctions, in that the Ministry of Economics, Finance and Industry raised €125 million from the auction of 3.5 GHz frequencies in July this year, and subsequently agreed to allow trading in that spectrum.

Italy

3.37 Italy presents an intriguing situation. Following a four-year deferral (from 2008 to 2012) of the DSO date, Italy's communications regulatory authority (Agcom) has allocated the first major portion of the DTT spectrum to the three leading terrestrial broadcasters, namely RAI, Mediaset and Telecom Italia Media. Agcom's decision was based on the belief that allocating equal portions of such spectrum would promote pluralism and competition and thereby boost the broadcasting market.

3.38 Although there appears to be no explicit statement in any of the documentation we have been able to procure, the decisions of Agcom as well as those of the Ministry of Telecommunications hint strongly that spectrum available after DSO will be used largely or solely for broadcasting purposes: no mention of any possible alternative use is made. At present, it is not even clear what frequencies will be freed up after DSO, and there are therefore no firm plans on how to use the Italian digital dividend.

3.39 Agcom has approved a national frequency plan that forms the basis upon which operators would build after DSO.

3.40 Agcom is also implementing some initiatives on the spectrum available for digital broadcasting which, although not specifically related to the "true" digital dividend, are interesting in relation to the Irish situation.

3.41 Broadcasters with more than one analogue channel are required[15] to reserve 40 per cent of transmission capacity on their digital multiplexes to third parties in order to allow them to broadcast DTT. Part of this capacity is to be made available on a national basis and

[15] By Law 66/2001.

part on a regional basis. Third parties in this context cannot be companies controlled by or controlling current broadcasters, and nor can they be part of the same group.

3.42 In December 2007 Agcom approved the process by which transmission capacity should be transferred to third parties. It left the current capacity holders to determine the price at which third parties could access transmission capacity, though Agcom reserved the right to intervene. The selection of third parties took place by means of a beauty contest and Agcom recently published the outcome: 25 operators have been identified as suitable to access national transmission capacity and two operators for local capacity. The evaluation took place against criteria laid down by Agcom relating to programme content, company standing, and technological issues.

3.43 It is important to bear in mind that, theoretically, the operators which succeed in this process will gain access to transmission capacity only up to the DSO date, since thereafter frequencies should be re-assigned on the basis of Agcom's National Frequency Plan. Whether this will actually happen is difficult to say: the first national plan, which dates from 1998 and did not cover digital, suffered long delays in implementation. The operators that held the frequencies up to 1998 have been allowed to continue using them at the expense of new entrants.

3.44 Overall, although Italy does not in our view present a model for others to follow, its approach to sharing digital transmission capacity, if only on a non-permanent basis, is worth noting.

United Kingdom

3.45 To summarise, the UK regulator, Ofcom, is strongly in favour of pursing a market-led approach to the digital dividend, having identified many possible uses for this spectrum and having estimated the likely benefits to be significant. Auctions for available spectrum are due to take place in the coming months.

3.46 At present, nearly half of the spectrum between 200 MHz and 1 GHz is used to broadcast analogue television: specifically 368 MHz, or 46% of the 800 MHz. As the UK's analogue television signals are switched off, region by region, between 2008 and 2012, in principle all 368 MHz might become available for new uses. But it had previously been decided by the Government that 256 MHz should be reserved for DTT. DTT will be provided by six multiplexes. This decision will allow digital terrestrial television to expand both its coverage – to match that of analogue, at 98.5 per cent of the population; and its capacity – to around ten times that of analogue in most of the country.

3.47 At the same time, DSO will allow the remaining spectrum – 112 MHz – to be released for new uses, and it is this 112 MHz, together with 16 MHz to be released from radar and radio-astronomy applications, that forms the core of the UK's digital dividend. The communications regulator, Ofcom, has identified many possible uses for this spectrum. But it has also recognised that it is not possible to identify *all* the possible uses.

3.48 Ofcom takes the view that excessive regulation of spectrum has led to scarcity and inflexibility. Competition and innovation have, it considers, been damaged as new entrants and new technologies have struggled to gain market access. Ofcom therefore adopts a market led approach which entails:

- liberalising spectrum by imposing as few constraints as possible. Some constraints are unavoidable, to avoid interfering with other services and to meet international obligations. But these constraints apart, users should be free to decide *how* the spectrum should be used, for *what*, and by *whom*.

- awarding spectrum through service and technology neutral auctions, or where spectrum is already licensed, introducing Administered Incentive Pricing (AIP) to ensure that licence fees provide incentives to use spectrum efficiently by reflecting its value.

- allowing spectrum to be traded between users.

3.49 Ofcom does, however, recognise that some rules are needed to ensure competition in downstream markets, and to guard against anti-competitive spectrum hoarding.

3.50 Ofcom has developed a model for the estimation of benefits arising from the digital dividend. Essentially, the model computes Total Value as the sum of Private Value and External (societal) Value. Private Value in turn breaks down into Producer Value and Consumer Value. External Value breaks down into "Broader Social and Citizen Value" and "Other Sources of External Value". In its report *"Digital Dividend Review, a statement on our approach to awarding the digital dividend"* dated December 2007 Ofcom supplies a table (it is Table 2 on page 56 of the original text) which breaks down these aggregate estimates by type of service, and we reproduce this table below. Apart from suggesting possible uses of the digital dividend, the table shows that the range of net present valuates for almost every service, and in total at between £3.5 billion and £15.5 billion (€4.4 billion to €19.3 billion) is extremely wide.

Table 3: Ofcom's valuation of services likely to use freed spectrum

Service	Range of producer and consumer value (NPV over 20 years in £bn)[a]	Range of spectrum requirements (total for this service)	Indicative range of external value as a % of producer and consumer value
Mobile multimedia	0.3-3	8-48	Up to 5%
DTT in SD	0.5-3	24-112[b]	Up to 10%
DTT in HD	1-3.5	24-112[b]	Up to 5%
Local television	0.05-1	8[c]	Up to 10%
PMSE	0.15-0.5[d]	8 (cleared) Up to 256 (interleaved)	N/A
Mobile broadband (data-centric)	1-2.5	30-60	Up to 15%
Mobile broadband (voice and data)	0.5-2	10-64	Up to 15%

Footnotes from Ofcom:
a Figures above £1bn are rounded to the nearest £0.5bn.
b. Using a multi-frequency network.
c. At each location, local television could use either cleared or interleaved spectrum.
d. May understate the true value. [Ofcom refers readers to an Annex for further details.]

3.51 Although it recognises that future applications are hard to predict, Ofcom has attempted through consultation to accommodate likely developments known at this stage into its thinking about spectrum use and allocation. It has, for instance, considered wireless microphones for community use (for which Channel 69 is prospectively reserved), other low-power uses, and local television, which is perhaps to be offered interleaved spectrum.[16]

3.52 Ofcom has identified different packages of channels to be offered at auction, ranging from three substantial lots of channels to fifteen smaller lots. Auctions could begin in late 2008 and proceed as DSO takes place, region by region, up to 2012.

[16] Interleaved spectrum is spectrum where a frequency used by a transmitter in one part of the country is effectively unoccupied outside the range of that transmitter. Interleaved spectrum is thus suitable for local or regional services. Ofcom estimates that as much as 208 MHz of interleaved spectrum may become available.

The non-EU countries

Digital timetable

3.53 Table 3 below sets out the dates when digital television broadcasting began and DSO is due to take place in our six selected non-EU jurisdictions – Australia, Canada, Japan, New Zealand, Switzerland and the United States.

Table 3: DTT start and DSO dates in non-EU jurisdictions

Jurisdiction	DTT start date	DSO date
Australia	2001	2013
Canada	2003	2011
Japan	2003	2011
New Zealand	Not started	Not yet set[1]
Switzerland	2007	2009[2]
United States	1998	2009

Note 1: The Government is not expected to announce a DSO date until 2012.

Note 2: In fact Switzerland achieved DSO in early 2008.

Sources: Europe Economics from NRA websites

3.54 Switzerland will have achieved a remarkably rapid transition from DTT start to DSO – two years. By contrast, the four non-European countries which have set dates will have taken roughly the same period of years as the slower EU Member States that we considered earlier.

Digital Dividend

3.55 Table 4 below sets out the digital dividend in the same six countries as in Table 3, with calculations made on the same basis as for the EU Member States.

Table 4: Digital dividend in non-EU jurisdictions

Jurisdiction	Total digital dividend (MHz)
Australia	110-147[1]
Canada	Min. 60[2]
Japan	75[3]
New Zealand	Potentially 136[4]
Switzerland	80[5]
United States	108

Sources: Europe Economics from NRA websites

Note 1: the Australian government has yet to decide how much spectrum will be released, and when.

Note 2: Channels 60 to 69 have been earmarked in Canada for public safety and commercial mobile purposes. No other allocations have yet been made.

Note 3: See paragraph 3.93 below.

Note 4: See paragraph 3.63 below.

Note 5: see paragraph 3.90 below.

Strategies adopted by the six non-EU countries

3.56 As with the five EU Member States, the diversity of strategies apparent from our small sample of non-EU jurisdictions is remarkable.

New Zealand

3.57 Summary: New Zealand is distinctively different from the other four jurisdictions in wanting to assess consumer interest in digital television and thus as yet having no *firm* plans in place to go all-digital.

3.58 Current digital TV penetration in New Zealand comes from a subscription satellite service and from "Freeview", a hybrid satellite and digital terrestrial transmission system delivered by a consortium of broadcasters.[17] Satellite has achieved 42 per cent penetration of New Zealand households, and Freeview, which launched only in 2007, 5 per cent.

3.59 The government has determined that a date for analogue switch off will be decided in 2012, or when 75 per cent of the population are able to receive digital services. Its thinking is that this will allow it time to gauge viewer interest in digital television and to measure take-up rates. It is concerned to minimise disruption and confusion in the minds

[17] For the benefit of UK readers, New Zealand Freeview is not the same thing as the Freeview service offered in the UK.

of consumers, but also to encourage new broadcasting entrants and to see the development of mobile applications and broadband wireless access.

3.60 In expectation of digital switchover at some future date, the government offered in 2004 (for those UHF analogue licences due to expire in 2010) renewal for ten years rather than the normal twenty. If DSO becomes feasible before the ten years are up, significant blocks of UHF spectrum could remain with current rights holders, thus impeding competition after switch-off. The implications have yet to be considered in detail.

3.61 The potential digital dividend in New Zealand could be 40 MHz of VHF spectrum plus 96 MHz of UHF – but it is far too soon to assess whether the total of 136 MHz is realistic. The value of the dividend[18] has been tentatively estimated in a study for the Government at between NZ$106 million (€50 million) and NZ$131million (€60 million).[19]

3.62 The study adopted four general ways of valuing the spectrum, namely examining recent spectrum awards in New Zealand; consulting research previously undertaken on spectrum valuation in New Zealand; reviewing data from private spectrum transactions within New Zealand; and international benchmarking of spectrum transactions.

Australia

3.63 To summarise: DSO is scheduled for the end of 2013 but there are no detailed plans in place for this process yet. Nor has the Australian government yet begun to analyse the potential uses for the spectrum released at DSO, so it remains unclear what emphasis it would wish to accord to (more) television as distinct from other digital communications services.

3.64 Digital television transmissions began in metropolitan areas in 2001 and in non-remote regional areas in 2004. In December 2007 the government announced that DSO would be achieved by 31 December 2013. The transition has been subject to much debate, particularly over the issue of rural communities, of which there are many, some extremely remote and thus uneconomic to serve with digital infrastructure.

3.65 Around 85 per cent of the population can *access* digital services from all their local free-to-air broadcasters, and at least 96 per cent of the population has access to at least one free-to-air digital service. At the end of 2007, 29 per cent of households were paying for subscription television, and it was thus estimated that 54 per cent of households had either digital free-to-air or digital subscription television. The relatively modest take-up of digital television, despite its ready availability, could betoken limited interest in digital services, and popular reluctance to part with analogue services.

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[18] This value was estimated for the purpose of providing a proxy for producer surplus that would result from the digital transition, and not with the explicit aim of valuing the digital dividend.

[19] Spectrum Strategy Consultants (2006), "Cost benefit analysis of the launch of digital free-to-air television in New Zealand", for the Ministry for Culture and Heritage

3.66 The Australian government has not yet begun to analyse the potential uses for the spectrum released at switch off. This could in part be due to timing (since DSO is not scheduled until 2013) as well as to the potential complexity of the transition, the latter having usurped attention to investigation of the digital dividend. The government's position is that the allocation of freed spectrum will be decided only once its potential size and value has been scoped – and that process is not yet complete.

3.67 Some initial estimates of the size and type of spectrum available were presented in 2006 by the Australian Communications and Media Authority (ACMA). One benchmark that ACMA took was other large countries, thinly populated and with no neighbours, which led ACMA to conclude that the potential dividend could possibly be 110 MHz (provided it is suitably re-packaged). This is the lower figure given in Table 4. But if four Australian analogue networks were closed then the equivalent of 18 channels, each of 7 MHz, would be freed up, resulting in 126 MHz split across VHF Band III and UHF. There is also the potential for one network in VHF Band I or II to be closed, giving a further 21 MHz and thus the higher total of 147 MHz that appears in Table 4.

3.68 The size of Australia and the distribution of its population make the achievement of spectrum efficiency more problematic than in many countries. Simply replacing old analogue channels with digital channels normally implies that freed spectrum would be organised in the same way, but in Australia that would be difficult.

