Spectrum Policy: Regulation and Markets

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[1] Note that the opinions expressed in this paper are those of the author and do not necessarily reflect those of the Commission for Communications Regulation.

Introduction

Many thanks for the invitation to speak at this workshop. Some of you may be thinking this is a rather "dry" area to be holding forth on, and wondering whether someone from ComReg could not find a more exciting topic to address. Some of you may even be wondering what exactly spectrum is! During this talk, I hope to at least explain what spectrum actually means, but more importantly, I hope to convince you that an effective spectrum policy is extremely important for innovation and productivity in the Irish economy, and that, if we choose the right policy instruments, the use of spectrum will make major contributions to Irish economic growth, and will be a key area in achieving the goals of the Lisbon Agenda.

I will first briefly discuss what the radio spectrum is, and then will set out how the Commission for Communications Regulation (ComReg) administers it. I then move on to consider potential changes in spectrum policy – notably a move towards more market-base mechanisms, which could lead to auctioning off of licences and secondary trading. I discuss the potential benefits this might bring, as well as the challenges it could pose, and conclude by briefly considering whether liberalisation of licensing could apply in areas such as content broadcasting for radio and TV.

What is spectrum?

When I joined ComReg, I was not really sure what spectrum meant – when I asked an engineer, he told me I accessed the spectrum many times every day. If I turn on the radio, I am using spectrum; if I use the remote control on my TV, I am using spectrum; if I use some form of clicker to open my car doors I am using spectrum; and if I use my mobile phone I am using spectrum. A large number of activities depend upon access to the radio spectrum. So how exactly does it work?

The radio spectrum is a finite but non-exhaustible natural resource. Radio signals are used for communications, with the area within the total spectrum being indicated by the number of frequency cycles (each of which describes a sine curve) per second. 1 cycle per second is denoted as 1 hertz (Hz). The number of cycles per second increases as one goes further up the spectrum - so-called longwave radio signals operate at around 200,000 Hz (or 200 kHz); taxi radios at around 200,000,000 Hz (or 200 MHz); and GSM mobile phones at around 2,000,000,000 Hz (or 2 GHz). At current levels of technology, the highest modulation that can be detected and measured is about 1000 GHz[2] . Thus the spectrum can be seen as a continuous interval between 9 kHz and 1000 GHz [the international ITU Radio Regulations cover the frequency range 9 kHz to 1000 GHz]. Within that range a huge variety of signals can be used. Over time, the usable range of the frequency spectrum will increase. The

[2] Radioastronomy observations take place at frequencies up to 1000 GHz (at sub-millimetric wavelengths) but are not suitable for commercial purposes. However, 200 GHz is the current perceived limit for commercial use.

task of the regulator is to ensure that this spectrum is used in the most efficient manner possible.

The range of the usable frequency spectrum has increased over time. Early radio transmissions were at low frequencies – the First World War stimulated considerable innovation in radio technology, but even then only long-wave radio was generally used. After the Second World War, technology enabled higher frequencies to be accessed – in excess of 50 MHz at first –which led to the FM band being situated there (the FM broadcasting band is 87.5-108 MHz) as the greater bandwidth facilitated the broadcasting of 'hi-fi' quality sound and the propagation characteristics of the radio waves were ideal for more localised broadcasting. The '80's and '90s saw the commercial development of GSM phones (which are essentially small radio transmitters and receivers) as well as the onset of satellite TV (situated near the 12 GHz range).

As radio spectrum developed, one of the biggest problems it faced was interference. If a set of signals operating at one frequency is disturbed by another set, interference will result and the signals may be impossible to decipher. This led to an attempt to delineate bands of spectrum available to a specific user: essentially someone would be licensed by the State to have exclusive use over some range of spectrum waves. This prevented interference from other users, and enabled signals to be read clearly. This still left the problem of interference across countries – if one country designated a band for a specific user, there was the possibility that the same band might be used in a neighbouring country and interfere with the signal.[3] The first international attempts to co-ordinate spectrum use attempted to grapple with this problem, and today there are a number of large international fora assigned with the task of ensuring harmonisation and a minimum of interference.

I think the historical evolution of spectrum is interesting in itself, but I also describe it to make another point. The assignment of spectrum proceeded on a historical basis: as a new technology was found it was generally assigned a band to operate in. This has meant that the current assignment of spectrum is largely determined by history and developments in technology: older technologies have occupied the lower ranges of the spectrum, while newer technologies have tended to be assigned higher parts of the band. Whether or not this is the optimal policy for assigning spectrum is something I will return to later.

