ODTR Radio Spectrum Management

- Planning for the Future

Consultation Paper

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Oifig an Stiúrthóra Rialála Teileachumarsáide

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FOREWORD

The last few years have seen dramatic changes in the ways in which the radio spectrum is used. Ten years ago, the major users of spectrum were broadcasters, State services, private mobile radio, aeronautical and maritime communications and trunk circuits for fixed line telephony. Virtually all radiocommunication was based on analogue technology, which provided limited scope for increasing the traffic capacity and efficient utilisation of the available spectrum.

Since then, market, regulatory and technological developments have set in motion significant changes in spectrum use. Market liberalisation, rapid growth in mobile communications and demand for bandwidth have put increasing pressure on the available spectrum. Over the coming decade even greater changes are anticipated, driven by the increasing popularity of the Internet, growth in electronic commerce and the development of new technologies and services such as digital television, third generation mobile communications and low power wireless connectivity devices.

This document presents the current spectrum management framework in Ireland and outlines key issues for spectrum use going forward. A number of scenarios are presented along with proposals relating to the future management of the radio spectrum.

Looking to the future, the paper gives rise to new issues that the Office will need to address in greater detail. Moreover, it is anticipated that further spectrum-related papers will be defined in light of responses to the questions set out above. In any event, the Office will in the coming weeks be publishing a revised Table of Frequency Allocations, a report on its earlier consultation on Digital Terrestrial Television, and its response to the Department of Public Enterprise's "Review of legislation relating to the licensing and use of the radio spectrum".

I look forward to receiving responses to the questions raised in this paper and to developing the dialogue on ODTR spectrum issues in further papers and other fora.

Etain Doyle

Director of Telecommunications Regulation.

0. EXECUTIVE SUMMARY

For almost a century, radio has made a vital contribution to Ireland's society and economy. Mobile communication, which depends entirely on radio spectrum, is one of the world's fastest growing industries, with over half the Irish population now owning a mobile phone, and with new high speed mobile services already coming onto the market. Developments in other spectrum-using services and technology, such as digital broadcasting and broadband fixed wireless access, also have the potential to provide significant benefits to industry and consumers, whilst long-established users of the spectrum such as emergency services, utilities and transport operators continue to rely on radio spectrum to support their core operations.

Reflecting this increasing impact of radio spectrum on the Irish economy and society, the Director commissioned a review of the market, economic, regulatory and technical factors likely to affect the use of radio spectrum in Ireland over the next ten years. The purpose of the review was to assist the ODTR in ensuring that Ireland has the necessary regulatory framework to maximise economic benefit from the radio spectrum, whilst protecting the needs of the wider community. This paper outlines the findings of this review.

0.1 Current Spectrum Management Framework in Ireland

Section 1 of the report explains the role and importance of the radio spectrum and how it is managed in a national and international context. The physical characteristics of the spectrum, which restrict key services such as mobile and broadcast to a relatively small part of the total available bandwidth are outlined, and the importance of international harmonisation is explained. A brief review of the current legal framework and the administrative processes (including licensing and enforcement) relating to radio spectrum is also presented.

0.2 Key issues and options

Section 2 of the paper addresses two of the key market and technology developments currently affecting the use of radio spectrum in Ireland and internationally. These are:

- the increasing **convergence** between traditionally distinct sectors, such as fixed and mobile telephony, broadcasting and telecommunications, and information technology and communications;
- the increasingly rapid pace of **market and technology evolution**, as evidenced for example by the increasing ubiquity of the Internet and mobile communication devices.

A scenario analysis was undertaken to assess implications for spectrum management. Scenario analysis (see annex A) provides a useful tool with which to explore alternative

futures and to develop regulatory frameworks and measures that are robust under these futures. Whilst there are an infinite number of possible future scenarios, useful conclusions can be reached by examining a small number of scenarios with sufficiently differing assumptions. In this case, three hypothetical future scenarios were developed and analysed, namely:

- a *market evolution* scenario, where market demand for new applications grows relatively slowly and existing companies retain a strong position in markets for communications services;
- a *socio-economic stimulation* scenario, where pro-active government policy regarding social integration and regional objectives leads to the benefits of advanced communications technologies being enjoyed throughout the country;
- a *technological revolution* scenario, where technology dominates, with rapid innovation being quickly adopted by consumers leading to a series of market discontinuities.

The results of the scenario analysis are discussed in detail in section 2.3. It emerges that, whilst the implications for different services differ from scenario to scenario, all three scenarios predict significant growth in the overall demand for radio spectrum. They also point to the need for increased flexibility in the way spectrum is managed and regulated.

0.3 Next Steps

Section 3 of the paper develops the ODTR approach to potential strategic and legislative reforms to address the issues identified in section 2. The proposals are intended to achieve a number of key objectives, including:

- maintaining efficient and effective use of radio spectrum;
- creating further economic growth and social well-being across Ireland through spectrum use;
- providing a framework in which Irish consumers can get the best communications services in terms of price, quality and choice;
- ensuring consistency with the developing EU and wider international regulatory framework;
- enhancing Ireland's international competitiveness;
- reducing administrative burden.

0.4 Consultation Questions

Views are sought on the following specific issues raised in the document. Please refer to the relevant section of the main report for background material relating to each question:

Question 1. (section 2.3.2) Do you have a view on the outline comments on each type of service addressed in section 2.3.2, in particular relating to future provision of DAB services in Ireland?

Question 2. (section 2.3.2) Do you have a view on whether there are further satellite service opportunities that might be appropriate for the Irish market in future?

Question 3. (section 3.2.1) Do you agree that the list of key issues presented in section 3.2.1 reflects the priorities the ODTR should pursue in the international arena, or are there other activities or developments that it should specifically address?

Question 4. (section 3.2.2) Do you agree with the proposal to publish a Spectrum Strategy document and do you have any views on what issues should be addressed by such a document?

Question 5. (section 3.2.3) Do you have a view on how an active dialogue on spectrum strategy can best be maintained?

Question 6: (section 3.2.4) Do you agree with the rationale for where spectrum demand is likely to be greatest? In particular, do you foresee any significant change in spectrum demand for service or applications other than those mentioned? (see also Table 2.1, p21).

Question 7. (section 3.2.4.1) What initiatives, if any, would you suggest to enable Ireland to capitalise on its comparative advantages in respect of spectrum-using technologies and services?

Question 8. (section 3.3.4) Do you agree that mechanisms to allow access to spectrum in congested areas should have regard to spectrum efficiency and alternative technologies?

1. CURRENT SPECTRUM MANAGEMENT FRAMEWORK IN IRELAND

1.1 Role and Importance of Radio Spectrum in Ireland

1.1.1 Introduction

For almost a century, radio has made a vital contribution to Ireland's society and economy. From its early years as a specialist tool providing essential communications for the maritime, aeronautical, transport and public safety communities, it has evolved to a mass-market medium delivering broadcast information and entertainment across the country. Over the last decade mobile communication, which depends entirely on radio spectrum, has become one of the world's fastest growing industries. Over half the Irish population now own a mobile telephone. The latest developments in radio, fixed wireless access, third generation (3G) mobile communications and short range wireless connectivity devices herald a new era of competitive, broadband communication services for Irish businesses and consumers, while digital broadcasting is set to deliver a multitude of new channels and novel, interactive services.

It is clear therefore that radio has a key role to play in shaping the future delivery of electronic communications in Ireland. However, the radio spectrum itself is finite, and like other limited natural resources must be managed carefully if the maximum benefit is to be obtained. A number of global and European initiatives are currently underway to ensure that available spectrum is used in an efficient and effective manner. Recognising the speed of change and growth in use of the radio spectrum, it is important to review arrangements for managing the spectrum to ensure that they are well tuned to the needs of the industry, while protecting the needs of the wider community. As part of this review, interviews were held with organisations representing a broad range of spectrum users in both the public and private sectors. These included manufacturers, operators and users, with interests in fixed, mobile, broadcast, space and terrestrial applications. The feedback gained from these interviews has been taken into account in developing this document.

A scenario analysis exercise was also conducted to help in identifying possible developments in spectrum management. This considered three hypothetical future scenarios, each based on a different set of assumptions concerning the evolution of technology and the electronic communications market over the next decade. These scenarios seek to provide different hypothetical views of the future but are not intended to be forecasts.

This discussion document presents the main conclusions from the review and outlines next steps open to the ODTR for its future management of the radio spectrum. A number of specific proposals are put forward regarding the ODTR's approach to radio spectrum management and how this can best meet the needs of a dynamic and expanding user community.

1.1.2 Availability and physical characteristics of radio spectrum

To illustrate the concept of radio spectrum as a finite resource, it is helpful to consider briefly just what is meant by "radio spectrum". The entire radio spectrum forms a relatively small part of the broader electromagnetic spectrum, which includes infrared, visible light and various other components, as illustrated in Figure 1.1 below. Note that this diagram has a logarithmic scale and that the total radio spectrum bandwidth amounts to just one thousandth of that of the infra-red range. Hence radio is not able to convey the sort of bandwidth that can be carried on today's optic fibre links, however for applications requiring mobility and wide area coverage such as broadcasting it is often the only viable solution.

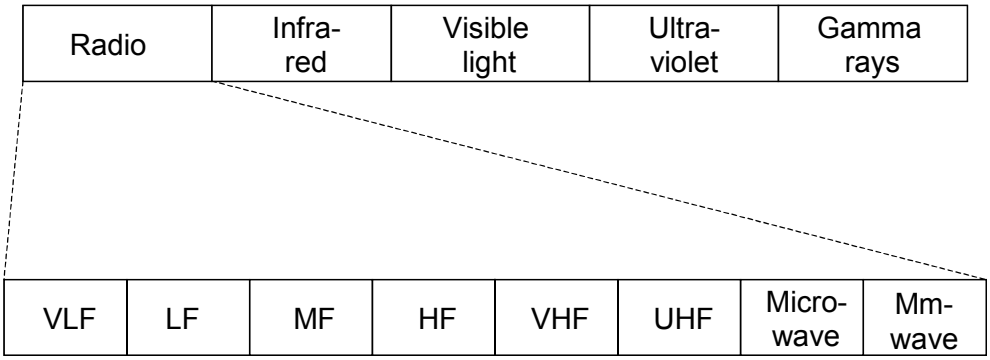

Figure 1.1 The Radio spectrum as part of the broader electromagnetic spectrum (not to scale)

Figure 1.2 shows the principal uses of the various parts of the radio spectrum, which are largely determined by the physical characteristics of the frequencies concerned. It can be seen that TV broadcasting and mobile communications are constrained within a relatively small part of the radio spectrum, which is further limited by the need to cater for other uses such as aeronautical, maritime, scientific and military applications. It is here that spectrum availability can present particular bottlenecks, for example by limiting the number of competitive service providers.