3.69 Whatever size the effectively freed spectrum proves to be, as yet no official policy has been produced concerning ways in which to allocate or use it. ACMA has published an analysis which outlines potential spectrum demand and work programmes to estimate it more accurately.[20] However, there is no official view yet on who would bid for the spectrum or how it should be made available. Nor is there any hint as to the emphasis that Australia would wish to accord to (more) television as distinct from other digital communications services.

Canada

3.70 Canada's chosen model for the adoption of DTT is a voluntary, market-driven one and the regulator has set a date for DSO of 31 August 2011.[21]

3.71 For obvious practical reasons Canada has had to work with the US in the formulation of a DTT transition plan. In 2000 the two countries signed a Letter of Understanding (LOU) regarding the introduction of digital television along their shared border. The LOU covers DTT operations within 400 kilometres either side of the border, and contains a table of mutually acceptable DTT channel allotments for each country, as well as the procedures each will use in notifying and evaluating proposed DTT facilities.

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[20] *Five-year Spectrum Outlook for 2009-2014*, www.acma.gov.au, April 2008

[21] The regulator, the Canadian Radio-television and Telecommunications Commission (CRTC), had originally decided not to enforce a date for DSO, choosing to let the economy determine when it would occur.

3.72 Canada's market-based approach to transition led the television broadcasting sector to favour a two-year lag behind that of the US, since it would save a great deal in early adoption costs for broadcast, production and consumer equipment. In practice, however, by 2006 Canada had fallen behind the US by about four years.

3.73 The reasons for Canada's relatively slow transition are rooted in its broadcasting legislation, regulation and business model. Broadcasters have said repeatedly that they do not see the value of building free-to-air digital transmission facilities across the country and going through the expense of simultaneous carriage of analogue and digital systems, when most digital markets are already served by cable and, to a lesser extent, satellite.

3.74 Furthermore, Canada has a regulatory framework which protects Canadian broadcasters from competing foreign digital services, which may act as a disincentive for broadcasters to embrace digital. In addition, Canada has not so far faced demands for the release of spectrum for other services, or market pressure to make the transition to digital in any more purposeful manner.

3.75 Industry Canada (IC), which has responsibility for authorising spectrum use in Canada, developed a DTV *Transition Allotment Plan* in 1998. It provided all broadcasters then having an analogue channel access to an equivalent DTT channel for simultaneous analogue and digital broadcasting ("simulcasting") for a defined period of time. The Plan envisaged that the core spectrum for DTT would reside in channels 2-59, with some allotments in channels 60-69 during the transition period to accommodate simulcasting. Channels 60-69 were to be freed after the transition and thus form the digital dividend.

3.76 To date Canada has identified 60 MHz in the spectrum band 746-806 MHz (channels 60-69) to accommodate public safety and commercial mobile requirements while meeting the requirements of broadcasters in rolling out DTT. The figure of 60 MHz is thus effectively Canada's digital dividend. In 2006 IC announced unilaterally (notwithstanding its preference for public consultation and market-based solutions) that the first two television channels to be freed up, 63 and 68, would be earmarked for critical public safety applications.

3.77 No official decisions have yet been made regarding the allocation of the remainder of the Dividend, or how to value it.

The United States

3.78 In summary, the US has adopted an almost entirely market-based policy and has auctioned (achieving proceeds of $19 billion) a large quantity of 700 MHz spectrum for future digital use. It has adopted a distinctive approach to sharing spectrum between commercial and public safety applications.

3.79 Although television in the US is provided predominantly through cable networks, some 70 million television sets will be affected by DSO. DTT was first introduced in the United States in 1998. The DSO target date was initially set by Congress at December 31, 2006, but was updated in December 2005 to February 17, 2009.

3.80 The FCC has adopted a market-based approach driven largely by consumer needs and economic incentives. Its declared priorities have been to:

- free up scarce and valuable spectrum for other communications uses;
- facilitate the introduction of new services;
- improve public safety; and
- promote a market-oriented allocation and assignment of spectrum.

3.81 In order to facilitate a smooth transition and to minimise the risk of service disruption to the public, the FCC has provided each existing broadcaster with an additional 6 MHz channel, to be used for digital transmissions, within channels 2 to 51. After the transition period, VHF channels 2-13 will remain available for DTT and the analogue TV service will end on all channels.

3.82 The expected digital dividend is 48 MHz in the lower 700 MHz band and 60 MHz in the upper, making 108 MHz all told.

3.83 The FCC has traditionally disposed of spectrum by auction. The auctions summary page on the FCC's website[22] records that 82 spectrum auctions have been conducted since 1994. The 700 MHz spectrum was auctioned between January 24 and March 18 2008 over 261 rounds, and raised a net $19 billion.[23] The total number of licences awarded was 1,090.

3.84 The FCC's approach to releasing spectrum for public safety applications is interesting. It established a single nationwide Public Safety Broadband Licence which is assigned to the Public Safety Spectrum Trust Corporation. The PSSTC and the commercial licensee for the upper spectrum band will form a partnership to develop "a shared, nationwide interoperable network for both commercial and public safety users". This network aims to provide public safety organisations with access to new broadband technologies across the US. Under the partnership, the public safety operators will have priority access to the spectrum in times of emergency, and the commercial licensee will have preemptible, secondary access to the public safety broadband spectrum. The FCC estimates that, "Providing for shared infrastructure will help achieve significant cost efficiencies while maximizing public safety's access to interoperable broadband spectrum."

[22] http://wireless.fcc.gov/auctions/default.htm?job=auctions_all#completed
[23] Auction no. 73, named simply the "700 MHz band".

Switzerland

3.85 In summary, Switzerland has taken up DTT more quickly than many nations but has published little planning in relation to future spectrum allocation or how best to measure or exploit its digital dividend.[24]

3.86 Historically the lower part of Switzerland's UHF spectrum has been more intensively used than the upper part, mainly because of the use of spectrum above channel 60 by military services in neighbouring administrations.

3.87 CEPT reports that because there are only "a few" content providers of television services in Switzerland, it will not need the whole of its allocation under the GE06 Plan. Analogue television has already ceased ahead of the end 2008, and by then the national public broadcaster will have implemented its first national DVB-T (i.e. DTT) coverage. The roll-out of the second multiplex is planned before 2010. DVB-H has already been licensed and has begun in operation in Bern. Spectrum currently allocated to DVB-H, and the next block of spectrum so allocated, is expected to use only channels below 46.

3.88 Although the CEPT report does not make clear the expected size of the Swiss digital dividend in terms of MHz, our interpretation of the block diagrams on pages 24 and 25 is that it could be equivalent to ten channels of 8 MHz each, i.e. 80 MHz. CEPT goes on to say that much more technical investigation is needed given technical difficulties and potential political difficulties.[25] For the present, therefore, we are unable comment further on how Switzerland might be able to exploit its digital dividend.

Japan

3.89 Terrestrial digital broadcasting in Japan was launched in three metropolitan areas in December 2003, and switch off of analogue is planned for 24 July 2011.

3.90 Japan faces extreme congestion in broadcasting spectrum (according to the national broadcaster NHK, "the degree of frequency congestion in Japan is approximately 50 times that of the United States"[26]) and has therefore established a firm plan for DSO. Although the government is determined to bring about a smooth transition, this may be challenged by the fact that almost all available frequencies are already in use to serve Japan's current analogue broadcasters, leaving insufficient frequencies for the introduction of DTT.

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[24] We are reliant for most of our information concerning Switzerland on CEPT Report 22, dated July 2007 but not published until July 2008The report is entitled *CEPT Report 22, Report B from CEPT to the European Commission in response to the Mandate on "Technical considerations regarding harmonisation options for the Digital Dividend".* It is further sub-titled, *"Technical Feasibility of Harmonising a Sub-band of Bands IV and V for Fixed/Mobile Applications (including uplinks), minimising the Impact on GE06".*

[25] The following quotation is highly relevant. "The studies so far conducted have shown that a sub-band in the upper part of the UHF-spectrum would be the only valid option for Switzerland. The Swiss administration is of the view that the introduction of a sub-band for mobile services would not allow [it] to reconstitute the broadcasting allocations that will be affected by such a sub-band. For the moment it is not clear if the loss of 14 GE06-allocations would be acceptable from a political point of view." (*op. cit.* p.25)

[26] HiQ Data AB (2006), "Digital Switchover and Spectrum Dividend - Market Status outside Europe"

3.91 The government (Ministry of Internal Affairs and Communication) expects analogue switch off to release about 70 MHz of spectrum in the VHF band and possibly 300 MHz in the UHF band.[27]

3.92 The current plan for allocation of the VHF digital dividend is two channels (18 and 17 MHz each) for broadcasting and 35 MHz for general services (public or private). A probable use of spectrum for broadcasting will be the introduction of multimedia broadcasting services deliverable to mobile phones. Spectrum needs for general services include a broadband wireless system for public safety bodies. The allocation procedure for the dividend has not yet been decided.

3.93 Of the 300 MHz potentially available in the UHF band, 60 MHz will be available as digital dividend as the other will be taken up by digital broadcasting (and possibly land mobile services). This Dividend will result from the 're-packing' of the spectrum to enable more efficient use. Of this, 10 MHz is to be allocated to Intelligent Transportation Systems[28], 10 MHz as a guard band, and 40 MHz to commercial services. Again, Japan has not decided upon the method by which to allocate the spectrum to commercial services.[29]

3.94 The above potential uses of the freed spectrum must be viewed within Japan's policy objectives regarding digital transition, the overall goal of which is to establish a ubiquitous network society "…the world's most advanced wireless broadband environment".[30] Thus in future spectrum reallocation Japan is likely to place a high priority on wireless broadband services.

3.95 In television the government wishes to see more viewer choice and more competition among broadcasters. Currently about 76 per cent of Japanese households are covered by the state broadcaster, with over 100 private commercial broadcasters providing regional services. Thus the demand for the broadcasting digital dividend is likely to be high, and the allocation thereof complex.

Lessons for Ireland

3.96 We begin with the assumption that Ireland will wish to abide by the decisions of RRC-06 and WRC-07.

3.97 It is clear from our study of eleven countries that no single national model has emerged in relation to the digital dividend that, even on the face of it, Ireland could apply to its own situation. Indeed, there is no single model at all.

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27 Ministry of Internal Affairs and Communications (2008), "Digitization of Terrestrial Broadcasting in Japan"
28 ITS provides vehicle-vehicle communication, providing safety assistance to prevent accidents.
29 Ministry of Internal Affairs and Communications (2008), "Digitization of Terrestrial Broadcasting in Japan"
30 HiQ Data AB (2006), "Digital Switchover and Spectrum Dividend - Market Status outside Europe"

3.98 Instead, we believe that international comparisons serve rather to highlight some strategic issues that Ireland will need to address. We summarise them as follows.

(a) Arguably the biggest decision for Ireland to make is **whether or not to devise and implement a detailed digital dividend plan**. Neither Italy nor New Zealand has done so, and it does not therefore follow that Ireland must.

(b) Next, and hardly less important, is the matter of arriving at spectrum allocation **agreements with neighbours**, in Ireland's case with the UK, in order to forestall signal interference. We have shown how this appears to have become a thorny problem for Switzerland and, conversely, how the US and Canada have resolved it formally at an early stage in the transition to DSO.

(c) A closely related matter is the extent to which, and the reasons why, Ireland might wish to support the principle of European **harmonisation** being promoted by the Commission. If the question of harmony with neighbours is (as we believe) of very great importance, then the extent to which the UK does or does not go along with the EC's harmonisation ambitions will affect Ireland, and *vice versa*.

(d) A fourth issue is **what priorities to apply to increased communications capacity**. We have seen that either explicitly (Finland, France and the UK) or by default (Italy) television broadcasting has ranked high in the priorities of politicians. Outside the US, which has explicitly earmarked capacity and structural arrangements for enhancing public safety communications, no jurisdiction among the eleven we studied has made any specific commitment to social or public service applications.

(e) An important decision, consequent upon the high-level choice of priorities, is **whether the market, or governments and regulators, should decide** how spectrum then should be allocated. A combination of the two may be workable.

(f) An important aid to such decision-making is good **assessments of what demands for spectrum may arise, and whether (and when) demand will exceed supply**. Such assessments may well need to be done iteratively.

3.99 We see no necessity for Ireland to devote significant resources to forecasting the value of the digital dividend. In Section 6 of our report we suggest some outline values based on simple but robust factors. Other countries that have made their own calculations (i.e. among those we have considered) have had to settle for broad approximations.

4 THE IRISH CONTEXT

Introduction

4.1 Having presented in the first part of our report a series of international comparisons as to how governments and regulators have approached the digital dividend, in this second part we concentrate on the Irish context. This work was based on a study of documents and on a programme of interviews, which we summarise below.

4.2 We have drawn only on published documents, although we are aware that the organisations we have consulted are likely to have produced confidential internal material as well. The documents we have studied are divided into those of Irish origin and those originating elsewhere, and the list appears at Appendix 2. We do not attempt to summarise these documents individually but draw on them as appropriate for our assessment of the Irish context.

4.3 Appendix 3 lists the organisations with which we made contact. There are 20 all told: in all but two cases our discussions were held face-to-face. We are grateful to ComReg for having assisted in the identification of relevant individuals within the organisations, and to all the interviewees who gave us their time. As with the documents we reviewed, we have not reported the interviews in detail but have instead drawn on them as necessary.

Background

4.4 The Irish electronic communications sector generated €4.46 billion revenues in 2007.[31] However, slightly more than fifty per cent of such revenues were generated by fixed-line services so that the revenue contribution of the spectrum-using services is approximately €2.2 billion. This amount can be further divided between the revenues generated by broadcasting services (€196 million) and mobile services (€2.0 billion).

