Licensing to support the mobile broadband revolution

A report for the GSM Association

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Table of Contents

Executive summary **3**

1. The mobile broadband revolution **9**

2. The general licensing framework **12**

2.1. Two main types of licences 12
2.2. Principles to guide spectrum management 14
2.3. Stability and transparency in the licensing framework 15
2.4. Licensing in practice: Sweden 16
2.5. Licensing in practice: India 17
2.6. Recommendations 21

3. Amount and use of spectrum to be released **22**

3.1. Internationally identified mobile spectrum bands 22
3.2. Freeing up spectrum resources to meet growing demand 24
3.3. Refarming and technology and service neutrality 25
3.4. Recommendations 29

4. Assignment and renewal of mobile licences **30**

4.1. Approaches to licence renewal 30
4.2. Administrative versus market-based approaches in general 34
4.3. Issues in auction design particularly in relation to spectrum for mobile broadband services 36
4.4. Spectrum licence renewal in Bangladesh 39
4.5. Spectrum assignment in South Africa 40
4.6. Recommendations 42

5. Pricing of mobile licences **44**

5.1. Objectives 44
5.2. Pricing approaches 45
5.3. Comparative summary 49
5.4. Reserve prices 50
5.5. Recommendations 50

6. Promoting competition through licensing **51**

6.1. Promoting competition is a means to an end 51
6.2. How should licensing authorities assess whether measures to promote competition are warranted? 52
6.3. Measures to promote competition 53
6.4. Recommendation 58

7. Reviewing non-price terms and conditions 59

7.1. Licence duration 59
7.2. Geographic dimension 60
7.3. Obligations in relation to specific policy objectives 60
7.4. Trading 63
7.5. Recommendations 66

8. Regional overview of spectrum licensing 67

8.1. Regional status of LTE and the digital dividend spectrum 67
8.2. Africa 68
8.3. Asia Pacific 72
8.4. Europe 78
8.5. Middle East & Central Asia 84
8.6. Latin America 88
8.7. North America 93

Appendix A. Sample licence to use radio frequencies 98

Executive summary

Mobile phones have become the main means for making voice calls in the world and have brought telecommunications access to many of the world's people for the first time. Now the industry is in the middle of another major transformation with rapidly growing take-up of mobile broadband services across both developed and emerging markets. Mobile data traffic is expected to increase 18-fold between 2011 and 2016 with growth rates being highest in emerging markets, including the Middle East and Africa, Asia Pacific, Central and Eastern Europe and Latin America.

Spectrum is the lifeblood of the mobile industry. The amount of spectrum made available and the terms on which it is made available fundamentally drive the cost, range and availability of mobile services. Across the world, substantial new spectrum is needed to support ongoing growth in both traditional voice and new broadband mobile services. It is also critical that the rights to use the spectrum are provided in a way that enables the industry to deliver maximum benefits to consumers. The rapid growth in demand for spectrum increases the importance and the difficulty of efficient spectrum management. The GSMA has commissioned this report to examine the experience with mobile spectrum licensing around the globe to date and draw out the lessons for policy. A key focus is on what works well in emerging markets and how the lessons can be applied to the additional spectrum to be allocated over the new few years. Choosing the correct spectrum policy will be particularly important in emerging markets where mobile services can be expected to provide the principal access to high-speed data, as they have with voice.

The countries that get their spectrum policy right will achieve widespread access to affordable and innovative mobile broadband services. Strong communications infrastructure, in turn, brings significant wider economic benefits including in boosting productivity and living standards. Governments that currently face significant fiscal demands also stand to benefit both directly from licensing revenues as well as more generally through the higher economic growth generated by access to mobile broadband.

Achieving a flexible licensing framework to support substantial new investment

Traditionally, many governments imposed highly prescriptive operating and spectrum licences that required operators to supply only certain services and/or use specific technology (although other countries have not had separate operating and spectrum licences). Given the rapid pace of technological and market developments, restrictive licensing requirements will limit operators' ability to make the best use of their networks to supply services and risk delaying the investment required to introduce new broadband services. Detailed spectrum licences that are specific to one operator, type of service, network or technology also risk distorting competition if operators supplying competing services face different licence conditions. While, in the past, operators have been subject to extensive restrictions, many licensing authorities provide little guidance on their own approaches to forthcoming spectrum issues. This increases regulatory risk and deters operators from making the large investments required to deploy new technologies and services.

Following are our key recommendations in relation to reforming the overall licensing framework:

- *Recommendation 1* - Licensing authorities should progressively remove restrictions that unduly restrict operators from determining which services they will provide and the technology that they will use. Restrictions that do not result in clear net benefits should be relaxed. Operating licences should be expanded to cover a greater range of services or, where appropriate, replaced altogether by simpler authorisations or class licences. Where restrictive operating licences are maintained they should be separated from licences for the use of spectrum. Spectrum licences should, in general, contain spectrum management provisions only or principally. This will assist changes in business activities and spectrum holdings and support the evolution of technologies and the different needs between radio spectrum management and other aspects of the licence. Operators offering similar services should be subject to the same terms and conditions.
- *Recommendation 2* - Spectrum should be managed to ensure that a country obtains maximum benefit from the use of its spectrum resources. Spectrum rights should be assigned to the services and the operators who can generate the greatest benefits to society from the use of that spectrum, i.e. to achieve the efficient use of spectrum. Market-based approaches represent a key means to ensure that spectrum is used to supply the services most in demand and operators are able to use the best available technology to deliver those services.
- *Recommendation 3* - Licensing authorities should ensure that the overall licensing framework offers stability and transparency to reduce regulatory risk and promote investment. Key principles should include:
  - establishing and adequately resourcing an independent regulator with responsibility for operator and spectrum licensing among other matters;
  - announcing in advance a long term plan for reform of the spectrum and operating licensing framework;
  - facilitating international harmonisation so that equipment and devices use the same frequency bands to support international roaming and enable the realisation of scale economies in manufacture;
  - publicly setting out the criteria and process to be followed in licensing decisions and including public written consultation in advance of key decisions being made with both consultation responses and the assessment of input in reaching final decision being published;
  - clearly defined spectrum rights that are backed up by a robust compliance/enforcement regime;
  - taking a holistic approach to licensing that ensures that the overall package enables the ongoing development of the mobile industry (including a process for the renewal of licences at their expiry); and
  - taking into account investors' legitimate expectations and providing compensation mechanisms where decisions are made in conflict with those expectations.

Freeing up spectrum resources to meet growing demand

Licensing authorities can take a number of key steps to free up spectrum that is currently poorly utilised and use that spectrum to deliver higher valued services. In particular, authorities should both identify what spectrum rights are able to be assigned to provide additional spectrum capacity as well as enabling current spectrum assigned for mobile services to be used more effectively. Enabling flexible/technology neutral use of spectrum so that operators who currently use spectrum for 2G services have the ability to determine when the use of part or all of this spectrum should be changed for 3G and newer mobile technologies such as Long Term Evolution (LTE) services. This is an important way to expand over time the services able to be carried with existing spectrum as well as facilitating lower cost services, expanded geographic coverage and better indoor coverage, depending on the bands considered.

- *Recommendation 4* – Current rights to use spectrum should be clearly specified and spectrum bands that are currently idle or being poorly utilised (including by public sector agencies) should be considered for re-allocation to services that could use the spectrum to generate greater benefits for society.
- *Recommendation 5* – Licensing authorities should publish a road map of the planned release of additional spectrum bands to maximise overall benefits from the use of spectrum including taking into account the benefits of international harmonisation. In doing so, aligning spectrum rights with the internationally harmonised mobile spectrum bands will ensure that operators and their customers can acquire competitively provided equipment and devices and that customers can readily access international roaming services.
- *Recommendation 6* - Licensing authorities should progressively remove service and technology restrictions in existing mobile spectrum usage rights to enable operators to choose when to deploy mobile technologies that can technically co-exist so as to increase spectral capacity, reduce cost of provision, extend coverage to rural areas and improve indoor coverage. Operators themselves are likely to be best placed to determine the speed of migration particularly recognising that 2G services are likely to remain important for the next 5 to 10 years.
- *Recommendation 7* - New spectrum usage rights within the mobile bands should be issued on a service and technology neutral basis subject to the use of technologies which can technically co-exist without intolerable interference.
- *Recommendation 8* - Licensing authorities should facilitate harmonisation of spectrum through allocating radio frequency bands in accordance with international agreements and by applying spectrum management approaches aligned with international best practice.

Assignment and renewal of licenses

A major forthcoming issue for many licensing authorities is to determine what should happen to spectrum rights as licences approach the end of their initial term. Uncertainty about the future rights to spectrum can lead to operators reducing or delaying investment in upgrading their networks and deploying new services. Securing funds for investment is difficult in the current economic environment even for established players. As such, authorities should be alert to the real danger that their investment incentives can be undermined by uncertainty over future rights. The loss of rights to spectrum currently being used for the supply of services also carries risks to customers in relation to the loss of service. Reflecting these risks, many authorities have established a presumption of licence renewal with only exceptional and well specified circumstances under which licences will not be renewed. More generally, where licences are to be re-assigned or assigned for the first time, authorities will need to determine whether market-based or administrative approaches will best promote efficient allocation of spectrum in the specific market context.

- *Recommendation 9* – Licensing authorities should clearly set out their approach to licence renewal in advance (a range between 2 to 4 years as a minimum should be adequate) of the expiry of the licence so as to avoid network investment being postponed. The authorities should publish the criteria that they will use to assess renewal as well as the terms and conditions that will apply to the renewed licence.
- *Recommendation 10* - There should be a presumption in favour of licence renewal for operating and spectrum licences to encourage long-term investment and minimise the risk of service disruption to customers. Reasons for not renewing licences should be limited to spectrum replanning, where there is little risk of stranding substantial investments, or where there has been a serious breach of licence conditions which should be evident in advance of the renewal time. Exceptionally, a licence may not be renewed in relation to the whole or part of the relevant spectrum so as to promote competition through re-assignment of spectrum. However, before not renewing a licence for this reason, regulators should first (i) assess whether competition is already effective in the market; (ii) identify whether competition can be promoted by other means such as the release of alternative spectrum; and (iii) assess whether the expected competition benefits will exceed the potential costs such as in relation to spectrum replanning, customer migration and the risk of deterring investment.
- *Recommendation 11* – Re-auctioning spectrum at the end of the licence should be limited to situations where there has not been evidence of substantial investment and there is a reasonable prospect that spectrum will be re-assigned between operators (or where additional, alternative spectrum is being made available), or situations where an existing licensee decides to reject a licence renewal offer. In most cases, the existing operators would be expected to re-acquire the licence with the consequence that an auction only creates unnecessary uncertainty and costs.
- *Recommendation 12* – Where spectrum is to be re-assigned or assigned for the first time, licensing authorities should determine the approach or combination of approaches to assigning licences taking into account their particular objectives as well as the likely advantages and disadvantages of the different approaches in the particular market context drawing on both theory and practical experience. Licensing authorities should attach priority to ensuring effective competition in downstream markets for services to end-users. Whether an auction or beauty contest is adopted, the detailed design of the approach is important. Open auctions are likely to be superior to sealed bid auctions for spectrum relevant to mobile broadband services in terms of promoting efficient spectrum use.

Efficient pricing of spectrum

The overall level of licence fees (including upfront and annual charges) can significantly impact market outcomes including the number of players that enter the market and, particularly where annual charges are levied, the prices for mobile services. There is a strong economic case to avoid the level of licence fees being determined on the basis of revenue maximising objectives. Rather, licence fees can be used to help recover the administrative costs of the licensing process and of managing spectrum and, in some circumstances, to encourage efficient spectrum use.

Following is our key recommendation in relation to spectrum pricing:

- *Recommendation 13* - Licence fees, if any, should generally be limited to recovering the administrative costs of the licensing process and associated regulatory costs (including spectrum management costs). However, where there is excess demand for spectrum, then an auction or administrative assignment of spectrum with a charge set in line with the Marginal Forward Looking Opportunity Cost (MFLOC) of spectrum should be considered. Indexation or benchmarking may prove a practical means to estimate MFLOC in particular circumstances. The MFLOC should be estimated conservatively to reduce the risk that valuable spectrum will be left idle. It is also important that the estimated prices are set appropriately relative to spectrum prices in other bands. The relative merits of upfront licence fees versus annual charges should be considered with regard to the particular market circumstances.

Promoting competition

The approach to spectrum licensing can significantly impact competition in the mobile services markets. There is a case for regulators to ensure that national spectrum resources do not become excessively concentrated in the control of only one or two operators. However, there is also a danger if spectrum becomes too fragmented as mobile operators would be prevented from realising scale economies so that service costs and prices are higher than otherwise. Generally, licensing authorities should ensure that operators are able to expand their access to spectrum if they are delivering value and attracting customers.

- *Recommendation 14* - Licensing authorities should aim to ensure effective competition in the downstream markets for mobile services. Many sector regulators and competition authorities have accepted that three to four national operators are likely to be sufficient to achieve effective competition.
- *Recommendation 15* - Specific measures to promote competition should only be imposed in markets where there is market failure and competition would otherwise be ineffective and where those measures are assessed as being likely to result in greater benefits than costs. Spectrum caps, spectrum set-asides, bidding credits, competition law enforcement and open access requirements carry advantages and disadvantages and should be assessed in relation to the specific market context.

Reviewing non-price terms and conditions

Efficiency can be promoted by licences that support operators making substantial investments that reflect fundamental market conditions rather than requirements imposed by regulators. Many governments have traditionally included a range of terms and conditions in licences which go beyond those necessary for the intrinsic purpose of the licence to authorise market access and/or manage the use of spectrum. However, licence conditions tend to be relatively inflexible and can create the risk of market distortions as competition develops in telecommunications markets. Alternative, targeted regulation is likely to better achieve particular goals such as the control of market power and promoting universal access.

Following are our key recommendations in relation to non-price terms and conditions:

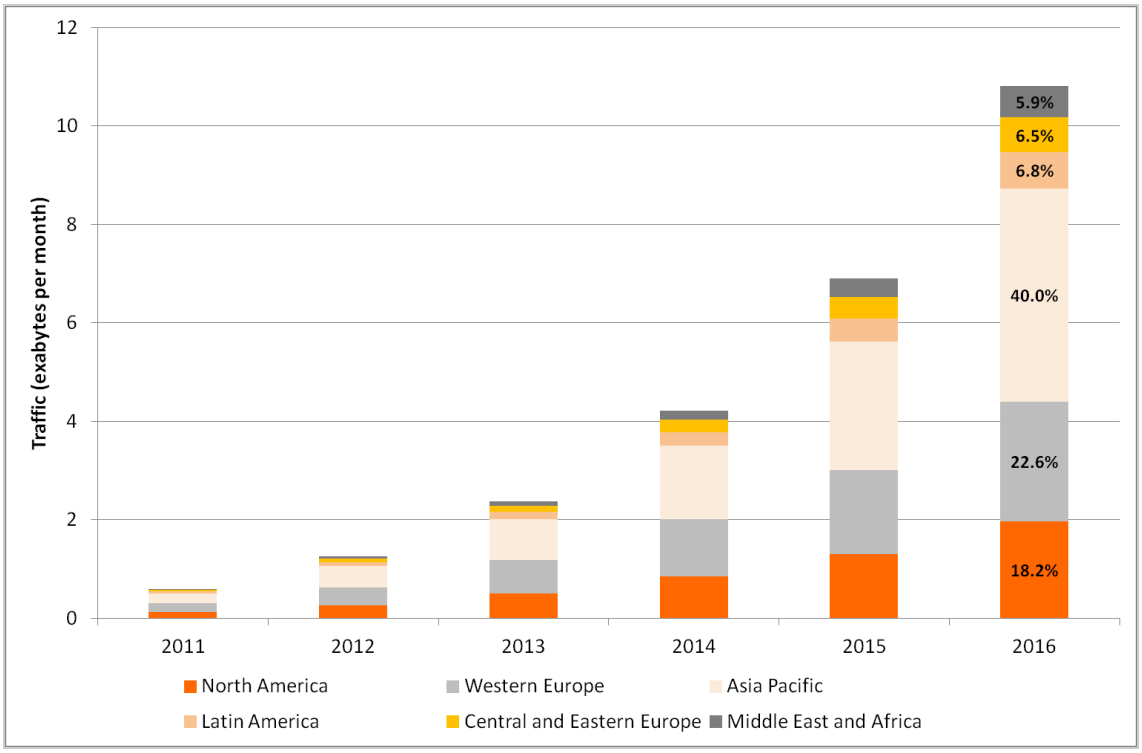
- *Recommendation 16* – Licensing authorities should introduce licence terms for mobile operators that are at least in line with the expected payback period for the investments and should consider the introduction of indefinite licence terms (with a specified minimum term, i.e. 15 years).
- *Recommendation 17* - Licensing authorities should provide for national licences where customer demand and/or scale economies are likely to support national provision as being most efficient. Where regional licences are under consideration, the auction process itself could be used to determine whether regional or national licences are valued most highly.
- *Recommendation 18* – As an alternative to licence obligations, governments should achieve universal access and competition objectives through policies that help to change the underlying economics of extending access or entering the market or through alternative targeted regulation.
- *Recommendation 19* – Licensing authorities should enable voluntary spectrum trading between operators and facilitate trading through well specified spectrum rights, long licence terms and minimizing administrative costs. Such trading helps to ensure that spectrum remains efficiently assigned over time. Competition concerns should be assessed taking into account the specific circumstances of each trade, although certain safe harbours could be established such as where the operator acquiring the spectrum has a market share below a certain threshold and/or the spectrum represents a relatively small share of the overall spectrum available for those services.

1. The mobile broadband revolution

The number of mobile subscriptions in the world reached more than 5.9 billion in 2011 and mobile penetration in the developing countries more than doubled between 2006 and 2011 to over 78%.[1] The expansion of the mobile industry has brought telecommunications access to the majority of the world's population for the first time, significantly improving the quality of life for billions of people as well as providing critical infrastructure to enable business to flourish even in remote areas. Mobile technology has proven to be a successful way to rapidly expand the reach of telecommunications at affordable prices while fixed networks remain very limited in most developing countries.

The global mobile industry is now undergoing another major transformation as mobile subscribers increasingly use mobile data services alongside traditional voice services. Cisco estimates that global mobile data traffic increased 2.3-fold in 2011, more than doubling for the fourth year in a row.[2] Cisco expects mobile data traffic to increase 18-fold between 2011 and 2016 with growth rates being highest in the Middle East and Africa (a compound annual growth rate of 104%), the Asia Pacific (84%), Central and Eastern Europe (83%) and Latin America (79%).

Figure 1: Mobile data traffic forecast by region 2011 – 2016



Source: Cisco visual networking index: Global mobile data traffic forecast update 2011-2016.

The rapid growth of mobile data volumes is being driven by the increasing variety of services being used across smartphones, laptops, netbooks, tablets and other devices. For example, mobile data services support access to the Internet and email for business and personal use, mobile video, business applications, cloud applications and services, social networking and many other online services. While in developed countries, mobile broadband's primary advantage is to have access to data

[1] International Telecommunications Union, Key Global Telecom Indicators.

[2] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011-2016.

services anytime and anywhere, for many subscribers in developing countries mobile often provides the only means to access these services. Smartphones are expected to outnumber personal computers by the end of 2012.[3]

On-going improvements in mobile technology have been integral to the growing use of mobile data services. Many existing 3G networks have been upgraded to High Speed Packet Access standards and the first Long Term Evolution (LTE) networks have commenced supplying services. The Global Mobile Suppliers Association (GSA) reports that 57 networks in 32 countries were supplying commercial LTE services by March 2012.[4] Technologies improvements are bringing substantial increases in connection speeds that improve the usability of existing services and are enabling new bandwidth-hungry services to be introduced. The first LTE deployments provide instantaneous downlink peak data rates of at least 100 Mbps within 20 MHz spectrum allocations. Cisco estimates that average global mobile connection speeds will increase from 189 kbps in 2011 to 2,873 kbps in 2016.

The new mobile technologies also increase the overall capacity of the networks which will help meet growing demand. Research for Ofcom found that 4G technologies including LTE deliver more than 200% of the capacity of existing 3G technologies using the same amount of spectrum.[5] Ofcom also noted that "*the research revealed that the capacity gain from the increased spectral efficiency of 4G technologies will not on its own be sufficient to meet the expected growth in demand for mobile demand. As well as using spectrum more efficiently, more spectrum itself is also needed*".[6]

Increased access to mobile communications in a country has been found to significantly increase overall economic growth and productivity. Studies found that a 10% increase in mobile penetration in a developing country typically leads to a 1.2% growth in GDP[7]. The gains from mobile access will now be magnified through its impact on expanding access to broadband. The World Bank has estimated that in low and middle income countries every 10 percentage points increase in broadband penetration accelerates economic growth by 1.38 percentage points.[8] Mobile broadband will better connect customers with businesses as well as supplying the information necessary for the efficient operation of markets. Access to the Internet can help match people with job opportunities and reduce unemployment. Mobile broadband will also increasingly be used to deliver health, education and financial services and better link citizens with governments.

[3] Strategy Analytics, January 2011.

[4] GSA, Evolution to LTE report, 13 March 2012.

[5] Real Wireless, Report for Ofcom – 4G capacity gains, 27 January 2011.

[6] Ofcom news release, 12 May 2011.

[7] Deloitte for GSMA Global Mobile Tax review 2006-07, ICRIER India the Impact of Internet 2009

[8] World Bank (2009) Information and Communication for Development: Extending reach and increasing impact.

Need for more spectrum and better use of existing assignments

Access to spectrum and better use of assigned spectrum are critical to realising the full economic and social benefits of mobile services including the potential of mobile broadband to spur economic growth and improve quality of life. In particular, the availability, cost, variety and quality of mobile services depends crucially on how much spectrum is made available to operators, what frequency bands are made available and the terms and conditions on which the spectrum is made available.

- An operator with more spectrum can supply a given volume of mobile services at lower cost because it will need fewer cell sites to do so. With limited spectrum, any one cell site will be able to carry fewer calls before that cell site fully uses the spectral capacity. Where too limited spectrum is made available, operators may find that they are not able in practice to meet growing demand for services.

- Spectrum in lower bands has greater propagation properties so that a given geographic area will be able to be covered with fewer cell sites. Access to this spectrum can be critical to enable coverage to be extended to rural and remote areas in an affordable way. Spectrum in lower bands also enables services to travel better into buildings and thereby improves indoor coverage where the majority of mobile services in many countries are accessed.

- Where particular spectrum bands are restricted for use with only certain services or technologies then operators may be prevented from achieving the maximum potential capacity or from supplying the services most in demand.

- Licence fees, if any, annual spectrum charges, taxes and other obligations impact on the economics of investing in the industry of a particular country and can also raise the price of services to consumers. While some charges may be efficient, large industry-specific charges and taxes can come at the expense of economic growth and can even be self-defeating as a way to raise revenue. By raising the cost of using mobile services, mobile-specific charges and taxes can constrain the growth of the wide range of industries that rely on mobile communications and hence reduce the ability of governments to earn higher revenues across the economy.

On-going rapid growth in demand for mobile voice and data services will require not only the renewal of existing spectrum rights but also the allocation of substantial new spectrum to mobile services. For example, the US National Broadband Plan recommended that 500 MHz of additional spectrum be allocated for mobile broadband technologies within ten years for the US to achieve world-leading mobile broadband infrastructure and innovation. The US FCC also found that the amount of mobile data demanded was likely to exceed the capacity of US mobile networks in the near-term and that making an additional 275 MHz of spectrum available would save approximately $120 billion in capital expenses to accommodate mobile data demand.[9] Fully realising the potential of mobile broadband also requires that spectrum licensing is undertaken in a way that promotes efficient use of the spectrum, competition to maximise benefits to end-users and avoids unnecessary regulatory risks so as to provide the confidence for businesses to undertake substantial new investment.

In the remainder of this report, we examine how government and regulators can best carry out spectrum licensing to maximise benefits to their citizens.

[9] Federal Communications Commission Staff Technical Paper, *Mobile Broadband: The Benefits of Additional Spectrum*, Oct. 2010.

2. The general licensing framework

This section addresses how the overall licensing regime should be structured and what steps can be taken to improve the general framework. An important distinction exists between general operating licences relating to network and service provision and licences for the rights to use particular spectrum bands. Many countries have introduced greater flexibility in operating licences and this promotes competition as well as spurring the growth of the overall electronic communications sector. For spectrum licensing, on the other hand, the immediate priority in many developing countries is to clarify current spectrum usage and rights and to ensure that valuable spectrum is not being left idle or underutilised. We conclude this section by considering key principles applicable to the overall licensing framework that can support high levels of investment and ensure that the licensing framework operates well to maximise benefits for consumers.