Because mobile and broadcast networks use higher frequency bands (above 3 GHz) to provide fixed radio links within their infrastructure, congestion can also arise in some of these bands. In the future, assuming broadband wireless fixed access is successful, similar bottlenecks may arise in the bands above 20 GHz that are earmarked for these services, even though at the moment (with the exception of a few specific geographic locations) there is a relative abundance of spectrum.

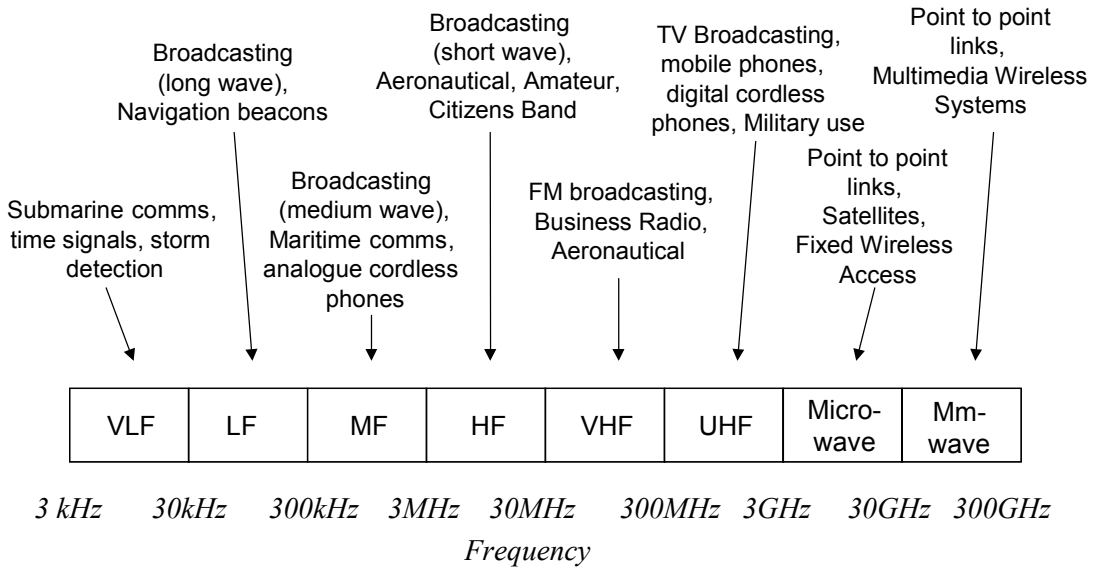

Figure 1.2 Uses of the radio spectrum (not to scale)

1.2 Current International Regulatory Framework

1.2.1 Introduction

Because radio transmissions can traverse great distances and are not constrained by national boundaries, an international regulatory framework has evolved to minimise the risk of interference between individual services. There is effectively a three level regulatory hierarchy, comprising global, regional and national layers. At the international (global) level, the International Telecommunications Union (ITU) issues Radio Regulations (RR) which have the status of treaties once ratified. These set out the broad uses of spectrum that are permitted in different global regions and are updated at World Radiocommunications Conferences (WRCs) which happen every two to three years.

At the regional (i.e. European) level, two organisations are involved in spectrum management, namely the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Commission (EC). CEPT, formed in 1959, is the regional body of policy-makers and regulators for Europe and currently has a membership of 44 European countries covering almost the entire geographic area of Europe. CEPT's European Radiocommunications Committee (ERC) harmonises the use of spectrum across Europe, where appropriate.

The ERC has five permanent working groups concerned with frequency management (FM), spectrum engineering (SE), radio regulation (RR), WRC preparation (CPG[1]) and ITU council

[1] Conference Preparatory Group

conference preparation (JWG-ITU[2])[3]. Up until now most aspects of spectrum harmonisation at the European level have been handled by CEPT, but following the publication of a recent green paper on Radio Spectrum Policy , the EC is likely to become more involved in strategic spectrum management decisions. This enhanced role of the EC is reflected in a package of new legislative measures, which are due to be enacted during 2001. These developments are addressed in section 1.2.2 of this document.

In general within the European Union, national governments are responsible for determining policy for the regulation of the electronic communications sector, within the framework defined by the EC. National Regulatory Authorities (NRAs) are responsible for implementing the Global and European spectrum management frameworks in their own territories, in line with national policies, and for administering the licensing or licence exemption of radiocommunications services.

1.2.2 The New European Framework

In July 2000, the European Commission published a package of legislative proposals designed to strengthen competition in the electronic communications markets in the EU. The package simplifies and clarifies the existing regulatory framework, by reducing the number of specific legal measures. The proposed revised framework includes:

Five harmonisation Directives, including a Framework Directive and four specific Directives on authorisation, access and interconnection, universal service and user rights, and data protection in telecommunications services.

- A draft Commission Liberalisation Directive.
- A draft Decision on EU Radio Spectrum Policy

Article 8 of the draft Framework Directive[4] proposes a number of obligations related to allocation and assignment of radio spectrum. In particular, it requires national regulatory authorities (NRAs) to manage spectrum efficiently and proposes to allow NRAs to permit the trading of frequency assignments, subject to certain safeguards. The draft Decision on Radio Spectrum Policy[5] aims to ensure the harmonised availability and efficient use of radio spectrum.

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[2] ERC / ECTRA (European Committee for Telecommunications Regulatory Affairs) Joint Working Group, ITU Council and Plenipotentiary

[3] In a re-organisation of CEPT it is proposed to merge the ERC and ECTRA into a single committee at the end of 2001

[4] COM(2000)393, "Proposal for a Directive of the European Parliament and of the Council on a Common Regulatory Framework for Electronic Communications Networks and Services", 12th July 2000

[5] COM(2000)407, "Proposal for a Decision on a Regulatory Framework for Radio Spectrum Policy in the European Community"

The draft Decision on EU radio spectrum policy follows the public consultation on the 1998 Green Paper on Radio Spectrum Policy and builds upon co-operation with the Member States and the CEPT in the area of spectrum management. It proposes to:

- establish a policy platform (Senior Official Spectrum Policy Group) which, on the basis of technological, market and regulatory developments and after consultation of relevant spectrum user communities, will advise the Commission on the use of radio spectrum in EU policy areas of a commercial and non-commercial nature;
- establish a legal framework which will allow the Commission, taking the advice of the Senior Official Spectrum Policy Group into account, to grant mandates to the CEPT and to secure implementation by the Member States of measures aimed at the harmonised availability and use of radio spectrum for EU policies;
- ensure EU-wide transparency through co-ordinated and timely provision of information related to radio spectrum use so that investment and policy decisions can be taken;
- safeguard EU interests in international negotiations on radio spectrum by ensuring that common positions are adopted to achieve EU policy objectives.

1.3 National Legislative Background

Spectrum use and management within Ireland is governed by the Wireless Telegraphy Acts 1926-1988 ("the WT Acts") and the Telecommunications (Miscellaneous Provisions) Act, 1996 ("the 1996 Act"). Regulations covering the licensing or exemption from licensing of specific services are issued under the WT Acts in the form of statutory instruments, which require the consent of the Minister for Public Enterprise. Under the WT Acts and the 1996 Act, the Director of Telecommunications Regulation is required to provide a frequency plan and is responsible for licensing the use of apparatus for all radio applications, except those used by the military[6]. The ODTR is the NRA for the telecommunications and radiocommunications sectors under EU and Irish law.

The ODTR is responsible for issuing two broad types of licences, namely those which relate to the type of service provided (Telecommunications Service Licences) and those which relate to use of the radio spectrum (Wireless Telegraphy Licences). The key legislation affecting licensing is Statutory Instrument 96 of 1998[7]. Equipment and standards issues for all radio services except those used exclusively for public or State security and certain other

[6] Wireless Telegraphy Act 1926, Section 3, paragraph 6

[7] European Communities (Telecommunications Licences) Regulation, 1998, being the transposition into Irish law of the Licensing Directive (97/13/EC)

exempted categories[8] are addressed by the Radio Telecommunications Terminal Equipment Directive (1999/5/EC). Other Directives, such as the Marine Equipment Directive, affect specific application areas.

Further information on the current approach to spectrum licensing in Ireland is presented in section 1.4.3 below.

1.4 Current Processes and Administrative Framework

1.4.1 The Director's Duties

The Director of Telecommunications Regulation ("the Director") and her Office ("the ODTR") are responsible for the regulation of the Irish telecommunications market in accordance with EU and National legislation. The Director's duties include the allocation of radio spectrum to specific radiocommunication services and the assignment of frequencies to individual licensees in accordance with the Wireless Telegraphy Acts.

1.4.2 Spectrum Allocation

Spectrum allocation is the process by which parts of the radio spectrum are designated for use by generic types of service, such as Fixed, Mobile or Broadcast. In some cases, notably mobile and broadcast services where the radio signal is distributed over a wide area, spectrum is allocated exclusively by an NRA to one generic service, or even to one application (e.g. television or GSM mobile phones). In other cases it may be possible for spectrum to be shared between two or more services. For example, several frequency bands are allocated to both the terrestrial Fixed Service and the Fixed Satellite Service, on the basis that both deploy fixed, highly directional transmitting and receiving stations that are relatively straightforward to co-ordinate with one another. Generic service categories are defined in the ITU Radio Regulations.

Under the WT Acts and the 1996 Act, the Director is required to maintain a national frequency plan[9]. With regard to allocation policy, the Minister for Public Enterprise may, following consultation with the Director, issue directions in writing to the Director, to comply with policy decisions of a general kind made by the Minister in relation to the allocation and use of spectrum. Reflecting the significant changes that have taken place since the current legislation was enacted, the Minister recently announced a proposal for an in-depth review of the existing legislation relating to the licensing and use of the radio spectrum.

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[8] Exempt equipment referenced in the Directive includes amateur, broadcast receivers, aviation and most maritime equipment.

[9] document ODTR 98/03, "Table of Frequency Allocations, Ireland", available on the ODTR web site at http://www.odtr.ie/docs/odtr9803.pdf

1.4.3 Frequency Assignment and Licensing

Under the WT Acts and the 1996 Act, the Director is responsible for licensing use of apparatus for all radio applications in Ireland, except those used by the military. In practice, this means issuing individual licences to individuals or organisations to permit the installation and operation of radiocommunications apparatus, and the publication of statutory instruments exempting certain apparatus from individual licensing.