Mobile telephony

4.5 At the end of 2007 there were 5.4 million mobile phones in use in Ireland, giving a penetration rate of 119 per cent based on a population estimate of 4.42 million in April 2008.[11] This penetration rate is just above the EU average of 118 per cent, and places Ireland fifth among the EU 27.

4.6 There are six mobile operators in Ireland: four established operators (Vodafone, O2, Meteor and 3 Ireland) and two Mobile Virtual Network Operators (MVNOs) that entered the market only in the last year (Tesco Mobile and eircom Mobile). 3 Ireland operates only in the 3G segment of the market.

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[31] Unless otherwise specified, all figures from this section of the report are taken from ComReg, *Irish Communications Market: Quarterly Key Data Report*, June 2008

4.7 Concentration in the market for mobile telephony is high, with the combined share of the two largest operators (Vodafone and O2) greater than 75 per cent.

Television

4.8 There are 1.46 million TV households in Ireland but only 24 per cent of these rely exclusively on free-to-air reception. And the number is declining: by 12 per cent in 2007 alone. Pay TV households thus represent just over three quarters of all TV households. Almost 71 per cent rely on cable or satellite TV[32] (33 per cent and 38 per cent respectively) and this number is still growing. The remaining 5 per cent of households use the Multi-channel Multi-point Distribution Service (MMDS)[33] to receive broadcasting signals.

4.9 No free-to-air digital TV is currently available in Ireland (except for a recent DTT pilot described below) but digital TV is available on a paid-for basis via cable, satellite or MMDS, and is well established in Ireland, with (as of March 2008) more than 850,000 paying subscribers, i.e. 60 per cent of all TV households.

4.10 There are four main free-to-air TV channels: RTÉ 1 and 2 from the incumbent national broadcaster, and TV3 and TG4 (the Irish-language channel). In areas close to the border with Northern Ireland and on the Irish east coast the main UK free-to-air channels (BBC1, BBC2, ITV, and Channel 4) are available, with a good quality signal, on an overspill basis. The cable and satellite broadcasters invariably carry these UK-originated channels, with the result that, as several interviewees impressed upon us, they are now, in respect of TV viewing, part of the Irish way of life.

The DTT pilot

4.11 In August 2006 the Department of Communications, Energy and Natural Resources (DCENR) launched a DTT pilot. The pilot covered 1,000 households on the east coast between Dublin and Dundalk, and provided access to DTT for a period of two years, i.e. up to August 2008, so that a number of tests could be conducted. The trial initially used MPEG-2 coding, although MPEG-4 coding was subsequently used in order to facilitate the testing of high-definition (HD) programme services.

4.12 The test allowed consumers to provide feedback on their experiences in the use of digital television so what they found could be taken into account by policy-makers. At the time of writing there is little detailed information publicly available on the results. However, according to the press, the results have been encouraging. The pilot showed that 82 per cent of those involved would recommend digital television to a friend, reception and

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[32] BSkyB ("Sky") is the sole satellite TV provider in Ireland.

[33] MMDS is a wireless communication technology used mainly in sparsely populated rural areas where cabling would not be economically viable.

picture quality being the prime reasons for doing so, and 84 per cent were satisfied with the overall service.[34]

Spectrum award in Cork, Dublin, Galway, Limerick and Waterford

4.13 ComReg is currently considering the possibility of awarding a licence for a single UHF channel (8 MHz) in each of the urban areas of Cork, Dublin, Galway, Limerick and Waterford.

4.14 ComReg is considering two options for this award. The first option restricts the use of the spectrum to mobile TV in the selected areas. The second option is to award the spectrum on a service- and technology-neutral basis, i.e. to any application deemed suitable.

4.15 The results of this award could provide valuable information for the possible uses of the digital dividend before the switch-off of analogue TV services.[35]

Spectrum management in Ireland

Spectrum management objectives

4.16 The radio spectrum is, as multiple commentators have observed, a finite resource that can support a number of different applications and can contribute considerably to consumer and citizen welfare. However, since the early days of radio transmission it has become ever more clear that spectrum use cannot be left completely unregulated. The most obvious reason is that if two nearby users transmit on the same frequency the interference would prevent both signals from being received clearly. Avoiding interference is the single most important factor for any spectrum manager to take into account.

4.17 But there are a number of other objectives that need to be considered. Within its duty to "enable the development of a sustainable, competitive and dynamic communications sector in Ireland" ComReg identified some further principal objectives in its *Spectrum Management Policy Statement 2008 – 2010*. They are to:

(a) meet the requirements of all radio services, ensuring a balance between commercial and public policy requirements;

(b) maximise the social benefits arising from radio use (for example in relation to public safety, national security and healthcare);

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[34] See http://www.broadbandtvnews.com/?p=6247

[35] It may be appropriate to refer here to the fact that O2 trialled mobile TV with some 300 customers. Reactions, shared with ComReg, were said to be very positive. O2 provided 12 programme services, together with some interactive channels. Most people watched it in the house, so the signal had to penetrate walls. However, O2 regards the business case as a tough one to make, given that it is not easy to estimate revenues.

(c) enhance Ireland's competitiveness by ensuring that adequate spectrum is allocated and assigned to users that derive the highest economic value from it;

(d) ensure the efficient use of the spectrum within the bounds of spectrum constraints and technology developments.

4.18 In some cases these objectives are not entirely complementary and thus have to be weighed against each other. Allocating spectrum to users that derive the highest economic value from it may clash with the exigencies of (for example) the healthcare or national security sectors, so a choice must be made as to which use should have priority. Such choice may be essentially political in nature. Even within the same class of objectives there could be different requirements: different public goals may be achieved with the same part of the spectrum.

Current spectrum management framework

4.19 Historically, in Ireland and beyond, spectrum management has been based on State control. However, technological advances in the telecommunications sector, changes in consumer preferences and the increased internationalisation of many communications markets have all served to push governments towards allowing a more flexible use of spectrum.

4.20 In Ireland the DCENR is responsible for overall communications policy, for spectrum policy, and for international agreements. In its Third Progress Report the Department highlighted the formation of the Spectrum Policy Group in 2007 to develop a new spectrum policy to meet national and international objectives. It has recently issued a report, and is currently holding a public consultation, on the principles of spectrum policy

4.21 ComReg is responsible for executing spectrum policy, for the development of a strategy for spectrum use (to be updated every two years) and for the National Frequency Plan.

4.22 The Broadcasting Commission of Ireland (BCI) was set up to regulate commercial broadcasting content but is now also empowered by statute to award up to four DTT multiplexes and must be consulted by ComReg in the possible disposal of two more. In determining the broadcasting requirements for the commercial and community sector BCI must take into account the availability of spectrum and must consult with ComReg. Overall BCI says (in its 2008 document on licensing policy referred to above) that it aims at the creation of a viable DTT platform in Ireland. Specific objectives are:

- to facilitate consumer choice with respect to the platforms on which broadcasting services are received;
- to maximise opportunities for broadcasting services and content providers by increasing the potential availability of services; and
- to provide an enhanced video, audio and interactive television experience for (terrestrial) television users.

4.23 The role of DCENR, ComReg and BCI collectively is to manage spectrum use within the constraints represented by national policies, international rules and government-to-government agreements that Ireland enters into. Consistently with these, and with the avoidance of signal interference, it is generally deemed desirable that the largest possible number of uses be provided.

4.24 National spectrum managers thus need to decide what use can be made of particular portions of available spectrum and, in principle, to allow only one entity to transmit on a particular frequency in a particular geographical area.

4.25 The demand for flexibility in spectrum distribution in Ireland has resulted in the use of management models different from the traditional administrative assignment, such as:

(a) Market mechanisms such as spectrum-licence auctions (though subsequent spectrum trading would require changes to primary legislation).

(b) Licence exemption, whereby the users of low power, non-interfering devices are exempt from licence requirements.

Ireland's advantages

4.26 Compared with many other EU Member States, Ireland is not densely populated, and thus has (at present) a relative abundance of spectrum in a number of geographical locations.

4.27 Located at the western edge of Europe, it does not have as many border-related issues to face as landlocked Member States within continental Europe. That said, Ireland has important matters of spectrum to coordinate with its nearest neighbour, the UK.

4.28 In general, it should be possible for Ireland to experiment more freely with innovative uses of the spectrum than many countries have been able to do, as ComReg's Test and Trial (T&T) licensing scheme appears to us to have done successfully. Such a possibility needs to be acknowledged in assessing what can be done with the digital dividend.

Ireland's disadvantages

4.29 Ireland's principal disadvantage (in the spectrum context) is the relatively small size of its population, which stands at 4.42 million[11]. The size of economic markets that this implies may limit Ireland's opportunity to achieve, or to permit suppliers to achieve, scale economies. The organisations we spoke to were, without exception, only too aware that equipment manufacturers would not be interested in producing goods to a distinctive Irish specification: the size of the Irish market simply would not justify it.

4.30 A second disadvantage is the size and scatter of the rural population. According to the Central Statistics Office, around a third of the Irish population, almost one and a half million people, live in rural areas. This sizeable part of the market has historically been

difficult to serve where infrastructure costs are high, and it is still a challenging target for access by digital wireless means.

International issues

4.31 The international obligations to which Ireland is subject too, with regard to the management of spectrum, are those determined by the International Telecommunications Union (ITU) and the EU.

4.32 As we have already reported, two recent conferences bear decisively on spectrum management in Ireland: RRC-06 on the transition from analogue to digital broadcasting and WRC-07 on new wireless services in general and on the future of International Mobile Telecommunications (IMT) particularly. Since Ireland participated in these conferences, and since we have seen no objections to their outcomes, we take it as read that Ireland will continue to regard them as givens in the development of its own spectrum policy.

Cooperation with the UK

4.33 In 2005 ComReg and Ofcom set up the so called "all-Island license project team" and for the first time spectrum (in the 1785-1805 MHz band) was assigned for the entire island.[36] For jurisdictional reasons it was necessary to have two separate competitions (one in the UK and one in Ireland) but the spectrum was packaged in the same way and the rights and obligations of the licensees were (as far as possible) made identical.

4.34 It is clear that there are considerable benefits for Ireland and the UK in coordinating spectrum management. To do so will avoid the loss of use of part of the available spectrum in both countries and, of course, will minimise cross-border interference.

4.35 Television viewers along the border with Northern Ireland and along the east coast have in the past had access by overspill coverage to the four main UK terrestrial television channels. While some degree of overspill is likely to continue in an all-digital environment, the nature of digital transmission and the outcome of GE06 may mean that it is not as extensive as it was in the analogue environment. UK television programme services will nevertheless continue to be available to viewers throughout the Republic of Ireland by means of alternative platforms such as cable or satellite.

4.36 Overspill of Irish free-to-air services into Northern Ireland from high power stations (for example from the Clermont Carn and Holywell Hill transmitter stations) is expected to remain a feature in the all-digital transmission era, and spectrum planning and coordination will be done on the basis of preserving the signal in Northern Ireland to the greatest extent possible in the absence of an alternative means of serving existing viewers in that jurisdiction.

[36] More information on the award of this spectrum can be found at http://www.ofcom.org.uk/consult/condocs/availspec/1785_1805.pdf

4.37 We heard no equivalent comments from the mobile network operators, although they too see every advantage in spectrum harmonisation with the UK and indeed with the EU generally. If full harmonisation can be achieved with the UK so that spectrum users can, in practice, use exactly the same specifications in the two countries, the result would be, effectively, a single market between Ireland and the UK in respect of digital electronic communications.

Developments before DSO

4.38 For Ireland, DSO seems likely to be completed in 2012, and indeed the Broadcasting Bill 2008 refers to 2012 – but it is for the Minister to determine a date.

4.39 Up to and beyond that date there will be a number of impacts affecting the spectrum-using industry in general and the digital dividend in particular. We briefly summarise below the demand and technological factors that we believe will be most likely to have an impact.

Demand factors

4.40 Outside television, demand is also likely to switch from voice-only services to video and data services: as such services come to be regarded as standard the network operators will require more bandwidth to provide them.

4.41 One of the most important issues arising is the availability of these services, in addition to other internet-based services, in rural areas. Demand for spectrum is likely to increase across the whole country, not just in areas that are currently served by broadband services. The digital dividend may be used to bring broadband to rural areas – but there are several ways of achieving this, some involving the allocation of freed spectrum, so there are choices to be made.

4.42 But the issue is far wider than in rural areas. Overall consumer demand for communications services is likely to continue growing rapidly before 2012, and demand for spectrum-using platforms is likely to grow with it. Mobile broadband, for example, has been taken up more rapidly even than the mobile network operators expected.

4.43 The traditional distinction between mobile telephony and TV broadcasting is likely to become less and less clear: new mobile devices are already capable of displaying media content and within the next three years or so will incorporate digital video and audio receivers. But we have so far found no studies estimating Irish demand for such devices or services.

Technological factors

4.44 There are additional changes that could be influential with policy-makers over the next four years or so.

4.45 Cognitive devices (which can determine which channels are in use and switch to others) are likely to become more widespread and more efficient, reducing the need to assign specific frequencies to specific uses. As yet, the technology is still under development and we have not been able to find any estimates of consumer uptake, but it is characteristic of telecommunications developments that uptake can be very rapid once a product is available – as witness (and these only the most recent) sat-nav devices and iPods.