2.1. Two main types of licences

There are two main types of licences in relation to mobile services: general operating licences and rights to use particular spectrum bands.

Operating licences

General operating licences have traditionally been used by governments to control or at least monitor which companies provide particular communication services as well as imposing a range of obligations on those companies.[10] Restrictive operating licences can, however, carry large economic costs in artificially limiting the ability of networks to provide a range of services and in preventing full competition between different types of operators. For these reasons, many countries have introduced greater flexibility in general licensing so that operators have the freedom to choose the lowest cost of way of supplying existing and new services. Greater flexibility has been achieved by:

- expanding the range of services and technologies covered by an individual licence such as in Malaysia or introducing unified operating licences covering all networks, technologies and services such as in Nigeria[11] or in India (where a unified licences for basic and cellular services were introduced in 2003 with the intention of moving towards a fully unified licensing regime); or

- introducing general authorisations which entitle a provider to commence offering services without being required to first obtain any explicit administrative approval (albeit they may still be required to notify the authorities and provide a minimal amount of information) – this has been the approach adopted by the European Union.[12]

In reviewing the framework for operating licences, important issues for authorities to consider are:

i. the ease with which providers can establish new networks and offer new services;

ii. the flexibility for a provider to choose the range/bundle of services depending on the market being served;

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[10] A more detailed discussion of the issues and approaches to operating licences is contained in our 2007 report, Licensing for growth. Since 2007, the trend to more flexible operating licences and the use of authorisations has accelerated.

[11] See CIPACO, *Unified licences: what benefits for the telecoms sector*, 17 January 2007.

[12] *Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services.*

iii. avoiding detailed obligations that carry more costs than benefits or that could be better targeted through regulation of operators with significant market power (we discuss licence conditions further in Section 7);

iv. limiting the extent to which existing operators are harmed through changes in conditions that conflict with investors' legitimate expectations (or compensating affected parties where reforms would bring significant benefits); and

v. promoting efficient competition by ensuring that operators which offer similar services are subject to the same terms and conditions.

By getting the operating licensing regime right, authorities can provide a substantial stimulus to the growth of their telecommunications sector both directly in terms of the provision of more services from existing networks as well as over time as stronger competition drives lower prices and more varied and better quality services.

Spectrum licenses

Rights to use spectrum raise a distinct set of issues. While competition between multiple providers of networks and services is generally desirable to promote better outcomes for consumers, a particular spectrum bandwidth on the other hand may need to be assigned to one user if it is to be used for certain technologies. Allowing multiple users of the same spectrum bandwidth can risk high levels of interference that would prevent some types of services from being offered at an acceptable quality of service.

For the provision of mobile services over wide areas, the risk of intolerable interference requires that the government restrict who is allowed to transmit on a particular spectrum bandwidth over a particular geographic area. Such restrictions can take several forms:

- Governments may mandate that only one specified user may transmit on a particular spectrum bandwidth using a particular technology and for the supply of a particular service (this is referred to as a Command and Control approach);

- Governments may allow some greater flexibility such as allowing users to choose from within a range of prescribed technologies or to buy and sell spectrum between each other; and

- Governments may allow anyone to use a particular spectrum band but restrict the type of use of the spectrum such as in terms of power constraints (this approach is known as licence-exempt use or a spectrum commons and is commonly used for short-range, low power services, such as Wi-Fi).[13]

In Appendix A, we have set out a sample generic licence as a guide to the terms and conditions that could form a spectrum licence along the lines of the approach proposed in this report.

[13] While a number of commentators have suggested that greater use of spectrum commons is desirable, spectrum commons can give rise to significant inefficiencies including no guaranteed quality of service (particularly in urban areas), ongoing government determined restrictions on use and acting as a deterrent to investment in the band. The problems of spectrum commons are discussed in J. Brito, "The Spectrum Commons in Theory and Practice", *2007 Stanford Technology Law Review* 1.

Separation of operating licences from spectrum licences

In most countries, operating licences and spectrum licences serve different purposes and it is desirable that they form separate licences where restrictions are being imposed unrelated to spectrum. Such a separation can help ensure that rules in relation to network or service provision are applied in a neutral manner across technologies and operators by allowing the same licence type to be issued to all network operators and service providers. Spectrum licences can then be targeted at issues of specific relevance to spectrum use, particularly interference management. Separation can also provide operators with greater flexibility to adapt their activities or spectrum holdings over time without calling into question the validity of their overall licence.

2.2. Principles to guide spectrum management

Historically, particular spectrum bands could be allocated to particular uses on a 'first-come, first-served basis' as new radiocommunications technologies were developed. This is no longer the case. The proliferation of technologies that rely on access to spectrum and the rapidly growing demand for services delivered via those technologies means that spectrum allocated to one use can come at the expense of the supply of other services. The growth of mobile broadband in particular is greatly increasing the need for spectrum to be allocated efficiently. As such, authorities are finding that in licensing rights to use spectrum they need to make choices between industries, services and operators. Establishing robust and clear principles to govern spectrum management is crucial.

Spectrum licensing is fundamentally about ensuring that a country obtains maximum benefit from the use of its radio frequency spectrum resources. This requires:

- Policies to ensure that spectrum rights are assigned to the services and the operators who can generate the greatest benefits to society from the use of that spectrum (i.e. to achieve the efficient use of spectrum). Market-based approaches represent a key means to ensure that spectrum is used to supply the services most in demand and that operators are able to use the best available technology to deliver those services.

- Mechanisms or reviews to identify where valuable spectrum is being underutilised so that it can be traded or reassigned. Mobile operators in many markets suffer from limited spectrum assignments while spectrum may be lying idle or assigned to other uses of little value.

- Clear rights governing the use of particular bands so as to avoid intolerable interference or preventing spectrum being used efficiently. These rights should be backed up by a robust compliance and enforcement regime. Users should have legitimate expectations that their rights to use will not be changed without good cause.

- Facilitating international harmonisation so that equipment and devices use the same frequency bands to support international roaming and enable the realisation of scale economies in manufacture.

- Avoiding unnecessary administrative restrictions on what services can be supplied or on the way in which they are supplied. With rapid advancements in technology and demand for services, such restrictions can prevent customers from being able to access innovative new services.

- Regulatory obligations to achieve specific policy goals or address problems of inadequate competition are best determined as part of regular market reviews with regulation being targeted in scope and duration.

- Stability and transparency in the licensing framework and with an overall spectrum plan to facilitate the large investments required in rolling out networks and introducing updated technologies and new services.

We expand on the justification for these principles in the remaining sections of this report. In the next section we consider specific measures to promote stability and transparency in the general licensing framework.

2.3. Stability and transparency in the licensing framework

Regulatory certainty can be promoted by establishing and maintaining a transparent, predictable regulatory framework. A stable regulatory framework, in turn, can encourage new entry as well as giving confidence to the existing operators to undertake substantial investment in developing their networks and deploying new services. Regulatory stability and transparency also improves the quality of licensing decisions and minimises the risk of protracted legal proceedings.

Following are key elements that can promote regulatory stability and transparency:

- Setting out the long term plan for reform of the overall licensing framework including a schedule for introducing greater flexibility in relation to operating licences as well as the future assignment of spectrum.
- Setting out publicly the criteria and process that will be used to determine how licences will be assigned and renewed at an early stage (licence renewal decisions should be taken well before the expiry of the licence[14]).
- Establishing and publishing other aspects of the licensing environment as early as possible including but not limited to the pricing approach for licence renewal, non-price terms and conditions, and longer term plans in relation to spectrum trading and liberalisation.
- Licensing decisions should be based on a detailed assessment of the costs and benefits of a range of licensing options with particular regard to longer term impacts on investment incentives and sustainable competition.
- Ensuring that regulatory action does not conflict with investors' legitimate expectations including in relation to the planned introduction of competition and rights to continue to use spectrum based on legislation and regulatory decisions, statements and past practice.
- Assigning the responsibility for licensing decisions to an independent regulator who is required to follow specific, transparent criteria in making its decision and with an independent appeals process with the power to enforce its decisions.
- Ensuring that the regulator is adequately resourced including in relation to spectrum management functions which can require specialist monitoring equipment and technical expertise to ensure the equipment can be used effectively. While regulators in developing countries may not be as well-resourced as in developed countries they can nonetheless learn from both the positive and negative experiences encountered by other regulators who have already sought to address particular licensing issues. Regulators must additionally work to maintain a clean spectrum construct by stopping the operation of unauthorised devices which create intolerable interference.

[14] A minimum period for a licence renewal decision should be determined with regard to the expected payback period for ongoing investment that relies on the affected spectrum. A minimum period of 5 years, as applied by some jurisdictions (e.g., the UK and New Zealand), is likely to be appropriate for ongoing investments in developing mobile networks.

- Prior to a licensing decision being made, consultation should be undertaken to ensure that the perspectives and information of different industry players and of customers can be taken into account and to help identify all the impacts of different options.
- Publishing the reasons for decisions to improve the transparency of the decision-making process and to provide guidance on the likely approach to other licensees.
- Where licensing decisions are made which conflict with a licensee's legitimate expectations or where licences are revoked before their expiry date, a commitment to pay compensation can be important to protect general incentives to invest in the sector.

International trade agreements act to reinforce sound licensing practices. In particular, the General Agreement on Trade in Services requires that authorisation requirements must not "constitute unnecessary barriers to trade" (GATS Article VI) and the Telecommunications Services Reference Paper sets out the following principles, among others, which have been incorporated in commitments made by a large number of countries:

- Where a licence is required, all the licensing criteria, terms and conditions of individual licences and time normally required to reach a decision concerning an application for a licence are made publicly available;
- The reasons for the denial of a licence will be made known to the applicant upon request; and
- Any procedures for the allocation and use of scarce resources, including frequencies, numbers and rights of way, will be carried out in an objective, timely, transparent and non-discriminatory manner and the current state of allocated frequency bands will be made publicly available.

Next we examine licensing approaches in practice by examining the experience in Sweden which is relatively well progressed in the allocation of spectrum for mobile broadband and India where operators have been hindered by very limited spectrum.

2.4. Licensing in practice: Sweden

The licensing framework in Sweden is managed by an independent and well-resourced Regulator, PTS. Commercial suppliers of public communications networks and publicly available electronic communication services in Sweden are required to notify the Regulator (PTS) before commencing operations. This arrangement has been in place since the European Union's Authorisation Directive (2002/20/EC) became effective in July 2003.

The PTS's policy for spectrum in Sweden (PTS-VR-2006:2) is to ensure that spectrum is managed in a way which ensures the greatest possible usage and maximum benefits to society. Key components of the spectrum policy include: technology- and service neutral spectrum licences; auction as a spectrum distribution method; and exemptions from licensing requirements if there is no risk for harmful interference.

PTS prescribes that licenses to use radio transmitters should be as neutral as possible to the technology and services used. This gives the licensee maximum flexibility to choose which services to produce and which technology to employ. In practice, technology neutral licenses mean that only obligations which are necessary to ensure co-existence with other users, and to avoid harmful interference, shall be imposed. In addition to this, PTS notes in its spectrum policy that the introduction of a greater degree of service neutrality is a logical consequence of convergence when the same network is able to distribute voice, video, data and other services.

In Sweden, auctions are used as a primary way of distributing spectrum when demand exceeds supply. The purpose of using auctions is to achieve an efficient and transparent distribution by awarding the spectrum to the party which values it the highest. A secondary market for existing spectrum licenses already exists.

The current regulations restrict to some extent the use of market mechanisms such as auctions. For example, an auction is undertaken primarily in the event of a new or significantly altered use, in combination with frequency shortages. Also, the law of electronic communications specifically regulates the transfer of licenses, not the leasing of licenses. PTS has used different types of auction forms to distribute spectrum, including single-round sealed bid, simultaneous multi round auction (SMRA), simultaneous clock auction and limited combinatorial auctions. It is the responsibility of PTS to choose the auction method which is most suitable to the situation and the spectrum that is being distributed.

PTS publishes a frequency plan online, which also includes a search function in which it is possible to determine the specific use of frequencies. This is designed to avoid uncertainty over the current use of spectrum. In addition to this, PTS has an orientation plan for how it intends to distribute spectrum over the coming years. The purpose of the plan is to increase transparency, and outline the work undertaken by PTS in relation to spectrum. The plan is updated annually, but more frequently if required.

Prior to PTS auctioning specific spectrum frequencies, a consultation process is undertaken. The purpose of the consultation is to analyse the future use of the spectrum frequency in question. Each step of the consultation and auction process is published on the PTS website.

An important consideration in the spectrum planning process applied to PTS is to ensure international harmonisation - especially in situations such as: to enable roaming and interoperability; to achieve benefits associated with scale (i.e. lower prices) in the production of radio equipment; when radio signals cross boarders; for international aviation and maritime transport; for research; and for areas with binding EU law.

Sweden's approach to licensing has been highly successful with Sweden often being among the first countries to licence additional spectrum for the ongoing development of its mobile industry. The spectrum policy and planning undertaken by the Swedish Regulator also provides a transparent and predictable regulatory framework to support ongoing large investments in the sector.

2.5. Licensing in practice: India

India has allocated relatively little spectrum for mobile services. Further, the available spectrum has been assigned to a large number of operators. In particular, in most parts of the country around 15 operators were licensed with the average Indian operator only receiving around 5.5 MHz of spectrum.[15] This contrasts with the situation in other major countries in which there are generally 3-5 operators and with each of these operators having around 22 MHz of spectrum. While competition is an important objective for regulators, it is not the case that additional entrants bring greater and greater competition. The ultimate aim should be to achieve lowest sustainable prices to consumers with the best quality services. In other large markets, three or four players have been sufficient to create vigorous competition. For example, the four Ukraine mobile operators charge similar prices (as proxied by mobile revenue per minute) as India's operators[16], despite Ukraine's much higher general

[15] Plum, An assessment of spectrum management policy in India, December 2008, p.7.

[16] Average revenue per minute data from Merrill Lynch, Global Wireless Matrix 4Q11, Table 2.

cost level. The European Commission has found that three to four operators is generally sufficient to ensure effective competition. Limiting operators so that they only have access to small blocks of spectrum increases the cost of service provision (including through more towers being required to cover a given area or provide a given level of capacity). This results in higher prices to customers than otherwise and makes it less likely that operators will find it economic to extend coverage in rural and remote areas.

A progressive feature of India's regime is that licences are awarded on a technology neutral basis and allow for the delivery of all types of mobile services. This flexibility allows operators to respond dynamically to technology developments and changing consumer demands without being delayed by the need to seek changes to licence conditions.

The award of further licences and spectrum in 2008 became the subject of a major public interest litigation before India's Supreme Court.[17] The case related to serious problems in the awarding of the spectrum including that: (i) the prices paid for the spectrum were based on 2001 prices which were substantially below current market prices; (ii) spectrum was assigned on a first come first served basis; and (iii) the date for receipt of licence applications was brought forward so that only parties with advanced warning of the change could apply (including some parties with no experience in the telecoms sector). The Supreme Court, in its judgment dated 2 February 2012, quashed the irregular grant of licenses and spectrum. While the problems possibly reflect irregularities on the part of some individuals, this case also highlights a number of general lessons:

Assigning valuable licences on the basis of a process that is neither transparent nor objectively justified, creates significant risks of misuse. With large profits available from the re-sale of licences (as took place in India), a process that can be manipulated to favour some parties over others. Regulators should instead follow a transparent, consultative process in which all parties are given equal opportunity to participate.

Assignment criteria should be designed to ensure that spectrum goes to the uses and operators that will bring most value to society. Criteria, such as first come first served, in cases where demand far outstrips supply, carry large costs including that the public fails to receive the full value of the licences/spectrum and that valuable spectrum is poorly utilised, at least until it is finally able to be acquired by operators that can make proper use of the spectrum. A well run auction is a key means of ensuring spectrum is assigned efficiently although other transparent, non-discriminatory and objectively justified processes may sometimes also be appropriate.

India did carry out an auction for 3G spectrum in 2010. The auction raised around US$15 billion for the government and was free of the irregularities that tainted the 2008 process. The auction also served to advance the rollout of mobile broadband in India, which is of particular importance given India's very limited fixed network. Bharti and Vodafone launched 3G services in the first half of 2011. In addition, the auction brought much needed additional spectrum to India's operators. However, one drawback of the auction was the very high prices for the spectrum that resulted from the scarcity of spectrum for mobile services in India as also the uncertainty regarding roadmap for 2G spectrum. High levels of debt among operators can restrict them in investing in the rollout of services and network. The Indian Government's Economic Survey 2010-12 found that Profit After Tax (PAT) in the Telecom sector is expected to fall during 2011-12 by 84.7 per cent particularly due to the heavy borrowings for acquiring 3G spectrum. As retained earnings are a key source of companies' financing for new investment, this dramatic fall in profits carries the risk of much lower investment in the sector in the period ahead. A further drawback of the auction was that due to the very high prices, no operator (except the incumbent for whom 1 block was reserved in all service areas) was able to

[17] A copy of the Supreme Court's judgment is available at :

http://www.thehindu.com/multimedia/archive/00911/Supreme_Court_verdi_911309a.pdf

acquire a pan India footprint. There are significant fixed costs in supplying mobile services so that unit costs can be minimised by supplying services on a national basis. Operators have sought to achieve a national 3G services footprint through roaming agreements, which are permissible under licence. However, despite the license clearly permitting such arrangements since mid-2008 and the Licensor explicitly clarifying on the permissibility of such arrangements prior to the auctions, it was ruled against these agreements in late 2011. While the matter is presently before the Telecom Tribunal, it is important to note that changes in rules such as these after the auction can unfairly penalise operators who paid the auction price based on the rules at the time.

In response to the Supreme Court judgment, the licences assigned as part of the 2008 process have been quashed and the spectrum is now to be re-assigned through an auction. However, this remedy is creating its own problem as the spectrum is now in use by operators including by some operators who acquired the spectrum at full price from parties reselling the licences they received under the flawed 2008 process. The cancellation of licences becomes operative in September 2012. It is therefore desirable that the re-assignment process should be undertaken as expeditiously as possible to remove the substantial uncertainty hanging over the industry and enable operators to proceed with investment plans.

The Indian regulator (Telecom Regulatory Authority of India TRAI) released a consultation paper on 7 March 2012 on proposals for auctioning of spectrum assigned in the 2008 process and this paper also raises a number of issues in relation to the assignment of spectrum in the 700 MHz band.[18] For example, the regulator is seeking to determine how best to package the spectrum across the bands to avoid operators being left with fragmented spectrum holdings. The regulator also raised whether spectrum in different bands should be auctioned simultaneously, eligibility criteria and what terms and conditions should govern the spectrum licences including in relation to refarming[19] of the 2G spectrum, reserve price and ongoing spectrum charges, rollout obligations and trading. The issues raised are important to the future development of the industry and we examine the best approaches to these issues in the various sections of this report.

Following this public consultation, on 23 April 2012, the TRAI published its recommendations on the 'Auction of Spectrum'. One of the key recommendations of the Regulator is that only 5MHz be auctioned in every service area as against 413.6MHz spectrum made available through license cancellation by the Supreme Court and 211MHz already available with the Government[20]. This will make it impossible for the cancelled licensees to have a fair opportunity to bid and acquire spectrum and ensure service continuity. In addition to the very limited spectrum being put up for auction, the Regulator has also recommended a very high reserve price, which is close to the final market discovered price discovered for the 3G spectrum in 2010. Under these circumstances, it is unlikely that a fair and effective auction can take place and the spectrum will either remain unsold or be acquired at close to the reserve price, which would defeat the very purpose of an auction.

The reason given by the Regulator for releasing only 5MHz for auction is that spectrum needs to be reserved so as to allocate in lieu of 900MHz at the time of the extension of licenses coming up from 2014 onwards. The regulator has recommended extinguishing the existing rights to 900MHz at extension and auctioning the same for 3G services. Accordingly, the affected Indian operators are faced with uncertainty over the future rights to the spectrum that is critical for them to be able to supply services to their customers. In Section 4, we highlight the serious risks to investment created by uncertainty over future rights to spectrum. As pointed out above, many countries instead adopt a

[18] http://www.trai.gov.in/WriteReadData/trai/upload/ConsultationPapers/285/Consultatition%20Paper%2007.03.2012%20.pdf

[19] The term 'refarming' is generally used to mean a change in the technology use (such as from 2G to 3G) without a change in the holder of the licence. However, in India, 'refarming' is used to refer to the removal of spectrum from one set of users in order to release it for future assignment (to be used with a different technology).

[20] TRAI recommendation on 'Auction of Spectrum' 23 April 2012

presumption of renewal so that licensees are allowed to renew their licences except under certain defined circumstances that are expected to arise relatively rarely. There does not appear to be any sound reason for the Indian regulator to depart from this international best practice. It is also the case that the licences are already technology neutral so that they already provide for the introduction of 3G services. A particular concern in the Indian market context is that the loss of access to 900 MHz spectrum could severely impact rural coverage and service for which 900 MHz spectrum is critical for the commercial viability of rural service provision. Operators with existing rights may stop investing in the roll-out of their networks until they know whether they will receive rights to the spectrum in the future. If a new entrant were to acquire the 900MHz spectrum, it is likely that they would first focus on urban provision so that it may be many years before they provide rural coverage that remotely match the levels currently being provided.

Another major challenge for the Indian industry will be to secure sufficient spectrum to improve the quality of 3G and help drive its take-up as well as to facilitate the development of LTE services. Currently, only spectrum in the 2.3 GHz band (assigned for broadband wireless access) is available for Time Division LTE services with Bharti being the first operator to offer TD LTE services in India in April 2012. Additional spectrum in lower frequency bands, particularly in the 700 MHz band, will be important to enable widespread access to mobile broadband services at least cost.

An on-going issue in India is the level and structure of annual spectrum usage charges. The Indian regulator takes a higher percentage of revenues the greater an operator's total spectrum holdings.[21] This means that an incumbent can pay substantially more than an entrant for equivalent spectrum. However, for efficiency, similar spectrum should be priced at similar levels. If a new entrant is making relatively poor use of spectrum, it is important that the operator faces incentives to return some of the spectrum. However, India's current spectrum charges instead penalise the operators that are most effectively using spectrum while setting much lower charges for operators that are making little use of their spectrum.

Although some steps have been taken for licensing and spectrum reforms in February 2012, with the Minister announcing delinking of spectrum and licence, introduction of a unified licensing regime, uniform licence fee for all services and service areas, some relaxation in the restrictions on mergers and acquisitions and permission being allowed for operators to share spectrum in the same area, there are still some areas of concerns.

[21] Somewhat inconsistently the charge rate is determined with reference to holdings of GSM and CDMA spectrum separately. This effectively penalizes operators who have all of their spectrum being GSM spectrum compared with another operators with a similar total amount of spectrum but split between GSM and CDMA spectrum.

2.6. Recommendations

Following are our key recommendations in relation to the overall licensing framework:

- *Recommendation 1* – Licensing authorities should progressively remove restrictions that unduly restrict operators from determining which services they will provide and the technology that they will use. Restrictions that do not result in clear net benefits should be relaxed. Operating licences should be expanded to cover a greater range of services or, where appropriate, replaced altogether by simpler authorisations or class licences. Where restrictive operating licences are maintained they should be separated from licences for the use of spectrum. Spectrum licences should, in general, contain spectrum management provisions only or principally. This will assist changes in business activities and spectrum holdings and support the evolution of technologies and the different needs between radio spectrum management and other aspects of the licence. Operators offering similar services should be subject to the same terms and conditions.
- *Recommendation 2* - Spectrum should be managed to ensure that a country obtains maximum benefit from the use of its spectrum resources. Spectrum rights should be assigned to the services and the operators who can generate the greatest benefits to society from the use of that spectrum, i.e. to achieve the efficient use of spectrum. Market-based approaches represent a key means to ensure that spectrum is used to supply the services most in demand and operators are able to use the best available technology to deliver those services.
- *Recommendation 3*- Licensing authorities should ensure that the overall licensing framework offers stability and transparency to reduce regulatory risk and promote investment. Key principles should include:
  - establishing and adequately resourcing an independent regulator with responsibility for operator and spectrum licensing among other matters;
  - announcing in advance a long term plan for reform of the spectrum and operating licensing framework;
  - facilitating international harmonisation so that equipment and devices use the same frequency bands to support international roaming and enable the realisation of scale economies in manufacture;
  - publicly setting out the criteria and process to be followed in licensing decisions and including public written consultation in advance of key decisions being made with both consultation responses and the assessment of input in reaching final decision being published;
  - clearly defined spectrum rights that are backed up by a robust compliance/enforcement regime;
  - taking a holistic approach to licensing that ensures that the overall package enables the ongoing development of the mobile industry (including a process for the renewal of licences at their expiry); and
  - taking into account investors' legitimate expectations and providing compensation mechanisms where decisions are made in conflict with those expectations.