A WT Act licence is required by any user of wireless telegraphy equipment, unless specifically exempted by statutory instrument. A wide variety of WT Act licences are issued by the ODTR, the majority of which are renewable on an annual basis. Licensees who operate public telecommunication networks (e.g. fixed wireless access or mobile telephony) are also required to have a service licence issued under the 1996 Act.

Broadcast spectrum is licensed for commercial services via the Independent Radio and Television Commission (IRTC), while RTE operates under statute as the State broadcaster and its spectrum use is licensed by the ODTR. Frequency planning for broadcast services is undertaken by both IRTC and RTE in conjunction with the ODTR. Spectrum use by the aeronautical community is licensed via the Irish Aviation Authority (IAA) but with the ODTR holding ultimate responsibility for spectrum use. Maritime licences are currently issued by the ODTR in conjunction with the Marine Radio Survey Office (MRSO), however these licensing responsibilities are expected to be transferred entirely to MRSO under new legislation planned for 2001. Military use of the spectrum is outside the Director's remit but use is generally notified to the ODTR for co-ordination purposes. Where civil frequency bands are used by the military the ODTR grants authorisation.

1.4.4 Enforcement

A 'clean' spectrum environment, free from excessive interference, is vital to the successful deployment of radiocommunication services. The licensing process enables the co-ordination of individual radio users use of frequencies so that they do not suffer mutual interference, or in the case of licence-exempt services, ensures that such services operate in specific frequency bands which are not shared with other licensed services. Operation of unlicensed equipment circumvents this co-ordination process and can result in interference to licensed services. Operation of licensed apparatus outside the terms of the licence, for example by operating at excessive power levels or with inadequately suppressed out-of-band emissions can lead to serious interference to other users.

It is important that those who hold major blocks of spectrum (e.g. public mobile, broadcast, MMDS or FWA operators) fulfil their service obligations, and that spectrum users are not affected by undue interference. The ODTR must have effective enforcement powers to ensure that spectrum is used properly and in conformance with the relevant licence or exemption regulation. The ODTR's remit in this regard includes the enforcement of licence conditions and the taking of action against unlicensed use of radio apparatus.

2. KEY ISSUES

2.1 Convergence

The term “convergence” is increasingly being used to describe the overlap between traditionally distinct services and applications. This trend has come about largely as a result of technology developments, notably the introduction of digital transmission techniques and the availability of increasing bandwidth in telecommunication networks, but has also been driven by broader developments in the market place. Digital transmission has enabled the growth of “multimedia” services, combining speech, music, video and information to be carried along a single transmission “pipe”. This might for example be a conventional telephone line, or a terrestrial or satellite broadcast network. Hence the telephone is no longer restricted to delivering voice communication and the television is no longer restricted to providing “passive” entertainment or information. Instead, these and other platforms can deliver a wide range of content and services, many based around the Internet which itself can deliver the whole range of multimedia content.

Convergence is also apparent between fixed and mobile services. Whereas ten years ago mobile phones were expensive, bulky and relatively unreliable devices addressing a niche market, there are now more mobile phones in use in Ireland than there are fixed line connections. Increasing numbers of people are tending to use a mobile phone as their primary means of communication, rather than the traditional fixed line. This trend is expected to continue with the introduction of third generation (3G) mobile phones which have the potential to deliver a range of services and performance significantly greater than today’s fixed networks.

In a radio spectrum context, convergence may make some traditional service definitions difficult to sustain as similar content becomes available over different delivery media. For example, the distinction between mobile and some fixed services will become blurred as services are integrated (e.g. using multi-mode terminals capable of accessing either fixed or mobile networks). Similarly the distinction between broadcasting and telecommunications services may blur as interactive broadcasting becomes more widespread and as fixed and mobile services include more broadcast content (e.g. broadcasts of popular web pages or simultaneous transmission of broadcast channels over the Internet).These changes are already happening. For example, when digital TV is implemented in Ireland (using MMDS and DVB-T technologies) broadcasters will be able to provide programming with interactivity.

The international and national frameworks used to allocate spectrum must be able to accommodate converged services. To a large extent this is already the case, e.g. in the ITU Radio Regulations many bands are allocated to several services and this allows a considerable degree of flexibility in terms of the detailed service implementation. This approach has enabled CEPT recently to designate spectrum for new converged services

such as Multimedia Wireless Systems, which combine elements of traditional broadcast and fixed wireless access services in a single delivery platform and spectrum allocation.

In the future it may be appropriate to refine some of the ITU Service definitions to take account of convergence in the wider communications and content delivery markets, although it will continue to be necessary to differentiate between applications with different technical characteristics. This is explored in more detail in section 3.2.4.

2.2 Market and Technology Evolution

2.2.1 Introduction

The electronic communications market is evolving at an increasingly rapid pace, as evidenced by the increasing ubiquity of the Internet and mobile communication devices. Consumers are becoming more sophisticated in terms of the range of content and services they demand. Multi-channel television is now largely the norm, thanks to the extensive penetration of cable and MMDS services. Over half the population now have a mobile phone and around a third currently have access to the Internet. Meanwhile, technology is developing at a similarly rapid pace, enabling greater volumes of data to be carried over both wire line and wireless platforms. Digital Terrestrial Television allows up to five channels to be accommodated in the radio spectrum previously occupied by a single analogue channel. The imminent launch of mobile packet data services will provide significant gains both in performance terms (higher data rates) and capacity terms (improved efficiency since resources are only used when data is actually being sent or received, not for the duration of the call).

The precise implications of these developments for radio spectrum demand over the coming decade are difficult to quantify, though it seems likely that demand for mobility and bandwidth will continue to grow, placing correspondingly greater pressure on the available radio spectrum. Planning for future spectrum requirements is complicated by the sheer unpredictability of the electronic communications market. For example, a decade ago few forecasters would have foreseen today's levels of mobile phone penetration. It is important that the spectrum management regime has sufficient flexibility to respond to, and where possible to anticipate, market and technology evolution.

2.2.2 Implications of technological change

Key technological developments that are likely to influence use of the spectrum in Ireland over the coming decade are likely to include both those in the wireless communications sector and those presenting a competitive threat from alternative delivery platforms (e.g. wire line or optical services). These are considered in the following sections:

2.2.2.1 Technological developments in the wireless sector

These can be split into two broad categories, namely

i) spectrally efficient technologies which provide existing functionality using less bandwidth, and

ii) innovative technologies delivering new or improved functionality by using radio.

The advent of digital technology has enabled dramatic improvements in spectrum efficiency to be made and this process seems likely to continue as further improvements to digital signal processing emerge. In telecommunications, the introduction of packet transmission as an alternative to circuit switching also provides a mechanism by which to increase the overall efficiency of spectrum use between multiple users. Similarly, the development of increasingly bandwidth efficient modulation and multiple access schemes can bring significant improvements in the capacity and utility of spectrum assignments, while interference resilient techniques such as spread spectrum technology allows self co-ordinated low power devices to co-exist with minimal risk of interference.

Innovative technologies that are already on the horizon, or that may reasonably be anticipated include:

- domestic television hard-drive storage devices, allowing viewers effectively to develop their own viewing schedules;
- equipment convergence, for example integration of a Digital Terrestrial TV (DTT) or Digital Audio Broadcast (DAB) receiver with a 3G mobile handset permitting mobile interactive multimedia applications;
- digital camera integration with a mobile handset (already available in Japan) allowing still shots, and in the future mobile clips, to be sent as a "video postcard" for example;
- wireless home and wireless office; use of radio local area networks (RLANs) of low-cost, low-power technologies like Bluetooth[10] to avoid the need for data cables from the majority of applications;
- home automation whereby one or more intelligent processors operate and monitor a series of comparatively 'dumb' devices around the house, including the television and local PCs;
- high altitude platforms (HAPs) including stratospheric balloons and aeroplanes, as a cost-effective alternative to satellite for the provision of fixed or mobile communications.

2.2.2.2 Competition from alternative technologies

Radio is unique in its ability to support wide area mobile communication. However, this is not necessarily the case for other applications of radio. For example, radio fixed links of almost

[10] Bluetooth is a wireless connectivity standard intended to replace proprietary cable links that currently connect IT and telecom devices to one another and replace them with a single universal short range radio link.

any type could, save for economics or convenience, be substituted by copper or fibre optic cable dependent upon the data throughput required. Economics of use will in many cases dictate the technology that is viable in a given case. Hence fixed wireless access (FWA) technology can provide rapid and cost-effective infrastructure rollout over a wide geographic area, and point-to-point radio links can support mobile network infrastructure in remote areas or hostile terrain where fibre would not be practical.

Digital Subscriber Line (DSL) technologies enable the transport of high speed digital data across the existing copper local loop, and are thus an alternative to radio for access purposes. Although the copper loop was not originally intended to carry high data rates, it is capable of doing so over relatively short distances from the exchange with the application of DSL technology. DSL is expected to make inroads into the market for high-speed Internet access and video on demand services, but broadband FWA is also expected to play a key role in delivering advanced services beyond the main towns. This is already starting to happen, providing flexible and rapid rollout of high speed services to business users. Narrowband FWA also has a role to play in extending competition in the mainstream telephony market, whilst also providing an evolutionary path towards wider bandwidth services in the future. FWA operators in the UK and elsewhere are already in the process of upgrading their narrowband access networks to provide higher speed access. At present, the cost per home passed is considerably greater for cable systems than for fixed wireless access systems.

For heavily used infrastructure links, fibre provides a natural alternative to radio and in high capacity networks can provide many times more capacity. Fibre can also support the rollout of radio-based access services, for example by providing the backbone infrastructure for mobile or FWA networks. Infra-red can provide an alternative to radio links for some applications, such as providing short range, line-of-sight connectivity into public carrier fibre networks. Infra red is also extensively used for linking devices such as mobile phones and laptop computers, however close proximity and an unobstructed line of sight are required. It appears however that the use of infra red for such applications may be largely superseded by Bluetooth low power radio links within the next few years.