4.46 Mobile devices will certainly become much less focused on mobile telephony (i.e. voice calls and texts) and will acquire much greater functionality. Network operators are clear that they will be used more and more by consumers to surf the internet, connect to GPS systems, receive and send e-mail, watch TV and listen to music (both as mp3/mp4 devices and as radio receivers). This would result in the bundling together of a number of technologies that have so far been separate.

4.47 Technical developments will also bring about a drastic restructuring of the business models of network operators and content providers. To put it simply, mobile network operators have traditionally not provided content: the participants in a voice call or a text message effectively provide it. But when a handheld device becomes (say) a portable television set, some kind of commercial arrangement needs to be set up between the provider(s) of the programming and the carrier of the signal to the handheld device. For example (but it is only one example), the DVB-H protocol has been devised as a means of getting a signal to the end user, although some of those we interviewed do not regard DVB-H as the one right solution that makes all others wrong. And in any event the technical protocols do nothing to resolve the commercial issues that arise.

4.48 Finally, it is likely that devices that use spectrum which has so far been little sought after (e.g. spectrum above 6 GHz)[37] will be developed. Such devices may well be used in military or scientific applications, but their development for commercial civil applications could free up additional spectrum which is closer to the digital dividend frequencies.

[37] But note that BSkyB Corporation uses 4-8 GHz and 12-24 GHz for up-linking and down-linking the Sky television services.

5 THE DIGITAL DIVIDEND IN IRELAND

5.1 We divide this section of our report into two principal parts – those that relate to the definition of the digital dividend, which is related to policy stances already adopted in Ireland, and technical issues.

Definitional and policy issues

5.2 It is possible to argue over what is meant by the term "digital dividend", and the definition may legitimately differ from country to country. We start from the purist point of view that, once analogue broadcasting signals have been switched off, all the spectrum thereby released could in theory be released for any other service that is technically suited to those frequencies. On this basis, and to put it simply, the digital dividend will characteristically be quite large.

5.3 The reality, of course, must be somewhat different. National governments and regulators within and beyond the EU have seen it as necessary to guarantee a certain amount – and usually a large amount – of spectrum to broadcasters.

5.4 In no jurisdiction that we have considered have we found a published quantitative assessment of future demand for broadcasting, especially television broadcasting, supplied either by publicly-funded or commercial broadcasters; nor any assessment of what public service broadcasting ought to look like once DTT becomes widely available.

5.5 Nevertheless, the priority accorded to the preservation of broadcasting is sufficiently widespread for the European Commission to have defined the digital dividend thus:

> "Digital dividend is the spectrum over and above the frequencies required to support existing [analogue] broadcasting services in a fully digital environment, including current public service obligations" COM (2007) 700.[38]

5.6 While the Commission's definition refers to *existing* broadcasting, a number of governments have reserved broadcasting spectrum sufficient not merely to allow broadcasters to sustain current output but to expand it considerably, by itself facilitating a dividend of sorts for broadcasters.

Broadcasting allocations already determined

5.7 The Irish DTT frequency plan resulting from GE06 provides for 8 national TV multiplexes or "layers" within the band 470 to 862 MHz.

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[38] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *Reaping the full benefits of the digital dividend in Europe: A common approach to the use of the spectrum released by the digital switchover* (November 2007)

5.8 The Broadcasting (Amendment) Act 2007 specifies a minimum of six multiplexes for television broadcasting:

- one multiplex initially for RTÉ
- a possible second multiplex for RTÉ
- three multiplexes, and a possible fourth multiplex, to be awarded by BCI

5.9 These six multiplexes may be regarded as the statutory minimum for broadcasting. But in addition BCI and ComReg may consult on additional television multiplexes.

5.10 ComReg works on the basis that spectrum required for 6 multiplexes on a nationwide basis is effectively reserved for broadcasting purposes.

5.11 A further provision allows for ComReg, after consultation with the Minister and the BCI, to issue further multiplex licences.

Other allocations

5.12 So far as we are aware, no other spectrum allocations have been made, either formally or provisionally.

The views and expectations of users and stakeholders

5.13 We gave all interviewees assurances of confidentiality and anonymity, save only that we would be happy to report directly if they so wished. On either basis we do not repeat everything that was said: we aim only to provide a summary of the views of different segments of stakeholders. We summarise the interview findings under three headings: the Irish context, how to determine the use of the digital dividend, and quantifying its potential impacts.

The Irish context

5.14 Our discussions with officials from DCENR raised no new issues.

5.15 RTÉ confirmed its understanding as to the multiplexes that it would be awarded. It said that it did not have a view as to how spectrum should be awarded or charged.

5.16 The high level of cable and satellite penetration in Ireland is related to the close geographical and cultural links between Ireland and the UK which, over the years, have put a commercial and indeed a political premium on widespread transmission of UK free-to-air channels in Ireland. This, together with the late start of DTT in Ireland by comparison with other countries, contributes to the risks attaching to DTT roll-out. In turn some uncertainty arises about the distribution of the dividend since it will not be clear, even over the medium term, what the ultimate demand will be for spectrum by DTT broadcasters.

5.17 Most views about harmonization were to the effect that Ireland should, to the extent possible, harmonise with the largest possible entity. This would be in the interest of obtaining the lowest cost user and operator equipment. Harmonization should be with the EU rather than with the UK (should it come down to a choice between the two). But some pointed out that in a global context the EU might itself be a relatively small player. In this respect it was noted that the other major global areas, the US and the Americas generally, and the Asia-Pacific region, have earmarked frequencies for mobile from 698 MHz to beyond the 862 MHz level earmarked by CEPT.

5.18 There are some problems of interference in mobile communications in the border areas, but these are well handled by ComReg and Ofcom under their Memorandum of Understanding and fall within the norm for contiguous jurisdictions. There is a particular issue in relation to terrestrial broadcasting in that, as far as practicable, the Irish authorities would want overspill of DTT in Northern Ireland.

5.19 Most interviewees believed that there will be excess demand for spectrum, given the strong growth in mobile communications and development of new mobile products – including notably mobile TV and, in due course, 3G enhancements and LTE (Long Term Evolution). This implied that demand would encroach on the lower CEPT boundary at 790 MHz. Telecoms operators cited the allocation of 112 MHz in the UK and extension of the non broadcast limits in the US and Asia (see above) as implying that there will be excess demand in Ireland where, under CEPT, the allocation will be 72 MHz.

5.20 The needs of DTT, on the other hand, would be highly influenced by consumer demand but some acknowledged that an enlarged offering of SD and/or HD television might prove essential to the viability of DTT.

Uses of the digital dividend

5.21 Most interviewees were of the view that the dividend should be allocated in its entirety, but with some believing that part of the spectrum might be reserved to cover the uncertainties of technological developments. The case for allocating the dividend in its entirety would be better supported if there were to be trading of licences. Consistent with the majority view, there was little support for reserving spectrum for particular uses such as local TV or licence-exempt applications.

5.22 It was suggested that local TV should be covered within the allocation of the broadcast multiplexes. As regards licence-exempt use, that was held to be a matter for global standards: one country could not go on its own with licence-exempt applications. As regards an “innovation reserve”, some interviewees felt that there might be a case, while acknowledging that the existing régime operated by ComReg was working well.

5.23 In short, the spectrum was seen as too valuable for anything except commercial use and likely to become more so.

5.24 For the mobile sector, the GSM Association (and some individual mobile network operators - MNOs) said that its members would want to develop mobile broadband

vigorously, encouraged by the rapid uptake that had so far been observed. The sector would need access to not less than 72 MHz of freed spectrum and preferably somewhat more than 100 MHz. MNOs would expect to pay for such spectrum and would favour auctions as preferable – on the grounds that they are quicker and more certain than so-called beauty contests.

5.25 The sector favoured a digital dividend plan rather than *ad hoc* developments. Even if the amount of spectrum available, or the allocation of frequencies, were to prove sub-optimal, certainty and stability were of more fundamental importance to the mobile operators.

How to determine the use

5.26 Opinions as to how the licences should be allocated were divided between a pure auction and beauty parades for particular purposes within specific bands. On the one hand there was caution about the use of auctions, considering the danger that these might lead to instances of "winner's curse", by which the successful bid costs so much that the bidder could not then develop use of the licence; or of accumulating spectrum to exclude competition. On the other hand excessive prescription by the authorities was considered as likely to prove inflexible in the face of rapidly evolving technologies. Disposal should be technology- and service-neutral. However, beauty parades were also acknowledged to have their problems: in the Irish context they had given rise to damaging litigation. Overall the preference was for auctions with strong performance conditions (e.g. "use it or lose it") attached.

5.27 Neutrality in service and technology in the allocation of licences and the requirement for flexibility point strongly to permitting licences to be traded. There was a general view that the necessary legislation should be introduced to allow trading to take place.

5.28 Reference should be made to the question of open access-type arrangements. There was a minority view in favour of arrangements by which a large "utility-type" operator might be awarded spectrum for wholesale to smaller operators. The wholesaler might or might not be permitted to operate at retail level. It was suggested that particular needs, such as Services Auxiliary to Broadcasting/Programme Makers and Special Events (SAB/PMSE) or innovation might be met from this allocation along with demand from general users. Another suggestion was that this might be an appropriate approach to the implementation of mobile TV, which several interviewees considered had a poor commercial outlook. Sharing infrastructure, as suggested in the ComReg consultation on mobile TV, might improve its economics.

5.29 Several interviewees observed that the allocation of spectrum in the digital dividend has knock on effects on spectrum outside the conventional limit: 470 MHz - 962 MHz, and vice versa. Decisions about the digital dividend have to be set in the wider context of use of the spectrum as a whole.

Quantifying the Impacts

5.30 Not surprisingly, few interviewees could offer much concrete comment about prices, likely take-up rates or turnover for particular future broadcast or non-broadcast services. Reference was made to the results of studies, such as that conducted by Spectrum Value Partners (q.v.) which showed large social, economic and commercial returns to mobile telephony. But in general, interviewees felt that the dynamics of the technology and market developments precluded firm quantitative forecasts about the future.

5.31 There were two clear perceptions of social benefits of the use of the dividend. On the one hand it was emphasised that providing DTT could carry a substantial improvement in the offer to people now relying on Free To Air (FTA) (even setting aside the fact that overspill FTA is thought likely to decrease) or indeed those reliant on MMDS. The other important social benefit is enhanced capacity to provide wireless broadband, thus contributing to the closure of the digital divide in rural areas, where about 1.5 million persons are resident.

Discussions with ComReg

5.32 Throughout the project we have discussed a number of matters with ComReg, and for convenience we summarise them here.

(a) With different conditions applying to different Radio Frequency (RF) channels, and different coexistence measures required for different potential new services in the digital dividend, spectrum packaging for an award (whether by beauty contest or auction) will be significantly more complicated than usual. It will be necessary to provide bidders with more information about the RF environment than usual. In particular this adds to the complexity of an auction, and perhaps points to the need for a combinatorial auction (as proposed by Ofcom) which will be significantly more complex than any auction ComReg has run so far.

(b) Not dividing the digital dividend up into many small blocks will maximise the range of services that can be accommodated.

(c) If several different services in the digital dividend are to be allowed for in the award process, specifying universal coexistence measures is likely to lead to inefficient spectrum usage. The value of adopting a flexible approach to coexistence (as exemplified by Ofcom's proposals) is a useful lesson.

(d) There is the possibility to make use of Channels 36 and 38 to expand the digital dividend.

(e) It is likely to be possible to release some of the interleaved spectrum (or some of the capacity within the interleaved spectrum) to add to the digital dividend. This should be investigated further.

(f) Channel 69 may have value to the SAB/PMSE community but could also increase the digital dividend if harmonized with the CEPT plan. This too should be investigated further.

Technical issues

Background

5.33 The UHF spectrum used for terrestrial TV broadcasting in Europe extends from 470 to 862 MHz. It is divided into 49 contiguous RF channels each being 8 MHz wide and numbered from 21 to 69. The transmission of a single analogue TV programme service (often referred to as a channel) occupies one 8 MHz RF channel, hence one analogue TV channel is equivalent to one RF channel. Several transmitter stations are required to provide coverage across the whole of a country, and different RF channels are used at different transmitter sites in order to avoid interference between them. In Ireland national coverage is achieved with 10 high-power main transmitter stations and over 100 fill-in stations.

5.34 A digital TV transmission also occupies one 8 MHz RF channel but it carries several TV programme services (6 to 8 at standard definition[39] (SD) or 4 at high definition (HD)[40]) and is referred to as a multiplex. As with analogue TV, multiple transmitters are required to provide national coverage and different RF channels are used at different sites to avoid interference[41].

5.35 The GE06 Plan agreed at the ITU Regional Radio Conference in 2006 provides an integrated frequency plan for the broadcasting of DTT across Europe. Under this plan Ireland has been allotted eight national multiplexes or "layers" of spectrum. Each layer consists of a series of RF channel assignments[42], one at each of the 10 main transmitter sites and one at each of the 34 most significant fill-in stations, which are sufficient to provide national, or close to, national coverage[43]. Thus, each layer can support the national broadcasting of a single multiplex.

5.36 Ireland's allotment of 8 layers will support 8 national multiplexes, equivalent to around 48 to 64 SD or 32 HD national TV programme services. At present there are four national analogue TV services. Thus, even with a significant increase in the number of programme services it is likely that some of the UHF TV band will remain unused after the switch to DTT, providing a digital dividend that could be used for other purposes.

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[39] Using MPEG4 compression, on which Ireland has already decided. These numbers are representative: the actual number can be varied depending upon the video quality required.

[40] Developments in the DVB-T2 and H.264/AVC standards may increase this to 4 or 5 HD programmes per mulitplex.