I should also state one of the main economic issues in spectrum policy: with free entry, the interference referred to above will have a negative external effect on other users. Economic theory predicts that this will lead to excessive entry and overcrowding of the spectrum. As mentioned above, the use of licensed bands was the response to the problem of interference – again, whether or not this is an optimal response is something discussed below.

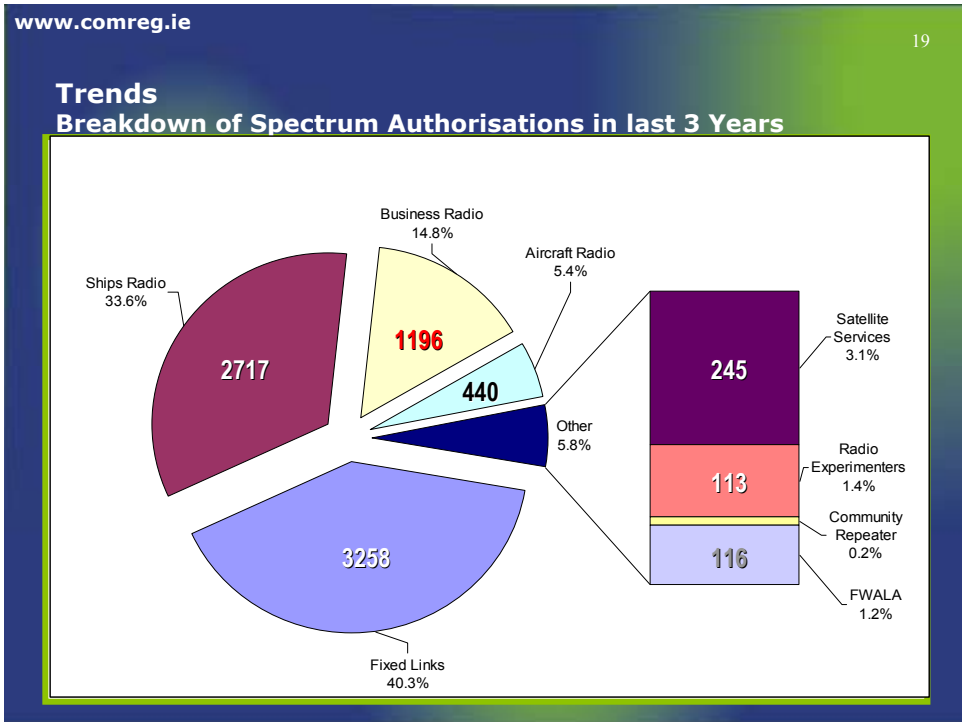
[3] The degree of geographical interference can vary enormously depending upon the frequency – one perceived advantage of the FM band was that its signals only travelled a limited distance, thus there was limited risk of interference between radio stations using the same frequency in different cities.

ComReg's role

ComReg is the National Regulatory Authority (NRA) charged with the role of efficiently managing the radio spectrum in Ireland. It recently published its Spectrum Management Strategy Statement 2005-2007[4] which sets out its approach to spectrum for the next three years. It focuses on four main objectives, namely:

(i) Facilitating access to radio spectrum, particularly for innovative technologies and services;
(ii) Maximising the economic and social benefits arising from the use of radio spectrum;
(iii) Promoting the efficient use of scarce radio spectrum resources; and
(iv) Ensuring compliance with national and international requirements and the avoidance of harmful interference.

ComReg allocates Licences for much of the spectrum – obviously these include Licences for mobile phone operators, but also for a whole host of other uses. Some of the variety of uses are delineated below:



There are generally fees charged for these Licences, but such fees are usually set at a low level, designed to cover the administrative costs of licensing. Some of the spectrum is set aside for specific social purposes such as the defence forces and the emergency services. There are also constraints imposed by international requirements and moves towards harmonization of spectrum – this issue is particularly relevant with regard to possible interference between the Republic and Northern Ireland. Subject to these constraints, a key aspect of ComReg's approach is to ensure that sufficient spectrum is available to meet any future demand.