2.3 Scenario Analysis

Looking forward over the next ten years there is a great deal of uncertainty about the nature and speed of deployment of new technologies and services and of their adoption by businesses and consumers. In this environment traditional forecasts do not provide an adequate basis for policy development, for the simple reason that the forecasts are likely to be wrong. Businesses and increasingly governments are using scenario analysis as a tool in which to explore alternative futures and to develop policies that are robust under these futures. Scenario analysis deals with uncertainties by analysing multiple views of the world, stretching outcomes in a variety of dimensions. There are many possible future scenarios,

however useful conclusions can be reached by examining a relatively small number of hypothetical scenarios with sufficiently differing assumptions. To help examine possible dimensions to the future regulatory environment, three scenarios looking over a 10-year period were developed as part of this review, namely:

i) A ***market evolution*** scenario, where market demand for new applications grows relatively slowly and existing companies retain a strong position in markets for communications services. This scenario implies a steady market, dominated by a small number of vertically integrated companies who effectively control the market for content and in some instances may also control the market for transmission. The major content providers work closely with platform providers together with some smaller, niche players. Applications are faster and more sophisticated, but otherwise broadly similar to those available, or being developed, in 2000. Required data throughput has increased fairly rapidly, though not explosively. Whilst increased spectrum efficiency has helped to meet this demand to some extent, providing sufficient bandwidth to support new applications remains a challenge. Key regulatory issues include maintaining competition; ensuring appropriate provision for rural areas; enforcing licence conditions and encouraging ever more efficient use of the spectrum.

ii) A ***socio-economic stimulation*** scenario, where pro-active government policy regarding social integration and regional objectives leads to the benefits of advanced communications technologies being enjoyed throughout the country. This again implies a steady market, but this time combining both large, vertically integrated companies, and a range of small and medium sized enterprises (SME)s. Integrated government policy and action has led to a significant change in the status of the BMW regions, which now enjoy a much improved overall level of prosperity and inclusion within the new Irish information society. Targeted funding has enabled SMEs to undertake a wider and more extended range of R&D projects than had formerly been the case, with Irish companies now holding IPR in a number of internationally recognised internet related products. Required data throughput has increased rapidly, as an increasing number of telecommunities have sprung up along the West coast. Initially, meeting the demand for spectrum was comparatively simple, however during the last part of the decade, ever growing demand led to the need for the introduction of a combined policy drawing upon use of administrative rules, spectrum pricing and proactive enforcement.

iii) A ***technological revolution*** scenario, where technology dominates, with rapid innovation being quickly adopted by consumers leading to a series of market discontinuities. This scenario is likely to involve a dynamic, rapidly evolving market with high levels of competition providing rich consumer choice, in a dynamic environment. Spectrum is in heavy demand, with particularly intense pressure on the lower bands. Self-assigning radio technology becomes commonplace, allowing the

regulatory focus to move to allocation to generic services / applications rather than assignment to specific operators.

Figure 2.1 gives a stylised representation of these three possible scenarios, as a subset of the many possible future scenarios. The key assumptions and conclusions for each scenario are presented in Annex A. However, a number of common themes emerge from each of these very different scenarios, and these are considered below.

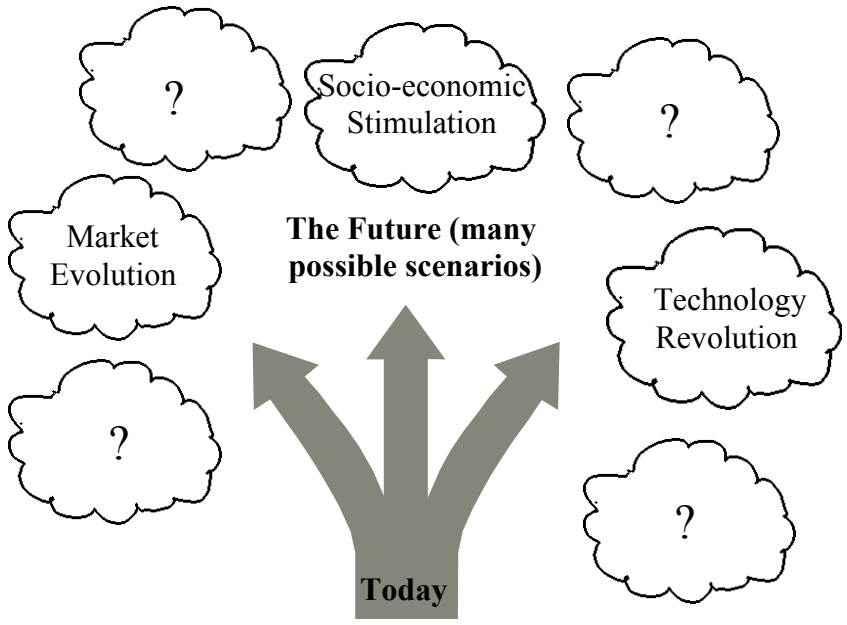

Figure 2.1: Illustration of scenario analysis concept

2.3.1 Regulatory issues

The scenarios suggest that a variety of regulatory developments may assist in achieving efficiency and effectiveness of spectrum use over the next ten years. These are noted briefly below and explored in more detail in section 3.

There is greater uncertainty with regard to the future use of spectrum in Ireland than has been the case in the past. To respond to such uncertainty it is important that the regulatory framework has sufficient flexibility to accommodate change at short notice. For example, it is likely that in future spectrum will be reallocated from one use to another more often than has been the case up to now.

- Convergence between conventional services (e.g. fixed and mobile telecommunications or broadcasting and the Internet) could make obsolete some of the current allocations and an alternative approach to applications such as broadcast, mobile and FWA may need to be developed.
- Spectrum is likely to remain a scarce resource in certain key geographical areas, such as Dublin, and at key frequencies, particularly the lower frequencies that support

high mobility and the high capacity fixed link bands. Efficiency of spectrum use must therefore be encouraged in these areas.

- The effectiveness with which the spectrum can be used will continue to be affected by a number of non-spectrum related factors, such as planning permission and availability of technically qualified staff.
- As spectrum management becomes more complex, due to increasing demand for mobile and broadband services, so the benefit of engaging in active dialogue with users and with other European regulators will grow.
- As use of spectrum continues to intensify, enforcement of licence conditions will become ever more important.

2.3.2 Implications for Key Radio Services

It is instructive to consider the implications for specific radiocommunication services of the three scenarios considered. Table 2.1 provides a broad-brush qualitative indication of the likely level of growth under each of the three scenarios. It must however be emphasised that the purpose of the scenario modelling applied here was not to develop growth forecasts for specific market segments, but rather to highlight the inherent uncertainty surrounding such future growth.

The key assumptions that have been made in developing the table are:

- that scenario 2 is expected to lead to greater investment in fibre infrastructure than scenarios 1 and 3, leading to less reliance on microwave radio relay systems;
- that scenario 3 is expected to drive significant growth in new, consumer and technology driven wireless applications, but the market is considered too volatile to justify significant investment in fibre infrastructure away from the main cities and trunk routes;
- that scenario 3 is expected to yield less demand for broadcast services, as users demand increasingly interactive services and content delivery.

	Market Evolution scenario	Socio-economic Stimulation scenario	Technological Revolution scenario
Fixed Links	++	+	++
FWA	+	++	++
Mobile	+	++	++
Broadcast	+	+	0
VSATs	+	++	+
Untethered[11]	+	++	++
ISM[12]	+	+	+
Radionavigation	+	+	+

Key: ++ significant growth

\+ modest growth

0 little or no growth

Table 2.1 Estimated qualitative growth levels for various radio services under each of the three scenarios

Fixed applications look set for continued growth, building on the rapid expansion that has taken place in recent years (the number of licensed point to point links in Ireland has grown from 615 in 1998 to 3000 today). Both core infrastructure links (point to point) and access links (FWA) seem likely to enjoy growing use over the next five to ten years. Demand for point to point radio links may level off in city areas as ever more fibre is rolled out, though there is likely to be continuing demand for radio to provide a secure back-up to fibre connections or where rapid installation is required. Away from the major urban areas broadband point to point links are likely to be a key component in the country's overall telecom infrastructure. FWA systems are already being rolled out in Ireland and are likely to present a highly competitive option for rural areas, whilst providing an effective solution to wayleave problems in urban areas.

Mobile applications, particularly cellular telephony and data, are expected to grow significantly during the next decade. This expectation reflects the great success of second generation mobile services, where Ireland saw an annual growth rate of 65% during 1999 / 2000. Ireland can also expect strong demand for third generation mobile services towards the middle of the decade, which may lead to calls for additional spectrum. It is also likely that demand for "untethered" radio technologies, such as Bluetooth, Radio Local Area Networks

[11] "Untethered" in this context refers to short-range wireless applications such as Radio Local Area Networks and Bluetooth

(RLANs) and RF Identification Devices (RFIDs) will also be strong. Initially operating at 2.4GHz, it seems likely that these applications will in time migrate to the 5GHz (HiPERLAN) and 5.8GHz (ISM[13]) bands, where there is substantially more capacity. There may be calls for yet more spectrum to support these applications and demand for high data speeds comparable to wired ethernet systems.

Not all mobile applications are likely to see such growth. Further substantial growth in the market for Private Mobile Radio (PMR) seems unlikely, as public mobile networks increasingly make inroads into this sector. There will however, continue to be those, particularly in the transport, logistics and utility sectors and among the self employed, who require the specific functionality of a PMR or Public Access Mobile Radio (PAMR) solution. Digital trunked radio (TETRA) provides an opportunity for PMR to evolve and cater for multimedia requirements, but so far interest in TETRA PAMR in Ireland has been limited.

The major changes in spectrum demand for **Broadcast applications** will relate to the introduction of digital broadcast techniques. Digital Terrestrial Television will need to operate in parallel with the existing analogue service for some years, but it is possible that some spectrum will be released following the eventual switch-over from analogue to digital. The extent of this release may depend on the success of alternative distribution methods for broadcast material such as satellite and high-bandwidth internet connections (e.g. FWA, HFC cable or DSL). The introduction of hard-drive storage devices may also have an impact in due course, as demand for 'prime-time' bandwidth diminishes.

Digital Audio Broadcasting (DAB) was primarily designed for the in-car market to provide reliable good quality 'fade free' stereo audio, and so that drivers would not have to tune to new frequencies as they enter and leave the coverage area of individual transmitters. The digital nature of the content carried by DAB allows for an increase in the diversity of services available to the consumer compared to a normal analogue FM radio. These services include travel information, surround sound, limited graphics, video clips and text information services such as stock prices, news headlines and advertising. For the current standard of audio quality to be maintained, five or six stereo programme services can be carried per DAB multiplex. If the audio quality were to be reduced this would allow 10 to 12 programme services per DAB multiplex. If and when DAB is implemented in Ireland it will operate alongside analogue FM services for the foreseeable future. Spectrum has been allocated in the upper part of VHF Band III (223 – 230 MHz) for DAB in Ireland.

Regarding the **satellite** market, the Director has recently issued regulations[14] under the Wireless and Telegraphy Act 1926, which encourage and promote the cohesive development

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[12] Industrial, Scientific and Medical applications

[13] ISM bands are designated for use by Industrial, Scientific and Medical devices but in some cases (e.g. 2.4 GHz and 5.8 GHz have also been allocated to short range, low power communications applications

[14] Wireless Telegraphy (Teleport Facility) Regulations 2001, (SI no. 18 of 2001)

of satellite 'Teleport Facilities'[15]. These regulations offer a significant advantage in terms of fees and flexibility for the larger operator who makes use of 'off peak' satellite capacity. As such there is no maximum power or bandwidth restrictions, subject to successful international co-ordination. It is recommended that co-ordination is carried out for as many earth stations as needed, on the site at the time of the initial application for a licence.