[41] It is also possible to transmit a multiplex using the same RF channel at each transmitter site by careful planning and synchronisation between the transmitters. Such a network is referred to as a single frequency network (SFN). Ireland plans to use a multi-frequency network (MFN) for its digital terrestrial TV network supplemented, in some instances, with SFNs.

[42] Each assignment specifies the RF channel (i.e. frequency), the maximum radiated power, the antenna height and the location.

[43] However, over 100 further fill-in stations will be required to replicate the current analogue coverage.

5.37 As reported earlier, legislation has specified that up to 6 multiplexes are to be made available to the broadcasters on request, and that the remaining 2 can be made available for broadcasting purposes upon reasoned request, which would need to show sufficient demand. For the purposes of the discussion in this section of our report we have considered the situation in which 6 multiplexes are used for DTT.

5.38 Determining which set of RF channels should be used for the TV multiplexes and which could be released for other uses requires consideration of many factors including:

- the existing use of analogue channels and the migration to an all digital network
- minimising the number of viewers that have to change their TV antenna, and
- reasonable levels of overspill.

5.39 In addition, it will be desirable that any RF channels released as part of the digital dividend is made available across the whole of Ireland, and it may be desirable to harmonise the digital dividend frequencies with those proposed by CEPT.[44] Consequently, there are a several alternative configurations in which the digital dividend could be realised.

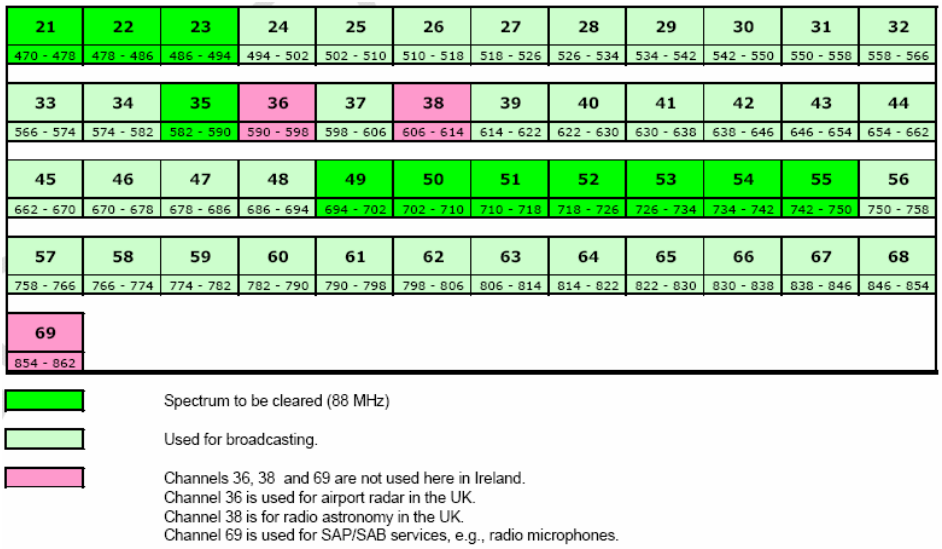
5.40 In the case of six TV multiplexes, four alternative configurations of the digital dividend can be identified without any revision of the DTT plan (i.e. Ireland's allocation of 8 layers). One is illustrated in Figure 5.1 below, and another is given in Figure 5.2. Additional configurations are possible with revision of the Irish plan but could require negotiation with, in particular, the UK.[45]

[44] See CEPT Report 22, July 2008. Note, CEPT ECC TG4 is continuing to consider technical aspects of a harmonised approach to the digital dividend within Europe.

[45] Changes to the GE06 Plan are permitted provided they are agreed with neighbouring countries affected by the changes.

Figure 5.1: One example of the RF channels that could be released to form the digital dividend if 6 national digital TV multiplexes are deployed

Note: this configuration was chosen for the purpose of discussion only: no inference as to its suitability for Ireland should be drawn.



5.41 Table 5.1 below shows how the amount of spectrum that could be released as the digital dividend varies with the number of TV multiplexes deployed.

Table 5.1: potential digital dividend for different numbers of national TV multiplexes.

	7 multiplexes	6 multiplexes	4 multiplexes	2 multiplexes
Potential DD	72 MHz	88 to 96 MHz	176 to 192 MHz	288 to 296 MHz

Note: these are based on no revision of the Irish DTT plan.

5.42 It is important to realise that there will be a number of constraints on the use that can be made of any released spectrum and that these will vary from one part of Ireland to another and from one RF channel to another. These are discussed in the following sections.

Interleaved spectrum

5.43 A low-power device, such as a radio microphone, operating within the coverage area of a TV transmitter, could cause interference to TV reception if it transmitted within the RF channel used to provide that coverage.[46] However, low-power devices within the same area can transmit on other RF channels without causing interference. Thus, with careful

[46] The low power applications typically occupy a much smaller bandwidth than the TV signals, and several may be transmitted within a single RF channel.

control of radiated power levels and the frequencies used in a given area, it is possible for low power devices to share the UHF spectrum with TV broadcasts. In Ireland and many other countries this so called interleaved spectrum is used for low power PMSE[47] applications, primarily radio microphones.

5.44 With the move to digital TV transmissions, which are less susceptible to interference, and the development of new technologies it is possible that some or all of the interleaved spectrum could be opened up to new uses and therefore form part of the digital dividend. This is discussed further below.

Channel 69

5.45 Channel 69 is not used for broadcasting in Ireland and does not form part of the GE06 Plan for DTT in Ireland. It is used for radio microphones and other PMSE applications but without the geographic restrictions that apply within the interleaved spectrum. Again, with the development of new technologies it may be possible for this spectrum to be opened up to new uses and therefore form part of the digital dividend. This too is discussed further below.

Constraints on use of the digital dividend

5.46 All use of spectrum is subject to some constraints in order to prevent harmful interference to other legitimate users of the spectrum. However, because any digital dividend falls within the internationally planned broadcasting spectrum, the constraints are more complex and can be more restrictive than would typically be the case. Determination of the constraints in detail requires extensive modelling which has not been performed for Ireland. Instead results developed by Ofcom for the UK have been used to provide an indication of what is likely to pertain in Ireland.

Constraints resulting from the GE06 Plan

5.47 The GE06 Plan specifies the particular frequencies, powers and locations at which TV transmissions may be broadcast in all participating countries. In addition, the GE06 Regional Agreement makes provision for the signatories to assign frequencies to other primary terrestrial services provided that any such alternative transmissions do not generate field strengths in other countries greater than specified within the GE06 Plan[48]. With this proviso, these alternative transmissions are also protected against interference from neighbouring countries to the same extent that the original digital TV transmissions would have been.

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[47] Programme making and special events (PMSE) covers a wide range of wireless applications used primarily in support of programme making and broadcasting (SAP and SAB services) such as outside broadcasting and news gathering. It also includes the making of film, radio, advertisement and corporate material as well as the production of plays, concerts and shows and events of all sorts.

[48] See Articles 5.1.2(e) and 5.1.3 of the RRC-06 treaty.

5.48 The GE06 Plan is an integrated frequency re-use plan across all participating countries and it therefore permits high levels of signal to be radiated from one country into neighbouring territories but only on frequencies and into areas that will not cause interference to the neighbour's transmissions which are in accord with the plan.

5.49 Any RF channel that is released for other uses as part of the digital dividend in Ireland will have to comply with the GE06 Plan. Thus the maximum field strength permissible within a released RF channel will vary with location and be different for different RF channels. Similarly, the level of interference received from neighbouring countries (essentially the UK) will also vary with location and be specific to each RF channel, and in some cases may cause interference to a new service operating in the digital dividend.

5.50 Note also that domestic TV transmissions, operating in accordance with the GE06 Plan, may also cause interference to services operating in adjacent digital dividend spectrum. This may be significant close to a TV transmitter.

General constraints

5.51 Although the detailed implications of these constraints cannot be identified at this point, the following general comments can be made.

(a) Where the use of the digital dividend is for a high-power network, such as for a DTT network, such use will largely be constrained to follow the GE06 Plan. To achieve wide geographic coverage, a number of RF channels would probably be needed.

(b) Where the proposed use is for a medium-power network, such as a mobile or a mobile TV[49] network, restrictions on base station transmit powers and locations would generally be much less onerous. In the case of a mobile network, however, reception at base station receivers would be susceptible to interference from UK DTT transmitters, especially in the border areas. As noted above, the level and distribution of this interference will be specific to the frequencies involved.

(c) Where the proposed application makes use of low-power transmissions, such as for licence-exempt applications or radio microphones, restrictions are likely to be minimal. Depending on the application and the level of screening associated with its use (such as indoor operation) incoming interference could be encountered, again particularly around border areas.

(d) It should be noted that where the digital dividend is used for up-link transmission, such transmissions are afforded no protection under the GE06 Plan.

[49] A mobile TV network could make use of high transmitter powers and use fewer transmitter stations. In this case it would be constrained in a similar manner to a DTT network as described above.

Protecting domestic digital TV reception

5.52 Domestic digital TV receivers are susceptible to interference from signals in the adjacent RF channels and also at their image frequency (9 channels above the receiving frequency). Even with reasonable limits on their in-band and out-of-band emissions[50], new services operating in any digital dividend can cause significant interference to TV receivers at the edge of a TV reception area. Such interference can be mitigated by:

(a) Introducing guard bands between the digital dividend spectrum and the adjacent DTT spectrum;

(b) Defining exclusion areas (at the edge of TV coverage areas) in which new services would be prohibited from transmitting;

(c) Coordinating the deployment of new services with the digital TV network so as to avoid the siting of transmitters (for the new services) in susceptible parts of the TV network.

5.53 The implications of the above measures on the deployment of a new service will depend in part on the characteristics of the service. An indication of the impact can be obtained from work undertaken on behalf of Ofcom in the UK which suggests that base station transmitters in a mobile or mobile TV network, operating in the spectrum immediately adjacent to a digital TV channel, would need to maintain a separation from the nearest TV receivers of around 600m in the outer parts of the TV coverage area[51] (this would reduce to around 220m for the image channel). Alternatively, guard bands could be used to prevent interference. These would need to be 8 MHz wide to avoid the adjacent channel problem but an impractical 72 MHz wide to also avoid the image channel problem. Ofcom's proposed approach is not to specify co-existence measures but to require any licensee operating in digital dividend spectrum to avoid harmful interference to DTT transmissions on the basis that this will give the licensee the flexibility to adopt the protection method most appropriate to their service.

5.54 Where mobile devices are involved exclusion zones and coordinated deployment will be of limited effectiveness leaving guard bands as the key method of protection. In this case Ofcom is proposing a guard band of 16 MHz between any mobile up link frequency (and any Time Division Duplexing system) and the DTT spectrum. As an example, this would limit the operation of a mobile up-link to four channels, namely Channels 21 and 51 to 53.

5.55 It appears likely that there will be demand for digital dividend spectrum for a number of different services, and the need to ensure co-existence between them will require appropriate licence conditions. Given that the deployment and operation of these new

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[50] We assume that new services will be subject to in-band and out-of-band emission limits which will be reasonable and not overly constrain their operation.

[51] *Digital dividend review*, Ofcom consultation, Annex Chapter 10, 19 December 2006.

services is speculative at this stage, and may well involve mobile devices, defining co-existence criteria in terms of exclusion zones or coordination criteria is difficult, leaving guard bands in combination with in-band and out-of-band emission limits as the preferred means to ensure co-existence.

5.56 To illustrate the implications for the operators of new services. Table 5.2 below gives the guard bands proposed by Ofcom[52] to protect adjacent services operating in the digital dividend.

Table 5.2: Guard bands (MHz) proposed by Ofcom between new services operating in the digital dividend spectrum

	DTT	Mobile TV	Wireless b/band (FDD down link[53])	Wireless b/band (FDD up link)	Wireless b/band (TDD[54])
DTT	0	5	5	16	16
Mobile TV	5	0	5	19	19
Wireless b/band (FDD down link)	5	5	0	10	5
Wireless b/and (FDD up link)	16	19	10	0	5
Wireless b/band (TDD)	16	19	5	5	5

5.57 Comparing the above guard bands with the digital dividend illustrated in Figure 5.1 shows that they will constrain but not prevent the deployment of the services considered.

5.58 Generic guard bands as above can only be approximate and some are quite large. It is worth noting that Ofcom proposes that the eventual licensees will be permitted to negotiate between themselves to change the conditions, for example by agreeing to coordinate their deployments and reduce the size of the guard band.[55]

Channels 36 and 38

5.59 In the UK, RF channels 36 and 38 are currently used for airport radars and radio astronomy observations respectively. Consequently, they are not currently used for broadcasting in Ireland, and are not used in the GE06 Plan for Ireland. However, both

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52 *Digital dividend review: 550-630 MHz and 790-854 MHz*, Ofcom consultation, 6 June 2008.

53 FDD (frequency division duplexing) refers to systems which use two frequencies to provide two way communications, for example one for the down link to a mobile phone and another for the up link from the mobile.

54 TDD (time division duplexing) refers to systems which provide two way communications over a singe frequency by rapidly alternating between transmitting in the down link and up link directions.

55 In the case of the largest guard bands Ofcom may retain the right, subsequent to the auction, to release parts of the guard band to other compatible services.

uses in the UK will cease over the next four years opening up the possibility that they could be included in Ireland's digital dividend.

