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Conducive to Access by the Poor

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'Spectrum policy for broadband diffusion'

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This paper is in three parts. The first outlines the range of spectrum management tools available. The second summarises possible ways in which spectrum management tools can be deployed in pursuit of meeting mobile broadband targets. The third outlines how spectrum currently used by the public sector might be redeployed to meet the growing need for spectrum for mobile data.

1. Introduction to spectrum management

In the year 2000, the UK Government had the full significance of radio spectrum drawn to its notice when it unexpectedly raised £23 billion by auctioning five 3G mobile licences. One consequence of this was that the government invited me to conduct a comprehensive review of its spectrum management policies. I concluded that the traditional policy of allocating spectrum that could only be used for a specific purpose (e.g. mobile 3G), either by administrative decisions or through infrequent landmark auctions, can raise revenues for the finance ministry, but was too inflexible to ensure that spectrum was used efficiently. My review recommended the increasing use of market-based mechanisms – auctions and spectrum trading – to allocate commercially used spectrum.[2]

I was not only the one addressing these issues, and countries other than the UK also sought a better way of allocating spectrum. In the USA Thomas Hazlett powerfully and successfully argued the case for auctions, and policy developments and early trials in New Zealand also shaped international

[1] Imperial College Business School, London & UK Competition Commission. The views in this paper belong to the author alone.
[2] Martin Cave, *Review of Radio Spectrum Management*, HM Treasury and DTI, 2002 The same proposal was extended to spectrum use by public bodies in Martin Cave, *Independent Audit of Spectrum Holdings: Report to the Chancellor, HMSO,* 2005.

thinking. As a result, the auction idea took off around the world. The questions we face now, more than a decade on, are how well reforms to date have worked, whether more reform is needed, and whether emerging economies should follow the same path as more developed economies.

A lot hangs on the answers to these questions, given the contribution the spread of mobile voice communications has already made to growth throughout the world. The World Bank estimates that a 10 percentage point increase in broadband penetration adds an average 1.3 percentage points to GDP growth.[3] In emerging markets, or other regions without extensive fixed networks, where broadband will be wireless, these economic growth opportunities are closely aligned to the success of the mobile operators. So spectrum policy is linked to broader issues of economic and social development.

Cisco currently forecasts that global traffic in mobile data in the Asia-pacific region will increase at a compound annual rate of growth of 66% from 2013 to 2018.[4] The actual figures will inevitably be different, but the trajectory is clear. Much economic growth and many new jobs will be foregone, if demand for mobile broadband is not met. Since the penetration of communications services quickly reaches high levels even in emerging markets, the growth it enables is likely to be distributed throughout the economy rather than captured by those who already have greatest access to economic opportunity. It is an opportunity therefore not only for growth, but also for growth distributed throughout the economy and society.

So what spectrum management regime will make it possible for governments to realise this prize in terms of economic growth and consumer benefits across the whole economy?

The traditional method of assigning frequencies on the basis of a 'beauty contest' was a somewhat arbitrary and often slow process. It typically resulted in inefficient outcomes because officials effectively had to guess who could make best use of spectrum, and spectrum was sometimes given to operators who simply didn't use it, didn't use it well, or 'hoarded' under-used spectrum. But at least in those days the opportunity cost of misallocating spectrum was nothing like as high as it is now, as the supply of spectrum was relatively plentiful compared to modest demand.

[3] World Bank, *Information & Communication for Development Report*, 2009.
[4] See the Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013–2018.

These days when operators compete in auctions for a specified number of licences, the licences tend to go to the operators that are likely to use the spectrum most efficiently. An auction also captures some of the investor's profits for the government, which benefits consumers as taxpayers – as long as governments are not tempted to use the auction primarily to raise revenues. If spectrum is withheld or the auction otherwise designed to artificially increase auction revenues, the harm done to users through higher prices and less innovation invariably far outweighs the short term finance ministry gain. Auctions now offer a tried and tested set of procedures. The evidence from the many spectrum auctions that have taken place suggests that they are a better and faster way of allocating spectrum licences.[5]

A simple extension of the use of market forces through auctions would be the introduction of 'secondary trading' – allowing operators who buy spectrum rights in an auction to on-sell the spectrum rights to other users. This would mean that the market could also correct misallocations of spectrum. If, for example, an operator thought it needed spectrum, but through a new technology found a way to use spectrum more efficiently, it could on-sell un-utilised spectrum to someone who could put it to better use. To date only some countries have actively allowed trading, such as the US, Australia, New Zealand and the UK.