Last year a licensing regime was established under the Wireless and Telegraphy Act 1926 for Fixed Satellite Earth Stations at frequencies over 3GHz[16]. These regulations have set up a competitive regime for Ireland's earth station operators most of whom, provide Very Small Aperture Terminal (VSAT) or Satellite News Gathering (SNG) facilities to a third party. A number of Satellite Personal Communications Systems have been exempted by regulations issued under the Wireless Telegraphy act 1926 in 1999 and 2000 these exemptions can be examined on the ODTR web site (www.odtr.ie).

VSATs offer the potential to provide broadband infrastructure almost immediately to even the most remote regions, and are already used by a number of multinationals in Ireland to provide access to their overseas headquarters. VSATs could be attractive as a mechanism by which to provide equality of access across the country. However, growth in VSAT use may to some extent be predicated upon a fall in the usage costs of satellite transponders.

The market prospects for Low Earth Orbit satellite systems (LEOs) seem uncertain, and some companies (e.g. Iridium) which have attempted to deploy such systems have experienced financial difficulties. Nevertheless, LEOs are still regarded by many commentators as viable, and could potentially be used to deliver services in Ireland.

In **other application areas** demand is not, generally speaking, anticipated to grow significantly during the decade. Sector specific use by the military, aeronautical, maritime and scientific communities is likely to remain steady, though each community has specific, ongoing frequency requirements that may restrict spectrum planning options.

Question 1. Do you have a view on the outline comments on each type of service addressed above, in particular relating to future provision of DAB services in Ireland?

Question 2. Do you have a view on whether there are further satellite service opportunities that might be appropriate for the Irish market in future?

[15] A 'Teleport Facility' is a site, which consists of several steerable antenna Fixed Satellite Earth Stations connected to the telecommunications backbone. Each earth station is capable of using multiple transponders simultaneously on any of the geostationary satellites visible from Ireland.

[16] Wireless Telegraphy (Fixed Satellite Earth Stations) Regulations 2000, (SI 273 of 2000)

The immediate short term trends can be estimated by considering the historic changes in demand patterns for some key services. Table 2.2 shows the number of licences today compared with those in 1998.

Service	Licences to Dec 1998	Current Licences (Jan 2001)
GSM Mobile	2	3
PMR	3485	4047
Fixed Links	615	3000
Fixed Wireless Access	0	6

Table 2.2 Licensing Statistics for key services, 1998 - 2001

2.4 Significance of the Scenarios

The scenario or combination of scenarios that emerges in the future will affect the emphasis and nature of detailed spectrum management policies. However in all cases it will be necessary to retain sufficient flexibility and responsiveness to cope with a rapidly changing and increasingly uncertain future. Among the issues that will be affected by future market scenarios are:

- the need for and type of reallocations and new allocations (e.g., as shown in Table 2.1, demand for new mobile allocations is likely to be greater under scenarios 2 and 3 than under scenario 1);
- the application of more market-based management tools such as administrative pricing and spectrum trading. Such tools provide greater benefit where demand is growing and hence the probability of spectrum congestion is highest;
- the need for faster processes for relocation of users within the spectrum. This will be more pressing where there is greater demand growth or competition for particular blocks of spectrum.

2.5 Conclusions

The future is, by definition, uncertain. However, in an effort to reduce some aspects of this uncertainty we have examined the future from a variety of standpoints. Firstly, we considered the developments that might occur in areas likely to influence demand for and use of the spectrum in the future. We then considered how these streams of activity, together with other drivers, might affect each other over the course of the next ten years. By drawing upon this information and using the scenario modelling technique, we developed three illustrative scenarios of the future.

This has enabled us to identify:

- where demand for spectrum may be expected to increase, and hence
- where regulatory changes may assist the Regulator in maximising the choice and quality of communications service available to consumers throughout Ireland.

Section 3 considers how these issues might best be tackled over the next ten years. Specific options are developed and where appropriate related back to the specific scenarios presented above.

3. NEXT STEPS

3.1 Introduction

To address the issues raised in the previous section, some reform of the existing legal and administrative framework for spectrum management in Ireland is likely to be required. The main driver for such reform would be to facilitate the timely implementation of new wireless communications services, and so help to promote further economic growth. This section presents a number of strategic and legislative responses which seek to achieve the following objectives:

- efficient and effective use of radio spectrum;
- continued economic growth and social well-being across Ireland through spectrum use;
- a framework in which Irish consumers can get the best in communications services, in terms of price, quality and choice of advanced services;
- effective competition in the provision of communications infrastructure and services with a level playing field;
- consistency with the developing EU and wider international regulatory framework for radio spectrum policy;
- clear and consistent rules;
- enhancement of Ireland's international competitiveness in the global information and communications technology market;
- practicality, avoiding undue administrative costs.

3.2 Strategic Issues

Decisions about spectrum use can have long term economic implications. Spectrum users make long term investments in spectrum-using equipment, while consumers make significant expenditures in reception or terminal equipment (e.g. TVs, mobile phones), so it can take many years to change the designated use of particular frequency bands. It is therefore important to get the allocations "right".

Ireland requires a strategy for the future use of different frequency bands that:

- is informed by and informs spectrum management decisions made at a European and international level;
- takes due account of likely future developments in communications technology and markets;

- takes account of the requirements of Irish users and broader Irish policy objectives;
- provides users with information to make efficient investment decisions

Steps to develop a spectrum strategy are discussed in Section 3.2.2 below. We then go on to discuss specific issues concerning future allocation policies.

3.2.1 International activities

Both the ODTR and spectrum users need to keep abreast of and understand plans to change internationally agreed allocations, such as those agreed at World Radiocommunication Conferences (WRCs). The ODTR needs to be well informed of technology and service developments potentially affecting the use of the spectrum well in advance of such developments receiving spectrum allocations, in order to:

- represent Ireland's interest and contribute meaningfully to discussions in international fora about new allocations;
- take new developments into account in planning the use of spectrum and when contributing to the development of communications policy for Ireland. (Note: there may be a lead time of 2 - 3 years before proposed Recommendations are accepted by either CEPT or the ITU, potentially increasing to 5 - 6 years for acceptance of a proposed Regulation);
- communicate possible future developments to users.

The ODTR's awareness of international developments comes through participation in the relevant international bodies, in particular the EC, CEPT, the ITU and its World Radiocommunication Conferences (see section 1.2.1 for a fuller discussion of the roles of these bodies). The decisions made in these fora increasingly influence the way spectrum may be used in Ireland. Participation in CEPT/EC working groups is particularly important, as this provides the foundation for participation in other bodies.

The ODTR already participates in CEPT radio spectrum activities through attendance at European Radiocommunications Committee (ERC) plenary sessions and Working Groups. Until the end of 2001, Ireland holds the Chairmanship of the ERC. The benefits of active participation in the international, and most specifically the European, spectrum allocation process, include:

- timely access to information about impending developments so that Ireland can be well prepared to take advantage of new technologies;
- avoidance of making allocations which subsequently conflict with what is agreed at a European level;
- influence over the direction of change: while it may be difficult for Ireland acting alone to influence directly spectrum allocations at a European level, it may often have the opportunity to exert such influence by aligning with other like-minded countries.

However, even allowing for such European co-operation, the range of international activities is extensive relative to the size of the ODTR's resources, and the Office is reviewing its deployment of manpower devoted to these in the light of key priorities. The Director plans to build on the Office's established foundation of international activities insofar as possible. Recognising the resource implications of these activities, the ODTR will continue to focus on key themes of particular relevance to Ireland. These are likely to include key issues currently being addressed within the international fora, such as:

- future spectrum for the expansion of 3G mobile services
- fixed service requirements for 3G infrastructure
- implementation of the new EU regulatory framework, where it relates to radio spectrum management and licensing
- further harmonisation of spectrum allocations within Europe
- preparation for WRC 2003
- the introduction of multimedia wireless services
- the implications of convergence for spectrum allocation strategy

Question 3. Do you agree that the above list reflects the priorities the ODTR should pursue in the international arena, or are there other activities or developments that it should specifically address?

3.2.2 Developing a spectrum allocation strategy

The Director is considering publishing a Spectrum Strategy document to inform users of future changes in spectrum use. The Director proposes that the Strategy document would include:

- the strategies and procedures the ODTR will adopt to encourage efficient use of spectrum and support economic development objectives;
- plans for the release of spectrum for existing and new allocations;
- a description of the approach the ODTR plans to take to managing any relocation of spectrum users to accommodate new allocations.

The Strategy would be published and updated regularly to take account of major developments. It would help to ensure an integrated approach to future spectrum management, and present the case for changes as they arise. The Strategy would incorporate the existing National Table of Frequency Allocations to provide a single, core reference document both for the Office and for users. Such Strategies are already produced by the Australian, Canadian and UK spectrum managers, for example.

To inform the Strategy, reviews would need to be undertaken to determine the likely future demand for spectrum for various applications. This work would build upon the market analysis undertaken by the European Radiocommunications Office in its Detailed Spectrum Investigations[17] suitably adapted for Irish policy and market conditions.

It is noted that Article 9 of the proposed EC Decision on a regulatory framework for spectrum policy suggests that national regulators should publish plans for changing existing allocations for the next 2 years at least, including relocation plans, and reserved bands for new services.

Question 4. Do you agree with the proposal to publish a Spectrum Strategy document and do you have any views on what issues should be addressed by such a document?

3.2.3 Dialogue with Users

For both international and national issues, an active dialogue with organisations using the radio spectrum can bring benefit both to the regulator and to users. The ODTR already engages in dialogue relating to specific aspects of spectrum use, for example there have been recent consultations relating to fixed link planning guidelines[18], third generation mobile[19], fixed wireless access[20] and digital trunked radio[21]. A broad range of public and private sector users were also consulted as part of the process of preparing this document. The proposed strategy document would also provide a further opportunity for dialogue, which could, for example, take the form of a short public seminar or workshop to address the main issues identified in the document.

Question 5. Do you have a view on how an active dialogue on spectrum strategy can best be maintained?