[4] See at www.comreg.ie Document 05/72

Research commissioned by ComReg found that spectrum made a considerable contribution to the Irish economy. It concluded that in 2003 the total share of GDP arising from use of spectrum was about 1.4% of GDP, or about €2 billion. A conservative estimate of the number of people whose jobs directly depend upon the use of spectrum is 24,000. A detailed breakdown for different sectors is as follows[5]:

	GDP (€m)		**Employment**	
	2002	2003	2002	2003
Mobile	569	834	8551	7928
Broadcasting	208	265	4310	4331
Fixed Links	1	1	20	20
Air Services	498	600	11988	11829
Short range devices	230	230	581	581
Other services	14	14	330	330
Total	**1520**	**1944**	**25780**	**25019**
% of total economy	**1.1**	**1.4**	**1.4**	**1.4**

As you would expect, mobile is the biggest contributor to GDP, and is growing rapidly. Estimates for consumer and producer surplus were also made[6], and are shown below:

Service	**Consumer and Producer Surplus (€m)**
Mobile	1625
Broadcasting	290
Fixed links and satellite	645
Business radio	56

Note that consumer surplus figures for broadcasting may be underestimated as they do not take account of terrestrial TV services originating outside Ireland.

How should spectrum be regulated?

Having described the nature of spectrum, its contribution to the economy and how ComReg administers its use, I now want to turn to a topic of direct relevance to economists: what is the optimal way to allocate spectrum?

[5] For a description of the methodology used to calculate these figures, see the Spectrum Strategy Statement, *op cit*, Annex 2.

[6] Consumers surplus was calculated using "willingness to pay" studies. Producer surplus was calculated by analysing the rate of capital employed in mobile businesses, and the average rate of return on capital set by European regulators. Again, Annex 2 describes this in more detail.

As said earlier, the way spectrum is assigned has tended to depend upon historical patterns. Spectrum became available and was assigned a particular use. Once that specific use was given, it was considered that it was essentially fixed for good; whatever application (e.g., fixed, mobile, broadcasting) used that band of spectrum should be assigned to it indefinitely, where the Licensee had (a) no right to use it for any other use; and (b) *de facto* the right to use it for an indefinite period.[7] The whole "command-and-control" approach was considered to be the most appropriate way to minimize interference, as well as ensure harmonization internationally. But by forcing specific spectrum bands into fixed usages as well as limiting the ability to change the usage over time it may not be the most appropriate way to maximise the value of the resource and encourage innovation in new technology.

This issue is particularly problematic at a time when technological innovation is at an exceptionally high level, and when convergence of different types of technologies is ongoing rapidly. While we know that technological improvements are taking place, what we cannot know is precisely which specific new technologies will prove to be most valuable. New technologies may prove to be most efficiently used in certain ranges of the spectrum – if such ranges are already being used by older technologies, then a non-optimal allocation of resources may take place. If new technologies cannot find an efficient place in the spectrum or even not be assigned any spectrum at all, then there will be static losses of efficiency, but also, if this proves to have a dampening effect on the whole incentive to innovate, significant dynamic losses as well. This is a key point about spectrum: it is a tremendous natural resource, but, if not used properly, also has the possibility of acting as a "bottleneck" inhibiting innovation and growth. As an expert commentator on spectrum allocation has said: *"Spectrum is the raw material for industry; radio connects the information society…But the boundaries between new services are blurring, reducing the predictability of spectrum use."*[8]

When considering this problem, an important point to remember is that no regulatory body can be expected to guess which technologies will have a major impact and which will not.[9] Innovation is occurring at such a rapid rate that a regulator can find it difficult to respond by attempting to ration spectrum or use a form of "command and control". In particular, there may be a bias in favour of the status quo, as incumbent users of spectrum attempt to defend their own turf. Any allocation mechanism should therefore not depend upon the regulator having to predict which as yet undiscovered technologies should be reserved certain bands of spectrum. This has led to calls for liberalization of spectrum allocation through increased use of market forces, which is the topic we turn to next.

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[7] Many commentators have written about the power of existing spectrum holders to cling on to their rights and to try deny spectrum to new entrants. This has been particularly prevalent in broadcasting in the US.

[8] See Martin Cave, "Reforming UK Spectrum Policy", 2002.

[9] The infamous quote by the then CEO of IBM in 1943 that there was "a worldwide market for maybe five computers" is indicative of our inability to predict how technology will evolve.

Spectrum Liberalization

The whole idea of making access to spectrum easier has seen two main approaches:

(i) Market-based approaches which favour the auctioning off and secondary trading of spectrum bands as well as the right to use a particular band not being tied to a specific technology.

(ii) Commons-based approaches which suggest that interference is less of a problem now than before, and which favour spectrum being available to anyone who wants to use it, with no licensing requirement.