Beyond secondary trading, a further reform is the adoption of the notion of 'spectrum-neutrality' or 'technology-neutrality' whereby spectrum is not restricted to a specified use but can be deployed by operators to maximise its value in a wide range of possible uses. Spectrum neutrality can makes interference management more complicated, but this is not an insurmountable problem.[6] This reform would allow operators to deploy the most efficient technology and service configuration at any given point in time.

This next phase of reform sees spectrum as a multi-purpose natural input, like land. As with land, property rights in spectrum can be either temporary or permanent; they can be bought or sold in different parcels, and subject to a variety of rights and restrictions. Several countries have adopted this extended approach, including secondary markets and service neutrality, include Australia, the UK and US.

[5] M. Cave, C Doyle and W Webb, *Essentials of Modern Spectrum Management*, Cambridge University Press, 2007, Ch. 5; P. Milgrom, *Putting Auctions to Work*, Cambridge University Press. 2004.
[6] See Ofcom, *Spectrum User Rights: a Guide,* 2008

In recent years many governments have become preoccupied with the need to develop national broadband plans, often in a top-down way. The ability to direct resources and investments through these plans is seen as a key lever of government policy. Market-driven approaches to spectrum allocation do not always sit comfortably with highly directive national broadband strategies. Most emerging economies have been occupied simultaneously with devising a national broadband policy and with the demanding task of deploying 2G and 3G in traditional spectrum bands, to meet the dramatic increase in consumer demand for services. Yet the simple ability to deploy high bandwidth services on low frequency spectrum, made available by extended spectrum markets, could pay significant long-term growth dividends and side-step a potentially complex policy debate.

One way forward would be 'strategic co-ordination' combining an auction of spectrum with a significant relaxation of technology restrictions for specific spectrum bands. An example is the way the 'digital dividend' (switching from analogue to digital television and freeing the analogue spectrum for other uses) has been approached in Europe. The 790-862 MHz band was earmarked for "mobile data services", enabling international harmonisation and allowing governments to achieve their national broadband objectives more quickly. Once the allocation of spectrum has been rebalanced in favour of mobile data, there is likely to be scope for more extensive market reform.

It is tempting for governments to use spectrum policy as leverage to pursue a wider range of national policy objectives. But adding these extra requirements risks creating large inefficiencies. This is especially true in emerging markets where there is significant uncertainty about how the economy will develop over the period of a spectrum licence. In these countries, economic benefits will flow not only from the use of newly available spectrum, but also from making better use of existing spectrum allocations. Given capital constraints, operators have to prioritise network investment based on economic considerations. The downside of setting over-prescriptive licence requirements in one spectrum band is that it limits operators' capacity to adapt in other bands as well. Whilst regulators can attempt to analyse the trade-offs in advance of making their allocation decisions, this will never be a substitute for allowing operators to react to market developments as they occur over the licence period.

The key point is that spectrum needs to be understood as an input like any other, the use of which will be improved by efficient market-based allocation

rules. Regulatory interventions via input prices - for example, the price of energy - are obviously not a sensible way to shape the services available to customers of firms that use energy. Changing the price firms pay for a single input, whether energy or spectrum, will cause all sorts of unanticipated and unintended distortions. Government policy has better tools at its disposal for achieving its objectives, such as subsidies or taxation of the end use. The well established economic policy principle is to let input markets operate efficiently to avoid waste of scarce resources. "Don't mess with input prices," is the lesson both in theory and practice.[7]

There are other examples of governments pursuing policy outcomes through restrictions or obligations placed on particular spectrum bands. One example is favouring a particular kind of operator, e.g. by including additional requirements for local ownership above and beyond those contained in general legislation or the licensing regime. I would encourage policy-makers to find different ways of pursuing these broader policy goals. Attaching more and more restrictions to individual spectrum assignments is likely to be one of the most costly ways of pursuing these objectives. It may diminish inward investment, restrict access to global economies of scale available only to international operators, and deprive the economy of expertise. As a result such additional obligations can jeopardise the health of a whole sector to the detriment of broader economic growth. At the very least novel conditions are likely to cause significant delays.