3.2.4 Future allocation policies

As discussed in Section 2, strong growth in demand for spectrum for the following applications is likely over the next ten years:

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[17] Reports on the ERO's Phase I, II and III Detailed Spectrum Investigations, covering the frequency ranges 3.4 – 105 GHz 29.7 – 960 MHz and 862-3400 MHz respectively, are available from the ERO web site (www.ero.dk)

[18] Document ODTR 00/93, "A Review of Document ODTR 98/14 "Guidelines for Applicants for Point to Point Radio Link Licences in Spectrum Above 1GHz."

[19] Document ODTR 00/92, "Opening the Market for 3G Mobile Services – Response to the Consultation"

[20] Document ODTR 00/81, "Expanding the Choice for Fixed Wireless Access – Response to the Consultation"

[21] Document ODTR 00/54, "Opening the Market for Terrestrial Trunked Radio – Response to the Consultation"

- Fixed applications: supporting point to point links for other networks e.g. FWA and mobile networks;

- Mobile applications: cellular telephony and mobile data services for public and private users;

- Short range mobile or “untethered” devices: for example, radio LANs, wireless bar code readers and so forth;

- VSATs: VSATs or other emerging broadband satellite solutions could provide cost-effective broadband infrastructure to rural and remote regions, where cable or other terrestrial solutions might be impractical or uneconomic.

There is considerable uncertainty concerning the timing of these developments and the amount of spectrum that may be required. In the case of broadcast applications, it is unlikely that additional spectrum will be required, however the migration from analogue to digital technologies will need to be managed and it is possible some spectrum may eventually be released for other applications.

Demand for spectrum for other uses, such as military, aeronautical and maritime, may increase. It is likely however that these users will be required to accommodate this demand within their existing allocations by adopting more efficient technologies.

Question 6: Do you agree with the above rationale for where spectrum demand is likely to be greatest? In particular, do you foresee any significant change in spectrum demand for service or applications other than those mentioned? (see also Table 2.1, page 21).

The challenges for the ODTR in this respect are:

- to release spectrum for high value applications in a timely manner whilst not imposing undue costs on existing users;

- to accommodate new converged services;

- to allow users scope for experimentation.

It is noted that the adoption of software radio technology[22] may ease relocation of users in the future, and will allow the *ad-hoc* or opportunistic use of portions of spectrum that may be temporarily available.

3.2.4.1 Promoting Innovation

Regardless of which new allocations are implemented, Ireland has a choice of how fast it will implement them. The choice depends on a number of factors including:

- the speed and costs of relocating any existing users of the spectrum or terminating their spectrum use;
- the speed of licensing new users;
- the price profile for equipment costs (i.e. how quickly prices fall as services become established internationally);
- the demand for the new versus existing services;
- the extent to which there are development benefits from being an early adopter;
- the impact on competition of introducing new allocations sooner rather than later;
- the social and regional impacts.

The speed and potential costs of relocation are likely to be less of an issue in Ireland than in other countries where there is much more extensive and intensive use of the spectrum or where use of spectrum is more severely constrained by neighbouring countries. Hence in principle, Ireland ought to be able to adopt new services faster than other countries. The benefits from doing this depend importantly on the demand for the existing versus the new service and whether equipment costs (receivers and transmitters) are initially set at mass market levels or not.

The economic development benefits for Ireland from being an early adopter of new wireless technologies would be largely indirect, in the sense that they would support the broader development of high technology sectors by enabling improved and potentially lower cost communications services to be used. High quality communications services are necessary to attract leading edge technology companies to locate in Ireland. Recent years have seen much improvement in Ireland's communications infrastructure and services. This is reflected in Ireland's success in attracting inward and indigenous investment in the technology sector.

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[22] This is where an increasing proportion of the functionality of radio equipment is being implemented in software, rather than hardware, form. This development is leading towards the concept of a software radio, which will be able to reconfigure itself rapidly, perhaps using over-the-air signalling, to accommodate different modes and frequencies of operation.

The regional development advantages of being an early adopter may also be considerable, as communications services in less densely populated areas are usually more cost effectively provided by radio rather than wired infrastructure.

The comparative absence of spectrum congestion, the high skill levels amongst the workforce, the existing strong ICT industry and Ireland's linguistic and geographic characteristics suggest that Ireland is well placed to promote innovation in spectrum-using technologies and services. The ODTR already issues test licences[23] to persons experimenting with or carrying out tests involving new radio equipment, new radio spectrum applications and/or new radio services. The licences are temporary (normally up to 6 months in duration) and cannot, under the terms of the Licensing Directive, be used for the testing or development of markets .

Question 7. What further developments, if any, would you suggest to enable Ireland to capitalise on its comparative advantages in respect of spectrum-using technologies and services?

3.2.4.2 Spectrum allocation categories

When spectrum is allocated to particular services the allocated use is categorised in accordance with current ITU definitions (e.g. fixed, mobile or broadcast) Within these categories a degree of flexibility may be applied to help promote the introduction of innovative, converged services. For example, where frequency bands are allocated to the fixed service, these may typically be deployed on a national basis for either point to point or point to multipoint applications, without a need to stipulate specific technologies or standards. In Ireland, this has for example enabled the licensing of broadband fixed wireless access services in bands such as 26 GHz to deliver a diverse range of services to end-users. For some other services, where there is a need to provide interoperability or roaming between networks and/or countries (as is the case with GSM mobile services for example), specific standards may need to be stipulated at the outset.

EU policy is that standardisation should remain primarily a market-driven process, though it is also considered that standards may need to be mandated to ensure interoperability in the single European market[24]. Where interoperability is not a major issue there is scope for NRAs to make decisions about whether to permit particular applications (be they standardised or not). The Director's favoured approach to spectrum allocation is therefore to mandate specific services, standards or technologies only to the extent required to comply with ITU,

[23] Licences for Radio Communications Tests: Guidance Note and Application Form. ODTR 99/15, March 1999.

[24] See Article 23 of a proposal for a Directive on a Common Regulatory Framework for Electronic Communications Networks and Services.

CEPT or EU requirements, to ensure compatibility between different radiocommunication services , or where it is necessary to provide interoperability or roaming between networks or countries.

3.3 Legislative Issues

A review of the legislation has already been proposed by the Minister for Public Enterprise and a consultation has been launched. Responses are due by 19th February 2001 and the ODTR will be submitting its views to the Minister by then. These views will be made public. The Director intends to work closely with the Department of Public Enterprise and other relevant bodies to help develop a more flexible and up to date legislative framework with regard to regulation and management of the radio spectrum. There are a number of areas where there is scope to update, clarify or simplify the legislation, including:

- What should be licensed? Apparatus, spectrum or both?
- What licence categories should there be?
- What services should be made licence exempt?
- How should access to licences be determined?

These points are considered briefly below.

3.3.1 What should be licensed?

The ODTR at present issues licences for the use of apparatus. In circumstances where users have exclusive use of channels or blocks of spectrum it may be administratively simpler to license use of the spectrum rather than the apparatus. . Licence fees could then be based on the spectrum occupied and the user would be required to provide information about the location and technical characteristics of transmitters in order to facilitate co-ordination and enforcement. This would provide users with greater flexibility to deploy equipment, consistent with interference constraints. The Director is considering options for licensing spectrum rather than apparatus, where this is appropriate, both under the current WT legislation and as part of the forthcoming legislative review being undertaken by DPE.

3.3.2 What licence categories?

At present a new statutory instrument is required each time a new service is licensed. Development of bespoke licensing frameworks for services takes time and means that users are often not able to be licensed in a timely manner . This can create delays and barriers to investment in spectrum-using services as users generally seek legal clarity over their use of spectrum before they make significant investments in infrastructure and services.

The Director will be considering as part of the forthcoming legislative review the scope for facilitating broader, generic licence categories, with technical or service-specific details

contained within the licence schedule. Such a move should reduce the need for fresh secondary legislation when introducing new licences or services, speeding up the licensing process and supporting innovation.

3.3.3 Licence exempt services

Spectrum access is typically exempt from licensing if one or more of the following conditions holds:

- licensing is costly or impractical because of the large number of users (e.g. cordless phones)
- licensing is unnecessary because users are unlikely to interfere with each other, for example because of the technology employed (e.g. frequency hopping radio LANs), or the power of transmissions (e.g. garage openers and car immobilisers).

In future there is expected to be widespread use of low powered, short range, licence-exempt wireless communications in homes, offices and other public places such as shopping centres and airports. For the majority of short-range devices exemption should be the norm except where there is a significant potential for interference to other services. In practice, because the absence of a licence means there is no control over the number or location of licence-exempt devices, it is not possible to protect such devices from interference.

An alternative approach would be to introduce low-cost, flexible licences, proportionate to the need for co-ordination, rapid service deployment and user information. The purpose of such a licence would be to give users information about the nature and identity of other occupants of the band. This type of approach might for example be used to encourage the development of metropolitan area networks (campus or town wide), using emerging HiperLAN technology[25]. The comparatively sparse density of population outside Dublin might permit Ireland to introduce such services with an expectation of service quality that would be unrealistic in more densely populated countries.

Full exemption from licensing would continue to apply for short range devices operating in harmonised spectrum within Europe, or where this is otherwise mandated in ERC Decisions or EU Directives.

3.3.4 Congestion management

The ODTR already uses administrative tools, such as link length policies, to promote the most efficient use of spectrum. Elsewhere, spectrum managers are considering the use of a range

[25] HiperLAN is a family of European technical standards for broadband radio local area networks, providing data rates of 25 Mbits per second or more.

of market mechanisms' , such as administrative pricing[26], to provide users with incentives to use spectrum more efficiently (e.g. by using more efficient equipment) and where appropriate to provide users with incentives to consider the use of alternative technologies (e.g. wired rather than wireless) or frequency bands (i.e. less congested bands).

The ODTR is considering the options for introducing limited administrative pricing for services and geographic regions where congestion is an issue, within the framework of the forthcoming legislative review.

Question 8. Do you agree that mechanisms to allow access to spectrum in congested areas should have regard to spectrum efficiency and alternative technologies?

3.4 Interface with Licensees

The Director is considering a number of areas of the ODTR's operations which might be revised, with a view to increasing the benefits to users. Specific proposals have been developed relating to shared licensing powers, use of on-line systems, licence duration and enforcement.

3.4.1 Shared Licensing Powers

This term covers a number of approaches where large users, groups of users or third parties might be able to share with the ODTR powers to plan and in some cases assign spectrum. The organisation best suited to manage any given band depends on:

- the practicality and cost of assignment by parties other than the spectrum manager;
- competition considerations;
- the need to retain control so the spectrum can be readily re-allocated.