3. Amount and use of spectrum to be released

Meeting the rapid growth in demand for mobile voice and data services will require significant additional spectrum being allocated to mobile services. Licensing authorities across the world are currently determining what spectrum can be made available and how it should be assigned. In this section, we first review what are the main frequency bands that are in use for mobile services or which have been identified for use by mobile services. We then examine key steps that licensing authorities can take to put that spectrum into use as early as practical to deliver services to customers.

3.1. Internationally identified mobile spectrum bands

Access to several key spectrum frequency bands have been identified internationally as fundamental to the development of the world's mobile industry. This includes securing ongoing rights to spectrum that is currently assigned to mobile operators as well as new bands that are only in the process of being assigned.

Original spectrum assignments to mobile operators

Mobile services were initially introduced into different countries using a variety of frequency bands. For example, AMPS and NMT (Nordic Mobile Telephone) analogue mobile services, which have now largely been discontinued, used the 800 MHz band and the 450 MHz band respectively. The most common mobile technology today, Global System for Mobile Communications (GSM), generally uses 900 MHz and 1800 MHz frequencies in Africa, the Asia-Pacific, Europe, Latin America and the Middle East. The GSMA supports the 880-915/925-960 MHz and the 1710-1785/1805-1880 MHz band plans with conventional duplex which gives 2x35 MHz and 2x75 MHz of bandwidth respectively for deploying mobile technologies. In the Americas and some other countries, spectrum assignments for mobile have also included the 700 MHz band (698-806 MHz), the 850 MHz band (824-894 MHz) and the 1900 MHz band (1850-1990 MHz).

In many countries with spectrum assigned for mobile services, licensing restrictions inhibit the full use of the spectrum. For example, some countries require that the spectrum only be used for 2G mobile services although a growing number of countries are removing these restrictions so that the spectrum can also be used for 3G, LTE or any technology that does not cause harmful interference to other spectrum users. As we discuss in this report, the aim should be to enable the spectrum to be used to generate the greater benefits to society. This should enable newer technologies and services to be introduced over time while still supporting ongoing use of 2G voice and data (in many emerging markets, GSM 2G voice services are likely to continue to be the predominant service for many years particularly given their role in enabling affordable access to voice connectivity).

A second issue in relation to current spectrum assignments is that many existing licences are approaching the end of their initial period. Where there is uncertainty over whether the licences will be extended, operators may decide that significant new investments in network extension and services are too risky thus inhibiting further growth and rollout of the network. Mobile customers may be disadvantaged until this uncertainty is resolved. The approach to licence renewal is a key focus of this report.

Assignments for 3G services

3G services have generally been deployed using 2100 MHz spectrum, although 3G services are increasingly also being supplied in lower frequency bands. For the 2100 MHz band, the GSMA supports the 1920-1980/ 2110-2170 MHz band plan with conventional duplex which gives 2x60 MHz of bandwidth available for deploying mobile technologies. In North America, 1710-1770/2110-2170 MHz has been made available for Advanced Wireless System services including 3G.

The issues affecting the original spectrum assignments are present (albeit to a lesser degree) with the 3G assignments. In particular, there are likely to be efficiency gains from allowing operators to use these assignments for newer technologies over time. In addition, as the 3G licences approach the end of their terms, new investment will become increasingly risky if operators are not given security over their future rights to use the spectrum.

Digital Dividend spectrum

The transition from analogue television to digital television will free up significant spectrum in the 200 MHz to 1 GHz frequency range. The excess spectrum is known as the Digital Dividend. Access to this spectrum for mobile services offers three key advantages: (i) significant new capacity to meet the needs of mobile broadband; (ii) the low frequency band enables coverage to be provided at relative low cost; and (iii) the low frequency makes it more economic to extend coverage to rural and remote areas as well as providing for much better indoor coverage. A report for the European Commission estimated that use of the Digital Dividend could generate between EUR150 billion and EUR700 billion of economic benefits to Europe (discounted value over 15 years) in addition to or instead of deploying the same services using other frequency bands or alternative delivery platforms.[22] Ofcom has estimated that the potential gains for the UK from the use of the Digital Dividend are likely to be between £5 billion and £10 billion over 20 years.

2.6GHz band

The ITU has identified the 2.6GHz band for mobile broadband use. The GSMA supports a 2500-2570/2620-2690 MHz band plan which gives 2x70 MHz of paired bandwidth with conventional duplex plus 50 MHz of unpaired bandwidth available for deploying mobile technologies. While the relatively higher frequency implies that the band is less suitable for providing widespread coverage, the significant amount of available spectrum provides substantial capacity to meet growing traffic volumes in densely populated areas. As such, the 2.6 GHz band represents a good complement to lower frequency bands. TeliaSonera who launched the world's first commercial LTE services will use 800 MHz frequency in addition to its existing use of 2.6 GHz spectrum to supply LTE services.

Future spectrum

In some countries other spectrum bands are already being considered to support mobile broadband. For example, Hong Kong auctioned spectrum in the 2.3 GHz band in February which will be used to support TDD LTE services. The International Telecommunications Union (ITU) has also started considering further spectrum allocations to mobile services. In February 2012, the World Radiocommunications Conference (WRC) adopted an agenda item for the next WRC in 2015 to secure additional spectrum for International Mobile Telecommunications (IMT) which cover a family of technology standards including EDGE, CDMA2000, UMTS, DECT, WiMAX and LTE.

[22] Analysys Mason, Exploiting the digital dividend – a European approach, 2009, p.6.

3.2. Freeing up spectrum resources to meet growing demand

Licensing authorities are at varying stages of the process of reviewing existing use of spectrum and identifying how they can best meet the increasing demands for spectrum for mobile services and for other public and private sector industries. In this section, we set out key preliminary steps that authorities are taking to determine what spectrum can be made available to meet new demand.

Spectrum inventory

In many developing countries, the major concern with current spectrum licensing is that little information is available on the current assignment of spectrum rights, particularly in regard to who has the legal rights to use particular bands and what services and technologies they are allowed to use. The lack of information on current spectrum rights can come at a substantial economic cost including in terms of:

- deterred investment, degraded quality of service and protracted disputes because of the heightened risk of interference; and
- valuable spectrum being left idle or underutilised because not even the licensing authority may have a good knowledge of the details of the spectrum rights that have been assigned in the past.

Thomas W. Hazlett, Professor of Law & Economics at George Mason University and former Chief Economist of the Federal Communications Commission, has commented that:

> "**To restrict the spectrum available to mobile networks is to reduce the value of the services they provide** (…) the restrictions that policy makers consistently impose on spectrum for mobile services most often simply freeze virtually unused bands in place. These actions do not enable alternative wireless applications of higher value, they simply squander bandwidth. This does yield regulators option values, as they can decide what to do with unused frequencies at a later date. But these options have negative value to society**. The bandwidth that lies idle is not saved but destroyed, as the opportunities not used are gone forever**."[23]

Licensing authorities should consider undertaking an inventory of existing spectrum if there is uncertainty over current ownership of spectrum rights and usage. This exercise should specify in detail which services currently use which frequency band, and by whom. This can also clarify current rights to use spectrum particularly in regard to key parameters such as frequency, users, use, geography and the levels of interference that are allowed so as to be compatible with other licensed uses. Such exercise should be focused initially on those spectrum bands and geographic areas which are most heavily used or which are likely to be most capable of supporting growing demand. This should include the spectrum bands that have been identified internationally for mobile services discussed in the previous section.

A key benefit of the spectrum inventory will be to identify where the current pattern of use gives rise to harmful interference that reduces quality of services and raises costs of operators in seeking to overcome the interference. Where incompatible uses are identified, a migration process should be introduced with compensation for legitimate users if licensed spectrum is required to be returned prior to the end of the licence period. In addition, where unlicensed users of licensed spectrum or users in breach of their licence conditions are identified, they should be subject to proportionate penalties.

The result of the spectrum inventory should be made public to facilitate network design and longer term planning by existing and potential new users of spectrum.

[23] Hazlett, T.W., "Spectrum policy and competition in mobile services", *Vodafone Policy Paper Series,* No. 12, May 2011.

Spectrum road-map

On the basis of the spectrum audit in relation to current use as well as knowledge of which particular bands are likely to be most in demand for future use, licensing authorities should develop a road-map which identifies which frequency bands will be made available and the proposed timing for those assignments. It is important that spectrum allocation decisions are made as part of a longer term plan because once spectrum has been allocated it can be difficult to re-assign. Information on future releases of spectrum is also critical for businesses to be able to prepare their investment plans including securing finance and developing arrangements for deploying particular technologies.

As well as setting out the timing of when particular frequency bands will be made available, the authority should also provide information on the approach that the licensing authority will take to spectrum management going forward. This information should aim to provide as much information as possible on the proposed approach to a range of areas including how licences will be assigned, what restrictions are likely to be apply on the use of the spectrum for particular technologies and services, what types of charges are likely to apply and the method to determine their level, whether particular measures will be adopted to protect competition, the ability of licensees to directly sell their licences or change the use of the spectrum and what other price terms and conditions will apply such as the term of the licence and whether specific policy-related obligations are likely. While it will not be possible or desirable to detail every approach in advance of analysing the expected demands for particular spectrum, where a menu of approaches will be considered investor certainty can nonetheless be promoted by the authority setting out what factors or criteria the authority will use to choose between the specific approaches.

In the next section, we examine the importance of reviewing restrictions on the rights to use spectrum that has already been assigned. In Section 4, we then turn to consider how rights to use can be renewed and new spectrum rights established.

3.3. Refarming and technology and service neutrality

Even without spectrum rights being re-assigned, authorities can achieve better use of spectrum by removing current restrictions on use that are found to be creating greater costs than benefits. Many current restrictions on use effectively create an artificial scarcity of spectrum. The aim should be to remove restrictions on the use of spectrum to deliver particular services or using particular technologies provided interference to other users remains limited so that the country can maximise the overall benefits from its spectrum resources. Thus technology and service neutrality can be seen as a precursor to further spectrum assignment.

Whether restrictions on the use of spectrum should be relaxed requires carefully weighing up the expected benefits and costs of doing so. Benefits can include enabling the supply of new or additional services or reducing the cost of supplying existing services by the deployment of more efficient technologies. For example, 3G technologies offers significant technological advantages and consumer benefits compared with 2G technology. However, in many countries, the use of 3G is limited by restrictions that still require initial spectrum assignments for mobile services to only be used for 2G. This means that 3G has often been restricted to a relatively high frequency band particularly at 2100 MHz. However, the last few years have witnessed a major trend around the world to enable 3G and more recently newer technologies such as LTE in frequency bands formally reserved for 2G services. This process is generally referred to as refarming and does not involve a change in the holder of the spectrum rights. Elisa in Finland was the first operator to commercially launch 3G services using 900 MHz in Finland in 2007. Authorities in a number of countries have also made changes/lifted technology restrictions to allow 3G networks to be used at 1800 MHZ and for newer technologies such as LTE to be introduced into the traditional 2G frequency bands (potentially leap-frogging 3G entirely). For example, the European Commission has provided for the introduction across the EU of

3G, LTE and WiMAX technologies in the 900 MHz and 1800 MHz bands. Refarming allowed by the Polish regulator has enabled a commercial LTE network to be launched in Poland in September 2010 (see case study).

The ability for operators to refarm lower frequency bands, currently used for 2G services, is estimated to generate substantial economic benefits.

- **Lower cost of provision**. For example, Elisa in Finland found that 3G at 900 MHz requires around half the number of cell sites as 3G at 2100 MHz in rural and suburban areas and this translated to a 50%-70% savings on opex and capex.[24]
- **Wider geographic coverage**. The need for fewer cell sites improves the economics of extending mobile broadband coverage further into rural and remote areas as well as enabling coverage to be extended in rural areas more quickly.
- **Better indoor coverage**. Ofcom found that a 3G network at 900 MHz delivered a minimum of 8 Mbps to 70% of indoor locations whereas 3G at 2100 MHz delivers the same data rate to only 45% of indoor locations.25

In addition, 3G and, to an even greater extent, LTE uses spectrum more efficiently enabling greater capacity (i.e. more services and better, innovative services) to be provided from a country's scarce spectrum resources.

Relaxation of spectrum usage restrictions does not mean that there will be random patterns of spectrum use across countries. Even with less technology and service neutrality, substantial international harmonisation of the use of particular spectrum bands will remain to take advantage of the realisation of scale economies to reduce equipment costs and roaming. Further, while 3G and LTE technologies bring benefits, the substantial existing base of 2G devices means that 2G services will continue to be important for the next 5 to 10 years.

Changes to the rights to use spectrum will not always be justified however. There may also be transitional issues that will need to be addressed.

Interference issues

The main rationale for restrictions on use being imposed is to minimise the risk of intolerable interference to other users of spectrum. Any decision to provide some liberalisation of the use of spectrum should ensure the careful management of interference issues. Where different technologies can technically co-exist then there is a strong case for licences to be neutral as between those technologies. In relation to refarming of spectrum from 2G to 3G use there is now significant practical experience in addition to technical studies on addressing interference issues. This experience also covers situations in which 2G services have been maintained while 3G services are introduced in neighbouring frequency as well as where countries with common borders pursue liberalisation in different time frames. More generally, the IMT technologies GSM/GPRS/EDGE, UMTS/HSPA and LTE have been standardised based on criteria for technical co-existence and are intended to be backwards compatible.

Operator issues

For operators, refarming raises a number of issues including how to free up some spectrum currently used for 2G services to use for the introduction of 3G, how to facilitate the migration of customers from 2G to 3G and how to transform the network from one supporting only 2G to one in which most traffic is carried using 3G or later technologies.

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[24] Qualcomm, HSPA and LTE can foster economic development presentation.

[25] Ofcom, Application of spectrum liberalisation and trading to the mobile sector – A further consultation, §4.34.

Competition issues

The benefit of refarming has also raised concerns that if only some operators in a market are able to use 3G and LTE at lower frequency bands then competition may be adversely affected. In many cases, it is the larger, more established operators that currently have rights to spectrum below 1 GHz. Whether or not competition will be significantly affected requires an analysis of the overall position and spectrum-holdings of operators in a market including what other spectrum bands will be made available in the foreseeable future. Generally, however, operators should be allowed to refarm their licensed spectrum as the market and technology change using whatever bands they are licensed in and all should be given a fair opportunity to obtain newly purposed spectrum

To simply prohibit refarming at all would deny customers the benefits that could be realised from greater capacity, lower costs of provision and the improved economics of extending networks further into rural and remote areas. Where relaxing restrictions on current rights is expected to harm competition, then a number of options exist that can allow for the benefits of refarming to be realised while preserving or even promoting competition:

- Some licensing authorities, such as ARCEP in France, allowed for refarming of 900 MHz spectrum for 3G use after the two major operators redistributed 2 x 5 MHz of 900 MHz spectrum to France's third operator, Bouyges. ARCEP also provided for a further re-distribution of 900 MHz spectrum upon the entry of a fourth operator and this process was activated by the award of a licence to Free in December 2009. Following these processes, the two major operators have 2 x 10 MHz of 900 MHz, Bouyges has 2 x 9.8 MHz and Free has 2 x 5 MHz.
- An alternative approach is for new spectrum releases (such as the Digital Dividend) to be licensed in a way that achieves a more uniform distribution of comparable spectrum (e.g. the sub-1 GHz spectrum) across operators. Regulators may also decide to prevent lower frequency bands being used for newer technologies until the additional spectrum is auctioned.
- Another approach is where equivalent wholesale access is provided to the services of a 3G or LTE network that uses the lower frequency bands. Such access may be provided nationally or only in rural/remote areas.
- Licence fees or annual spectrum charges can also be adjusted to take into account the different value of liberalised spectrum at different frequency bands. Where licences are auctioned, then the bids of operators for different licences can be expected to reflect the differences in the expected value of the rights to use each frequency band.

We examine measures to protect competition more fully in Section 6. These measures can carry costs as well as benefits and hence it is important to carefully assess which particular approach would be in the best interests of end-users. Consultation with all affected parties is crucial to ensure that all costs and risks are identified and that the regulator is able to choose from the full range of practical measures.

Next we examine the experience of Poland and Singapore which have successfully provided for refarming.

Refarming in practice - Poland

In September 2010, Poland's Mobyland and CenterNet deployed the first phase of their commercial LTE network in the 1800 MHz frequency band – becoming the first commercial LTE technology network in the 1800 MHz band in Poland and only the fourth in the world. Huawei, the supplier of the LTE network solutions, noted that "*Refarming Mobyland and CenterNet's existent 2G bands at 1800MHz, allowed for greater performance across bandwidth. This in turn enabled the LTE network to improve spectrum efficiency, enhance coverage quality, reduce the quantity of sites, and decrease carbon emissions*."[26]

In January 2012, the Polish regulator announced the start of consultations on assigning currently available frequencies (2 x 25 MHz) in the 1800 MHz band. The regulator noted that there will be two tender procedures: the first will be aimed at providing a licence for 2 x 10 MHz of the spectrum for an operator that does not currently have any 1800 MHz spectrum and the second will be aimed at granting three additional blocks of 2 x 5 MHz of 1800 MHz spectrum. The Polish Regulator has also dedicated the 2.6 GHz and the digital dividend bands for the deployment of LTE. The LTE spectrum auctions are expected in 2012 or later.

Refarming in practice - Singapore

Singapore's regulator, the IDA, issued an interim decision on spectrum framework 4G mobile communication systems in Singapore in January 2011. The IDA clarified the use of existing spectrum rights for wireless and mobile services, especially on the 900 MHz and 1800 MHz bands which are suitable for refarming (while noting that it was not in a position to then conduct a re-allocation of the 2.3 GHz and 2.5 GHz bands).

The 900 MHz and 1800 MHz bands have been allocated in Singapore to 2G and 3G technologies and other technologies on a similar platform with higher speed data services. The rights are due to expire in 2017. The IDA noted that should operators wish to deploy technologies other than 2G and 3G or their evolved versions, that are capable of providing public mobile services, they would need to seek the IDA's approval before doing so.

Further, the IDA noted that it will not prohibit operators from deploying LTE in the bands so long as operators meet the requirements for public mobile services. Operators that deploy LTE within the 900/1800 MHz band also need to coordinate with other operators to reduce harmful interference. Operators deploying LTE may be required to dedicate additional spectrum for larger guard bands between their LTE system and the 2G systems of other operators.

The IDA noted that operators which intend to deploy LTE using their existing mobile (or WBA) spectrum bands **need to consider the remaining duration of the spectrum rights, and consumer transition issues at the end of the spectrum rights**. The IDA also commented that **its decision to allow LTE deployment in its interim decision should not be seen as restricting its flexibility to re-allocate bands for 4G or other systems in the future**.

Singapore is thus supporting the timely introduction of LTE services and at the lower frequency bands that will maximise benefits to customers.

On 3 March 2011 IDA announced an auction for 1 x 5 MHz of 1800 MHz spectrum. The auction closed on the 28 March 2011 with the winning bid of S$21.69m from M1 Limited. After securing the rights to the 5 MHz of 1800 MHz spectrum, M1 launched a dual-band network on the 1800 MHz and 2.6 GHz bands. M1 is the first in Singapore, and South-East Asia, to launch ultra-high speed mobile services with LTE. Other operators that are already using 1800 MHz spectrum for 2G services will first need to free up some of this spectrum to support the introduction of LTE.

[26] Huawei (2011) *LTE 1800 MHz Ecosystem Drivers,* p. 14.

3.4. Recommendations

Following are our key recommendation in relation to the amount and use of spectrum to be made available.

- *Recommendation 4* – Current rights to use spectrum should be clearly specified and spectrum bands that are currently idle or being poorly utilised (including by public sector agencies) should be considered for re-allocation to services that could use the spectrum to generate greater benefits for society.
- *Recommendation 5* – Licensing authorities should publish a road map of the planned release of additional spectrum bands to maximise overall benefits from the use of spectrum including taking into account the benefits of international harmonisation. In doing so, aligning spectrum rights with the internationally harmonised mobile spectrum bands will ensure that operators and their customers can acquire competitively provided equipment and devices and that customers can readily access international roaming services.
- *Recommendation 6* - Licensing authorities should progressively remove service and technology restrictions in existing mobile spectrum usage rights to enable operators to choose when to deploy mobile technologies that can technically co-exist so as to increase spectral capacity, reduce cost of provision, extend coverage to rural areas and improve indoor coverage. Operators themselves are likely to be best placed to determine the speed of migration particularly recognising that 2G services are likely to remain important for the next 5 to 10 years.
- *Recommendation 7* - New spectrum usage rights within the mobile bands should be issued on a basis that is on a service and technology neutral basis subject to the use of technologies which can technically co-exist without intolerable interference.
- *Recommendation 8* - Licensing authorities should facilitate harmonisation of spectrum through allocating radio frequency bands in accordance with international agreements and by applying spectrum management approaches aligned with international best practice.

4. Assignment and renewal of mobile licences

Where demand for particular spectrum exceeds the amount of available spectrum, governments will need to determine which operators should obtain a licence. In this section, we evaluate the advantages and disadvantages of the main approaches to assigning licences. We first focus on what should happen to spectrum rights that have already been assigned but where those licences are approaching their date of expiry. We then consider more general approaches to assigning licences.

4.1. Approaches to licence renewal

In many countries, spectrum rights to mobile operators were licensed on terms that are due to expire over the next few years. In these countries, governments need to clearly set out their approach to licence renewal well in advance of expiry of licence. Such decisions are clearly of critical importance to operators that rely on access to the spectrum to serve their customers. These decisions, moreover, can fundamentally impact the development of a country's mobile industry including on the level and timing of investment, continuity of service provision, competition and ensuring that spectrum is available where efficient for new services and technologies. In this section, we assess the approaches that countries are undertaking to manage this process.

Presumption of licence renewal

A number of countries have established a presumption or high expectation of renewal in relation to spectrum licences (such as the Canada, Jordan and the US) – indeed this characterizes most countries that have already considered the renewal of GSM licences. For example, the World Bank states that "*While the legal regime for license renewal could embrace the process of automatic renewal, tacit renewal, or renewal at the express request of the licensee, most legal and regulatory frameworks adopted a regime based on the 'presumption of renewal' or 'renewal expectancy'*".[27] A presumption of renewal means that licensees are allowed to renew their licences except under certain defined circumstances which are expected to arise relatively rarely.

Where a country's licensing regime does not already specify a presumption of licence renewal then a key question is whether it would be desirable to establish one.

A presumption of renewal can make sense where the service, such as mobile communications, clearly represents the best use of a particular spectrum band and where the ongoing continuity of communications is important given the particular service's role as part of the economy's key infrastructure. A presumption of renewal also gives operators greater certainty and encourages them to bid for licences and invest in network development and the deployment of new services knowing that after the initial licence period it is highly likely that the licences will be renewed with little risk of losing the investment. This can be critical for investments that have long payback times such as mobile networks. A presumption of renewal can also improve operators' abilities to raise capital from financial markets.

If operators were instead given no confidence over renewal, they would be expected to undertake only shorter and shorter term investments as the year of expiry of their licences approaches and avoid undertaking any longer term investments – an operator may face large losses if sunk assets need to be written off because its licence is not renewed. This could mean that consumers in that country go without a major network upgrade for years compared with consumers in other countries. A failure to allow an operator to renew its licence can also cause harm to customers through service disruption with the potential that coverage in some areas is lost and/or handsets purchased by consumers no longer work. Service disruption may be prolonged given the timeframe for a new entrant to establish its network.

[27] World Bank, *Mobile licence renewal: What are the Issues? What is at Stake"*, June 2005, p.4.