The most widespread example of government policy influencing market behaviour is the use of spectrum caps, which restrict the amount of spectrum an operator can hold in a particular spectrum band or in total. This is intended to enhance competition and in particular to avoid 'warehousing', a contemporary version of 'hoarding' that bedevilled allocations by beauty contest. However, services at different frequencies have different characteristics, and impose different costs on the operators, so working out how to apply caps so that they are neither too tight nor too loose can be complicated.[8] Caps can confer benefits on end users, but getting them wrong will have unintended consequences.

[7] See the work of two Nobel prize-winning economists, P Diamond and J Mirrlees, 'Optimal Taxation and Public Production I: Production Efficiency', *The American Economic Review* Vol. 61, No. 1 (Mar., 1971), pp. 8-27.

[8] See M Cave, "Anti-competitive behaviour in spectrum markets: analysis and response" *Telecommunications Policy* , 34 (2010) 251-261.

In conclusion, allocating spectrum by auction has placed licences in the hands of efficient operators, who are more likely to deliver a broad and speedy rollout of services. The gains to efficiency and growth have been all the greater in emerging markets, where auctions also give confidence that regulators are taking transparent and thus defensible decisions.

Market reform beyond auctions, introducing secondary markets and technology neutrality, has not been so widely applied. But in emerging markets this has the potential to enable the deployment of high bandwidth services at low frequencies, rather than just the high frequencies currently assigned to mobile operators.

2. Spectrum management in the interests of broadband diffusion[9]

This section summarises some suggestions for spectrum policy geared to the promotion of wireless broadband. Because the suggestions are familiar ones, I express them succinctly here. The general framework I have in mind is one in which investment comes mostly from the private sector, and the roles of the government and regulator are to assign spectrum, use public investment as a means of leveraging private investment, and as far as possible to create a stable and predictable environment of governance and regulation which is favourable to private investment. (This does *not* mean being generous to investors.) Unless expressly stated, I am assuming that the method chosen to assign spectrum is the auction context is one in which spectrum assignment.

In this context I have four suggestions as to how to conduct spectrum policy.

Suggestion no 1: Release spectrum as quickly as possible in a format suitable to mobile broadband.
Generally speaking, making more spectrum available reduces its scarcity, reduces service prices, increases take-up, permits more competitive markets.

Suggestion no 2. Maintain competitive pressure in the supply of mobile data.
Network competition has acted as a spur to the unprecedentedly successful roll out of mobile voice to more than 6 billion people. There is no reason why it will not do as well in diffusing mobile data. The impediments to infrastructure competition which afflict fixed access networks do apply to mobile networks to a much lesser extent. This does not mean that competition will extend

[9] This section is the subject of the slide presentation, and is dealt with here in summary form.

immediately to all localities in a country, and some network sharing or explicit subsidies for coverage (see suggestion 4 below) may be appropriate.
One instrument for maintaining competition among mobile networks is the use of mobile caps or floors.

Suggestion no. 3.Maximise the flexibility of spectrum using firms.
This has two dimensions – often known as 'technology neutrality' and 'service neutrality'. A firm benefitting from the former has a spectrum licence which may specify the service to be produced (eg mobile data), but not the choice of technology (eg 3G or 4G). Service technology raises potentially major issues in interference management, which are largely absent in the case of technological neutrality – which does, however, promote innovation and higher broadband speeds.

Suggestion no 4. Use the auction process to achieve coverage obligations.
A government or regulator can increase coverage by issuing on or more licences available in an auction subject to a requirement that the service area covered by the licence holder must by a certain date meet a pre-ordained coverage requirement, say 90% of the population in particular region. Such a licence is likely to generate less revenue. Thus essentially the government is 'buying' the extra coverage from the successful licence applicant.

3. The role of public sector spectrum

In most countries a great deal of spectrum - roughly half - is used within the public sector. This applies both to all bands taken together and to the highest value spectrum in the 300MHz to 3 GHz range. The uses include for aviation and maritime, communications, radar, and science. Most of them, up to, say, 70%, are defence related. The following slide shows the breakdown of spectrum use in a typical European country. The pattern of use across countries is not very sensitive to geographical location and income per head data, so a similar division can be expected elsewhere. It is also common for defence-related spectrum to account for more than half of public sector spectrum use.

Historically, defence and, to a lesser extent, other public sector uses of spectrum had priority over civilian uses. Often public sector users were not subject to licence requirements or to licence fees in the same way as private sector. In periods of spectrum plenty (ie before the recent growth of spectrum

demand for communications services), the public sector was given generous assignments.