Implementations differ between countries but give an indication of the types of bands where private management might be considered. In the UK, examples of where the Radiocommunications Agency (RA) has delegated management or licensing functions include:

- the Joint Frequency Management Group (JFMG) - undertakes day-to-day management of spectrum allocated to services ancillary to broadcasting;
- the Joint Radio Committee (JRC) of the fuel, power and water industries - plans the use of spectrum for these services although the RA issues the licences;

[26] Administrative pricing involves setting spectrum charges which reflect the spectrum resource utilised, e.g. taking account of bandwidth, frequency band and/or the geographic area sterilised. Administrative pricing can take many forms from complex algorithms based on the least cost alternative to the spectrum resource, to a simple application of a higher spectrum charge in cases where congestion is likely to occur.

- Wray Castle - undertakes the administration of maritime licensing.

In Australia, Section 263 of the Radiocommunications Act 1992 allows the Australian Communications Authority (ACA) to accredit individuals to assign and issue frequency assignment certificates and interference impact certificates[27]. In 1998/9, 21% of all licence assignments were undertaken by accredited assignors.

In the US, private companies co-ordinate spectrum use for fixed links, private mobile radio and satellite earth stations. The private co-ordinators access relevant assignment databases and use these to supply a frequency planning service (at a charge) to users. Licences are still issued by the FCC.

In Ireland, the tightness of the labour market, particularly in telecoms and high tech industries, might argue for sharing some powers with external parties. However, against this, a major implication of convergence and growing demand for spectrum is that the spectrum manager must retain control of the spectrum allocated to different uses so that reallocations can be managed effectively.

In general therefore the Director does not propose to share planning and licensing powers with third parties. The main exceptions to this include the administration of maritime and aeronautical licensing where the relevant government department also undertakes related administration of operator licences. The ODTR is already in the process of transferring its responsibilities for maritime services to the Department of the Marine and is considering options for a similar approach for aeronautical services with the Irish Aviation Authority.

3.4.2 Use of automated or on-line systems

The ODTR has already made substantial progress towards the automation of its frequency assignment processes. Fixed link assignment is already automated and steps are being taken to extend this to other services including PMR, VSATs and broadcasting. In the longer term, further options that may be helpful in supporting more efficient assignment include:

- **On-line licensing** enables speedier processing and can reduce administrative costs, and can also be simpler for the user, although its successful implementation can present a number of security and technology related challenges .[28] Putting administrative transactions on-line is consistent with Ireland's ambitions to be a hub for e-commerce, and should be facilitated by the recent Electronic Commerce Act, under which electronic documents and signatures will carry equivalent force to their paper-based counterparts.

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[27] Frequency assignment certificates refer to transmitters and receivers covered by apparatus licensing. Interference impact certificates refer to the operation of transmitters subject to spectrum licensing.

[28] Examples of administrations that have or are planning to put in place such systems in the next year are Australia, Denmark, Sweden, the Netherlands, the UK and New Zealand.

- **Publication of the assignment criteria and databases**: this would allow users to make better-informed requests for assignments and to suggest ways of changing assignments to use spectrum more efficiently. This is already undertaken in a number of other countries e.g. Denmark, the Netherlands, Australia, New Zealand. Also the draft Decision on a Regulatory Framework for Radio Spectrum Policy in the EC suggests Member States should, amongst other things, make available information on existing frequency assignments.[29] The Director has already announced that a database of high/low sites for point to point links[30] will be made available on the ODTR website in order to assist licence applicants in preparing their application.

The Office has already begun moves towards the implementation of an on-line licensing system. It is currently considering options for extending its current IT development programme to include on-line licence application and payment.

3.4.3 Licence duration

With certain exceptions (e.g. MMDS and satellite teleports), all WT licences are currently annual and generally renewable on the payment of a licence fee, provided licence obligations have been complied with. Providers of public services (e.g. mobile, FWA, MMDS, TV etc) also require service licences issued under relevant broadcasting or telecommunication legislation, which include commitments to provide services using radio spectrum. A number of users who were consulted during the course of this spectrum review expressed a preference for longer licences to match the duration of their investments.

A move away from apparatus licensing towards spectrum licensing would facilitate longer licence durations, since it would no longer be necessary to update regularly the number of stations covered by the licences. In her response to the 1999 consultation on Opening the Market for Satellite Services[31], the Director stated that she was "supportive of the concept of longer-term wireless telegraphy licences and may consider a review of the general periods of validity of wireless telegraphy licences, as the issue is not confined to satellite services only".

3.4.4 Enforcement

Enforcement is already a significant issue, and is one that is likely to increase in importance as spectrum demand grows and congestion increases. While the ODTR already has

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[29] See article 9 and Annex 1 of COM(2000)407.

[30] Point to point link channels comprise two frequencies, one from a "high" sub-band and one from a "low" sub-band, each conveying traffic in a single direction. Within a given frequency band, in order to minimise interference, the ODTR divides radio sites into sites transmitting on the high frequencies (high sites) and sites transmitting on the low frequencies (low sites). Applicants will not be licensed for a high frequency on or in the immediate vicinity of a low site, and vice versa.

[31] Document 99/49, "Opening the Market for Satellite Communication Services – Response to the Consultation"

monitoring and enforcement procedures in place, the Director considers that some strengthening of enforcement powers is necessary, for example to prevent use of the spectrum by non-legitimate users. The Director proposes to seek enhanced powers of enforcement, for example with regard to major spectrum licence compliance and to streamlining the processes for prosecution of unlicensed users and inappropriate licensed operation, noting that this would require legislative action. The rules with which users must comply will also be given greater prominence as part of the moves to enhance user dialogue and within the proposed Spectrum Strategy document.

3.5 Conclusions and Future Work

This paper presents the findings of a high-level review which has examined the current spectrum management framework in Ireland and has outlined key issues for spectrum use going forward. In so doing, the paper has addressed the market, economic and technical factors likely to affect the use of the radio spectrum in Ireland over the next ten years, with a view to ensuring that Ireland has the necessary regulatory framework to maximise economic benefit from the radio spectrum, whilst protecting the needs of the wider community.

Looking to the future, the paper gives rise to new issues that the Office will need to address in greater detail. Moreover, it is anticipated that further spectrum-related papers will be defined in light of responses to the questions set out above. In any event, the Office will in the coming weeks be publishing a revised Table of Frequency Allocations, a report on its earlier consultation on Digital Terrestrial Television, and its response to the Department of Public Enterprise's "Review of legislation relating to the licensing and use of the radio spectrum".

4. SUBMITTING COMMENTS

The Director welcomes views on the questions raised in this paper. Responses should be sent via e-mail or in writing to the address below, to arrive not later than Friday 16th March 2001.

All comments are welcome, but the task of analysing responses will be simplified if comments are referenced to the relevant question numbers from this document.

In order to promote further openness and transparency, the ODTR will make copies of the comments available for public inspection at its offices, excluding commercially sensitive information. Where material that is commercially sensitive is included in a response, this should be clearly marked as such and included in an Annex to the response.

Responses should be sent to Ruth Kenny at ODTR, Block DEF, Irish Life Centre, Lower Abbey Street, Dublin 1 or via e-mail to kennyr@odtr.ie and should be clearly marked "Comments on document ODTR [01/06], ODTR Radio Spectrum Management".

This consultation paper does not constitute legal, commercial or technical advice. The Director is not bound by it. The consultation is without prejudice to the legal position of the Director and to her rights and duties under legislation.

ANNEX A: SCENARIO ANALYSIS

Scenario 1: Market evolution

Summary end state:

A steady market, dominated by a small number of vertically integrated companies who effectively control the market for content and in some instances may also control the market for transmission. The major content providers work closely with platform providers together with some smaller, niche players. Applications are faster and more sophisticated, but otherwise broadly similar to those available, or being developed, in 2000. Required data throughput has increased fairly rapidly, though not explosively. Whilst increased spectrum efficiency has helped to meet this demand to some extent, providing sufficient bandwidth to support new applications remains a challenge. Key regulatory issues include maintaining competition; ensuring appropriate provision for rural areas; enforcing licence conditions and encouraging ever more efficient use of the spectrum.

Sign-posts

1. **Economy:** Macro-economic climate closely reflects that of Continental Europe; inflation rises towards the middle of the decade; the Euro has difficulties for some years before finally becoming established and stable, inward investment policies focus on developing BMW area; all national infrastructure projects (road, rail etc) begin automatically to lay fibre as part of the project.
2. **Legislation:** During the decade the existing legal structure is revised on an incremental basis, gradually clarifying areas of uncertainty. Efforts to increase radio and wireline capacity are initially hampered by a mismatch between local and national planning priorities.
3. **Investment:** Investment in Irish ICT is largely restricted to existing major players, most of whom are now subsidiaries of larger, overseas companies; some R&D undertaken by small start-ups, who are quickly bought out by the larger companies, leading to an increasing consolidation of power within a small number of major players at a European level.
4. **Regional Impact:** Sees a gradual roll-out of services to the more densely populated rural areas: intense negotiations by government with major platform providers result in public funding being used to support provision of ICT infrastructure to all parts of the country; teleworking is actively encouraged.
5. **Providers:** A small number of vertically integrated service / content provider companies begin to dominate the market, providing all elements of service delivery from user interface down to, but stopping at, transmission; payment model increasingly seeks to tie buyers in to a single provider; brand becomes a core corporate asset, particularly for

service / content providers; transmission capability, including spectrum licences, becomes a tradable commodity provided by specialist technical companies to the bigger content providing companies; whilst open standards dominate for transmission, value-added, user-facing services are provided through proprietary means and offer a key service differentiator; customer base, and depth of customer knowledge / relationship critical to ensure corporate profitability.

6. **Domestic consumers:** Waxing and subsequently waning public antipathy towards radio devices retards growth of the market and tends to stifle early innovations, though this is overcome towards the middle / latter part of the decade; technology responds to, rather than drives, market needs, with the market dominated by conservative, risk averse, buyers with only moderate interest in innovation; development of user friendly interfaces and intelligent agents ensure that users can remain fairly IT illiterate yet still gain most of the benefit of technological changes later on in the decade; platform becomes transparent to the user – interest is in content not delivery.

7. **Corporate consumers:** Certain key sectors, such as finance, ICT, biotechnology etc, are willing to pay the innovator cost in order to gain market advantage (e.g. for cryptography R&D) and increasingly split front office and back office functions; quality of service is crucial with corporate consumers being prepared to switch between providers to achieve the quality that they seek.

8. **Technology:** The national communications infrastructure continues to be expanded, with VSATs becoming increasingly widespread as a means by which to meet corporate demand for high bit-rate applications, particularly in rural areas; problems with e-commerce fraud lead to heavy investment in encryption products; use of technology in Ireland closely follows that in the rest of Europe

9. **Spectrum demand:** A modest growth in demand for spectrum is to some extent matched by the introduction of increasingly spectrum efficient equipment as older equipment becomes obsolete and regulation encourages spectrum efficiency; overall however, demand continues to outstrip supply; user resistance to DTT prevents early switch-off of analogue TV thereby delaying reuse of the spectrum; considerable use of wireless LANs in offices and homes as these are made user friendly.