The World Bank has noted the importance of licence renewal for investment:

> "*Providing details for license renewal or reissue is an important guarantee for regulatory certainty, which is a prerequisite for attracting potential investors entering the market of developing and emerging economies… For the sake of regulatory certainty, the discretion offered to the licensing body should be curtailed by conditions set in the regulatory framework or in the license. itself, and be subject to checks and balances. The conditions requested for renewal and the methods for specifying them become minimum guarantees to ease investors concerns over arbitrary refusal to renew. They give a positive signal for operators to continue to invest in their networks and to fulfill their obligations, at least until the end of the license term. Prospects for license renewal also offer needed assurance to operators to engage long-term financing for their network.*"[28]

Given the risks to ongoing investment in the sector, licensing authorities should determine their approach to licence renewal as early as possible. Even within 5 years of the expiry of mobile licence, an operator may not be able to recover even smaller scale network investments within the remaining licence period and hence may put off investing until receiving greater certainty over their future rights. At a minimum, a licensing authority should be able to specify the approach that they will take to assessing whether a licence will be renewed. This should cover important licence elements including:

- Whether a presumption of renewal will be applied and under what circumstances would a licence not be renewed;
- Whether there will be any changes in the bandwidth or the amount of spectrum covered by the licence;
- Whether any technology or service restrictions will be removed as part of the renewal (see Section 3) or whether other licence obligations will be changed (see Section 8);
- The cost or the method to be used to determine the cost of licence renewal as well as any ongoing spectrum charges (see Section 5); and
- What protections will be applied in the event that an authority decides not to renew a licence such as a right of appeal, a minimum period for the spectrum to be vacated (including so as to enable customers to migrate to other services) and under what circumstances would compensation be paid particularly where there was a legitimate expectation of renewal.

While recognising the major benefits of providing security of tenure for certain spectrum licensees, it is useful to examine circumstances under which particular countries provide for licensees not to be renewed. Indeed, a presumption of renewal will only provide a high degree of business certainty where the conditions under which licences will not be renewed are clear.

Spectrum replanning

Many countries provide for licences to not be renewed where continuing the current use of the spectrum would be incompatible with the planned use of spectrum. The impetus for a change in use of the spectrum may arise from international radiofrequency planning and co-ordination or from national decisions. Such a provision can be an important means to enable new technology platforms to be introduced particularly where spectrum management continues to be centrally planned. For example, the change from analogue to digital broadcasting will imply that broadcasters need much less spectrum to supply the same content and the spectrum that is freed up (i.e. the Digital Dividend) can instead be used for newer technologies and services such as LTE. Spectrum may also be replanned where the spectrum is required for national security or other purposes.

[28] World Bank, *Mobile licence renewal: What are the Issues? What is at Stake",* June 2005, p.1-2; 5-6

While spectrum replanning may be necessary to support efficient use of the spectrum on an ongoing basis, it is important that the benefits of different uses are carefully assessed and that where a change in use is contemplated, the cost of migrating or terminating the current use is taken into account. Further, spectrum plans should be announced as early as possible to give existing users sufficient notice. Forward reviews could be linked with the ITU's World Radio communications Conferences held approximately every three years. \

Finally, the need for regulatory-imposed spectrum replanning can be reduced by providing existing licensees with greater flexibility over the services for which the spectrum is used.

Breach of licence conditions

A breach of a licence condition is also commonly included as a reason for not renewing a licence. Where the licence conditions are made clear at the time of the initial assignment of the licence, then not renewing the licence or, indeed, revoking the licence before its expiry may be seen to be a proportionate response to a breach of a condition. For instance, revocation of the licence may be necessary if the licensee continually breaches the licence's technical conditions causing intolerable interference to users of neighbouring spectrum. Given the serious consequences to consumers and to investment, denial of renewal should be considered as a last resort, after having been through a series of sanctions, fines and alternative remedial measures.

It is the case that occasionally licence conditions prove to be infeasible to meet such as where there are delays in equipment for new technology or because the economics of the business have fundamentally changed. This may call for some flexibility on the part of the regulator, albeit that too much flexibility may invite disputes where other operators who have made more progress towards meeting licence conditions or where bidders who were unsuccessful in acquiring a licence believe the later relaxation of conditions discriminate against them. In many cases, less severe measures than revoking the licence may be more proportionate. For instance, in Norway, one operator received a fine for not meeting its 3G coverage requirements based on the expected savings to the operator from not completing its coverage.[29] Many of the issues associated with failures to meet licence conditions can generally be avoided by keeping ongoing licence conditions to the minimum necessary to ensure efficient spectrum use, i.e., essentially what is necessary to manage interference (we discuss this further in Section 8).

Promoting competition

Another reason that has been used by some regulators for not renewing spectrum licences is where ending a licensee's current use of spectrum is used as a means of promoting competition. For instance, the Australian Government sought to encourage the entry of new GSM operators in the early 1990s by undertaking to close the incumbent analogue AMPS network in 2000 and thereby putting all players on an equal footing. As discussed in Section 3.3, a key issue in the consideration of whether 2G spectrum should be allowed to be refarmed for use in supplying 3G services is whether some existing licensees should be required to give up some of their spectrum so that the lower frequency spectrum is more evenly distributed among all the mobile operators in the particular market.

Given the risk of deterring investment, any provision that would result in a licence not being renewed for competition reasons needs to be carefully circumscribed. We examine approaches to protect competition in Section 7.

[29] Bird & Bird, "Crunch time in the roll-out of UMTS in Swedish electronic communications markets", 16 February 2005.

Poor use of spectrum

A licence may also not be renewed where the existing licence holder is considered not to be making the best use of the spectrum. Such a provision is often put forward as a means by which to guard against valuable spectrum being left idle or underutilised. In Hong Kong, the regulator decided to not give a right of first refusal to the CDMA and TDMA licensees at the time of renewal because it considered that they had neither actively developed their networks nor actively marketed their services. In Bangladesh, despite limited spectrum being available for mobile operators, certain spectrum that could be used for GSM was being left idle because it had been allocated to wireless local loop operators that had not established businesses. Bangladesh's regulator has subsequently cancelled some of the wireless local loop operators licences.[30] In the US, licensees are required to demonstrate that they are providing "substantial service" as a pre-condition for licence renewal.

While such provisions are reasonable in principle, there is a significant risk of error where a regulator seeks to assess whether spectrum is being poorly used. For instance, there may be sound economic reasons as to why spectrum is left idle for a period such as when new technology or equipment is expected to become available shortly. In that regard, a regulatory requirement to demonstrate substantial service may encourage operators to behave inefficiently such as by undertaking investments prematurely so as to avoid losing the spectrum.[31] There is also a more general danger arising from such provisions in that they risk greatly increasing business uncertainty and undermining the incentive to undertake long-term investments.

The FCC in the US has argued that the concept of "substantial service" provides licensees with the flexibility to determine how best to use their service rather than having the regulator mandate particular benchmarks to be met. The FCC does set out 'safe harbour' benchmarks, such as a particular level of coverage that, while not mandatory for licence renewal, would meet the "substantial service" requirement for renewal. However, given the value generally placed on licence renewal, licensees tend to focus on the 'safe harbour' benchmarks rather than risking alternative service delivery.[32] Thus, the use of specific benchmarks (which limit licensees' flexibility to use spectrum in its most valuable use) or vague concepts such as "substantial service" (which creates business uncertainty that risks deterring investment) can cause some uncertainties.

Where an authority provides for operators to change the use of spectrum (without causing intolerable interference to others) and to trade licences amongst themselves, then market forces are likely to lead to the efficient use of spectrum without any need for a regulator to assess whether or not spectrum is being poorly used. Such market-based approaches are likely to prove superior to an administrative assessment over time as they are more flexible and responsive to changes in the market and will reflect information on the value of different uses from multiple parties rather than being reliant on the regulator's information which is likely to be more limited.

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[30] Wireless news, "Fixed line licences cancelled", 2 August 2007.

[31] Similar "use it or lose it" provisions are often applied to airport landing slots and have resulted in empty planes being flown simply so that the airline does not lose its landing slot (for instance, see the Times, "The plane now leaving Heathrow is…empty", 11 March 2007).

[32] Prime, J., "Finding substance in the FCC's policy of 'Substantial Service'", *Federal Communications Law Journal*, Vol.56, March 2004.

Re-auctioning of spectrum versus administrative renewal of a licence

An alternative approach to a regulator deciding to automatically renew a licence subject to the operator meeting certain criteria is for the licence to put up to auction. Re-auctioning can be viewed as ensuring all operators and potential new entrants have an equal opportunity to acquire spectrum in a fair and transparent manner. Further, assigning a spectrum licence on the basis of bids in an auction represents a more transparent allocation mechanism than regulatory judgements as to which operator is likely to better meet particular objectives.

Re-auctioning of spectrum rights does however have a number of major drawbacks. In particular, where spectrum rights are to be re-auctioned then the existing rights-holder will face uncertainty about whether or not they will retain their rights to the spectrum until the outcome of the auction is known. There could thus be a period of years in which investment in the development of the network (including extending coverage to rural areas) and the deployment of new services is delayed with the possibility of stranded investment. This delay could represent a loss in foregone consumer benefits of hundreds of millions of dollars. In addition, where licences are re-auctioned there is always a risk that a problem in the process leads to the rights going to operator that fails to make the best use of the spectrum. For example, a number of new operators that acquired 3G licences in Europe around 2000 and 2001 did not succeed in developing commercially viable networks and eventually exited the market. If spectrum rights are re-assigned to a new operator, customers could be left without service (or with fewer competitors than otherwise) for years until that new operator is able to build its network to provide coverage that is at least equivalent to that of the current rights-holder. In addition, there is also the risk that competitors may game the re-auction by bidding up the price, putting the winning bidder at a cost disadvantage. Auctions can also be administratively costly to run.

To avoid such problem, licensing authorities should only decide to re-auction spectrum rights where there is a real chance that other operators could make better use of the spectrum than the current rights-holder. For example, in 2005 the Norwegian Ministry invited parties to register their interest for an auction of 900 MHz licences that were coming up for renewal (and to supply a bank guarantee for the NOK100 million reserve price). When no other parties registered their interest, the existing operators' licences were renewed without the need for an auction. Indeed, in general, incumbent operators with networks and customer equipment already tailored for the particular spectrum band have already incurred substantial costs that are sunk in the sense that only a proportion of the total costs may be recoverable if they are unsuccessful in retaining their licence. As such, incumbent operators will bid for the spectrum on the basis of the expected profitability of the services excluding the sunk costs, i.e., the sunk costs have already been borne regardless of whether the operator retains its licence. In contrast, a new entrant would need to factor in all its costs in establishing its business were it to win the licence. Thus, in many cases incumbent operators would be expected to win an auction and thus the costs and uncertainty created by re-auctioning are unlikely to be justified in those cases.

4.2. Administrative versus market-based approaches in general

Where an authority has decided not to renew existing rights or where rights to spectrum are to be assigned for the first time, there are three main approaches to assigning the future rights to use that spectrum band.

- Administrative approaches involve the licensing authority assigning rights on the basis of a number of criteria (such approaches are sometimes called 'beauty contests').
- Market based approaches (particularly auctions) involve the licence being assigned to whichever party bids the most for the licence (with that bidder either paying the amount of its own bid or in some cases the amount of the second highest bid).

- A hybrid approach combine aspects of the two main approaches such as where the licensing authority initially selects a short-list of bidders based on administrative criteria and then holds an auction to assign the licence between the bidders.

Administrative approaches are often seen as desirable on the grounds of allowing a range of criteria to be taken into account such as where applicants present plans for coverage extensions and the introduction of new or higher quality services. Administratively set licence fees are likely to be below the fees that would be determined at auction and this can improve operators' ongoing financial viability to assist in raising capital for network investment. Administrative approaches may also be cost efficient where there is no real competition for the licence such as where sunk costs imply that only one particular operator is expected to win any competitive process. On the other hand, administrative approaches may result in licences being assigned to the operator that presents an attractive proposal rather than necessarily the operator that can use the licence to generate the greatest benefits for society. There are a number of cases in which commitments provided at the time of licence renewal are later not met. Administrative discretion is also more vulnerable to bias or even misuse, which can lead to administrative approaches ending in legal disputes. This typically occurs in instances where clear tender procedures and evaluation criteria are not applied. Finally, while there are grounds to believe that high licence fees will have a limited impact on future investment (in terms of that investment being based primarily on the expected returns on that future investment), it may be the case that high licence fees increase an operator's cost of capital and this can result in lower investment than otherwise.

Auctions have the desirable property of assigning the licence to the operator that attaches the highest value to the licence, which will generally be the operator that can generate the greatest benefits to society from the licence. While the final assignment will be determined by price, non-price objectives can be targeted through including particular conditions in the licence to be auctioned (see Section 7). Auctions can also be highly transparent and maximise revenue for the government given the number of licences being assigned. As with administrative approaches, outcomes in practice from auctions may not always be efficient, particularly where poor auction rules lead to coordination between bidders. However, the deficiencies of auctions can generally be remedied by attention to auction design whereas the problems of administrative discretion may be less easily dealt with.

Licensing authorities should determine the approach or combination of approaches to assigning licences, taking into account their particular objectives as well as the likely advantages and disadvantages of the different approaches in the particular market context, drawing on both theory and practical experience. Particular criteria to take into account are:

- how best to ensure that the licences are assigned to the most valuable use for society;
- ensuring the Government receives a fair return on spectrum without risking charges that are so high that valuable spectrum is left idle;
- the cost effectiveness and transparency of the differing assignment approaches; and
- competitive neutrality across technologies and players.

Whether an administrative or market-based approach is adopted, importance should also be attached to the detailed design of the approach. This includes: (i) ensuring a transparent process with sufficient time and information being provided to maximise participation; (ii) determining which operators should be eligible to apply/bid and whether the design should treat incumbent operators and new entrants equally; (iii) how to determine the price in a beauty contest or the reserve price for an auction; (iv) what non-price objectives should be targeted either in the beauty contest criteria or in licence conditions; and (v) what rules should govern participants particularly to prevent coordination. Public consultation on the design of the licensing approach can help in ensuring that all key issues are taken into account.

4.3. Issues in auction design particularly in relation to spectrum for mobile broadband services

There is no single auction methodology that is best in all situations. The appropriate auction design will depend on the specific objectives of the auction, any relevant legal, regulatory, and institutional constraints, the characteristics of the licence(s) being auctioned and the likely competition for the licence(s) and the likely competition in the downstream markets for services to end-users.

Objectives of the auction

Licensing authorities can in practice seek to pursue a variety of objectives including efficiency (i.e. the winning bidder is the bidder who values the opportunity the most), optimal revenue and price, and various policy goals (for example, to increase post-auction competition in the downstream markets). Sometimes these objectives can conflict in which case the authority will need to balance them in its choice of design. For example, the immediate revenues from an auction can be maximised by licensing only one mobile operator. However, to do so would come at a large cost to the overall economy through high prices for mobile services as well as the loss in the competitive discipline to provide high quality and widely available services. Creating a monopoly mobile operator would constrain the growth of all the other sectors of the economy that rely on mobile communications. The government would then have less ability to raise as much revenues from these other sectors. As such, licensing authorities should aim to ensure that the auction leads to effective competition in the downstream markets for end-user services. Such auctions can still raise substantial revenues for governments including in terms of both licence fees as well as higher general taxation revenues from the faster economic growth enabled by competitive communications markets.

A recent report has identified approaches to spectrum licensing that can boost government revenues while maintaining competition in downstream markets.[33] These include: establishing clear rights and obligations in licences; maintaining a predictable regulatory approach including in relation to future spectrum charges and taxes on the industry; promoting participation in the auction, flexibility in the auction of spectrum that bidders may bid for and setting reserve prices to ensure a floor price for spectrum in case competition is weak but to avoid setting the price too high as to risk valuable spectrum being unsold.

Sealed-bid auctions versus open auctions

Two main types of auctions are:

- Sealed bid auctions where each bidder submits one bid without knowing what others have bid and the licence is awarded to the highest bidder who pays either their bid (first price sealed bid) or the highest losing bid (second price sealed bid); and
- Open auctions in which there are multiple rounds of bidding until only one bidder remains

Sealed bid auctions can be relatively easy to run, attract entry, reduce the risk of collusion and can potentially raise more revenue than open auctions if competition for the licence turns out to be weak. However, sealed bid auctions for licences that will support mobile broadband have a major drawback in that bidders are prevented from gaining useful information on how much others are valuing the licence. Mobile broadband services are still relatively new and there is significant uncertainty over the future demand for the services and the path of technology. Open auctions in which there are multiple rounds enable bidders to gain information on how others view the development of the market. For the bidder, this helps avoids the problem of the winner's curse where they bid based on excessively optimistic assumptions about the market and then find that they are unable to earn revenues to recover the licence fees (with the risk of bankruptcy). Licensing authorities can also gain from open auctions. First, efficient use of spectrum is promoted where bids are put forward taking into account as much useful information on the market as possible. In doing so, the licence is more likely to go to the party that can generate the greatest value from the spectrum rather than a party

[33] Dotecon, *Collecting revenues from spectrum – A report for GSMA*, February 2012.

whose limited information on the market leads them to over-estimate the value of the licence to them. Second, knowledge of the risk of winner's curse will lead to parties discounting their valuations so that the uncertainty over the market's development leads to lower bids in general. An open auction can thus lead to higher licence fees being paid and with the licences more likely to go to the parties that can make best use of the spectrum.

In addition to establishing the objectives (and constraints) for the auction, the choice of auction will also depend on the characteristics of the licence(s) being auctioned. For example, how important is the common value component of the licence: the common value is the component of value derived by the bidder from the licence that is correlated across bidders. When the common value is important and there is uncertainty about the common value itself, the auction design should aim to mitigate the "winner's curse" effect in which bidders bid conservatively for fear of "outbidding the market." Finally, the best design can depend on who is likely to bid in the auction: how many bidders, the similarities and differences amongst bidders, and how strong are these asymmetries amongst bidders.

Simultaneous Multiple Round Auctions are the most well established type of open auction for mobile spectrum. Bidders bid on single licences in a series of rounds and the auction stops when no new bids are submitted on any licence. Combinatorial auctions instead allow bidding for packages of items. Combinatorial clock auctions are a particular type of auction that has been adopted by a growing number of regulators for recent licensing of spectrum relevant to mobile services. This auction format involves several stages: (i) a first clock phase in which prices for different categories of spectrum lots are increased with bidders allowed to make a bid for a package of lots across multiple categories until the price level is reached where there is no excess demand remaining for any of the lots; (ii) a supplemental sealed-bid round in which bidders make their best and final offers for all combinations of spectrum they want with their bids being required to be consistent with their bids in the first phase; (iii) the assignment phase in which the winners from the supplemental round (i.e. those who made the highest value combination of bids) can offer to pay extra to secure a specific spectrum lot from within the relevant category. However, combinatorial clock auctions are more complex and a relatively new concept for spectrum allocations. The rules to achieve optimal outcomes in a combinatorial clock auction are still evolving. These auctions have been used to assign spectrum for mobile services recently in Austria, Denmark, the Netherlands and the UK.

The following table lists a number of upcoming auctions.

Table 1 – Upcoming mobile spectrum auctions

Country	Spectrum band	Proposed auction date
Albania	2.1 GHz	Early 2012
Australia	700 MHz and 2.5 GHz	Late 2012
Austria	800, 900 and 1800 MHz	September 2012
Brazil	450 MHz and 2.6 GHz	June 2012
Canada	700 MHz, 2.5 and 2.6 GHz	Late 2012
Chile	2.6 GHz	Q2 2012
Colombia	1700 and 1900 MHz, 2.1 GHz	Under consultation
Czech Republic	800 and 1800 MHz, 2.6 GHz	Consultation Mar 12
Denmark	800 MHz	May 2012
Finland	800 MHz	By end of 2013
Hong Kong	2.5 and 2.6 GHz	Targeting Q1 2013
Hungary	900 MHz, 2.6 GHz	Early 2012
India	700 MHz	Possibly 2014
Ireland	800, 900 and 1800 MHz	During 2012
Lithuania	2.5 and 2.6 GHz	Early 2012
Netherlands	800, 900 and 1800 MHz	Planned for October 2012
New Zealand	700 MHz	November 2012
Nigeria	2.6 GHz	Under consultation
Norway	800 MHz	Under consultation
Pakistan	700, 800 MHz, 2.1 GHz	March 2012
Peru	1700 MHz and 2.1 GHz	Under consultation
Poland	1800 MHz & 800 MHz and 2.6 GHz	Mid 2012 & During 2013
Romania	800, 900, 1800 MHz and 2.6 GHz	Under consultation
Slovakia	900 and 1800 MHz	Auction proposed, no timeframe
South Africa	800 MHz and 2.6 GHz	Postponed until further notice
Sweden	2.3 GHz	During 2012
Thailand	2.1 GHz	Late 2012
United Kingdom	800 MHz and 2.6GHz	2012

Source: Various

In the following sections, we consider the experience of spectrum licensing in Bangladesh which has been carrying out a licence renewal process and South Africa where a specific proposal has been made for the licensing of digital dividend spectrum.

4.4. Spectrum licence renewal in Bangladesh

Bangladesh has allocated significant spectrum in the 800-900 MHz and 1800 MHz band, although it is still to licence spectrum in the 2.1 GHz band.

In 2011, Bangladesh's regulator determined arrangements for the renewal of the existing 2G spectrum licences. The renewal of these licences will ultimately give Bangladesh's GSM and CDMA operators security over their rights to spectrum for an initial period of 15 years which will enable them to plan for investments in the development of their networks. The regulator also included a provision for the future refarming of the spectrum to be used for 3G services. However, to date, the 2G licence renewal process is not yet finalised, creating uncertainty for the operators.

The licence renewal process in Bangladesh did indicate a number of areas where improvements to the process could have been made to better support the development of the industry in the interests of Bangladesh's consumers.

First, the rules themselves were still being decided in the months leading up to expiry of the licence and a court case relating to the payments to be made was only decided this year after the expiry date. Given that mobile services required network investments with long pay-back periods, licence renewal should be determined years in advance of the licence expiry date so as to avoid necessary network investments being postponed. Further, operators need time to arrange funding when large amounts are to be paid.

Second, there was little transparency over the basis for the determination of licence fees and the resulting structure does not appear consistent with promoting efficient use of spectrum. The general level of fees was set at the same level for 900MHz and 1800MHz spectrum and at a lower level for the 800MHz spectrum used by the CDMA operator. However, the lower the frequency band, the more valuable the spectrum because it enables coverage to be achieved at lower cost. Thus higher fees for lower band spectrum would have better reflected the opportunity cost of the spectrum. The level of fees does not appear to have been set on any objective basis. While comparisons could be made with other countries, these should take into account all significant factors impacting on the value of spectrum. For example, Bangladesh's taxes on the mobile sector are amongst the highest in the world which will significantly impair the profitability of investment in the sector even before payment of the spectrum fees. An additional issue in the fee structure is that the regulator imposed a utilization factor requiring operators with more subscribers to pay higher fees even for spectrum in the same band. This effectively punishes operators for seeking to attract new subscribers and thereby can reduce the intensity of competition. It will also undermine the efficient use of spectrum as operators who make poor use of spectrum by using the spectrum to supply relatively few subscribers pay lower fees. It should also be noted that in addition to the licence fees, Bangladesh's operators face the highest mobile-specific taxes in the region.

A third area where the licence renewal process could have been improved is by providing for the use of the spectrum for 3G services at the same time as the renewal of the licences. Mobile broadband will be a critical enabler of economic growth in Bangladesh because of the very limited fixed network and yet Bangladesh is already well behind other countries in the availability of 3G services. Further, while initial 3G services in other countries were offered at 2.1 GHz, many countries are now also supplying 3G using the 900 MHz band and the 1800 MHz band. Accordingly, there is no technical reason as to why restrictions on the use of the 900 MHz and 1800 MHz could not have been removed already to enable the rollout of 3G services in those bands.

Bangladesh's regulator and Ministry are currently defining guidelines for the 3G licensing process, expected to take place later in 2012. While the issuing of 3G licences would ideally have been made much earlier, the auctioning of this spectrum will greatly help Bangladesh's operators in meeting demand for mobile services including the take-up of mobile broadband. The choice of an auction for the assignment of the spectrum should greatly help in leading to a transparent and fair process with spectrum going to the operators that are likely to be able to generate the greatest benefits from the use of the spectrum.

The success of the auction will nonetheless depend on its detailed arrangements which are still to be determined. Of the information that has been provided by the regulator to date, two particular aspects are of concern. First, the regulator has stated that the state-owned operator will not be required to bid but will receive 3G spectrum for a payment equal to the amount of the highest bid. The state-owned operator will also be given a 6 month head-start in launching 3G services. It is not clear what the rationale is for having a state-owned mobile operator. Bangladesh's other operators show that competitively provided mobile services can be supplied by private operators without the need for a state-owned operator. If the Government were to instead sell the operator, it will gain funds that it could use to increase support to services that are reliant on government support such as health and education services to low income households. To the extent that Bangladesh's Government considers it important to retain ownership of the operator, that operator should nonetheless be treated on an equal basis with other operators. In guaranteeing spectrum for the Government-owned operator, the regulator may prevent another operator from being able to use that spectrum even when it could better use that spectrum in delivering services to consumers. If that is the case, then Bangladesh's consumers would be made worse off. A final concern is that the regulator has indicated that if a new operator wins 3G spectrum, that operator will also be given the opportunity to acquire 2G spectrum. If that situation arises, it will be important to ensure that the 3G auction is not distorted by arrangements for the 2G spectrum. For example, if the new entrant were able to acquire 2G spectrum at less than the market price then they might be prepared to pay more for the 3G spectrum to take advantage of this opportunity. In that case, the 3G spectrum would not necessarily go to the operators who could best generate value for society from the use of the 3G spectrum.