5.60 Neither Ireland nor the UK have any transmission rights in Channel 36 under the GE06 Plan. However, the GE06 Regional Agreement provides for changes to be made to the plan through negotiation between the affected countries and the UK plans to enter into such negotiations. The outcome of any negotiations cannot be predicted, and further study of the interference situation will be required. However, as the UK is Ireland's nearest neighbour it is quite possible that Ireland could negotiate mutually acceptable cross border interference limits that would permit the operation of medium power networks in this channel.

5.61 Similarly neither Ireland nor the UK have any transmission rights in Channel 38 under the GE06 Plan but again changes to the plan can be negotiated between neighbours. Under the ITU-R Radio Regulations Ireland is also required to protect radio astronomy use in Channel 38 and the protection criteria are stringent[56]. However, Ireland is in excess of 800km from the nearest radio astronomy use in Belgium, France, Germany and the Netherlands suggesting that use in Ireland may be possible. Further study will be required to determine the use that could be made of this channel in Ireland.

Spectrum requirements for new services

5.62 The use that can be made of the digital dividend will be affected both by the amount of spectrum released and the amount that is contiguous, and how well this matches the requirements of the new services. It is therefore pertinent to consider the spectrum requirements of potential new services.

5.63 In the absence of any calculations specific to Ireland the estimates given below are taken from work published by Ofcom.[57] We emphasise that the figures shown would apply only to a given single site. It is possible that some of these will be smaller in Ireland.

Table 5.3: Ofcom's estimates of the likely spectrum requirements of new services in the digital dividend

	National DTT	Local DTT	Mobile TV	Wireless broadband	Public safety
Spectrum requirement	8 – 48 MHz	8 – 16 MHz	8 – 24 MHz[1]	10 – 48 MHz[2]	8 MHz

Notes 1 and 2: the GSMA and some MNOs in Ireland said that they would require a minimum of 72 MHz for future operations, and would prefer at least 100 MHz.

5.64 Two-way services, such as mobile radio, often use two frequencies, an up link to the base station and a down link to the mobile – that is they operate frequency division duplexing

[56] The protection conditions are laid down in ITU-R RA 769-2.

(FDD). The spacing between the two frequencies is fixed and varies between different technologies and frequency bands. Common spacings in mobile systems are 45, 95 and 190 MHz, though others are used.

5.65 Clearly, the distribution of the digital dividend across the UHF band will affect the extent to which such FDD technologies could make use of the dividend.

5.66 Of course, equipment could be modified to use alternative duplex spacings where the market justified it, and future equipment may be capable of more flexible duplexing arrangements. Technically, there is also the possibility that an up-link in the digital dividend spectrum could be paired with a down link in the GSM900 band.

5.67 In addition, there may be a preference for the down link frequencies to be located towards the lower TV frequencies to minimise filtering problems for equipment which also operates in the 900 MHz band.

Harmonisation of the digital dividend

5.68 As noted elsewhere in this report the European Commission is strongly encouraging member states to take advantage of the digital dividend and CEPT[58] has identified channels 62 to 69 inclusive (expanded to 61 to 69 following WRC-07) as the best opportunity for a Europe wide, non-mandatory, non-exclusive sub-band for a harmonised allocation to mobile broadband. A harmonised approach will be important for some of the potential uses of the digital dividend where economies of scale are required. It may, therefore, be beneficial to the Irish consumer and the Irish economy to align the digital dividend in Ireland with the emerging harmonisation in Europe. There may also be some benefit to be had from a degree of harmonisation with the UK's plans for the digital dividend where, for example, this could allow the two countries to agree on less onerous emission limits or on lower levels of interference than are specified by the GE06 Plan.

5.69 An example of the RF channels that could be released to form a digital dividend that partially overlaps with the proposed CEPT non-mandatory harmonised sub-band is shown in Figure 5.2. This particular option also partially overlaps the digital dividend planned for the UK.

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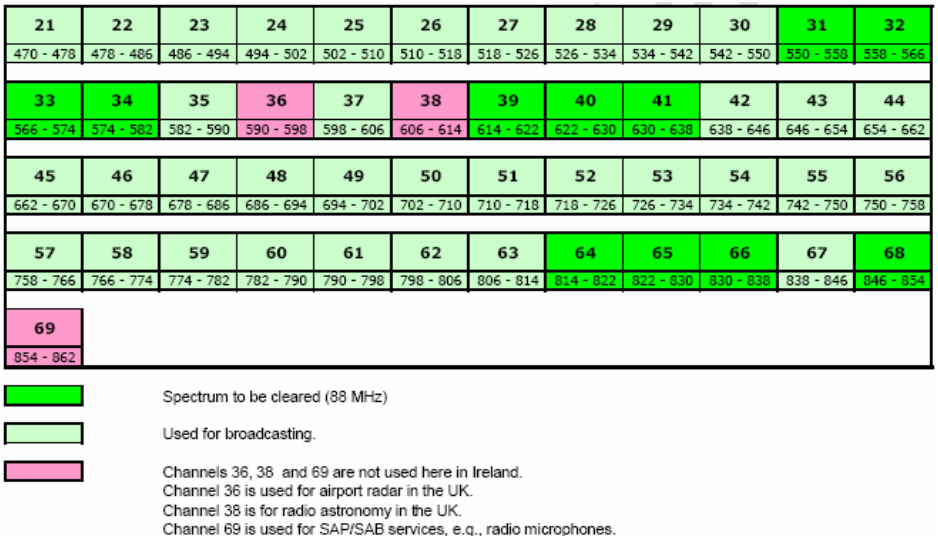
[57] Digital Dividend Review: 550-630 MHz and 790-854 MHz, Consultation document, 6 June 2008.

[58] See CEPT Report 22, July 2007. Note also that CEPT ECC TG4 is continuing to work on channel and international coordination arrangements for the sub-band.

Figure 5.2: An example of the RF channels that could be released to form the digital dividend if six national multiplexes are deployed (with no change to the GE06 Plan).

There is a partial overlap with the proposed harmonised sub-band from Channel 61 to 69



5.70 It is possible to customise the configuration of the digital dividend by making changes to the GE06 Plan for Ireland, giving Ireland the potential to match the proposed sub-band more closely. [59] Optimising the configuration taking account of harmonisation and the other constraints and criteria identified above whilst at the same time meeting the objectives for digital TV in Ireland will require detailed study and coordination with Ireland's neighbours, in particular the UK. It is likely to be a significant challenge for broadcasters.

Interleaved spectrum

5.71 As noted earlier, the interleaved spectrum within the analogue RF channels is currently used for low power PMSE applications, and the use of these applications will continue after the switchover to digital TV.

5.72 Releasing some of the UHF spectrum used for TV broadcasting as the digital dividend will clearly reduce the amount of spectrum from which the interleaved spectrum is derived, and might be expected to reduce the amount of interleaved spectrum available. However, digital TV receivers are less susceptible to interference than is the case with the

[59] Any such changes will of course need to be agreed with Ireland's neighbours.

analogue technology with the result that more interleaved spectrum is available within the same amount of TV spectrum.[60]

5.73 Other uses for the interleaved spectrum can also be considered. Firstly, with careful planning local (lower power) TV stations can be co-sited with the main transmitter stations. Secondly, Google and others have suggested that licence exempt cognitive devices could share the interleaved spectrum with the existing users[61]. Other potential uses are mobile TV and possibly mobile broadband.

5.74 The proposed cognitive devices would automatically determine what interleaved spectrum was available in their locality and, if no other use was ongoing, make use of the spectrum. Proposed applications include fixed broadband access. By giving priority to existing uses it is claimed that such devices could share the spectrum without affecting existing PMSE usage. Prototype equipment has been tested by the FCC but so far has not proved reliable enough to be approved for use.

5.75 Determining the interleaved capacity both before and after digital switchover and identifying the capacity required by existing PMSE usage requires detailed studies which have not been undertaken for Ireland. In the UK, Ofcom has given significant consideration to this issue and an indication of the capacity of the interleaved spectrum can be obtained from their proposals. These are that with the 6 national UK multiplexes[62] there will be adequate capacity within the interleaved spectrum:

(a) To award interleaved channels suited to local TV transmission at 25 main TV transmitter stations and at up to 81 stations in total;

(b) To award separately the interleaved spectrum in Channels 61 and 62;

(c) To award the remaining interleaved spectrum to a band manager primarily for PMSE use;

(d) To allow the operation of licence-exempt cognitive devices within the interleaved spectrum provided it is demonstrated that adequate protection will be provided to existing users.

(e) This suggests that with 6 (or fewer) national TV multiplexes in Ireland there will be more than adequate interleaved spectrum to continue to accommodate the existing PMSE users.

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[60] The difference comes about because radio microphones can use almost the whole (>90%) of the RF channel adjacent to a digital TV transmission whereas channels adjacent to an analogue transmission cannot be used at all.

[61] The IEEE 802.22 standard is currently being developed for such devices.

[62] The 6 multiplexes are allocated a total of 256 MHz from which the interleaved spectrum is derived.

Channel 69

5.76 Channel 69 is used for PMSE applications, particularly radio microphones. Because the channel is not used for broadcasting in Ireland (nor in the UK) it is particularly useful to PMSE users as it can be used anywhere within the country, and can be used by those working on both sides of the border.

5.77 Much of the equipment sold for operation in the channel is also capable of working in Channels 67 and 68 (giving users useful flexibility if or when Channel 69 becomes congested). This flexibility would be lost if these channels were to form part of the digital dividend.

5.78 Channel 69 is included within the harmonised sub-band proposed for mobile broadband within Europe and how this and the current use might share the spectrum is currently being considered within CEPT. Use of the licence exempt cognitive devices discussed earlier in relation to the interleaved spectrum could also be considered in this channel.

5.79 In the UK, Ofcom is proposing to retain this channel for use by PMSE users but is continuing to consult on the matter.

6 VALUING THE DIGITAL DIVIDEND

6.1 In this section we begin by identifying the range of options available to Ireland, taking into account the international comparisons we have carried out, the technical appraisal above, and the opportunities and constraints that Ireland faces. We then attempt a simple valuation of different policy approaches to use the digital dividend.

Background considerations and assumptions

6.2 We first make the assumption, which is wholly fundamental, that Ireland will work within the frameworks established by RRC-06 and WRC-07.

6.3 Secondly, although a plan is by no means a pre-requisite[63], we are firmly of the view, based on what we have read and on what interviewees have told us, that government, regulators and industry players in Ireland wish to see a plan for the digital dividend rather than to see it exploited *ad hoc*. Provided that it commands general support, a plan provides at least some certainty, and the supply-side in particular attaches importance to this.

6.4 Although Ireland has no mandatory need to harmonise its spectrum use with a large number of other countries (as EU Member States in continental Europe need to do) neither is it free to allocate frequencies at will. It needs close coordination with frequencies used in mainland UK and in Northern Ireland, and it needs to recognise that communications equipment suppliers will want maximum commonality of frequencies – not just within the EU but worldwide if possible – in order to exploit economies of scale.[64]

6.5 We acknowledge that Irish legislation has established that television broadcasting must have spectrum sufficient to cover a minimum of six multiplexes.

6.6 Within what is left, choices have yet to be made, between the demands of commercial organisations (e.g. mobile network operators), more broadcasting and some non-commercial services (e.g. new or enhanced public service or public safety applications). Such choices must of course be in the best interests of Ireland and its consumers.

6.7 EU policies suggest strongly that technology- and service-neutrality should prevail in the allocation of spectrum to non-DTT services. No interviewee dissented from that view, and we assume therefore that Ireland will wish to work to such a principle.

6.8 ComReg's spectrum management objectives already reported in paragraph 4.17 should be applied. For convenience we restate them here as to meet the requirements of all radio services, ensuring a balance between commercial and public policy requirements;

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[63] As we have seen neither Italy nor New Zealand have yet developed such a plan.

[64] One interviewee pointed out that, with world-wide demand for mobile telephone handsets running at over a billion per year, and rising, even the whole EU no longer counted as a large market.

to maximise the social benefits arising from radio use; to enhance Ireland's competitiveness by ensuring that adequate spectrum is allocated and assigned to users that derive the highest economic value from it; and to ensure the efficient use of the spectrum within the bounds of spectrum constraints and technology developments. There are some difficult conflicts here, in that economic and social benefits may well militate against each other. For example, one interviewee suggested that social benefits should include the maximisation of Irish employment.

6.9 Finally, Ireland may have sufficient spectrum capacity, and may wish to develop distinctive skills, that would make it an attractive international test bed for new spectrum-using technologies. ComReg's Test & Trial (T&T) licensing regime rather encourages further consideration of this possibility, and it may be useful to consider explicitly reserving part of the dividend for this use, especially in frequencies where demand is less intense.

Developing Ireland's options

6.10 The experience of other countries, especially the UK and New Zealand, confirms that it is difficult to assess with any great precision or certainty the value of specific uses of spectrum generally or of the digital dividend in particular. Huge uncertainties surround changes in consumer tastes, the impacts of technological developments, the cost of producing different services and consumers' willingness to pay.

6.11 We question too the reservation of so much spectrum for television broadcasting against a background of unknown consumer appetite for yet more of what already exists in abundance. Ireland is not, of course, alone in taking such a stance: priority treatment for broadcasting is widespread within and beyond the EU, but appears to have been driven by political rather than economic rationales. There may yet be questions for governments to ask about whether television quality will keep pace with quantity, and if not what to do about the spectrum consumed by it.