10. **Regulation:** Competition becomes a key issue as the European market consolidates into a small number of providers; the risks associated with vertical integration become a key issue throughout Europe; enforcement of licence conditions becomes increasingly important as a mechanism through which to help maintain active competition.

Ireland 2010

- Service Provider branding is a major issue for the fairly conservative domestic market, where consumers are reluctant to turn away from familiar, established brand names; for

the business market quality of service issues challenge brand as the key decision determinant.

- A relatively slow rate of change in services and devices and a large, loyal consumer base, tend to reduce consumer costs, though exploitation of market power offers the potential to keep prices high.
- Many applications are now mobile although tethered communications remain important; much communication and entertainment is now carried out via a home-based server allowing indoor mobility, but using wireline access to the PSTN.
- Tension exists between the desire of consumers to benefit from the advantages of technology whilst having concerns regarding the environmental impact of the support infrastructure.

Scenario 2: Socio-economic stimulation

Summary end state

A steady market, combining both large, vertically integrated companies, and a range of Small and Medium Sized Enterprises (SMEs). Integrated government policy and action has led to a significant change in the status of the BMW regions, which now enjoy a much improved overall level of prosperity and inclusion within the new Irish information society. Targeted funding has enabled SMEs to undertake a wider and more extended range of R&D projects than had formerly been the case, with Irish companies now holding IPR in a number of internationally recognised internet related products. Required data throughput has increased rapidly, as an increasing number of telecommunities have sprung up along the West coast. Initially, meeting the demand for spectrum was comparatively simple, however during the last part of the decade, ever growing demand led to the need for the introduction of a combined policy drawing upon use of administrative rules, spectrum pricing and proactive enforcement.

Sign-posts

1. **Economy:** A strong economy, built upon the burgeoning ICT, pharmaceutical and bio-technology industries, provides the tax revenue required to fund a series of progressive government investment policies. These in turn engender a virtuous circle of reduced regional unemployment and further increased revenue. Inflationary pressures are ameliorated through investment in a range of programmes designed to relieve infrastructure bottlenecks.
2. **Legislation:** The 1926 Wireless Telegraphy Act is extensively revised or replaced early in the decade with a new Act, bringing together both a series of EU Directives and encapsulating a more flexible approach to the use and exploitation of radio. Disparate approaches to the granting of planning permission for telecommunications infrastructure are tackled through a pan-regional conference which agrees a harmonised approach

across the country. Following agreement of the new rules, roll-out of the new infrastructure speeds up.

3. **Investment:** Government invests extensively in educating and empowering the nation to use, enjoy and understand new technology; major companies work closely with Government to develop a greater lay understanding of the issues and capabilities of modern communications technology.

4. **Regional Impact:** A strong focus on regional development sees an inter-departmental approach to promoting economic growth in less advantaged areas. This is achieved through significant improvements in transport, communications and social (i.e. education and health) infrastructure in gateway towns, together with the introduction of an integrated approach to the use of land. Early in the decade, a programme of investment in the regional broadband telecommunications infrastructure leads to the development of a more spatially balanced economy. A high priority is given to rolling-out services to the less densely populated areas. Teleworking is actively encouraged.

5. **Providers:** A variety of company sizes and types have become involved in the development and provision of telecommunication services. SMEs benefit from the introduction of positive policies across government, particularly with regard to set up and operations in the BMW regions.

6. **Domestic consumers:** An active policy of national education leads to the development of a solid, basic understanding of the capabilities and limitations of radio technology within the domestic user community. Early public antipathy towards radio devices is overcome through education, with users coming to appreciate the link between provision of services and the necessity for telecommunications infrastructure. Development of user friendly interfaces and intelligent agents enhance the ability of users to operate on a teleworking basis.

7. **Corporate consumers:** Following the introduction of a range of incentives, commercial operations in the regions become very much more prominent. Companies making extensive use of telecommunications begin to move away from the major conurbations to take advantage of the investment capital and increasingly extensive telecommunications facilities, offered in the regions.

8. **Technology:** The national communications infrastructure continues to be expanded, with VSATs becoming increasingly widespread as a means by which to meet corporate demand for high bit-rate applications, particularly in rural areas.

9. **Spectrum demand:** Demand for spectrum grows, particularly in the regions, as an increasing number of companies and individuals choose to locate away from Dublin and its hinterland, preferring instead gateway regional centres.

10. **Regulation:** Competition is an issue as the European market consolidates into a small number of providers; however, the prevalence of SMEs within Ireland offers some

protection to the Irish consumer. Towards the middle of the decade, the introduction of spectrum pricing to reflect the balance between supply and demand, results in a significant differential between the cost of spectrum use in congested areas and in less congested areas. This proves beneficial to the regions.

Ireland 2010

- Ireland becomes a country of greater regional equality;
- A mixed economy develops as an increasing number of people choose to spend at least some of their working week teleworking from home, rather than spending time in the office;
- A culture of innovation becomes established across the country;
- A pan-Ireland, broadband telecommunications infrastructure is completed as part of an overall development plan;
- Greater knowledge and use of radio communications helps to ensure that the obstacles that initially retarded infrastructure roll-out have gone by the end of the decade.

Scenario 3: Technological revolution

Summary End state:

A dynamic, rapidly evolving market with high levels of competition providing rich consumer choice, in a dynamic environment. Spectrum is in heavy demand, with particularly intense pressure on the lower bands. Self-assigning radio technology becomes commonplace, allowing the regulatory focus to move to allocation to generic services / applications rather than assignment to specific operators.

Sign-posts

1. Economy: Attractive macro-economic climate develops, with low inflation, steady currency, positive inward investment incentives; strong government focus on benefits of future technology to the country; tax incentives and welfare state structured to attract human capital to Ireland.

2. Legislation: Legal structure reviewed and revised to support innovative and competitive use of the spectrum; integrated approach ensures that related issues, such as planning permission, are addressed.

3. Investment: Government invests in educating and empowering the nation to use, enjoy and to understand technology; corporate investment focuses on development of functionally innovative applications.

4. Regional impact: An increasingly non-interventionist policy leads to companies basing themselves in Dublin and to a lesser extent in other major population centres. Rural areas are unable to provide either the social, or the transport / housing infrastructure necessary to

compete with Dublin in attracting and retaining the Irish and immigrant workforce required by the ICT industry.

5. Providers: Many small companies enter the market, but the failure rate is high. No specific firm has a stranglehold over the market as a whole, but some companies come to dominate specific niches. High levels of innovation are found throughout the ICT industry; both open and proprietary standards co-exist. Open standards allow common platforms on which new companies can offer new services (e.g. IP for networks, MPEG for video / audio compression and possibly some common conditional access systems). Proprietary standards dominate certain innovative niche markets; payment model permits platform/provider promiscuity; profit is generated through micro-payments, advertising and transaction fees.

6. Domestic consumers: Consumers become completely comfortable with use of ICT and wireless in particular, which comes to permeate all aspects of their lives. Early adopters are critical to market; mobility becomes an assumed characteristic of all ICT devices, with the next generation of high powered, self-configuring, plug and play devices (such as Bluetooth mk-2 for example), becoming an accepted norm. Technology used in the work place is assumed also to work in the home enabling a blurring of the boundaries between workplace and home.

7. Corporate consumers: Proactively seek and invest in, innovative applications to gain competitive advantage; whilst quality of service in the core telecommunications services remains key, newer services are seized upon for the possible "first to market" advantage that they may offer to companies in providing new ways to reach and service their b2b and b2c operations; mobility is assumed for all devices.

8. Technology: During the decade a state of the art communications infrastructure is developed, with a fibre backbone and radio spurs. Innovative applications come quickly to the market and move through a rapid product lifecycle, with some technological devices showing a similar lifecycle to a fashion accessory.

9. Spectrum demand: Radio spectrum becomes a tradable commodity, as does network capacity (mobile and fixed); demand becomes intense, particularly at lower frequencies most suited to wide area mobility; congestion becomes a critical issue; shortage of bandwidth encourages increasing intensity of spectrum use; the successful introduction of short-range infra-red and optical links helps to relieve pressure on radio spectrum for specific applications, as does the early switch-off of analogue TV; radio fixed link connections between mobile cells and the cable backbone become hotspots as volume of traffic grows and density of provision increases (i.e. cells become smaller).

10. Regulation: Breakdown of traditional service definitions leads to radical shake-up of regulatory environment; self-assignment technology releases regulator's resources to focus on more strategic regulation; innovative policies encourage R&D; government takes a proactive role in promoting Ireland's technology friendly inward investment and regulatory polices.

Ireland 2010

- Ireland becomes the country of choice for e-commerce and for beta testing technology products; builds on its unique combined characteristics – small country, English speaking, with available radio capacity at some frequencies and nurturing regulatory environment;
- Mixed economy prevails with regard to work; home working, local centre working and office working all co-exist, all use mutually compatible technology; mobility is expected and delivered for all applications; “killer applications” lead to faster turnover in spectrum occupancy, but presents significant challenges in re-claiming spectrum from ailing licensees;
- Whilst a metropolitan fibre network is established between the major cites, platform providers find provision of a pan-Ireland network, using cable, VSAT or radio fixed links, difficult to justify on cost grounds.

ANNEX B: GLOSSARY

3G	Third Generation (mobile telephony)
CEPT	Conference of European Postal and Telecommunications Administrations
DAB	Digital Audio Broadcasting
DECT	Digital European Cordless Telecommunications
DTH	Direct To Home (satellite TV broadcast)
DTT	Digital Terrestrial Television
EC	European Commission
ECTRA	European Committee for Telecommunications Regulatory Affairs
ERC	European Radiocommunications Committee
FCC	Federal Communication Commission (USA)
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
HFC	Hybrid Fibre Coaxial
IPR	Intellectual Property Right
LAN	Local Area Network
MMDS	Microwave Multipoint Distribution System
PMR	Private Mobile Radio
PAMR	Public Access Mobile Radio
SNG	Satellite News Gathering
S/PCS	Satellite Personal Communication Systems
STM	Synchronous Transmission Mode
STM-1	155 Mbit/s bit rate
UMTS	Universal Mobile Telecommunications System
VSAT	Very Small Aperture Terminal
(X)DSL	(type of) Digital Subscriber Line
WAN	Wide Area Network
WRC	World Radiocommunications Conference
WT	Wireless Telegraphy