In summary, while the Bangladesh's regulator is taking decisions to support the development of its mobile industry to the benefit of consumers, there is nonetheless, in the detail of the decisions, considerable scope for the regulator to align the process more closely with international best practice and thereby generate greater value to Bangladesh's consumers from the use of the country's scarce spectrum resources.

4.5. Spectrum assignment in South Africa

Mobile spectrum licences were initially directly assigned by the South African Government. Two licences were granted in 1993 with a licence for a third operator being granted in 2001 and with Telkom establishing the fourth network following the divestment of its stake in one of the original operators, Vodacom.

The South African Government and the regulator, ICASA, have been seeking to introduce more market-based approaches to assigning and managing spectrum. The Government's Radio Frequency Spectrum Policy for South Africa, released in April 2010, sets out an overall framework for spectrum policy with the aim of promoting efficient use of spectrum resources in the national interest.

In December 2011, the South African Government published draft policy directions for the assignment of spectrum in the frequency bands 790 – 862 MHz ("800MHz") and 2500 - 2690 MHz ("2.6GHz")[34] and invited applications for the licences[35]. The 800MHz spectrum (together with 2x10MHz of the 2.6GHz spectrum) is to be licensed to one wholesale open access network as the Government considers that there is insufficient 800MHz bandwidth to support full network competition. The wholesale access conditions include "no locking" (no prohibitions against devices that may be connected to the network), "no blocking" (no restriction against legitimate content, applications, and services), and "no retail" (entity will not be allowed to compete with its customers).[36] Multiple operators can apply for licences in the 2.6GHz band (with the proposal for some spectrum to be exclusively for new entrants and for some to be available in the future for sharing by a group of operators which the Government labels a Managed Spectrum Park model).

The proposed licensing process involves a number of phases. Phase 1 involves prequalification criteria, including 30 per cent ownership by Historically Disadvantaged Individuals (HDI), holding an electronic communications network service license and financial credibility such as proof of funding. Phase 2 involves comparative selection (i.e. a 'beauty contest') which takes into account the business plan (20%), technical plan (20%), market innovation and stimulation (15%) and the network rollout plan (50%). Minimum network rollout requirements have been specified for the open access network and for the 2.6GHz only licensees. If more than one applicant meets the prequalification criteria and passes the threshold points required in Phase 2, then the applicants will move to Phase 3 in which they submit seal bids. Phase 4 involves granting the licences to the highest bidder.[37]

The duration of the radio spectrum licence would remain valid from 1 April until 31 March of the following year, and thereafter will be renewable by payment of the annual licence fee for 15 years or the duration of the ECNS licence, whichever comes first.[38]

The proposal is currently suspended to take into account a forthcoming policy announcement on high demand spectrum.

Assessment of the new South African proposals

The South African Government has recognised the importance of releasing additional spectrum to achieve widespread access to mobile broadband. The open access network proposal is a practical way forward which limits the potential harm of a single provider, although the first best approach would have been to try to make sufficient lower bandwidth spectrum available to support competing providers. This is particularly important given the substantially better propagation properties of that spectrum. A number of details of operation of the proposed open access network remain to be determined (such as to how congestion in local hotspots would be resolved), although these should not prove insurmountable.

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[34] Department of Communications (2011), *Notice 898 of 2011 Policy Directions Drafted in Terms of Section 3(2) of the Electronic Communications Act, 2005 (ACT No. 36 of 2005),* available at:

http://www.info.gov.za/view/DownloadFileAction?id=156635

[35] ICASA (2011), *Draft Invitation to Apply for Radio Frequency Spectrum License to Provide Mobile Broadband Wireless Access Service for Urban and Rural Areas Using the Complimentary Bands, 800 MHz and 2.6 GHz.*

[36] ICASA (2011) *Notice 911 of 2011,* p. 4 -5, available at:

http://greengazette.co.za/documents/national-gazette-34872-of-15-december-2011-vol-558_20111215-GGN-34872.pdf

[37] Ibid, p. 24

[38] ICASA (2011), *Draft Invitation to Apply for Radio Frequency Spectrum License to Provide Mobile Broadband Wireless Access Service for Urban and Rural Areas Using the Complimentary Bands, 800 MHz and 2.6 GHz*, p. 22, available at:

http://greengazette.co.za/documents/national-gazette-34872-of-15-december-2011-vol-558_20111215-GGN-34872.pdf

There are a number of reasons to question aspects of the qualification criteria and comparative selection round. Generally allocating licences to the highest bidders can be expected to lead to those bidders to aim to supply services in the way that generates the greatest benefits to consumers because in doing so they maximise their own returns. The main exception would be if a licence were acquired to limit competition, although such rules can be adopted to prevent this. A comparative selection leads to the licences being assigned based on the regulator's, rather than consumers', view of the value of different service features. Further, where a regulator is being called upon to assess the business plans and strategy, then there is a risk that product variety and innovation will be constrained either because the regulator might wrongly reject a very innovative plan as impractical or because bidders design their plans with the aim of appealing to the regulator's interests rather than consumers' interests.

The requirement for the bidder to have 30% HDI ownership may appear a desirable way of reducing inequality; it could reduce significantly the revenues that would otherwise be earned by the Government. The forgone Government revenues might have been able to fund expenditures that could more effectively alleviate poverty.

The choice of a sealed bid auction has the advantage of simplicity and can also encourage entry as well as limit the risk of collusion. However, it is not clear to what extent the Government has considered the relative merits of alternatives such as a multiple round ascending auctions (which can enable bidders to gain from information of earlier bids which may, for instance, encourage them to bid more highly than they otherwise would do) or a sealed bid auction in which the winner pays a fee for the licence equal to the second highest bid (such an auction can be expected to encourage bidders to bid their true valuation rather than a discount to that valuation).

4.6. Recommendations

Following are our key recommendations in relation to the assignment of licences and the approach to licence renewal.

- *Recommendation 9* – Licensing authorities should clearly set out their approach to licence renewal in advance (a range between 2 to 4 years as a minimum should be adequate) of the expiry of the licence so as to avoid network investment being postponed. The authorities should publish the criteria that they will use to assess renewal as well as the terms and conditions that will apply to the renewed licence.
- *Recommendation 10* - There should be a presumption in favour of licence renewal for operating and spectrum licences to encourage long-term investment and minimise the risk of service disruption to customers. Reasons for not renewing licences should be limited to spectrum replanning, where there is little risk of stranding substantial investments, or where there has been a serious breach of licence conditions which should be evident in advance of the renewal time. Exceptionally, a licence may not be renewed in relation to the whole or part of the relevant spectrum so as to promote competition through re-assignment of spectrum. However, before not renewing a licence for this reason, regulators should first (i) assess whether competition is already effective in the market; (ii) identify whether competition can be promoted by other means such as the release of alternative spectrum; and (iii) assess whether the expected competition benefits will exceed the potential costs such as in relation to spectrum replanning, customer migration and the risk of deterring investment.

- *Recommendation 11* – Re-auctioning spectrum at the end of the licence should be limited to situations where there has not been evidence of substantial investment and there is a reasonable prospect that spectrum will be re-assigned between operators (or where additional, alternative spectrum is being made available), or situations where an existing licensee decides to reject a licence renewal offer. In most cases, the existing operators would be expected to re-acquire the licence with the consequence that an auction only creates unnecessary uncertainty and costs.
- *Recommendation 12* – Where spectrum is to be re-assigned or assigned for the first time, licensing authorities should determine the approach or combination of approaches to assigning licences taking into account their particular objectives as well as the likely advantages and disadvantages of the different approaches in the particular market context drawing on both theory and practical experience. Licensing authorities should attach priority to ensuring effective competition in downstream markets for services to end-users. Whether an auction or beauty contest is adopted, the detailed design of the approach is important. Open auctions are likely to be superior to sealed bid auctions for spectrum relevant to mobile broadband services in terms of promoting efficient spectrum use.

5. Pricing of mobile licences

A wide variety of approaches have been adopted for determining the fees to be charged in relation to mobile licences. In this section, we first evaluate different pricing objectives and then examine the various pricing approaches against a range of criteria.

5.1. Objectives

Licence fees can be set for three main purposes:

- to recover the administrative cost of the licensing process itself, of administrative management of spectrum and associated regulatory costs;
- to encourage efficient spectrum use such as where the level of the licence fee is determined in an auction or where it is set at the level estimated to be in line with the market value of the licence; and/or
- to raise revenue for the government.

The first objective of setting the licence fee to recover the cost of the licensing process is particularly common in relation to operating licences and for spectrum licences where there is no excess demand for a particular spectrum band. We discuss this pricing approach further in the next section.

Where there is excess demand for spectrum, the level of licence fees may serve an additional purpose of helping to assign scarce spectrum resources efficiently, i.e., so that spectrum is assigned to the user that is able to generate the greatest value to society from its use. Auctions can be expected to function in this way. Alternatively, even where spectrum rights are assigned using an administrative process, setting the licence fee in line with the opportunity cost of the spectrum[39] can promote efficient spectrum use. For spectrum that has previously been assigned, charges set in line with the opportunity cost of spectrum may also facilitate efficient spectrum use if that spectrum is not already assigned to its highest value use. Where the spectrum is already in its highest value use then raising the licence fee would bring no efficiency benefit and may even harm efficiency if the level is set too high so that valuable spectrum is left idle. As we discuss in Section 7, where spectrum trading is effective then the market can be expected to result in spectrum being assigned to the user who can generate the most value from the use of the spectrum without any need for a licence fee to be set to achieve efficient spectrum use.

A third potential objective of setting a licence fee is to raise revenue for the government. It is reasonable for governments to seek to earn a fair return on selling rights to use public resources such as spectrum and such a return may be achieved either from an upfront licence payment or from ongoing taxes and charges. However, there is the need to ensure that the licence fees are not set so high as to harm investment and the efficient development of the sector. High upfront licence fees can deter new entry and lead to debt levels which increase the cost of raising funds for investment in network and service deployment. High ongoing charges flow through into high mobile prices which can retard growth in the number of subscribers and limit call volumes and ultimately high overall economic growth. A number of studies have found that reductions in mobile specific taxes can have a significant positive impact on subscriber numbers and overall economic growth.[40] The faster growth of the sector, in turn, acts to limit any loss in government revenues – indeed, in certain cases, overall

[39] The opportunity cost of spectrum is the value of the spectrum in the best alternative use which is the highest price that would be offered by a rival bidder at auction. In this Section, we discuss a number of approaches to determining the opportunity cost of spectrum. Note that where there is no excess demand for a particular spectrum band, then the opportunity cost of that spectrum band falls to zero.

[40] For instance, see Deloitte, *Global mobile tax review 2006-2007*.

government revenues may even increase from lower rates of tax on the mobile sector. The studies' finding that lower mobile specific taxes and charges may boost overall economic growth is in line with general taxation theory that it is more efficient to raise revenue from as wide a base as possible.

In short, there is a strong economic case to avoid the level of licence fees being determined on the basis of revenue maximising objectives. Rather licence fees should be limited to recover the administrative costs of the licensing process and, in some circumstances, set higher to encourage efficient spectrum use (i.e., where efficient spectrum use would not otherwise be achieved).

5.2. Pricing approaches

We now turn to examine particular pricing approaches that have been applied in practice.

Setting fees to recover administrative costs of licensing

Licence fees in a number of countries are set to recover the administrative costs of the licensing process and regulatory costs associated with the licensed activity. This pricing approach is in line with a user-pays principle (i.e., that telecommunications users should ultimately bear the cost of licensing activity incurred to support the provision of the particular services).

The European Union's Authorisation Directive (Art. 12) provides for EU Member States to levy administrative charges but requires that the total amount of the charges should not exceed the administrative costs incurred in relation to management, control and enforcement of the licensing scheme and in relation to associated regulatory activities. The Directive also requires that the charges be imposed in an "objective, transparent and proportionate manner which minimises additional administrative costs and attendant charges".

It is important that the licensing authority faces external control to ensure that costs are kept at efficient levels and in that regard the funding arrangement should also be relatively simple and practical. Further, the licence fee should be collected across the industry in a competitively neutral manner and avoid creating incentives for firms to restructure their activities so as to reduce their liability for the charge.

The European Union's Authorisation Directive (Art. 13) also provides for fees to be levied, where objectively justified, for the rights to use radio frequencies which reflect the need to ensure the optimal use of these resources. We next consider how such charges might be determined.

Auctioning or re-auctioning of spectrum

Auctioning of spectrum provides the most transparent and direct way of determining the market or efficient price for spectrum. However, as discussed in Section 4, auctions will not always be appropriate. As such, indirect ways of estimating the market price of spectrum may be desirable in many cases. Even in these cases, licensing authorities may decide to maintain the option for existing licensees to decline to pay the regulatory-determined price and instead to re-bid for the spectrum rights at auction. This can provide a safeguard against the regulatory-determined price being set too high with the risk that valuable spectrum is left idle.

Marginal forward-looking opportunity cost (MFLOC)

The MFLOC approach is based on estimating the change in costs that would result for an operator, operating an optimal network, to maintain the same quantity and quality of services to customers if it were to gain or lose an increment of spectrum. For example, if a mobile operator were to gain a marginal unit of spectrum then it would need fewer base stations (and other inputs) to maintain the same volume of services and service quality. Those additional network costs that the operator incurs represent the opportunity cost of using that marginal unit of spectrum for another purpose rather than the operator using it. The MFLOC can thus be estimated by modelling how a network's costs would change with and without additional spectrum while maintaining the same quantity and quality of services.

The rationale of a MFLOC approach is to promote efficient spectrum use by encouraging holders of spectrum licences to return their licences (or part of their licensed spectrum) whenever the value they place on the licence (or part of the spectrum) is less than the price charged. The choice of the optimal network is akin to a forward-looking cost approach of using the costs that would be incurred by a new entrant using the least cost modern equivalent assets for supplying the services. Estimating the MFLOC can be useful for spectrum that is not sold at auction or that is not tradable. Charges based on MFLOC may be particularly relevant to public sector users of spectrum who may not face incentives to maximise the value from their use of spectrum with the risk that spectrum assigned to them is poorly utilised.

The Australian Communications and Media Authority (ACMA) has decided to use opportunity cost pricing to improve incentives for the efficiency allocation and use of spectrum in cases where it sets prices for administratively allocated spectrum. In particular, the ACMA has decided to prioritise the introduction of opportunity cost pricing for spectrum bands where an auction is not considered optimal but where: (i) there is evidence of congestion; (ii) there is evidence of inefficient pricing; (iii) new high value uses become apparent; (iv) there are expected net benefits to opportunity cost pricing; or (v) opportunity cost pricing is expected to contribute to its statutory objectives.[41] The ACMA also noted that opportunity cost pricing will not always be justified as the expected benefits may not outweigh the costs.

Calculating the MFLOC directly can rely on assumptions with consequent uncertainty over the actual level. A risk of an MFLOC charge being calculated incorrectly too high is that efficient spectrum use may be undermined. As such, choosing a conservative value from within the estimated range for MFLOC will be appropriate. Further, if the charges are imposed where they do not affect the use of spectrum (i.e., where spectrum is already in its best use), the charges will simply represent a transfer of income from customers of the services using the spectrum to the Government rather than promoting efficiency. We turn next to consider indexation and benchmarking which may be more practical means to estimate the opportunity cost in particular circumstances.

Indexation of historical fees

An alternative way of arriving at an estimate of the current market price for spectrum is to take the original price (particularly if it has been determined at an auction) and adjust this price by an estimate of how much the forward-looking value of the spectrum has changed over time. For instance, the New Zealand Government has applied this approach to the renewal of AM and FM radio licences based on adjusting the original auction prices for the spectrum by a growth factor estimated to reflect the change in value of the spectrum up to the time of reallocation (in practice, the value may have increased or fallen over time). The change in value was estimated based on comparing net cash flows from the current period with expected net cash flows over the period of the renewed licences taking into account revenue drivers. The Government's own advisors rejected the use of an indexation approach for mobile services in New Zealand given the significant technological and commercial

[41] ACMA, The ACMA response to public submissions: opportunity cost pricing of spectrum, January 2010, p.4.

changes impacting the mobile market since the time that the initial licences were issued. However, this approach could be considered for licences where historical prices have been more recently determined and where the development of market values over time is less uncertain.

Benchmarking

Another way to estimate the market price for a particular band of spectrum is to use benchmarks based on recent prices determined in auctions or in secondary trading of spectrum either for similar spectrum in the same country or in other countries. A benchmark will provide a reasonable estimate provided that:

- the chosen benchmark is for spectrum that can be expected to have a similar market value to the particular band given the demand and cost factors impacting on the use of the spectrum; or
- robust adjustments can be made to the chosen benchmark to account for any differences in demand and cost factors.

Relevant demand and cost factors that would need to be controlled for include population and population density, GDP per capita, the type of spectrum, license duration, license conditions and expected future releases of spectrum in the market.

In Pakistan, prices for the renewal of licenses for the existing mobile operators were determined on the basis of prices paid at auction for licenses provided to 2 new entrants. Pakistan's Government was able to draw on the results of a recent auction for similar spectrum. Where a comparable price exists then benchmarking may be a practical means to estimate the fee for a new license. Benchmarking may also be useful as a cross-check on the reasonableness of other approaches.

Discounted Cash Flow (DCF) modelling

DCF modeling seeks to value spectrum on the basis of the present value of the future cash flows that the use of the spectrum is expected to generate. In particular, the modelling estimates the discounted present value of expected future revenues from the output produced by the asset, less the present value of associated future operating costs and taking into account any potential future re-sale value for the spectrum rights. An investor would be expected to be prepared to pay a price for the spectrum up to the value at which it can no longer make a commercial return on the investment given the expected future cash flows.

DCF modeling would be problematic if it were used to seek to capture all the economic profits of an operator that has already incurred significant sunk costs in building its network.[42] This is because it is the opportunity to earn such profits that provides the incentive for such investment. DCF modelling can also be highly complex and contentious, particularly as uncertain forecasts of future demand can have a significant impact on the valuation. Accordingly, there may be a large margin for error in relation to DCF modelling, particularly given the information available to the regulator.

An alternative approach of establishing the value of spectrum would be to seek to disaggregate the market capitalisation of a listed operator so as to identify the value attributed to the spectrum rights. However, it is unlikely that this approach can be applied robustly in most cases because of uncertainty over the value of non-spectrum assets as well as volatility in share prices. Sales of wholesale capacity are also unlikely to provide a reliable approach because of uncertainty of the value of the non-spectrum assets.

42 DCF modelling could instead be used to estimate the MFLOC of spectrum by valuing the spectrum to an operator at the margin. As such, it would have the efficiency properties in principle described above under the MFLOC section as well as the difficulties of estimation in practice.

Annual versus upfront licence fees

In addition to determining the amount of licence fees to be recovered, there is also a question of the structure of the fees, particularly in relation to whether the full amount should be recovered upfront, by annual charges or by a combination of the two.

As a matter of principle, licence fee payments should be aligned with the timing of rights for a licensee to access and earn a return from the spectrum asset.

Recovering licence fees through an upfront payment may help ensure that spectrum is allocated to only serious operators. Upfront fees also imply that, once the fees have been paid, they will not affect the pricing of services as operators will set their prices to maximise their profits given the competition in the market regardless of what they have paid previously.

Annual charges, on the other hand, may encourage new entry. Particularly where entrants would have difficulty raising a large upfront payment and where the risk of entry is reduced by being able to return the licence if their business does not succeed. Royalties, i.e., annual charges levied as a percentage of revenues, can further reduce the risk to new entrants as their payment to the Government will be relatively small while their revenues are small. However, precisely because royalties imply a relatively small payment for operators that are making little use of its spectrum, royalties may undermine efficient spectrum use - indeed some licensees may choose to hold off making any network investment. Further, the actual royalty rate in practice tends to be highly political and contentious.

Annual charges carry a further problem in that they will tend to be factored into service prices. This is particularly the case where the level of charges varies with service volumes as occurs with royalties, i.e., where a charge is set as a percentage of revenues. As discussed above, earlier reports for the GSMA have found that mobile revenue taxes in some countries are so high that they are significantly inhibiting the growth of the mobile sector. Further, in markets in which competition is limited, royalties can also exacerbate the welfare loss arising from any excess pricing.

5.3. Comparative summary

Table 2 summarises the advantages and disadvantages of the different pricing options.

Table 2: Assessment of pricing options

Approach	Advantages	Disadvantages
Pricing to recover administrative costs of licensing process	Appropriate for operating licences and where spectrum is already in its best use or where there is no excess demand for spectrum	May not lead to efficient spectrum use where there is excess demand for spectrum
Re-auctioning	Accurate market value (subject to auction design and competition among bidders in the auction)	In the context of licence renewal, can create substantial uncertainty and significant administration costs
MFLOC	Can promote efficient spectrum use (subject to accuracy of estimate)	Difficult and contentious to model
Indexation of historical prices	Simple and transparent where changes in market values from historical prices can be estimated	Accuracy depends on the extent to which the change in market values over time can be estimated
Benchmarking	Simple and transparent where close benchmarks exist	Can be misleading if no close benchmarks exist because of differences in the nature of spectrum bands or differences between markets
DCF modelling	Can be accurate in principle	Requires detailed modelling and may be highly inaccurate given uncertainty over forecasts. Assumptions may prove contentious. DCF modelling would carry a large risk of deterring investment if it were used to seek to capture all the economic profit from acquiring a licence
Royalties	Reduces risk for licensees compared with upfront charges and encourages new entry	Royalties act to increase service prices. Royalties can also undermine efficient spectrum use as operators with low revenues make only small payments

In the case of several bands being renewed or auctioned simultaneously, it is important to ensure that appropriate consideration is given to pricing relativities between the bands in order to avoid distorting investment decisions toward inefficient deployments.

5.4. Reserve prices

A separate pricing issue to the level of licence fees is what approach licensing authorities should take to setting reserve prices in auctions. Reserve prices help discourage non-serious bidders and they can also ensure a floor price for spectrum in case competition for the licences are weak. However, reserve prices should be set conservatively rather than to try to match the expected market price. This reflects the danger that even a reserve price that is set a little too high may lead to the auction failing to assign the licence. If a licence fails to sell, there can be unnecessary administration costs in needing to hold another auction and consumers can also be harmed by the delay in the spectrum being able to be used. Where competition is expected to be strong, reserve prices can be set as minimum safety net as competition in the auction will ensure a fair price for the spectrum.

3G licensing experience shows the problem that can be caused by inappropriately set reserve prices. High prices for 3G licences auctioned in 2000 in Germany and the UK led to a number of countries setting high reserve prices in 2001. However, these countries failed to recognise that the UK and German experience was not directly applicable to countries with smaller populations and that in any event market expectations changed fundamentally with the end of the dotcom boom. As a consequence, licences failed to sell in Belgium, Singapore, Greece, the Czech Republic and Israel in 2001. In later auctions, authorities applied more appropriate reserve prices and in most subsequent 3G auctions all licences were sold. The experience of 3G licensing shows the need for caution in using benchmarking for setting reserve prices and, in particular, to take into account local market conditions expected to prevail at the time of the auction.

5.5. Recommendations

Following is our key recommendation in relation to licence fees:

- *Recommendation 13* - Licence fees, if any, should generally be limited to recovering the administrative costs of the licensing process and associated regulatory costs (including spectrum management costs). However, where there is excess demand for spectrum, then an auction or administrative assignment of spectrum with a charge set in line with the Marginal Forward Looking Opportunity Cost (MFLOC) of spectrum should be considered. Indexation or benchmarking may prove a practical means to estimate MFLOC in particular circumstances. The MFLOC should be estimated conservatively to reduce the risk that valuable spectrum will be left idle. It is also important that the estimated prices are set appropriately relative to spectrum prices in other bands. The relative merits of upfront licence fees versus annual charges should be considered with regard to the particular market circumstances.

6. Promoting competition through licensing

As access to spectrum is essential for the supply of mobile services, the way that spectrum is assigned and how it is managed on an ongoing basis can impact on the level of competition in the downstream markets for mobile services. As such, it is important for licensing authorities to consider how their decisions may impact on competition for services.