6.12 In Ireland the question is rendered even more pertinent by that fact that multi-channel digital satellite and digital cable TV is so well established. While there was widespread support among interviewees for a successful DTT deployment, the question remains as to whether Irish viewers will cease their subscriptions to satellite and cable in favour of DTT. Unless DTT carries, free or for a lesser subscription, the programmes that attract viewers to satellite and cable, why would they switch? If DTT carries only a subset of the programmes that satellite and cable carry[65], again we ask: why would viewers switch? Will the potential for using DTT for second/third TV sets prove attractive? And if relatively few viewers switch to DTT, or, worse, if free-to-air viewers switch to satellite or cable, what will DTT broadcasters fill their additional capacity with? We have to ask: what assurances can DTT broadcasters give that they will use their increased capacity in a way that clearly benefits Ireland?

[65] And particularly if DTT does not carry premium sports and film channels.

6.13 One subsidiary issue arises in relation to television, and that is the continuing provision of spectrum for SAB/PMSE – making and sending television material out-of-doors, particularly for sporting events. We do not think that this segment presents particular problems in the context of allocating spectrum. It exists only on a relatively small scale[66], and we assume that access to interleaved spectrum could be provided in relevant geographical areas.

6.14 Outside television, the strategic options are self-defining:

- What are the minimum and maximum amounts of spectrum that may be awarded to non-TV services?
- How should such awards take place?

6.15 Confining the strategic options (for non-TV spectrum) to these has the advantages that (i) it allows many possible applications to arise and (ii) it would support a market-led approach and (iii) would respect the principle of service and technology neutrality.

6.16 In principle, there is no reason why the entire spectrum released by analogue switch-off should not be offered by way of auction or beauty contest to whichever applicants bid for it. In practice, as we have seen, a substantial amount of spectrum is actually or prospectively reserved for television broadcasting. This narrows the range of scenarios as follows:

(a) to allocate the entire released spectrum to broadcasters;

(b) to allocate part of the spectrum to broadcasters and the rest to other uses; or

(c) to allocate part of the spectrum to broadcasters and the rest to other uses with a share of it reserved for testing and innovation.

6.17 **Scenario (a)** envisages that broadcasters will retain the entire spectrum band (470 MHz to 862 MHz). This implies a very substantial increase in the amount of TV programming available or a considerable under-usage of the available spectrum, or a combination of the two.

6.18 **Scenario (b)** envisages that, current analogue TV programming is guaranteed only the spectrum necessary for it to be broadcast digitally. Thus spectrum over and above that amount could be allocated to uses which may or may not include broadcasting.[67]

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[66] Even in the UK, where the scale of SAB is much larger than in Ireland, potential problems have been identified only in relation to major events that take place in a limited number locations over a limited number of days.

[67] As we reported above, the Irish Government has already established that part of the spectrum, in addition to that that would be required to broadcast the current free-to-air programmes using a digital technology would be assigned to broadcasters. However this scenario represents a useful benchmark to assess the value of the entire spectrum that could, potentially, be released.

6.19 **Scenario (c)** attempts to deal with the additional possibility that Ireland may wish to become a test-bed for new spectrum-using technologies in order to attract new investment and human capital.

6.20 Finally, there remains the question of how spectrum should be awarded to non-broadcasting services.

Background and assumptions

6.21 For the purposes of this study we have not conducted any surveys or interviews regarding the willingness to pay of Irish consumers. To do so would have been an immensely time-consuming task. Rather, we base our evaluation on studies conducted in other countries and on publicly available data.

6.22 In particular we rely on a series of documents published by Ofcom in its consultation on the digital dividend review in the UK, a report written by Spectrum Value Partners[68] (SVP) commissioned by a number of mobile operators and a report written by Analysys Mason (AM) for ARCEP, the French regulator.[69] Both SVP and AM attempt to value various spectrum-using services in a number of countries and to include economic effects as well as societal values. Although the aforementioned reports use different methodologies, they share a common basis for their analyses of the costs and benefits.

6.23 After a thorough review of the documents we came to the conclusion that the analysis conducted by SVP on the Netherlands is the one that matches more closely the specific characteristics of Ireland. The other studies either focus on considerably larger countries such as France, Italy and the UK or on less wealthy countries such as Slovakia. The major difference between the Netherlands and Ireland is population density which is much higher in the Netherlands. However, since we are not attempting to model regional differences within countries we believe that it has resonance with the Irish situation.

6.24 In our view, SVP's approach is apposite in the present context for a number of reasons.

- First, our own study represents only the first step in a process that Ireland will implement before the switch-off and our primary aim is to provide an initial evaluation of the possible uses of the digital dividend.
- Second, the telecommunications market is one where innovation, coupled with continuously changing consumer tastes, implies that the situation faced by decision makers in three or four years' time could be substantially different from the one they face now.

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[68] Spectrum Value Partners, *Getting the Most Out of the Digital Dividend*, 2008. This report was commissioned by Ericsson, Nokia, Orange, Telefonica and Vodafone.

[69] Analysys Mason, *Etude sur la valorisation du dividende numerique*, 2008

- Finally, as we reported in Section 3, precise estimates of the value of specific spectrum-using services are very difficult to obtain: ranges tend to be extremely wide and it is unclear what likelihood attaches to any particular value.

6.25 Given the limitations of our study, the results we show should be interpreted as indicative rather than a precise estimate.

Broadcasting and alternative uses

6.26 We have already said that in our view it is not necessary for Ireland to devote any significant resource to a detailed valuation of alternative uses of spectrum, and our principal reason for saying so was that previous estimates had produced only approximate valuations. Nevertheless, it is possible and useful (and economical in resource terms) to apply past estimates to the situation in Ireland in order to derive approximations which may be of value to policy-makers.

6.27 We believe it is worthwhile to assess approximate values for each of three possible uses of the spectrum:

- the value of broadcasting services;
- the value of alternative uses; and
- the *possible* value of the innovation reserve.

6.28 It is important to bear in mind that our objective should be to estimate the value of such services over and above the value that they are currently providing, either using spectrum bands that are not part of the digital dividend or that they could provide with less spectrum once the analogue switch off has been completed.

6.29 As explained above, our process is mainly to transpose the results obtained by SVP for the Netherlands to the Irish situation. In summary, the process that SVP applied was as follows.

6.30 SVP grouped EU Member States into three clusters: the “wealthy terrestrials”, the “wealthy cabsat [cable-satellite]” and the “less wealthy.” Then they selected a country that was deemed representative in each of the three clusters.

6.31 The countries selected were Italy, the Netherlands and Slovakia for each cluster respectively. SVP then assessed the value of assigning spectrum to two different uses, i.e. mobile and broadcasting, for the three representative countries. For the value of broadcasting services SVP modelled the supply of different mixes of DTT service and available spectrum, where a service mix is defined by reference to the number of available channels, the channel supply for each platform, and the broadcast quality (i.e. SD vs HD). For the value of alternative services, SVP modelled consumer demand for mobile broadband services under different demand forecasts.

6.32 Theoretically, in transposing SVP's techniques to Ireland, it would be possible to take account of a number of different features of the Irish market. However, on grounds of transparency and robustness we decided that a "minimalist" approach would be more appropriate. The calculations are approximate in any event, and over-refining some of the inputs could suggest an accuracy which in practice would be spurious.

6.33 We focus therefore on factors that are easy to measure accurately and that have a decisive effect on the potential value of services. These are factors that influence either the number of people consuming such services or the amount of money they are willing to spend on services. Therefore we have adjusted the SVP results only on the basis of the following three factors:

- differences in total population;
- differences in GDP per capita;
- differences in the share of households relying solely on terrestrial television.

6.34 Factoring in total population reduces the aggregate benefits accruing to Ireland for the simple reason that its population is much smaller than that of the Netherlands (4.42 million *versus* 16.4 million).

6.35 Adjusting for per capita GDP works in the opposite direction because (according to Eurostat) the figure for Ireland is 11 per cent higher than for the Netherlands.

6.36 Finally, since the share of households relying solely on terrestrial television is higher in Ireland than in the Netherlands (cable television was almost ubiquitous in the Netherlands before the completion of the switch over) assigning spectrum to DTT would have more value in Ireland.

6.37 All the figures we present below include an "externality" value associated with the use of spectrum. Externalities are effects which are not taken into account by economic agents (i.e. consumers and producers) when buying or selling goods and services. These would include improvements in labour productivity, the inclusion of disadvantaged individuals, additional job creation etc.

The value of broadcasting services

6.38 As in the SVP report we provide results for five different scenarios regarding the amount of spectrum allocated to broadcasting services. The base case assumes that all national free-to-air channels will be in HD after the switch-off (a number of interviewees, including RTÉ, told us that HD is likely to become the future norm, so we think this is a reasonable hypothesis). The base case assesses, in essence, only the value of migrating the current analogue channels to digital, leaving (almost) the entirety of the digital dividend available for other uses. The only difference is that consumers will receive the national channels in HD rather than, as now, in SD.

6.39 The other scenarios assign additional spectrum capacity to broadcasters up to the point in which the entire dividend is assigned to them. With an increasing amount of spectrum available, broadcasters will be able to supply a larger selection of channels, both in HD and in SD. The modelling (critically) assumes that consumers will demand such additional channels, though at a decreasing rate.

6.40 The modelling results show that the majority of benefits associated with the digital dividend come from the migration of analogue to digital and that assigning additional spectrum to broadcasting yields (unsurprisingly) decreasing overall benefits to Ireland.

6.41 As shown in Table 6.1, transferring the current analogue channels to a digital platform (the base case) yields a benefit of €1,052 million.[70] Assigning the entire digital dividend spectrum to broadcasters yields a benefit of €2,110 million[71]: a net increment of just over 50 per cent. The intermediate scenarios produce results that lie between these two extremes and they show that the incremental benefits associated with assigning additional spectrum to broadcasting taper off.

Table 6.1: Estimated benefits generated by broadcasting services in terms of different amounts of the digital dividend assigned to other services (NPV 2008 – 2027 in €million)

Base Case	120 MHz to other services	80 MHz to other services	40 MHz to other services	Entire digital dividend to broadcasters
1,052	1,432	1,723	1,926	2,110

Source: Europe Economics estimates

The value of alternative uses

6.42 The value of alternative uses is calculated on the basis of the value that would result from assigning the spectrum to entities different from broadcasters. For simplicity we use mobile broadband as a proxy for all possible alternative uses, which is consistent with the SVP report.

6.43 We have analysed a number of possible developments of the demand for additional services in terms of technology developments and change in consumer preferences. We report results for a "medium" outcome in which we assume that mobile broadband usage becomes complementary to fixed broadband and that there is an improvement in the functionality of mobile broadband applications. In addition connection speeds improve and there is a convergence in functionality between handsets and laptops.

[70] These are therefore the (minimum) benefits that would arise from broadcasting under Scenario (b). They are minimum as it may well be the case that broadcasters would be allocated spectrum in excess of this amount.

[71] These are therefore the overall benefits that would be associated with Scenario (a).

6.44 Table 6.2 shows that assigning 40 MHz of digital dividend to alternative uses would yield €1,241 million in terms of benefits to Ireland. However, the benefits would increase to €2,131 million should 180 MHz be allocated to other uses and to €2,196 million if the figure increases to 200 MHz.

Table 6.2: Estimated benefits from assigning the digital dividend to alternative uses (NPV 2008 – 2027, €million)

Spectrum assigned to other services								
40 MHz	**60 MHz**	**80 MHz**	**100 MHz**	**120 MHz**	**140 MHz**	**160 MHz**	**180 MHz**	**200 MHz**
1,241	1,421	1,645	1,756	1,868	1,970	2,060	2,131	2,196

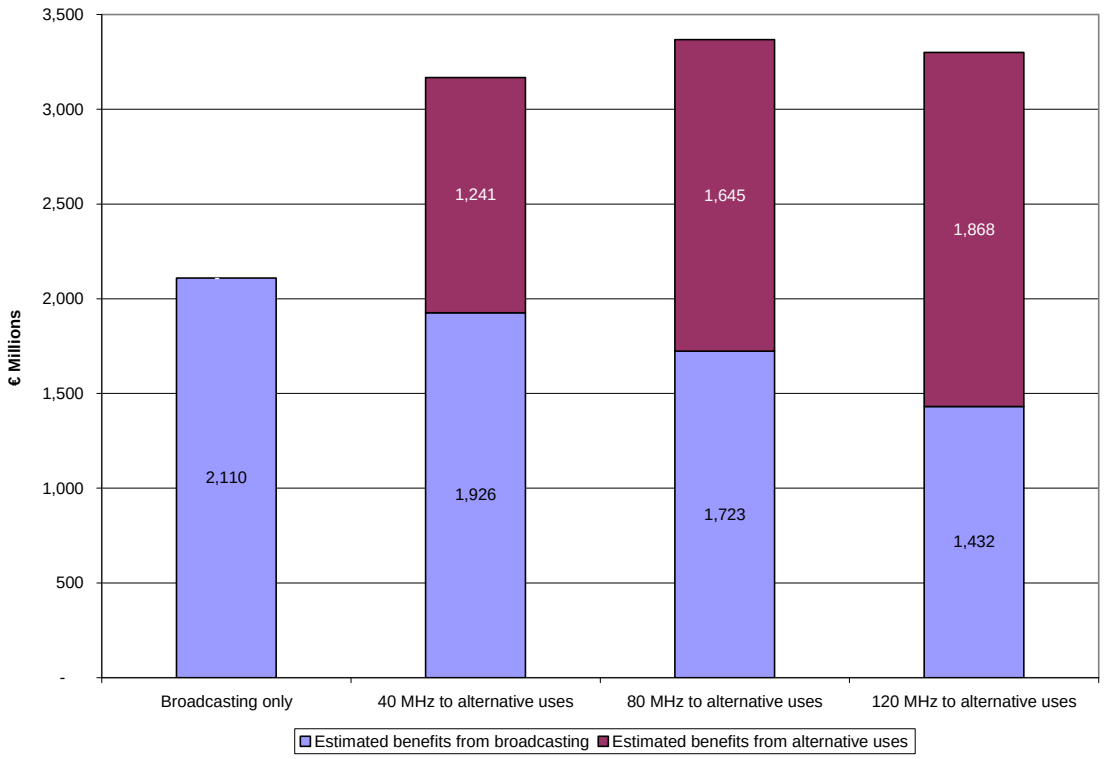
Source: Europe Economics estimates

The combined value of broadcasting and alternative uses

6.45 We illustrate in Figure 6.1 what the overall benefits, obtained from broadcasting services and alternative uses would be if the medium-demand level for alternative uses materialises.