I will deal with the market-based approach first as it has already been used in a number of jurisdictions, with the US Federal Communications Commission (FCC) using some market mechanisms to allocate spectrum from the 1980s onwards. More recently, auctions have been used in a number of European countries, notably for the granting of 3G Licences for mobile phones.[10]

The basic purpose of an auction is straightforward: to give the item being auctioned to the bidder who values it most. Unless there are compelling reasons for private valuations being different from social valuations, this kind of mechanism will tend to result in an efficient use of resources. A side-benefit of auctions is the raising of revenue for the State exchequer fund. The whole concept of auctions is quite compelling to an economist: they allocate scarce resources efficiently, they raise funds, plus, by giving the auction winner a clear and exclusive right, they provide a stable framework for innovation to take place in.

The potential benefits of auctions compared to "beauty contests" as methods to allocate Licences are becoming clearer (at least to me!). Beauty contests tend to be extremely difficult to judge as the criteria may be subjective, and have the potential to lead to litigation, as developments have shown. Indeed, the recent competition to award a new commercial radio Licence for Dublin (conducted by the BCI) is currently being litigated.

However, auctions are only one half of the market-based approach. Once a Licence has being obtained, technology may further evolve, and a new technology may come along which is more suitable for that band. In that case, efficiency considerations would suggest that the original owner should be able to sell the Licence to someone else – either someone who wants to use the same technology, or perhaps more importantly, someone who has developed a new technology which is more efficient in that band. This kind of "secondary trading" of Licences, along with the Licence covering the right to use the band with any technology you want, is now increasingly being called for in spectrum policy.

Thus a coherent market-based approach would see Licences being allocated on efficiency grounds, with auctions being used if there is greater demand than supply. Licences would not be automatically linked to a specific use; they would be flexible and could be employed for other purposes, subject to meeting basic requirements about non-interference. This whole approach has recently being considered by both

[10] ComReg is about to conduct its first auction, selling the rights to use digital mobile radio services in the 400mhz and 900mhz bands.

the EU and the UK.[11] In the case of the EU, they have suggested that with both the trading and flexibility discussed above, market-based mechanisms could generate benefits of over €9bn across the 15 EU countries (pre-enlargement), with most of these gains being due to enhanced innovation, but some accruing to enhanced competition. OFCOM (the UK regulator) has suggested that a plausible goal is to have nearly ¾ of the available spectrum subject to secondary trading by 2010.

Problems?

There are a number of issues with the market-based approach. One is that spectrum is currently used for many immensely valuable social purpose, such as emergency services, the Gardai, and (more in other countries) the military. However, such purposes can still be achieved by reserving specific allocations of spectrum for certain public services.

A second issue is the question of "spectrum hoarding", where one operator, usually an incumbent with "deep-pockets" buys up large allocations of spectrum to deny it to entrants. This is a potential problem but I would note it could be dealt with by the usual methods of competition law – should anyone obtain a dominant position and seek to abuse it, that would be a violation of Section 5 of the Competition Act. Alternately, should they attempt to buy up existing spectrum rights holders that could be prevented under the merger provisions of the Competition Act. Another possible solution, advocated by Baumol[12], is that all Licences should be limited in duration, perhaps expiring every 15 years. This would create extra administrative costs in terms of granting Licences, but would be at least a clear and predictable rule which should allow long enough for investment and innovation incentives to operate. And it would prevent the potential accumulation of a dominant position, as well as generally limiting the power of vested interests to retain any market or economic power they had gathered over time.

Commons-Based approaches

Some recent commentators on spectrum policy have suggested that access to spectrum should be free, and that interference-avoidance technology has progressed to the extent that interference – one of the main reasons for regulating spectrum – is no longer a serious problem. As such, there would be no Licences.

Some aspects of this approach are clearly attractive, as it seems to remove the "bottleneck" problem of spectrum: anyone can enter and use whatever technology they want. However, there are some problems, partly as most commentators suggest interference-prevention technology is not yet at a stage to facilitate this. As long as

[11] See Commission documents, "A forward-looking spectrum policy for the European Union – second annual report", COM (2005) 411, and "A market-based approach to spectrum management in the European Union" COM (2005) 400, plus OFCOM, "Spectrum Framework Review", November 2004.
[12] See William Baumol, "Toward an evolutionary regime for spectrum governance: licensing or unrestricted entry?" AEI-Brookings Joint Center for Regulatory Studies, April 2005.

interference is still an issue, the basic negative external effect that each new entrant imposes on others through interference is preserved, and we are likely to see excessive entry and overcrowding of the spectrum. The effect on innovation may also be negative: if an entrant knows that someone else can enter the same band as them and immediately offer the same service, this may tend to limit innovation. Proponents of the commons approach suggest there will be an incentive for operators to invest in solutions which limit interference, but the incentives to engage in investment in such technology are limited, as the benefit will accrue not just to the innovator who bears the cost of this, but also to those content to "free-ride" on the innovator.