6.1. Promoting competition is a means to an end

Competition is a process of rivalry between firms in a market as they seek to win customers from each other. Competition is important because it helps constrain price levels to efficient cost levels as well as strengthening the incentive for operators to maintain high quality of service and introduce innovative new services so as to avoid losing customers to competitors.

It should be noted that competition is not an end in itself. It is valuable to the extent that it leads to higher social welfare, particularly in terms of lower sustainable prices and better quality services for customers. Achieving the lowest sustainable level of prices will also depend on the costs of operators supplying the services. In markets such as the mobile industry where there are significant economies of scale, it is likely to be efficient for there to be only a relatively small number of operators. In particular, market volumes may only enable a few operators to reach the minimum efficient scale. If a regulator were to try to achieve a greater number of operators, customers could be made worse off because these operators would need to set higher prices to recover their higher unit cost levels. Customers could also be harmed if a regulator prevented an operator that was better at delivering services from being able to expand to meet customer demand. Thus, while having many small competitors may give the appearance of greater competition compared with a market with fewer operators, in terms of what should ultimately matter – outcomes for consumers – a market with fewer but more efficient operators may be better.

A further consideration is that, depending on the market context, rivalry between a few large operators can be intense with additional operators making little difference to the level of competition. Features of the mobile market contribute to greater competitive rivalry including the rapid pace of technological and commercial developments (that imply that it would be hard for operators to reach or maintain coordination between themselves) and there have been generally low barriers to expansion (although regulators could perversely harm competition if operators reach the practical capacity of their spectrum assignments). Longer term evidence of rapid falls in prices also indicates that competition in mobile markets is generally effective.

Competition authorities have recognised that effective competition in mobile markets is consistent with a few, large competitors. For example, the European Commission has allowed in a number of merger regulation decisions for the consolidation of European mobile markets to generally 3 to 4 operators, together with a number of retail services providers.[43] Under the European regulatory framework for electronic communications, market reviews also found that markets with at least 3 mobile operators were generally effectively competitive. Bank of America Merrill Lynch data shows that across developed markets the average number of mobile operators is 3.5 and across emerging

[43] For example, *Case No COMP/M.5650 – T-Mobile/Orange, Case No COMP/M.4748 – T-Mobile/Orange Netherlands* and *Case COMP/ M.3530 - TeliaSonera/Orange.*

markets the average number of mobile operators is 3.9. Of all the countries in the Bank of America Merrill Lynch data set, only three markets have more than 5 significant operators: Bangladesh, India and Nigeria. The US Department of Justice did block the proposed acquisition of T-Mobile by AT&T and expressed the concern that the merger would combine two of the four national mobile providers in the US that between the four of them account for more than 90 per cent of US mobile subscriptions.[44]

6.2. How should licensing authorities assess whether measures to promote competition are warranted?

Competition works by firms expanding or contracting based on their relative success in providing services at prices and quality levels that are attractive to customers. Thus, spectrum policy should aim to support downstream competition by enabling operators to gain the spectrum required to expand. Specific policy measures to promote competition are only likely to be needed where spectrum resources would otherwise become excessively concentrated in the hands of one or two operators and without sufficient spectrum available to support the growth of other operators. In the previous section, we noted that around 3 to 4 national operators is likely to be sufficient to ensure effective competition in most mobile markets. Were a licensing authority to impose measures with the aim of creating more operators, particularly more than 4 or 5 national operators, there would be a significant risk of customers being harmed particularly in terms of facing higher prices than would otherwise be the case.

In assessing whether to impose particular measures to promote competition, licensing authorities should:

- Assess what would be the level of competition in the absence of the measures. Where competition is already expected to be effective then imposing additional obligations may bring little additional benefit while carrying costs such as in terms of spectrum not being assigned to its most valuable use or where the market becomes excessively fragmented resulting in higher costs and prices than otherwise.
- Identify whether there are ways to achieve effective competition that do not constrain the ability of any operator to grow by attracting more customers. For example, it may be possible to free up additional spectrum resources so that all operators can acquire sufficient spectrum for their needs.
- Whether particular measures are introduced to protect or promote competition, it is important to evaluate the costs and benefits of each measure to ensure that benefits do exceed costs and that the particular measure is chosen that is expected to achieve the policy aim at least cost.[45]
- Even where obligations are imposed initially, regulators should undertake periodic reviews of the competitiveness of the market to determine whether such obligations continue to be required.

[44] US Department of Justice press release, 31 August 2011.

[45] For example, the New Zealand Government decided to renew the mobile licences of the major NZ operators except for a part of the spectrum which was made available by the major operators to a new entrant.

6.3. Measures to promote competition

Licensing authorities have imposed a variety of specific measures to promote competition in the downstream services markets. In this section, we assess the experience with a number of these measures.

Spectrum caps and set-asides

Many licensing authorities have adopted spectrum caps and set-asides in licensing mobile spectrum, particularly in the early stages of market development. Spectrum caps limit the quantity of spectrum that can be held by an operator in a particular geographic area. For example, in an auction, bidders may be limited to acquiring only one block of spectrum. Spectrum set-asides reserve a particular block of spectrum for a particular bidder, such as a new entrant.

Spectrum caps and set-asides have the ability to promote competition in markets where competition is limited or would become limited (such as if only one firm were to acquire most of the available spectrum). This in turn can have benefits such as lowering the price and expanding the choice available to consumers. Spectrum caps can increase participation in (and potentially revenue derived from) an auction. Incumbent bidders often have an advantage over non-incumbents; in for example lower incremental cost of network build, so without a spectrum cap non-incumbents may be reluctant to participate in an auction. With a spectrum cap, non-incumbents know that some licenses will be awarded to non-incumbents, encouraging them to secure financing to participate in the auction. This in turn can have the effect of increasing not only competition but also auction revenues.

Spectrum caps can also potentially encourage more efficient use of spectrum, as carriers could have more incentive to invest in capacity enhancing technologies earlier on than they would have done if there was no spectrum cap.

Despite the potential benefits, a spectrum cap does not necessarily lead to a socially efficient outcome. An incumbent provider may be able to integrate any additional spectrum won in an auction into an existing network. That is, the incumbent may be able to provide additional capacity at a lower cost that a new entrant. Alternatively, the incumbent operator may be able to use additional spectrum won in an auction to offer a new service which requires more capacity, but which it could not have offered without the additional capacity. For example, tight restrictions on LTE spectrum can impede both the speed and the services offered, noting that LTE can use contiguous spectrum for carrier sizes up to 20 MHz.[46] If a new entrant into the market did not result in increased competition or lower prices, but rather if the new entrant incurred additional network and operating costs relative to the incumbent, or failed to establish itself, then it would not be socially efficient to promote new entry (by way of spectrum caps, set-asides or otherwise).

Given the risks associated with spectrum caps and set-asides, they are only warranted in cases where competition would not otherwise be effective. In light of this, it is necessary for a regulator to conduct a detailed market analysis to ensure that there are in fact other operators in the market whose access to spectrum would deliver more socially efficient outcomes than could be achieved in the absence of spectrum caps. Importantly, what matters is the overall level of competition in the mobile market and hence the case for any spectrum cap should take into account the distribution of all spectrum available for mobile services (including both the amount and type of spectrum held by different operators).

[46] Future LTE-A systems will support the aggregation of non-contiguous spectrum and the ability to create effective bandwidths in excess of 20 MHz.

Spectrum caps and the Colombian licensing experience

Colombia offers a useful example of the experience of spectrum caps in practice.

Colombia has currently allocated an amount of spectrum to mobile services which is around the average for Latin America but well short of the top five globally. Nonetheless, the Government's ambitious Vive Digital Plan to quadruple access to the Internet in four years includes plans for the release of substantial additional spectrum for mobile services. The Colombian Ministry of Information Technology and Telecommunications has announced plans for the release of additional spectrum in the frequency range of 1850 MHz to 1990 MHz ('the 1900 MHz band") as well as indicating other spectrum to be released in the future in the bands 1710 to 1755 MHz, 2010 to 2155 MHz and 2500 to 2690 MHz. The 1900 MHz band spectrum will be assigned on a technology neutral basis and for a period of 10 years. While the technology neutral basis will enable the spectrum to be used with the best and latest technology, the period of 10 years is relatively short and creates risks for investments in extending networks into rural areas where payback periods are likely to be long.

The Ministry sought expressions of interest to acquire the 1900 MHz band spectrum on 29 December 2011. The Ministry plans for the new spectrum to be assigned on the basis of a first-price sealed bid auction if demand for the spectrum exceeds the amount of available spectrum. A reserve price of $15,860,850 per 5 MHz has been set for the spectrum based on spectrum prices determined in other countries. Sealed bid auctions tend to be better suited to relatively simple situations such as where only 1 licence or uniform frequency licences are to be assigned. While more complicated forms of sealed bid auctions can be used, they tend to make it more difficult for bidders. A second price sealed bid auction is easier for bidders to participate in than a first price auction as under a second price auction, bidders should optimally bid their actual valuation of the spectrum. Open auctions with multiple rounds have tended to be used more frequently in recent spectrum auctions. A key reason for this is that open auctions enable bidders to gain information from the bids of others that helps them to more accurately value the spectrum. This reduces the risk that bidders may overestimate the value which is a significant risk where spectrum is being sold for new services or in a market that is still developing rapidly. With less risk, bidders may be prepared to offer higher bids than otherwise so that the licensing authority can also gain more revenue from an open auction. The reduction in uncertainty over the valuation of the spectrum can also improve the likelihood that the spectrum will go to the bidders who can actually generate the greatest value from it, rather than to bidders who incorrectly estimate the value. This improves the efficiency of spectrum use.

Since 2009, Colombia has maintained a cap of 55 MHz of spectrum for any one mobile operator. This cap applies both to spectrum that has already been assigned as well as to new spectrum assignments. This cap will greatly constrain the ability of the existing operators to gain sufficient spectrum to support their ongoing service growth, particularly as their subscribers use data services more intensely. For example, the spectrum holdings of the major Colombian operators are close to or already at the cap. The impact of preventing operators who are already at the cap from being able to acquire new spectrum is that they will not be able to utilise their existing infrastructure to relatively cheaply rollout new services that require more spectrum. Any new entrant who acquires spectrum would have to first rollout a brand new network and with a small customer base they are unlikely to find it commercially viable to roll out the network to rural areas.

The ability of all operators to bid for additional spectrum will be particularly important in relation to the digital dividend spectrum which Colombia's plans to assign in late 2012 or early 2013. Access to a sufficient amount of this spectrum will provide greater capacity, the ability to supply higher speed mobile services and reduce the cost of providing widespread coverage.

Bidding credits and auction design

Bidding credits provide for a particular type of operator, such as a new entrant, to receive a discount on any winning bid. For example, a new entrant may only have to pay 80% of their bid if they win an auction. Bidding credits can thus increase the likelihood of an entrant acquiring spectrum compared with an incumbent with the potential for competition in the downstream market to be greater than otherwise. Ideally, bidding credits should reflect the additional value to society of new entry. However, this can be difficult to measure in practice. If a bidding credit is set too high then it may lead to the licence being acquired by an entrant even when the overall benefits to society would have been greater had an incumbent operator been able to acquire more spectrum. Bidding credits may also be open to exploitation if an entrant is able to acquire the licence cheaply and then re-sell the licence after the auction. As discussed in Section 4, different auction designs may also be relatively attractive or unattractive to entrants.

Competition law enforcement

Competition law is generally an effective means to protect competition and enables particular transactions to be assessed on a case-by-case basis with regard to the specific market circumstances. In a number of mergers involving mobile operators, regulators have required that the parties divest some of their spectrum resources to smaller rivals.

A competition law approach is less useful in the case of spectrum auctions. In particular, it may only be after the outcome of an auction is known that a competition regulator is able to assess whether an acquisition of spectrum rights by an operator would harm competition. If so, then forced divestment or a second auction may be required with the risk of significant delay before consumers can benefit from the use of the spectrum.

Open access requirements and Kenya

Another measure to promote competition that is being considered for auctions for LTE spectrum is a requirement that the winner of a particular licence should provide wholesale access to its services to other operators. We examine the use of such measure in the context of Kenya's mobile industry.

Kenya's mobile industry has been growing strongly with mobile penetration reaching over 67% in September 2011 (20% more subscriptions from a year earlier). Four mobile operators compete vigorously offering a range of services including traditional mobile voice services, SMS, mobile money transfer and mobile data/internet services growing by 68% in the year to September 2011.

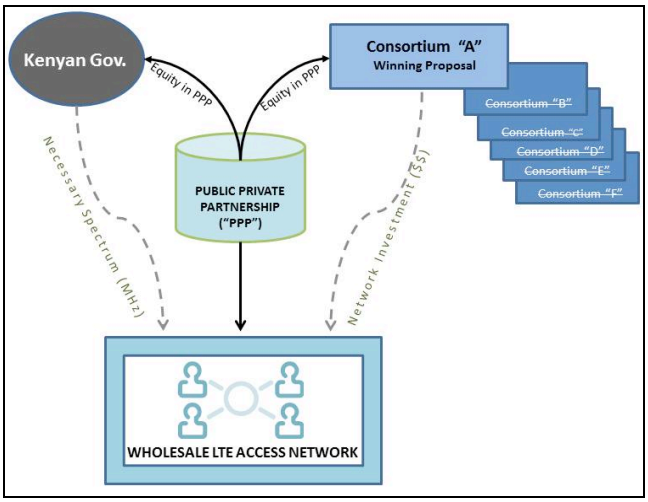
Additional spectrum allocation is critical to support the continuing rapid growth of mobile services. The Communications Commission of Kenya (CCK) has traditionally allocated spectrum under administrative approaches, although it has set out a policy framework to expand the role for market based mechanisms in the future to help ensure the efficient allocation of spectrum. Currently, spectrum for public cellular mobile services has been allocated around the 900 MHz and the 1800 MHz bands. Annual spectrum licence fees are charged which comprise a fee for the exclusive use of particular bandwidth and a spectrum usage fee based on the number of TRXs in the network.

Key priorities for the Kenyan authorities are to free up and re-assign spectrum currently used by the Government in the 400MHz, 800MHz and 2.3-2.6GHz bands as well as the re-assignment of television broadcasting spectrum with the transition from analogue to digitial television (i.e. Digital Dividend spectrum).

Proposed new models for LTE

Kenya's Ministry of Information and Communication (MoIC) proposed on 30 August 2011 that LTE services be introduced in Kenya through open access models. In particular, the MoIC has issued a tender for a Private Public Partnership (PPP) model in which the Government will provide access to the necessary spectrum to support LTE (which is likely to be in the Digital Dividend spectrum and in the 2.5GHz band) while the private sector party will undertake to meet all other costs related to the deployment and operations. The use of an open access model is intended to ensure equal access for all operators and avoid problems encountered with 3G licensing where operators acquiring licences at different dates paid differing amounts.

Figure 1: Kenyan PPP Open Access LTE Model



Source: Kenyan MoIC (Tender No MIC/9/2011-2012)

The MoIC has also raised a variation on this model, which they call a Special Purpose Vehicle (SPV), in which all local operators participate in the development of the national open access LTE network with the Government again providing the necessary spectrum.

Assessment of proposed LTE models

The Kenyan Government has recognized the importance of releasing new spectrum so that the mobile industry can meet rising demand for mobile data services. The consideration of open access models also takes into account the risk that if only one player were able to access LTE spectrum then this might damage competition in the market. The specific proposals of the MoIC raise a number of issues however.

First, competition will generally deliver better outcomes to consumers than a single provider model, even an open access model. In particular, where two or more players compete to supply services, they will face stronger incentives than a single provider to minimise costs, keep prices in line with costs and to develop innovative new services to win and retain customers. Thus, governments should seek to ensure that sufficient spectrum is made available to support competing LTE providers. The MoIC may wish to first review what spectrum it can make available including in light of other countries' abilities to free up sufficient spectrum for multiple LTE providers.

Where it is not possible to enable competing providers, then an open access model could be considered. While the MoIC contemplates the model being applied on a national basis, it might be that there is sufficient spectrum available but that in more rural and remote regions it would not be economically viable to have multiple providers. Accordingly, the MoIC could aim for competing providers in urban areas and a single wholesale provider in rural/remote areas that supplies national roaming services to the other providers.

Whether an open access network would be best operated by one winning party or all parties will depend on a number of factors. Clearly a potential risk of allowing for only one winning party is that this party might give preferential access to the LTE services to its business over other parties. Preventing opportunities for discrimination may require a ban on the winning party also having a retail business or more extensive regulation than might be needed where all parties effectively controlled the open access network. If the winner is required to only operate at the wholesale level this can lead to coordination problems such as underinvestment if one party is unable to capture the full returns to its investment.

A network controlled by all parties (and the Government), on the other hand, may have difficulties reaching decisions as parties will differ in terms of the priorities and financial resources. Allowing for individual parties to compete to provide the open access network could also enable the right to build the network to go to the party offering to supply the services at the best price/quality combination.

The proposed model also envisages that the Government would take an equity stake in the open access network in return for the provision of spectrum rights. The rationale for the Government's equity involvement is unclear. Generally, PPP models are applied where a government does not have sufficient revenue itself to fund infrastructure or where it believes that the private sector will better provide a service traditionally delivered by the public sector. However, in this case, the Kenyan Government would be giving up revenues that it would otherwise obtain from selling the spectrum rights – these revenues could be used to help fund other important demands on the Government. The Government may be concerned that a high price for spectrum licences may reduce operators' abilities to fund network rollout. However, if the price for the licences was determined at auction (or set in line with auction prices determined in comparable countries), then that price is likely to be at a level that operators expect to be able to afford while also rolling out infrastructure to supply the services. Further, if operators were expected to have trouble financing the licence fees upfront, then the Government could provide for the licence fees to be paid in instalments over time.

Another alternative would be for the Government to instead collect a tax on the services supplied. While a tax would reduce the upfront funding needs and risks of the business, it would represent a cost of supplying the services and be expected to result in higher service prices.

If the Government is uncertain as to whether operators could afford an upfront licence fee, then the Government could hold a first round in which it seeks bidders for the licence to operate the open access network without any Government equity ownership. Only if this round failed to attract a bidder at a reasonable price should the Government then consider another round in which bids are sought to operate the network with the Government taking a specified share of equity. It will also be important that the terms and quality of service on which the wholesale services are to be provided are also specified in advance. By doing so, bidders could determine an appropriate bid level taking into account the future requirements on the business. The specified share of equity could be determined after consultation with operators to identify a share that they would be prepared to accept before bidding for the right to operate the network.

A Government equity stake may also give rise to some ongoing risks. For example, if the Government were involved in decisions on the strategy and operations of the business then it might come under pressure to pursue political objectives that come at the expense of the legitimate interests of other equity-holders. Second, the Government's involvement may lead it to favour the business over other existing or potential new rivals. For instance, other spectrum that could enable rival LTE networks to enter might not be made available so as to protect the value of the Government's equity holding. The experience more generally with PPP-type arrangements is that they are complex to get right, require transparent and well-specified rights and obligations and do not always deliver value for money over more traditional approaches.[47]

Network sharing

Over the last decade, there has been a significant increase in the use of network sharing between operators. This can take a number of different forms from the relatively limited sharing of sites to sharing of the Radio Access Network to sharing of all network services. Such sharing might be seen as undermining full network competition between operators. However, where the alternative to two operators undertaking sharing to some extent is that only one of the operators is viable then sharing may achieve a degree of competition that would otherwise not occur. Further, forms of sharing can bring lower network costs while still enabling operators to compete with differentiated services. Lower network costs not only bring cheaper services to consumers but can also support more extensive rollouts than otherwise. Accordingly, the case for network sharing should be assessed by regulators relative to what level of efficiency, competition and consumer benefits would be likely in the absence of sharing.

6.4. Recommendation

Following is our key recommendations in relation to competition measures:

- *Recommendation 14* - Licensing authorities should aim to ensure effective competition in the downstream markets for mobile services. Many sector regulators and competition authorities have accepted that three to four national operators are likely to be sufficient to achieve effective competition.
- *Recommendation 15* - Specific measures to promote competition should only be imposed in markets where there is market failure and competition would otherwise be ineffective and where those measures are assessed as being likely to result in greater benefits than costs. Spectrum caps, spectrum set-asides, bidding credits, competition law enforcement and open access requirements carry advantages and disadvantages and should be assessed in relation to the specific market context.

[47] For example, see the South African Institute of International Affairs, *Working together – Assessing Public-private partnerships in Africa*, 2005.

7. Reviewing non-price terms and conditions

Licences can contain a range of obligations and conditions which go beyond authorising access to the market and/or the use of spectrum for a period of time upon the payment of a licence fee. The purpose of the section is to assist licensing authorities in reviewing particular non-price terms and conditions at the time of the initial licensing of operators and when licences are being considered for renewal.

7.1. Licence duration

An integral part of a licence is its duration. In many countries, licences of as short as one year are issued with operators forced to make investment decisions based on assumptions as to how long their licence will continued to be renewed. The uncertainty created can be a significant deterrent to investment, distort investment decisions and increase operators' cost of funds.

The longer the duration of a licence, the more attractive it will be for the licensee to undertake long-term investments in developing and upgrading its network. Investors will be reluctant to undertake investments if the licence runs for a shorter period, than the expected payback period and if there is uncertainty over whether the licence will be renewed again in the future. Depending on the type of investment and the nature of the market, some communications industry investments may take over 15 years to recover the cost of that investment, such as where operators are expected to re-use a current "2G band" for 3G or other advanced services. A shorter timeframe may be more relevant upon the renewal of a licence for other spectrum if there is expected to be less significant ongoing investment. A further consideration is to set the timeframe so as to align the expiry dates for licences for similar spectrum. This can help ensure that similar licences are subject to the same terms and conditions going forward.

Industry Canada considered the issue of licence duration in relation to the renewal of mobile and PCS licences which are expiring between 2011 and 2013. Industry Canada noted that the international trend to a less interventionist approach and decided that at the end of the current licence terms, the current licence-holders would be eligible (subject to having met the licence conditions) for a new licence for a 20-year term and that these new licences will have a high expectation of renewal for another licence term unless a breach of licence condition has occurred or there is a fundamental reallocation of spectrum to a new service or other overriding policy need.[48]

As licences become more service and technology neutral and where trading in spectrum rights is permitted, longer duration licences are likely to make more sense as the greater flexibility can help ensure spectrum is used efficiently on an ongoing basis while the longer duration provides for greater investment certainty. Thus licensing authorities which are more advanced in introducing trading and spectrum liberalisation have moved to generally auctioning licences with a minimum term, no defined expiry date and with a minimum period of notice required were the authority to seek to recover the spectrum after the minimum term. For example, Ofcom is proposing that the licences for the 800 MHz and 2.6 GHz spectrum be of indefinite duration (with a minimum term of 20 years) continuing in force until relinquished or revoked.[49]

[48] Industry Canada, Renewal process for cellular and personal communications services (PCS) spectrum licences, March 2011.

[49] Ofcom, Second consultation on assessment of future mobile competition and proposals for the award of 800 MHz and 2.6 GHz spectrum and related issues, January 2012.

7.2. Geographic dimension

Many mobile licences are issued on a national basis while some, particularly in larger countries, have been issued on a regional basis. Issuing licences on a regional basis may appear attractive to authorities as a means of facilitating the entry of small players. However, even in the USA with relatively large regional markets for mobile services, there has been a trend towards consolidation of regional licences to enable operators to offer services nationally. There are two key drivers of this trend. First, customers attach importance to the ability to be able to use their mobile services nationally (and without incurring unexpectedly higher call charges if they happen to go outside their network's coverage area and roam onto another's operator's network). Second, there are significant fixed costs in supplying mobile services including head office costs and potentially national marketing that if spread over national service volumes lead to lower unit costs than if they are only able to be spread over small service volumes. If licences are issued on a regional basis, customers may end up paying higher prices for services or regional operators may incur significant debts in acquiring other regional operators to be able to achieve national presence. One approach is for the auction itself to offer the ability to either acquire rights to use particular frequency on a national or regional basis. The rights could then be awarded on either a national or regional basis depending on which was found to be valued most highly.

7.3. Obligations in relation to specific policy objectives

Regulators often impose additional obligations on licensees which are aimed at achieving particular policy objectives and that are not integral to the purpose of the licence. These can include obligations relating to universal access, such as coverage and service commitments as well as obligations relating to the promotion of competition. Where a licence is assigned using a beauty contest, rather than an auction, commitments to meet non-price criteria can come to dominate the assignment process.