6.46 Even the lowest allocation of spectrum to non-broadcasting (40 MHz in Figure 6.1 below) gives a value to Ireland higher than if the entire digital dividend is assigned to broadcasting only. The benefits to Ireland of assigning the digital dividend to both broadcasting and alternative uses yields a higher value than assigning spectrum for one use only. This is wholly consistent with the Analysys Mason findings for France, namely that a mixed allocation is better than a single-purpose (broadcasting) allocation.

Figure 6.1: Combined value of broadcasting and alternative uses based on medium demand for alternative services



PMSE, SAB and Channel 69

6.47 In our earlier analysis and in the relevant stakeholder interviews we asked whether it would be necessary to reserve channel 69 for the SAB/PMSE segment. We take the view that it is probably not necessary, and that at a minimum, the option of allocating channel 69 to other uses should be considered.

6.48 The SAB/PMSE segment could be granted the right to use interleaved spectrum and, given the limited requirements of the sector in Ireland, this should be enough to fulfil its needs. Clearly, it will be necessary to make sure that the required interleaved spectrum is available and this might have an impact on the regional allocation of spectrum. However, the benefits of increasing the amount of nationally available spectrum are likely to be greater than the cost associated with a reduction of locally available spectrum.

The value of an innovation reserve

6.49 We have not carried out any detailed analysis to put a value on the innovation reserve. By its very nature, it is almost impossible to forecast what innovation will produce over the next twenty years or so. However, there are a number of considerations that can be made on the basis of the analysis we conducted and the regime currently in place in Ireland.

6.50 ComReg currently allocates T&T licences for spectrum if it happens to be free. If the spectrum is occupied, ComReg will consider alternative spectrum bands or assist the applicant in seeking arrangements with the entity that has the right to use the spectrum. Generally ComReg is able to facilitate most T&T applications.

6.51 It does not therefore seem that Ireland faces a shortage of spectrum for innovative purposes. On the other hand, the analysis we carried out on the estimation of the value of various spectrum-using services suggests that increasing substantially the spectrum available for both broadcasting and non-broadcasting uses has relatively minor incremental benefits and, given that the possible benefits from innovation are usually quite large (albeit uncertain) assigning some of the digital dividend as an innovation reserve may be justified. Earmarking and promoting an innovation spectrum reserve may help to build intellectual capital and employment in Ireland, although it is very hard to estimate how big such benefits might be.

6.52 Furthermore, such a reserve could be used to trial products or services for any market (for instance Asian or American markets), not only the internal Irish or European market. This might contribute to the attraction of foreign investments as well as of human capital from abroad.

6.53 Innovation spectrum is in its own right worth further consideration.

Shared spectrum for public safety services

6.54 We have seen no evidence to suggest that there is demand for increased spectrum for use by such "public safety" authorities. We reported in Section 3 that in the US the FCC was planning to share spectrum between commercial and public safety uses, with the latter having primacy in certain emergency situations. The plan, however, has not (yet) succeeded, and its fate suggests that it may be very difficult to share spectrum between different users, or at least between commercial and non-commercial users. We have no reason to recommend that Ireland should even contemplate an approach similar to that of the FCC.

7 NEXT STEPS FOR IRELAND

Key findings

7.1 Our key findings are as follows:

1 Once the initial benefits associated with broadcasting are guaranteed there is little scope for increasing the value by assigning larger amounts of spectrum to it. On the other hand, although this is dependent on the level of demand yet to materialise, there is clearly more scope for (and more value gained from) increasing the amount of spectrum for other services.

2 On the basis of the above analysis **a mixed approach to the allocation of the digital dividend spectrum is central to Ireland's ability to achieve greatest benefit from its digital dividend.**

3 Depending on demand, **the amount of spectrum assigned to alternative uses could be in the region of 80 MHz to 120 MHz**.[72] We believe this amount could be available if six multiplexes are assigned to broadcasting.

4 Monitoring the demand for spectrum in the future is crucial so that more spectrum can be allocated to those services that would provide larger benefits. This is a complex issue, constrained as it is by frequency harmonisation between EU Member States. **Legislation and regulation will need to ensure that re-allocation can be implemented if needed**. A multiplex review, after the digital switch over, would therefore seem prudent.

5 Reserving a limited amount of spectrum for innovation may bring material benefit to Ireland, although if spectrum demand is high the cost of doing so could have a substantial effective cost.

6 A possible solution, for a limited number of years only, would be to use a single 8 MHz channel, specifically Channel 69. If Channel 69 does not have to be harmonised to SAB/PMSE uses, the prospectively enhanced image of Ireland as a test bed, available to international equipment and service providers for spectrum-related technologies, may justify the allocation of a whole channel. We would therefore urge that this possibility be given full consideration.

Issues for further consideration

7.2 In a number of important respects we have been unable to reach firm conclusions about the scale of the digital dividend, the potential uses to which it could be put or how Ireland might decide between competing claims upon the spectrum. In principle and in practice,

[72] Assuming demand in the "middle" scenario.

therefore, these matters seem to us to be matters on which public consultation *should* take place. The range of issues appears to us to span the remit of more than one body.

7.3 Any further consideration or consultation should set out to be as inclusive as possible, both geographically and in respect of the range of interested parties to be consulted. At several points this report has highlighted the particular needs of rural communities in Ireland, yet we acknowledge that our own work on this project has (perhaps unavoidably) been Dublin-centric. Regional gatherings may be a good way of securing a proper cross-section of attitudes and expectations across the whole of the Republic of Ireland.

7.4 We therefore conclude with a list of principal subjects which we suggest Ireland should explore further. Not every issue will be relevant to every category of stakeholder, but it would be prudent to admit the widest possible range of inputs from the widest possible range of parties.

(a) Do stakeholders agree with a "mixed approach" to spectrum allocation?

(b) What do stakeholders think is the justification for (alternatively) 4, 6 or 8 national television multiplexes?

(c) What television services and what types of television content might be used to fill the additional broadcasting capacity that will become available? Where will the additional content come from?

(d) What demand is envisaged for free-to-air television once analogue transmissions have ceased (i.e. for DTT)?

(e) Should Ireland and the UK align their broadcasting frequency allocations closely, regardless of differences that may then arise with the European Commission's desire for frequency harmonisation? What additional benefits might this bring for Ireland?

(f) What services do non-broadcasting operators (e.g. mobile network operators) envisage supplying and/or developing over (say) the next five years?

(g) What amount of spectrum do non-broadcasting operators envisage they will require? In what frequency range(s)?

(h) How do such operators think that spectrum should be awarded and paid for?

(i) Should spectrum trading be allowed after the initial award (bearing in mind that this would require new primary legislation)?

(j) Does the present Channel 69 need to be reserved for SAB and PMSE? If not, how should SAB and PMSE be catered for?

(k) Should Ireland aim explicitly to promote innovation in spectrum-using applications and attract organisations that so specialise? Should it then explicitly reserve spectrum for

innovation? What would the benefits be? Should Channel 69 be so reserved, subject to licensing by ComReg?

(l) Channels 36 and 38 are unused in Ireland and will cease to be used in the UK over the next four years. Should Ireland enter negotiations with the UK to use either or both of Channel 36 and Channel 38? Could these channels be best used on an all-island basis, and if so how?

APPENDIX 1: PRINCIPAL TERMS OF REFERENCE

The following is taken from ComReg's Invitation to Tender dated June 2008, pages 4 and 5.

"2.1 Terms of Reference of consultancy advice to be provided

The requirement is to advise and recommend approaches for Ireland's digital dividend Strategy in a national context and the potential benefits that the uses of digital dividend spectrum can bring to our economy, our society and the communications industry, in general.

Scope of Work

The main elements of the consultancy project will be: -

Analysis of current thinking and practices regarding digital dividend

- A review of the European Commission positions on digital dividend strategies.
- An overview of digital dividend strategies adopted elsewhere: in Europe, Canada, Japan, Korea, New Zealand and the United States of America with an emphasis of the merits (or otherwise) of these strategies and highlighting elements that could be adopted in Ireland.
- Optimal approaches for Ireland's digital dividend Strategy.
- In light of the above, prepare a report suitable for publication and presentation(s) for ComReg's Annual Conference on 1 October 2008.
- Contribute to a consultation which will advise and recommend approaches for Ireland's digital dividend Strategy in a national context. This should include details of possible uses and benefits for society, industry, consumers and the economy. It should also suggest an appropriate role which ComReg could play in achieving Ireland's optimal digital dividend Strategy."

APPENDIX 2: DOCUMENTS REVIEWED

Irish-originated documents

(a) Broadcasting (Amendment) Act 2007 and the Broadcasting Bill 2008

(b) BCI, DTT Multiplex Licensing Policy 2008

(c) ComReg, Irish Communications Market: Quarterly Key Data Report, June 2008

(d) ComReg, Spectrum Management Strategy Statement 2008-2010

(e) ComReg, Licensing Digital Terrestrial Television, November 2007

(f) ComReg, Award of available UHF spectrum in the urban areas of Cork, Dublin, Galway, Limerick and Waterford and related licensing options, consultation document dated June 2008

(g) The Department of Communications, Energy and Natural Resources, *Towards 2016: Third Progress Report,* December 2007

(h) The Department of Communications, Energy and Natural Resources, Report of the Working Group on Spectrum Policy, September 2008

(i) RTÉ, Opinion on the Introduction of Multimedia Services, in particular in the frequency bands allocated to the broadcasting services, a response to RSPG dated July 2006

(j) RTÉ, Review of the Regulatory Framework for electronic communications networks and services, response to the EC dated October 2006

Documents of other origin

(k) OECD, Communications Outlook 2007

(l) The Effects of a Market-based Approach to UHF Spectrum Management and the Impact on Broadcasting, Oliver & Ohlbaum Associates Ltd and DotEcon Ltd, February 2008

(m) Quotient Associates, Supply and demand of spectrum for Programme Making and Special Events in the UK, Report to Ofcom, December 2006

(n) Mobile TV Technology – Evolution or Revolution? A presentation by Prof. Hyacinth S. Nwana, Managing Director – Mobile Media Solutions, December 2006

(o) RSPG, Opinion on Wireless Access Policy for Electronic Communications Services (WAPECS), November 2005

(p) Two documents supplied by Vodafone Ireland, namely Reaping the Dividend – the universa*l broadband future,* authored by Vodafone Group and published in 2008; and *The BBC's Efficient and Effective use of Spectrum*, a report by consultants Deloitte for the BBC Trust, dated December 2007.

(q) Spectrum Value Partners, *Getting the Most Out of the Digital Dividend*, 2008

(r) Analysys Mason, *Etude sur la valorisation du dividende numérique*, 2008

APPENDIX 3: ORGANISATIONS INTERVIEWED

All interviews were held in Ireland unless otherwise stated

3 Ireland

Broadcasting Commission for Ireland

BT Ireland

ComReg

Department of Communications, Energy and Natural Resources

E-Net

Eircom

Ericsson

Forfas

Google

GSM Association (in London)

IDA

Irish Broadband

Meteor

O2

Qualcomm

RTÉ

Telecommunications and Internet Federation

TV Mobile

Vodafone Ireland

APPENDIX 4: ABBREVIATIONS USED

3G	Third Generation
ACMA	Australian Communications and Media Authority
Agcom	Italian Telecommunications Regulatory Authority
ARCEP	French Telecommunications Regulatory Authority
BCI	Broadcasting Commission of Ireland
CEPT	European Conference of Postal and Telecommunications Administrations
DCENR	Department of Communications, Energy and Natural Resources
DSO	Digital Switchover
DTV	Digital Television
DVB-H	Digital Video Broadcasting – Handheld (Mobile Television)
DVB-T	Digital Video Broadcasting – Terrestrial (DTT)
FCC	Federal Communications Commission
FDD	Frequency Division Duplexing
FTA	Free to air
GE06	Geneva 2006 plan for transition from analogue to digital broadcasting
GPS	Global Positioning System
HD	High Definition
IMT	International Mobile Technology
ITU	International Telecommunication Union
MMDS	Multi channel Multi point Distribution Services
MNO	Mobile Network Operator
MPEG	Motion Picture Experts Group
Ofcom	Office of Communications UK
PMSE	Programme Making and Special Events

PTS	Post & Telestyrelsen, Swedish Telecommunications Regulator
RF	Radio Frequency
RRC-06	Regional Radio Conference, 2006
RSC	Radio Spectrum Committee
RSPG	Radio Spectrum Policy Group
SAB	Services Ancillary to Broadcasting
SD	Standard Definition
SVP	Spectrum Value Partners
T&T	Test and Trial
TG4	Teilifis na Gaeilge
UHF	Ultra High Frequency
VHF	Very High Frequency
WRC-07	World Radio Communication Conference, 2007

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