In the UK a study monitoring spectrum use found low levels of use of some public spectrum, including in the GHz 1.0-1.8 range, as contrasted with high levels of use in mobile bands, 900, 1800, 2300 MHz, for example. This says nothing about the value of such use. However, the observation both of low usage levels and of the lack of incentives for efficient use of public sector spectrum does at least raise questions for further investigation, and may suggest the need for a more comprehensive audit.

The same economic and market tools can be deployed with public sector spectrum as are used with commercial spectrum, with two major differences:

1) Public sector bodies, especially Defence Departments are prone to resisting the application to spectrum of price or market discipline. It is therefore often expedient to apply a graduated approach to introducing it. It is also helpful to seek to enlist the support of the country's Finance Ministry, which should have an interest in applying underused public sector spectrum to promote economic growth in the country as a whole

2) Public sectors spectrum users are often producing non-marketed outputs, such a public protection. Unlike mobile companies, their costs are not covered by revenue but by payments from the Finance Ministry. This means that charging them an annual fee for spectrum use will not give them an incentive to economise on spectrum, if the Finance Ministry automatically gives them an additional allowance to pay the extra bill

It is possible to think of a range of measures to promote the efficiency of public sector spectrum use:

Step 1: subsidised refarming

Some countries, notably France, have developed very effective procedures for paying the costs of clearing spectrum for refarming. The US has also developed an interesting market-guided procedure. In 2004, the US congress passed the commercial spectrum Enhancement Act, which created a Spectrum Relocation Fund, funded for auction proceeds, to cover the costs of incurred by US Federal Government entities which relocate to new frequency assignments or alternative technologies. The basic idea is that if expected auction revenues exceed expected transfer costs, the transfer should take place. It is possible to

use the expected transfer cost as the 'reserve price' in the auction. If that price is not attained, the sale does not take place.

The first auction of this kind to occur was of the 1710 -1755 MHz band, which was used by 12 Federal Agencies, including the Department of Defence. The sale proceeded and a portion of the auction proceeds is being used to cover spectrum relocation costs. It subsequently transpired that these costs exceeded estimates by about 50%. However, these larger costs were still exceeded by auction revenues, by more than four times.[10] A similar process has been contemplated in the US with the 1755-1850 MHz band.

Step 2: use of spectrum valuations in public sector procurement.

The hypothesis is that public sector spectrum may be used inefficiently because it is free and users do not appreciate its value. Estimating the aggregate value of spectrum employed, for example, in defence uses, can show government departments and law makers the billions of dollars which are locked up in public sector spectrum uses.

There are several methods of estimating the value of spectrum and of setting administrative prices for its use;[11] these can be applied to any frequencies. It is possible initially to use such prices not in their normal role of determining how much money has to be paid annually by the spectrum user, but as an aid to making other decisions. Used in this fashion, they are 'shadow prices'- ie prices which are used in making an investment decision but not actually charged

For example, if the government is deciding between two weapons systems, using different spectrum bands, the appraisal can be based on the lifetime costs of the two systems, including the valuation of the spectrum each would employ. The expected result is a better choice of weapons system AND a better understanding of spectrum's value.

Step 3: audit

Spectrum audits are not so much an economic or market tool in spectrum management as a helpful first step or even a pre-requisite for the use of such tools – since they enhance knowledge of the scale of use of the various bands, on one side of the government and regulator and, on the other side, of spectrum users themselves. The UK Government commissioned an audit of

[10] See http://www.gao.gov/assets/660/654794.pdf

[11] See M. Cave, C Doyle and W Webb, *Essentials of Modern Spectrum Management*, Cambridge University Press, 2007, Ch. 11-12.

spectrum use published in 2006, which identified certain underutilised bands in the public sector.[12]
In 2013, the European Union, as part of Radio spectrum Policy Programme the European Commission published a decision to implement a spectrum inventory within the EU[13]. Such audits cannot be complete, as some spectrum uses have to be kept secret for reasons of national security; however, the two examples show that useful information about public sector spectrum use can safely be disclosed

Step 4: sharing public sector spectrum
Much attention has recently been paid to the sharing of public sector spectrum with the commercial sector, especially for the purposes of providing mobile broadband. In 2012, the US President's Council on Science and Technology published a report which advocated freeing up 1,000 MHz of government spectrum for shared use. Today's apparent shortage of spectrum, they claim, is in fact an illusion created by the way the resource is managed. If the US widens its options for managing federal spectrum, spectrum availability will be transformed from scarcity to abundance. The norm for spectrum use should be sharing, not exclusivity.