By way of general comment, we note that when only one incumbent operator was being licensed, then imposing a series of obligations as part of that operator's licence represented a relatively straight-forward way to achieve particular objectives. However, the development of competition in telecommunications markets raises the need to review relatively regularly which policy objectives remain relevant and whether obligations should be imposed on all operators or only on particular operators. In this context, more flexible and targeted regulatory measures may prove to be more effective and efficient than seeking to achieve the objectives through licence conditions.

Reflecting such considerations, there is a regulatory trend against seeking to achieve universal access and competition objectives through licence obligations. The UK Government's independent review of spectrum management recommended that:

> *The RA [Radio Communications Authority] should aim to minimise the licence conditions to those necessary for efficient spectrum use. Existing licences should be amended to remove restrictions which are not needed for reasons of international co-ordination or interference management, and new licences should be issued with the minimum number of restrictions possible.*[50]

We explore these issues further in relation to the specific areas of coverage and service obligations as well as obligations to promote competition.

[50] Review of Radio Spectrum Management, March 2002, para. 7.2.

Coverage and service obligations

Many regulators have imposed licence obligations on mobile operators to provide a particular level of service coverage within a specified timeframe. A number of regulators have also included additional requirements to offer particular services or a particular quality of service as well as measures relating to universal access and consumer protection goals.

In deciding whether to impose such obligations, licensing authorities should consider:

i. the benefits and costs of such obligations; and

ii. whether there are less costly means to achieve the objectives.

Achieving high levels of access to telecommunications services is a common objective of many governments. Whether a particular regulatory obligation is required to support universal access goals will, however, depend on the particular market circumstances. In many cases, competition in the mobile industry has resulted in the widespread availability of affordable mobile services with levels of coverage being a key means by which operators seek a competitive advantage over their rivals.

Licensing authorities should also be aware of the potential risks of imposing stringent coverage or service requirements. In particular, obligations may sometimes force operators to deploy networks and/or services faster than it is economically or commercially sensible to do so. For instance, this could arise where technology is still at an early stage with a number of technical flaws remaining or where equipment prices are relatively high before more widespread take-up of the equipment internationally.

Obligations may also force operators to incur losses (e.g., by deploying networks in advance of sufficient demand for the services) which can create particular difficulties for new entrants without established cash flows. Where operators fail to meet their licence conditions (as was the case with 3G licence conditions in a number of European countries including France, Spain and Sweden), regulators are confronted with the dilemma of whether to take the drastic step to revoke the licence with potential harm to competition or postpone or abandon the licence condition. Relaxation of licence conditions can lead to legal challenges by other operators who have met the conditions or by potential new entrants who may have bid for the licence if they had known the licence conditions would not be enforced.

As an alternative to imposing rigid coverage and service obligations, governments could also consider other measures to improve access to mobile phones including ensuring that spectrum is released to the market to the greatest extent possible, allowing for refarming and liberalisation so that the spectrum can be used efficiently and facilitating greater voluntary network sharing particularly in relation to parts of the network that do not constrain service differentiation and in rural areas. These measures help to change the underlying economics of extending coverage and thus may be more likely to be achieved, and achieved at lower cost, than seeking to enforce licence obligations.

If the aim is to achieve mobile coverage in some remote areas, then government funding for the provision of one network in those areas may be sufficient to achieve that aim without needing obligations to be imposed on all operators. In the first instance, it is likely to be desirable to consider steps to remove barriers to the commercial provision of services in rural and remote areas (such as releasing additional spectrum in lower frequency bands or permitting greater network sharing), although public procurement such as tenders for operators to apply for government funding to extend network coverage to areas where commercial provision is uneconomic may also be useful. In this regard, the Nigerian Communications Commission (NCC) has noted that:

> *It is no longer fashionable to give rollout obligations to licensees. To spur the growth of rural service provision, regulators are rethinking their strategies and it has been found that reduced entry barriers, lower entry fees, infrastructure sharing and unhindered use of new wireless broadband technologies are more effective measures to promote cost-effective and rapid deployment of last-mile network technologies in rural and unserved areas…The Commission will not impose separate rollout obligations on unified licensees, but rather deal with universal access issues in a separate universal access regulation, in which universal access targets and respective designation mechanisms are defined.*[51]

The potential of mobile broadband services to help achieve universal broadband coverage has been recognised by a number of regulators. However, if extensive coverage obligations are imposed on all licences for spectrum for 3G and LTE, there may be costly and wasteful duplication of expensive network infrastructure. The German regulator instead imposed a 'shared' obligation on all operators who acquired 800 MHz to ensure coverage in rural areas before rolling out to urban areas. An alternative approach applied in Sweden was for one of the 800 MHz licences to have an obligation to provide mobile broadband to locations currently lacking access to other forms of broadband. These more limited forms of coverage obligations avoid duplication of network infrastructure in areas where such duplication would not be economically efficient. In addition, by setting the obligation prior to the auction, the cost of the obligation will be reflected in the licence fees determined in the auction. Accordingly, the obligations are thus equivalent to the Governments subsidising the fulfilment of that obligation. The Governments should thus have assessed whether the use of those funds (i.e. the amount by which the licence fees were reduced because of the obligations) to extend mobile broadband coverage represents the best use of those funds.

Finally, where obligations are imposed, then it is important that regulators recognise the significant cost that can be incurred by operators in meeting those obligations. In particular, the cost of extending coverage to more and more remote areas can increase substantially while there may be relatively few customers in those areas from which to help recover the cost. In France, the cost of meeting the licence obligations was explicitly taken into account in the setting of the licence fee.

[51] NCC website, "Licensing Framework for Unified Access Service in Nigeria".

7.4. Trading

Secondary trading of spectrum rights is the ability of a current licence holder of spectrum bandwidth to re-sell its rights to use all or part of its allocated spectrum at commercially negotiated terms. In this section, we first outline the benefits of spectrum trading before briefly reviewing the experience of countries in which trading has been introduced. Finally, we turn to consider specific implementation issues and identify regulatory best practice.

Economic theory identifies a number of significant benefits from the introduction of spectrum trading including that trading:

- promotes efficient spectrum use by enabling spectrum to be acquired by the operators who can generate the greatest value from the use of that spectrum. At the same time, the ability to trade spectrum provides the incentive for licensees who have unused or underutilised spectrum to on-sell their spectrum to those who can make better use of it. As such, trading is likely to result in more efficient use of spectrum. In particular, by helping to reduce spectrum shortages faced by operators facing high demand, trading can support expansion in service volumes, increase quality of service and reduce service prices.
- enables those parties who have the best information, the individual users of spectrum, to make the decisions that determine the allocation of a resource among competing uses and users. Secondary trading in spectrum can also overcome inefficiencies in the initial allocation of spectrum.
- allows flexibility and speed in re-assignments between users helping to facilitate the introduction of new services.
- reduces operators' sunk costs and risks, i.e., operators will be more willing to invest in spectrum for innovative services with the knowledge that they have the ability to sell the spectrum rights should the services not be successful.

Spectrum trading has been introduced in Australia, Canada, Guatemala, New Zealand, Norway, the USA and the UK and on a more limited basis in Austria, France, Germany, the Netherlands and Sweden. Guatemala's experience is set out in Box 6. In other countries, individual spectrum trades have sometimes been allowed after regulatory review. The degree to which spectrum trading has been undertaken in the countries that allow trading is mixed[52] and this is likely to reflect the extent to which spectrum rights are currently assigned to the operator than can make best use of it as well as factors potentially inhibiting trades such as spectrum licences being of limited duration.

Spectrum trading is not a panacea. For instance, it would not deal with restrictions on the total amount of bandwidth available to mobile services, which would continue to require governments to allocate more bandwidth or enable spectrum currently being used for other services to be used for mobile. However, trading can reduce the cost of spectrum shortages by allowing some re-allocation between users.

Even for one country, there are substantial differences in relation to estimates of the magnitude of the benefits from spectrum trading. Ofcom estimated that the introduction of spectrum trading in the UK would generate overall benefits in the range of a net present value of £142 million over 20 years, up to several billions of pounds a year.[53] The benefits will depend on the extent to which current spectrum allocations in a particular country are constraining existing operators from expanding their services or constraining new operators from entering.

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[52] For example, the ACMA found that in most years between 1998 and 2008, less than 10% of Australian spectrum licences were traded (ACMA, *Spectrum trading*, November 2008).

[53] Ofcom, *Spectrum trading – Regulatory Impact Assessment*.

Spectrum trading in Guatemala

In 1996, the Guatemalan National Assembly enacted a new telecommunications law,[54] which, among other policies, introduced secondary trading of spectrum for some frequency bands. Guatemala thus became one of the first countries to allow for spectrum trading.

Rights to use regulated frequency bands (TUFs) are granted in fully transferable and fragmentable usage titles, i.e., they can be totally or partially rented and/or transferred. TUFs have no service limitation, and existing users are granted flexibility in the utilisation of spectrum as long as emissions are confined to the original bandwidth assigned. TUFs are subject to two interference limits: a "maximum effective radiation power" and a "maximum potency admissible in the coverage area". The regulator can impose fines for cases of repeated abuses (i.e., where interference exceeds allowed levels). If the abuse is established, the harmed user can also file a claim for damages or other remedies in the courts.

Spectrum trading in Guatemala appears to have been a significant success. Over 41 per cent of TUFs had been traded by 2004.[55] Liberalisation in Guatemala has resulting in more spectrum becoming available for key services such as mobile services and has reduced entry barriers. Competition has been strong in Guatemala's relatively unconcentrated mobile market, resulting in among the lowest mobile prices in Latin America and continuing high rates of subscriber growth (despite its relatively low GDP per capita and law and order problems).[56] Interference issues are mostly minor with tight deadlines for their resolution, although an issue has been irregular enforcement of restrictions such as in relation to pirate radio. Other practical problems have included spectrum hoarding and difficulties in retrieving spectrum for licence exempt use.[57]

Implementation issues

Markets work best when they are based on well-specified, enforceable, property rights, low transactions costs, and competition. If these features are not present, secondary trading may be inefficient or distorted. In this section, we explore the steps that can be implemented to facilitate spectrum trading in the longer run.

In principle, spectrum trading (with no change in the technology and services being provided using the spectrum) should not lead to greater interference problems. However, the prospect of spectrum rights being re-assigned between users does increase the risk of inadvertent interference as well as raising a range of other implementation issues. While the general introduction of spectrum trading at this stage is unlikely to be a high priority for many developing countries, licensing authorities should be prepared to assess proposals for particular trades subject to consultation and detailed examination of any risk of heightened interference.

Well-specified spectrum rights

Markets are based on a private property rights system. Trading bandwidth requires a clear and commercially sensible and defensible definition of initial property rights or entitlements. A spectrum licence may specify the right to exclusive usage in terms of frequency and geography (and potentially in relation to a time dimension) as well as reasonable interference levels both in terms of allowable levels of interference caused by the licensee to other spectrum users and the maximum levels of interference which the licensee must accept experience from others. As experience of spectrum

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54 *Ley General de Telecomunicaciones*, D.C.A. 14 November 1996.

55 Ovum et al, *Spectrum policy review – final* report, 2006, p.145.

56 Leighton, W., "Telecom reform in Guatemala: A case study in spectrum liberalisation", Presentation to National Academy of Science Workshop, 1 March 2006.

57 Wellenius, B. and I. Neto, *Managing the Radio Spectrum: Framework for Reform in Developing Countries*,19 June 2007, p.9.

trading in developed countries grows, developing countries will be well-positioned to learn from their experience enabling trading to be introduced in the longer term at lower risk.

However the definition of well defined, technology neutral, property rights has proved to be very complex, and there is no universally agreed right adopted by the ITU or CEPT. In general, the more flexible the property right that is used, the more problematic interference control becomes. Regulators should do a careful cost benefit analysis about what level of flexibility is appropriate for their market. This is important in the absence of an internationally agreed definition of such a well defined and enforceable spectrum property right.

Licence renewal

Uncertainty over future rights to use the spectrum can act as a major barrier to spectrum trading. There may be few buyers of spectrum rights if there is only a short tenure left and significant uncertainty over whether a right will be renewed. The lack of a commitment to renewal has been identified as a key factor holding back trading in Australia.

Transactions costs

Transactions costs will also affect market efficiency. These will in part be a function of the frequency and ease of spectrum trades. In the absence of the ability to re-sell spectrum licences, the only way spectrum can be traded may be by acquiring a firm which holds a licence. Apart from the costs of doing this, and the subsequent costs and losses of disposing of other assets owned by the acquired company, the licence is for a large amount of bandwidth. Secondary markets should allow parties to divide or aggregate spectrum.

Transaction costs can also be reduced by ensuring that detailed information on current spectrum holdings is reasonably available as well as plans for future spectrum releases. Allowing the development of specialist spectrum trading brokers can also help reduce transaction costs.

Competition issues

Governments may be concerned that spectrum trading would lead to the largest operators buying up spectrum rights so as to gain or consolidate market power in the downstream markets for the services supplied using the spectrum. One response to this concern has been the imposition of caps on the amount of spectrum able to be acquired by any one operator. However, while such caps are relatively simple to apply, they are an imperfect way of protecting competition because they are not based on an assessment of the particular competition implications of the specific transactions

Whether spectrum trading would actually lead to a loss in competition would depend on: (i) the amount of spectrum available to competitors; and (ii) the degree of competition in the downstream markets. Accordingly, whether a particular transaction should be prohibited on competition grounds is likely to require a case-by-case review which could potentially be under general competition law (as, for instance, occurs in New Zealand). Safe harbours could be determined, for example, and spectrum acquisitions could be permitted, without further investigation being conducted by the competition authority, if the operator has a current market share below a particular level and if the spectrum being acquired represents only a small share of the total spectrum suitable for supplying that service.

Concerns about windfall gains

Another concern about the introduction of spectrum trading is that it may result in existing licensees earning significant financial gains over the price that they originally paid for their licences. It may be argued that such gains should belong to the government. However, the gains provide the incentive for spectrum trades to take place and the more the government confiscates these gains, the more likely it will be that a trade does not occur even when it would have generated overall benefits to society. Further, the experience with some 3G licences in Europe shows that operators may experience significant losses acquiring licences so the opportunity to earn some gains may be seen as the counterpart to the risk of significant losses if market conditions do not turn out as expected.

Governments will need to determine how best to meet their revenues requirements, taking into account principles of efficiency, equity and simplicity. A large tax on gains from spectrum sales would be likely to come at a substantial cost to efficiency. There would appear to be no reason to tax gains from spectrum sales any more than gains on the sale of other business assets.

7.5. Recommendations

Following are our key recommendations in relation to non-price terms and conditions:

- *Recommendation 16* – Licensing authorities should introduce licence terms for mobile operators that are at least in line with the expected payback period for the investments and should consider the introduction of indefinite licence terms (with a specified minimum term, i.e. 15 years).
- *Recommendation 17* - Licensing authorities should provide for national licences where customer demand and/or scale economies are likely to support national provision as the most efficient. Where regional licences are under consideration, the auction process itself could be used to determine whether regional or national licences are valued most highly.
- *Recommendation 18* – As an alternative to licence obligations, governments should achieve universal access and competition objectives through policies that help to change the underlying economics of extending access or entering the market or through alternative targeted regulation.
- *Recommendation 19* – Licensing authorities should enable voluntary spectrum trading between operators and facilitate trading through well specified spectrum rights, long licence terms and minimizing administrative costs. Such trading helps to ensure that spectrum remains efficiently assigned over time. Competition concerns should be assessed taking into account the specific circumstances of each trade, although certain safe habours could be established such as where the operator acquiring the spectrum has a market share below a certain threshold and/or the spectrum represents a relatively small share of the overall spectrum available for those services.

8. Regional overview of spectrum licensing

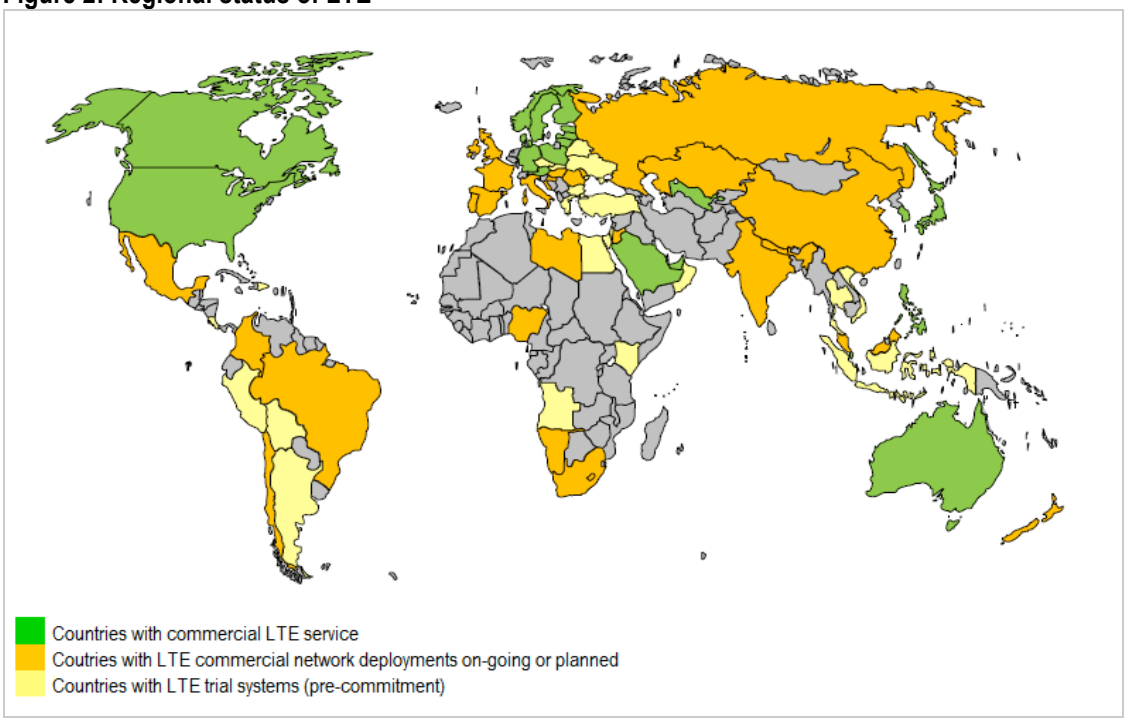
In this section, we review the status of spectrum licensing around the world. We first provide a global overview of the status of LTE and the digital dividend spectrum and then consider in more detail the status of mobile spectrum licensing in six broad regions of the world:

- Africa;
- Asia Pacific;
- Europe;
- Latin America;
- Middle East and Central Asia; and
- North America.

8.1. Regional status of LTE and the digital dividend spectrum

Figure 2 below shows the countries in which commercial LTE network launches have taken place (as at 12 October 2011). In total, there have been 35 commercial network launches in 21 countries. In addition to this there are also 185 operator commitments to commercial LTE networks in 66 countries and 63 pre-commitment trials in an additional 21 countries.[58]

Figure 2: Regional status of LTE

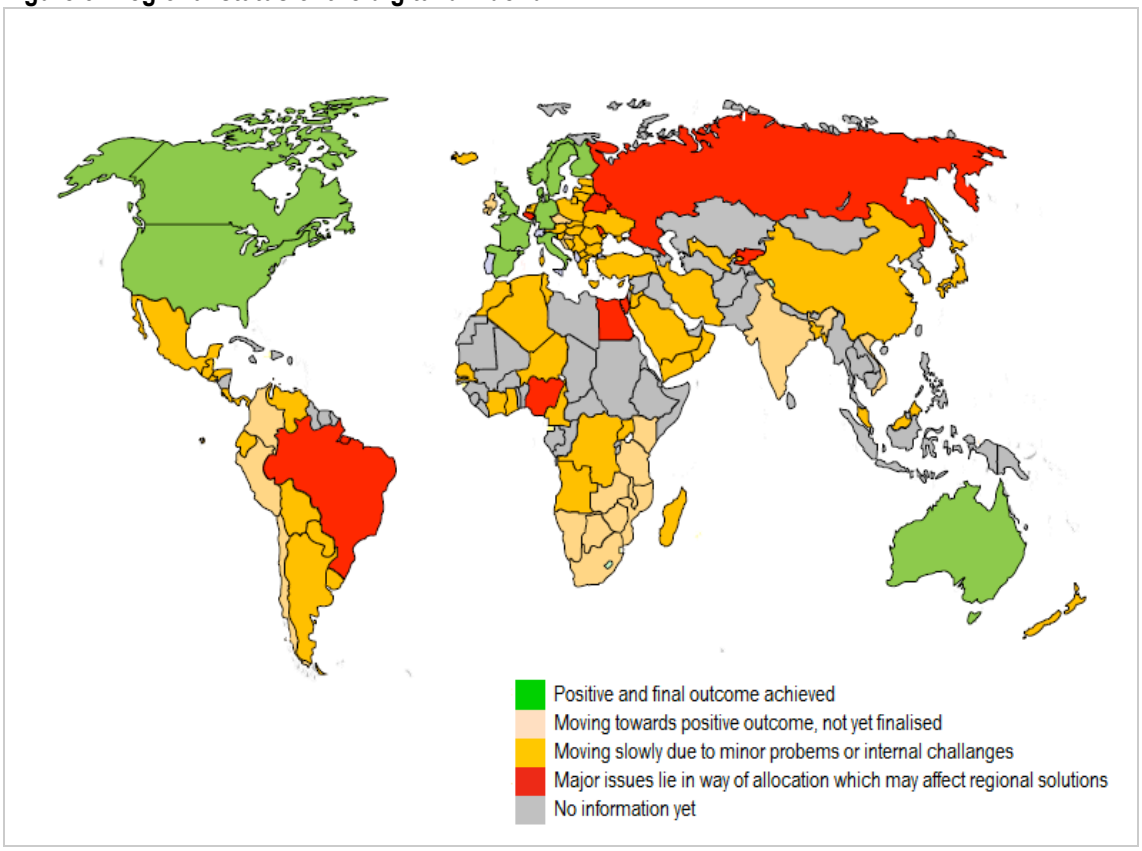


Source: GSA (2011)

The digital dividend is the prime spectrum for mobile broadband. The relatively lower frequency than the current mobile spectrum means that fewer base stations are necessary to cover the same geographic area. This lowers the cost of deployment, which in turn means that operators can provide more affordable rural coverage and capacity for broadband services. The regional status of the digital dividend spectrum is illustrated in Figure 3 below.

[58] GSA (2011) *Evolution to LTE report*

Figure 3: Regional status of the digital dividend



Source: GSMA (2011)

8.2. Africa

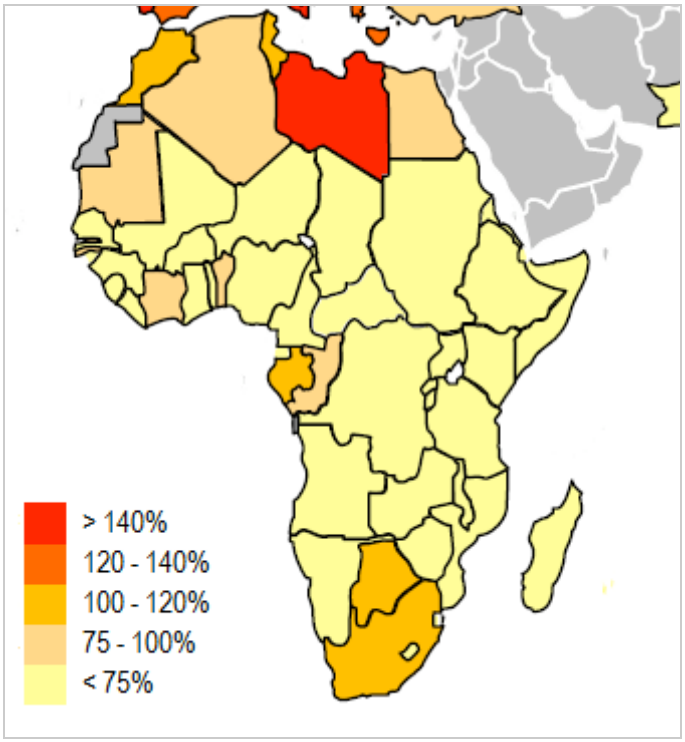
Africa is the fastest growing mobile market in the world: Over the past 10 years, the number of mobile connections has increased by an average of 30 per cent annually, and is forecast to reach 735 million by the end of 2012. Over 95 per cent of the subscriptions are pre-paid, and most of the revenues are derived from voice rather than data (although revenues from data are also increasing steadily).[59]

Despite the rapid growth of the mobile market, Africa still has a relatively low mobile penetration rate relative to other parts of the world. This is illustrated in Figure 4 below. Most countries in the African region have a mobile penetration rate of less than 75 per cent, with only a few exceptions. Libya has a very high penetration rate, which is associated with a high prevalence of multiple SIMs/handsets[60]. Mobile penetration rates of selected countries in the African region are summarised in the regulatory scorecard (Table 4) at the end of section 8.2.