The case for a full-blown commons regime is thus dubious at present. But it may be appropriate in certain cases. Some portions of the spectrum are relatively little-used, and such bands could be good candidates for the commons approach. Indeed, ComReg was the first European regulator to introduce Licence-exempt wireless broadband access in the 5.8GHz band.

Internationally, the 'commons' approach has to date generally been applied to *low-power* applications where there is less likelihood of interference to start with, e.g the 2.5 GHz band used by WiFi, microwave ovens, and other short range devices. Also the nature of use tends to be intermittent and/or mobile/portable in nature, thus further mitigating against interference. It has not yet been applied in bands used by high power transmitters such as broadcasting, mobile phones, radar, etc.

Synthesis

I have discussed a number of approaches to spectrum allocation: the traditional approach, a market-based one, and a commons-based one. From an economist's point of view, the market-based one is particularly appealing, and indeed is becoming more prevalent. But I think that advocating one approach as the perfect one would be a mistake: there are many different uses for spectrum, both commercial and non-commercial, and there is room for a number of approaches. Certain social or economic goals may be well-served by making spectrum available in a certain way; for instance, to stimulate the take-up of broadband, which is at a low rate in Ireland compared to the rest of the EU. A move towards the use of more market mechanisms such as auctions and trading, along with some Licence-exempt areas of spectrum, as well as the reservation and allocation of areas that are not suitable for market allocation seems the most appropriate framework going forward.

Epilogue: Content?

I will finish with a very specific issue, but one where I think a change of approach could yield definite benefits. ComReg is the regulator for the allocation of spectrum, but as you probably know, does not regulate the transmission of content, a task performed by the Broadcasting Commission of Ireland (BCI). In particular, they regulate the broadcasting of commercial radio, where a Licence from the BCI is required to (legally!) be on the air. Formally, the BCI is granted the spectrum by

ComReg and then gives out a Licence to broadcast commercially in that spectrum. In the past, the BCI has tended to issue a relatively small number of Licences, with a Licence generally limited to a specific area and/or the provision of a certain approach in content, eg, the Licence might specify a certain demographic must be addressed, or a particular style of music be played. This has resulted in a number of Licence holders in Dublin, but relatively few local stations in rural counties. The last few years have seen considerable consolidation in the radio sector, with various smaller operators being bought by larger ones.

As discussed above, there are good reasons to limit Licences if they cause harmful interference to others. However, it would seem – at least to my inexpert eye - that the commercial radio sector in Ireland is not near capacity, with a large amount of free space available. The BCI also has a very laudable public obligation to promote diversity, and to ensure a wide range of opinions and views are catered for in the radio sector. But does it need to restrict the total number of Licences to achieve this?

The BCI does not limit the number of Licences. However, in terms of the criteria for granting a new Licence, they take into account the viability of the Licence-holder, plus the viability of other radio stations they will be competing with. To me, this does not seem a reasonable criterion – particularly given that existing radio stations will often say their viability is being undermined by new entrants. Given this framework which essentially acts as a severe barrier to entry, there is considerable competition for new Licences – the recent one for the new Licence in Dublin was keenly contested, and is currently the subject of extensive litigation. To me at least, there is a strong case for some degree of liberalisation of broadcasting licensing. This would encourage new entry, which by itself would stimulate further diversity. If it was felt that the market would not ensure sufficient variety, ie, every station would be playing music aimed at people aged 15-40, then certain Licences could be reserved thus ensuring that public broadcasting obligations and the representation of minority tastes would be catered for. If there are worries that any single operator would attempt to garner a large share of radio Licences then I would reply (a) this is much less likely to occur when there is relatively free entry as compared to a situation where the number of Licences is very low; (b) any such problems could be catered for by public interest criteria “kicking in” if one operator was gaining a large share, analogous to those governing media mergers in Section 3 of the Competition Act.

I should note that the BCI is bound by primary legislation, and that they do appear to be moving towards granting more Licences. I hope this move will continue and that ultimately the viability criteria will disappear.