In November 2013 it was announced that The US Department of Defense (DOD) has agreed to vacate the 1755–1780 MHz band to allow it to be paired with the 2155–2180 MHz band in an auction. It has previously been estimated that the paired block would raise nearly $12 billion, while the worth of the 2155–2180 MHz band by itself has been estimated at just $3 billion. The military currently uses the 1755-1780 MHz band for pilot training and the operation of drones. These technologies will move to the 2025–2110 MHz band, which will be shared with broadcasters in accordance with an agreement it has made with the National Association of Broadcasters (NAB).

However, others cast doubt on the practicability of public/commercial spectrum sharing, which requires not only the solution of technical problems be solved, but also appropriate incentives for both parties and control over transaction costs

[12] See http://www.spectrumaudit.org.uk/
[13] See http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:113:0018:0021:EN:PDF

As with other sharing proposals, a sensible approach in other countries may be to monitor the success of such ventures in early-adopting countries and be prepared to follow if this turns out to be a successful and economic strategy.

Step 5: charging spectrum prices

The step up from setting shadow prices for spectrum (see step 3 above) to charging actual administrative prices is a major one, which is strongly resisted by both commercial and public sector spectrum users.

If the Finance Ministry sets a fee which a government department must pay for spectrum, and simultaneously and automatically increases that department's financial allocation by exactly the same amount, the system will not work, as there is no incentive to economise.

Accordingly spectrum pricing only works within a system for managing public expenditure in which the Finance Ministry makes an overall allocation of funding to the relevant department organisation against specified output targets, leaving the department to decide how to meet those targets. In such circumstances, a department will choose to hand back unwanted spectrum and use the money saved more effectively elsewhere. This method of organising public sector activities is becoming increasingly widespread under the name of the 'new public management.' In these conditions, spectrum pricing can promote the return of unutilised spectrum, as the UK case studies below indicate.

Step 6: integrating commercial and public spectrum markets

In market economies, most inputs (labour, land and buildings, utility services, capital equipment) are bought by public sector organisations in broadly the same way as by commercial organisations – in an integrated market place. Spectrum has been an historical exception in being largely assigned by administrative processes. But when a market for commercial spectrum is created, it is natural to ask whether it should include public sector spectrum, with the two types of organisations vying with each other for the spectrum which they need, as they now compete for labour and materials

In such a world , if additional public sector spectrum were needed, the relevant organisation would have to seek funds from the Finance Ministry to acquire the spectrum, at auction, for example.

Equally, if a public sector organisation had surplus spectrum, it could either give it back or auction it on the market. If the seller could keep some of the proceeds, this would encourage it to sell.

An example of public sector spectrum reform – the UK

The United Kingdom is one of the countries which has been engaged in has been engaged in reform public sector spectrum management. Beginning in the late 1990s, an annual charge was levied on certain spectrum users, including the Ministry of Defence. The charges were kept low and introduced gradually over a 4-year period. In 2003 and 2006, the UK Government commissioned two reports on spectrum management reform. The first recommended using spectrum markets as a means of assigning spectrum and the second proposed extending charges for public sector spectrum and allowing or requiring public sector bodes to buy and sell in the spectrum market as a whole. Ofcom implemented these measures and following a review in 2009 it imposed charges additional charges on many spectrum users; the annual charge on the Ministry of Defence grew to £500m. in 2013.

In 2011, in a document signed by minsters in no fewer than 8 departments, the UK Government committed to freeing 500 Mhz of high value (sub 5 GHz spectrum for commercial use by 2020.[14] In 2013, the Ministry of Defence announced an auction, to be run by Ofcom in 2014, of Under plans announced today, the MOD intends to auction around 200 Megahertz (MHz) of its spectrum usage rights, at 2350-2390 and 3410 and 3600 MHz. Ofcom will conduct the award process.[15]

[14] See www.gov.uk/government/uploads/system/uploads/attachment_data/file/77429/Spectrum_Release.pdf

[15] See http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz/summary/2.3-3.4-ghz.pdf