[59] GSMA (2011) *African Mobile Observatory,* p. 6

[60] Ibid, p. 13

Figure 4: Mobile penetration in Africa



Sources: Merrill Lynch (2011) and ITU (2010)

Spectrum awarded to mobile services in Africa

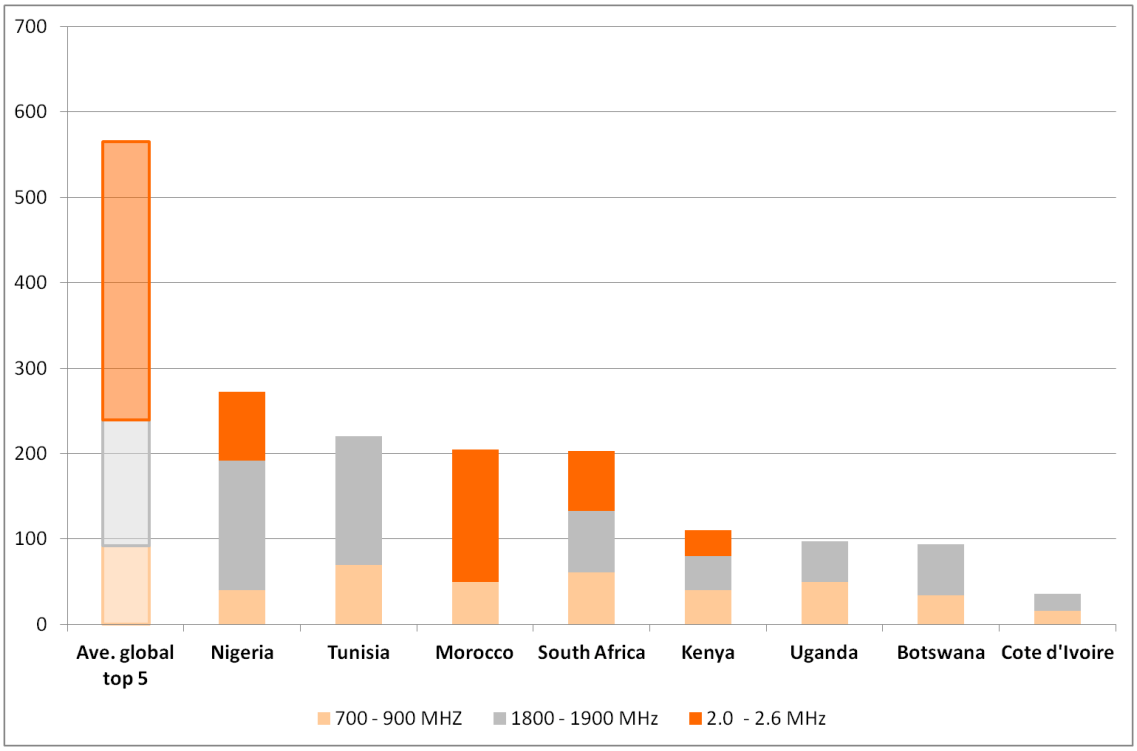
Figure 5 below illustrates the relatively limited amount of spectrum which has been allocated to mobile services in African countries in the categories 700-900 MHz, 1800-1900 MHz and 2.0-2.6 MHz[61]. Only in Nigeria has more than 250 MHz been allocated to mobile in total in these categories. The figure visually compares the spectrum released in seven African countries with the average of the five countries which have released the most spectrum[62].

For the mobile industry to continue to drive growth in Africa, it is necessary for governments in the region to allocate sufficient amounts of spectrum to the provision of 3G and 4G technology mobile services. To enable this process, it is important for governments to have clear guidelines in regards to spectrum planning, licensing, pricing and re-farming.

[61] It should be noted that it is possible that some countries have allocated spectrum in alternative frequencies to mobile, and that they would not be included in the figure. This applies equally to the following sub sections in this chapter on spectrum allocated to mobile services.

[62] The top 5 average consists of Germany (total of 594 MHz), Sweden (total of 585 MHz), Denmark (total of 552 MHz), Finland (total of 550 MHz) and Austria (total of 547 MHz).

Figure 5: Spectrum released to mobile in selected African countries



Source: GSMA (2011)

Mobile services play a large part in total broadband provision in Africa, as the fixed access networks are relatively underdeveloped. In light of this, African regulators have been licensing 3G spectrum to mobile operators over the last few years. Since 2006, 3G licenses have been released in at least 29 countries in Africa.[63]

LTE trials are happening in several countries in Africa, including for example Angola, Egypt, Kenya and Nigeria. Vodacom in South Africa reportedly has 1,000 LTE ready sites, and are planning a launch as handsets become available. Also MTN South Africa is deploying LTE in the 1800 MHz spectrum, as 2.6 GHz is not yet available.[64]

Digital switchover programmes started to take shape throughout the African continent in 2009. For example Kenya and Nigeria have scheduled to complete digital switchovers by mid-2012. South Africa is scheduled to complete the switchover by the end of 2013, and Egypt by the end of 2015.65 Table 3 below outlines possible award dates for the digital dividend spectrum for several African countries.

Allocating the digital dividend spectrum to mobile services will bring connectivity to greater parts of Africa and increase the level of mobile penetration. This, in turn, will act as a catalyst for economic growth in the region.

[63] GSMA (2011), *African Mobile Observatory,* p. 43

[64] GSMA (2011) *Evolution to LTE report*

[65] GSMA (2011), *African Mobile Observatory,* p. 44

Table 3: Bands to be allocated in the digital dividend spectrum

Country	Band to be allocated	Possible award date
Cameroon	790 – 862 MHz	2015
Ghana	790 – 862 MHz	2014
Kenya	790 – 862 MHz	2012/13
Lesotho	790 – 862 MHz	2013
Nigeria	698 – 806 MHz	2013
Senegal	790 – 862 MHz	2015
South Africa	790 – 862 MHz	2013
Tanzania	790 – 862 MHz	2012/13
Uganda	790 – 862 MHz	2012/13
Zambia	790 – 862 MHz	2013

Source: GSMA (2011)

Spectrum licensing in Africa

Spectrum allocation has previously taken place behind closed doors and through more ad hoc processes in many African countries. In recent years however, allocation processes in many African countries have become more transparent.[66]

Local ownership pre-qualification criteria in African auctions

In two recent announcements of auctions, in Kenya and South Africa, pre-qualifying criteria has been imposed relating to local ownership. In September 2011, pre-qualifying criteria for the Kenyan 4G licenses were announced, including the requirement of at least 20 per cent national ownership. Similarly, in 2011 pre-qualifying criteria for the South African 2.6 GHz were announced, including the requirement of 30 per cent equity ownership by "Historically Disadvantaged Individuals". Concerns raised by the operators about this particular pre-qualification criterion resulted in delays in the South African auction.[67] The proposal in South Africa has now been suspended.

It is important that any procedures for the allocation and use of scarce resources such as spectrum are carried out in an objective, timely, transparent and also non-discriminatory manner.

Regulatory scorecard

Table 4 below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the African region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

[66] Computer World Uganda (2010) *Race issues arise in South Africa spectrum auction*

[67] GSMA (2011) *African Mobile Observatory,* p. 46

Table 4: Regulatory scorecard, selected countries in Africa

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
Nigeria	Medium	58%	6%	5.4%	Launch date TBC
Tunisia	Medium	106%		18.0%	Launch date TBC
Morocco	Medium	113%		20.0%	No plan / info
South Africa	Medium	118%	22%	14.0%	2011
Kenya	Low	62%		20.5%	Pre-commit trial
Uganda	Low	38%		28.2%	No plan / info
Botswana	Low	118%		10.0%	No plan / info
Cote d'Ivoire	Low	76%		18.9%	No plan / info

Sources: [1] GSMA (2011) and regulators' website, [2] Merrill Lynch (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

8.3. Asia Pacific

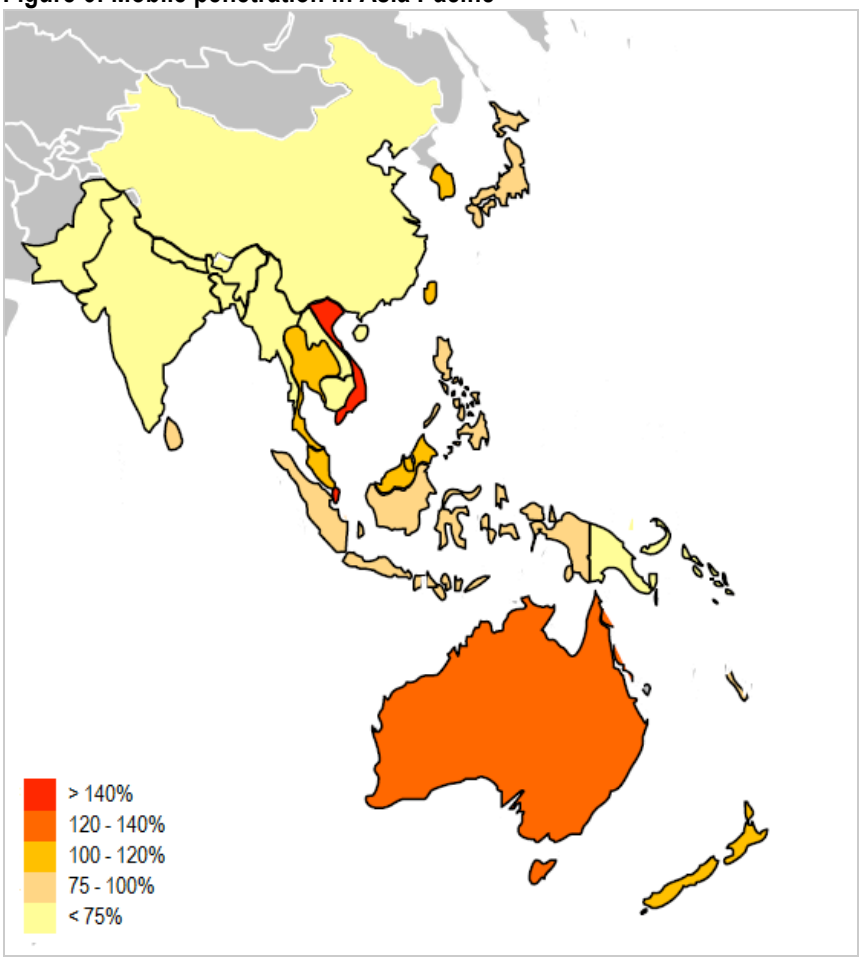
Asia Pacific is the largest mobile market in the world – accounting for half of the total mobile connections. Almost all of these connections are contributed by the largest 17 economies in the Asia Pacific region.[68]

Asia Pacific has a relatively high, but varied, mobile penetration rate, as is illustrated in Figure 6 below. Some countries, like Vietnam and Singapore, have a mobile penetration rate of over 140 per cent, whereas for example Bangladesh and Cambodia have a mobile penetration rate of below 75 per cent. Some countries in the Asia Pacific region have mobile penetration rates far below 75 per cent. One billion people remain unconnected across China and India.[69] Mobile penetration rates of selected countries in the Asia Pacific region are summarised in the regulatory scorecard (Table 6) at the end of section 8.3..

[68] GSMA (2011), *Asia Pacific Mobile Observatory,* p. 3, 7

[69] GSMA (2011), *Asia Pacific Mobile Observatory,* p. 7

Figure 6: Mobile penetration in Asia Pacific



Sources: Merrill Lynch (2011) and ITU (2010)

Wireless service revenue growth in the Asia Pacific region has been relatively stable over the last four years, with the wireless service revenue growth from data steadily increasing, and the wireless revenue growth from voice declining. The trend towards stronger growth in revenue from data than voice is also apparent in Europe and North America (see Figure and The mobile penetration in North America is relatively high, albeit not as high as in parts of Europe and Asia Pacific. In the United States, mobile penetration is about 103 per cent, and in Canada mobile penetration is about 76 per cent.

Wireless service revenue growth in the North America region has been declining slightly over the last four years, with the wireless service revenue growth from data steadily increasing, and the wireless revenue growth from voice steadily declining. This is illustrated in Figure 17 below.

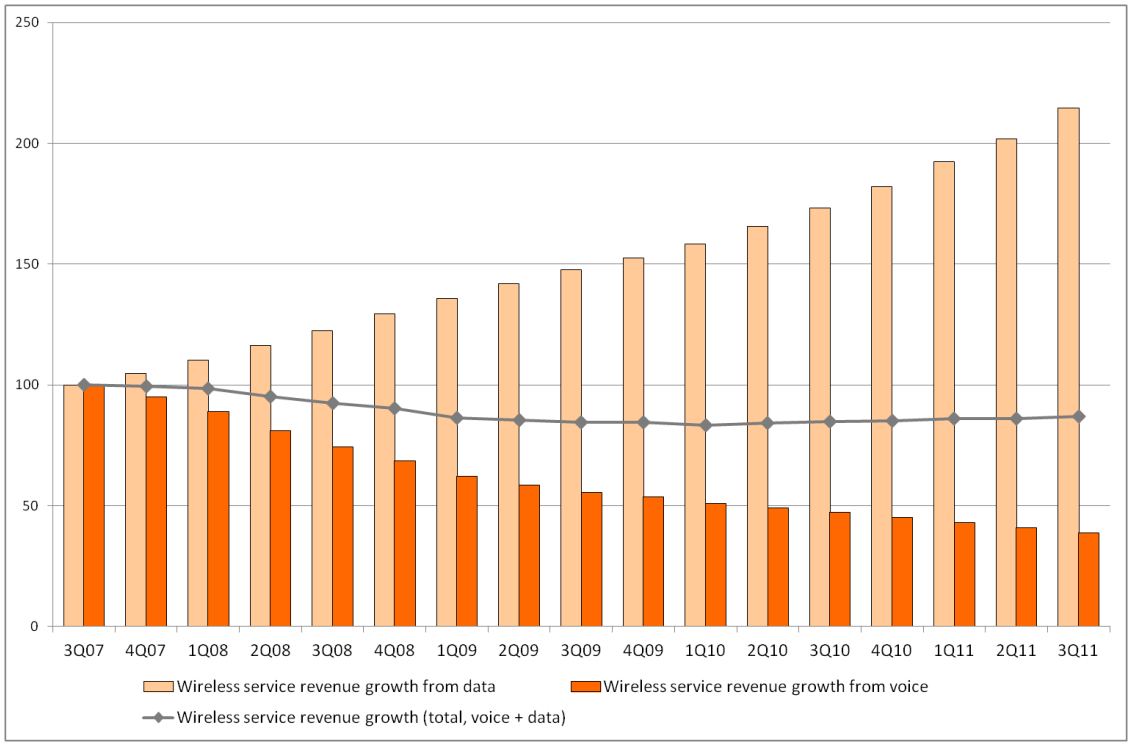
Cisco forecasts that the mobile data traffic in North America will grow at a CAGR of 75 per cent between 2011 and 2016 (see Figure 1). This indicates that the trend towards strong growth in revenues derived from data will continue.

Figure respectively).[70] Nonetheless, the large existing share of revenue from voice means that even high growth in data in percentage terms is often inadequate to offset the decline in voice revenue growth in absolute terms.

[70] Merrill Lynch (2011) *Global wireless matrix 4Q2011,* p. 42

Cisco forecasts that the mobile data traffic in Asia Pacific will grow at a CAGR of 84 per cent between 2011 and 2016 (see Figure 1)[71]. This indicates that the trend towards strong growth in revenues derived from data will continue.

Figure 7: Wireless service revenue growth Asia Pacific



Source: Merrill Lynch (2011)

Spectrum awarded to mobile services in Asia Pacific

The amount and types of spectrum released to mobile in Asia Pacific varies across the region. Some countries have released in excess of 350 MHz to mobile services, whereas some countries have released 200 MHz or less. The allocation of spectrum in the 700-900 MHz bands, the 1800-1900 MHz bands and the 2.0-2.6 GHz bands to mobile services in countries the Asia Pacific is illustrated in

Figure 8 below. The figure also illustrates the average amount of spectrum released in the five countries which have released the most spectrum worldwide in these frequency bands.

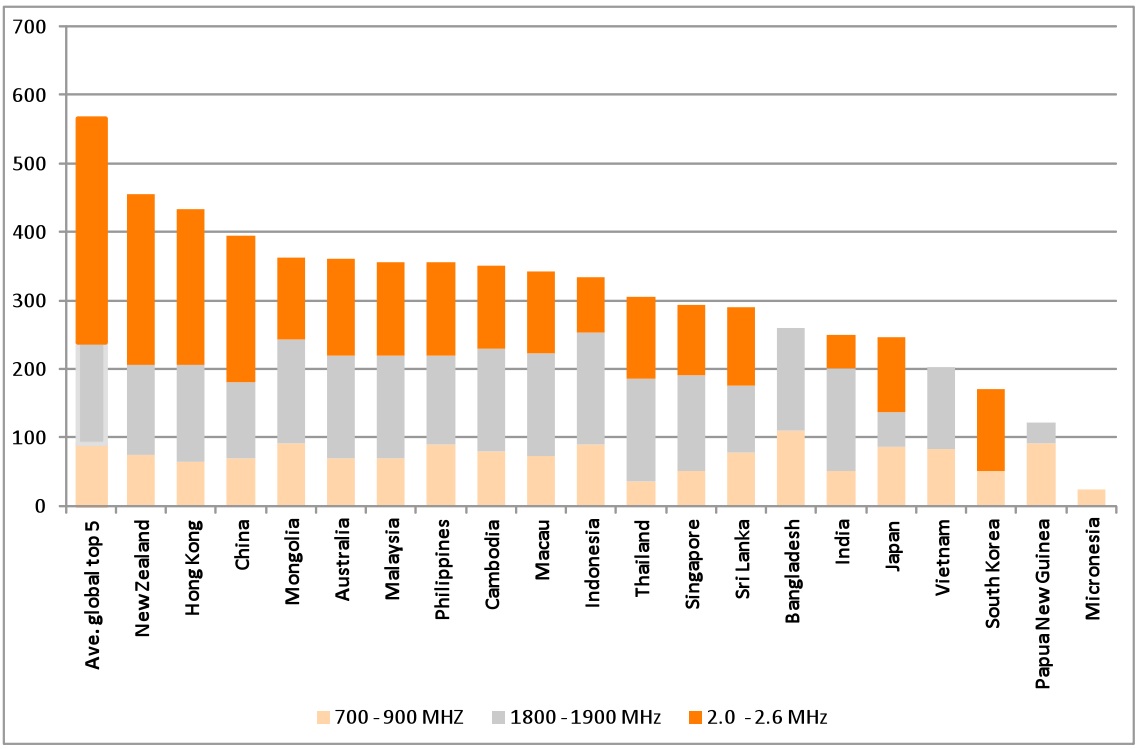
For the mobile industry to be able to deliver high quality and affordable access, it is important that governments' make available not only sufficient amounts of spectrum, but also that it is the 'right' spectrum (i.e. most suitable for mobile services) allocated using efficient, fair and transparent spectrum allocation processes.

As is evident in the figure below, Asia Pacific countries have awarded a varying amount of spectrum to mobile. Several countries including China, Australia, New Zealand, Indonesia and Thailand have awarded over 300 MHz to mobile in the categories outlined above, whereas Micronesia has awarded less than 25 MHz to mobile.[72] .

[71] Cisco (2012) *Visual Networking Index: Global mobile data traffic forecast update, 2011 – 2016*, p. 24

[72] Note that some countries have allocated spectrum to mobile in alternative frequency bands (e.g. 1500 and 1700 MHz bands), and that these allocations would not be included in

Figure 8: Spectrum released to mobile in selected Asia Pacific countries



Source: GSMA (2011)

Commercial LTE networks has been launched in several countries in the Asia Pacific region, including by CSL Limited in Hong Kong in November 2010, by NTT DOCOMO in Japan in December 2010, by Smart Communications in the Philippines in April 2011 and by M1 in Singapore in June 2011. The launch of several more commercial LTE networks are planned for 2012 by operators in for example China and India. Some countries, like Thailand and Indonesia, are in a pre-commitment trial phase.[73]

In some developed countries in the Asia Pacific region, such as Australia and Singapore, the transition from terrestrial to digital TV is an approaching reality, whereby a significant amount of spectrum is expected to become available through the digital dividend. This is the case also in some emerging markets such as Indonesia. Other countries in Asia, such as India, Bangladesh and Pakistan, are looking into allocating the UHF band, previously used for other purposes, to mobile.[74]

Japan was the first Asian nation to complete the transition to digital transmission in July 2011. This freed up spectrum which may later be allocated to mobile operators wanting to improve service.[75]

Figure 8.

[73] GSA (2011) *Evolution to LTE report*

[74] GSMA (2011) *The Digital Dividend in Asia Pacific,* p. 1

[75] Bloomberg (2011) *Japan ends all analog TV broadcasts in Asia's first transition to digital*

Thailand's National Broadcasting and Telecommunications Commission (NBTC) announced in early 2012 that it hopes to begin digital TV trials this year. This would be the beginning of a switchover process which will take around four years. The digital dividend switchover will free up 'digital dividend' spectrum for reallocation to the 4G mobile sector.[76]

Bands to be allocated in the digital dividend spectrum, and possible award dates, for selected countries in Asia Pacific are summarised below:

Table 5: Bands to be allocated in the digital dividend spectrum

Country	Band to be allocated	Possible award date
Australia	698 – 806 MHz	2013
Bangladesh	698 – 806 MHz	2015
China	698 – 806 MHz	2012
India	698 – 806 MHz	2014
Indonesia	698 – 806 MHz	2012
Japan	710 – 806 MHz	2012
New Zealand	698 – 806 MHz	2013
Philippines	698 – 806 MHz	2013/14
Singapore	698 – 806 MHz	2015
South Korea	698 – 806 MHz	2012/13
Vietnam	698 – 806 MHz	2015

Source: GSMA (2011)

Spectrum licensing in Asia Pacific

It is important that governments design and implement spectrum allocation procedures which are efficient, technology-neutral, fair and transparent. This ensures that participant costs remain low and that usage benefits are delivered to customers in a timely manner.

Spectrum allocation procedures have at times been unclear and resulted in inefficient outcomes. For example, 3G awards have been postponed in Bangladesh until 2012, and have not yet taken place in Thailand (but are also expected for 2012).

There have been examples in the region of both unfair spectrum allocation and over-licensing. In India and Thailand 3G licences were awarded to stated-owned operators before other market players were given an opportunity to compete for spectrum. In India, the government over-licensed to maximize revenue and stimulate competition. In Malaysia, the government issued plans to award 2.6 GHz spectrum for LTE to 9 operators despite the fact that there are only four mobile operators. The Government is also indicating that it does not expect to see all of these operating viable networks of their own but instead expects to see industry collaboration on RAN sharing.

Good practice examples in relation to spectrum allocation have come out of the Asia Pacific region, both from developed and emerging economies, including public consultations of the distribution of the digital dividend in Australia, New Zealand and India.[77]

[76] TeleGeography (2012) *Digital TV migration to take four years*

[77] GSMA (2011) *Asia Pacific Mobile Observatory,* p. 69-71

Regulatory scorecard

The table below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the Asia Pacific region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

Table 6: Regulatory scorecard, selected countries in Asia Pacific

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
New Zealand	High	118%	40%	15.0%	Launch date TBC
Hong Kong	High	196%			Launched 2010
China	High	69%	37%	3.3%	2012
Mongolia	High	91%			No plan / info
Australia	High	128%	44%	10.0%	Launched 2011
Malaysia	High	117%	36%	16.0%	2013
Philippines	High	97%	51%	12.4%	Launched 2011
Cambodia	High	58%		10.3%	No plan / info
Macau	High	206%			No plan / info
Indonesia	High	90%	42%	10.2%	Pre-commit trial
Thailand	High	117%	16%	7.1%	Pre-commit trial
Singapore	Medium	146%	38%		Launched 2011
Sri Lanka	Medium	83%		12.3%	Launch date TBC
Bangladesh	Medium	49%		20.2%	No plan / info
India	Medium	72%	14%	10.4%	2011
Japan	Medium	97%	55%		Launched 2010
Vietnam	Medium	175%		10.0%	Pre-commit trial
South Korea	Low	105%	30%		Launched 2011
Papua New Guinea	Low	28%		10.0%	No plan / info
Micronesia	Low	25%			No plan / info

Sources: [1] GSMA (2011) and regulators' website, [2] Merrill Lynch (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

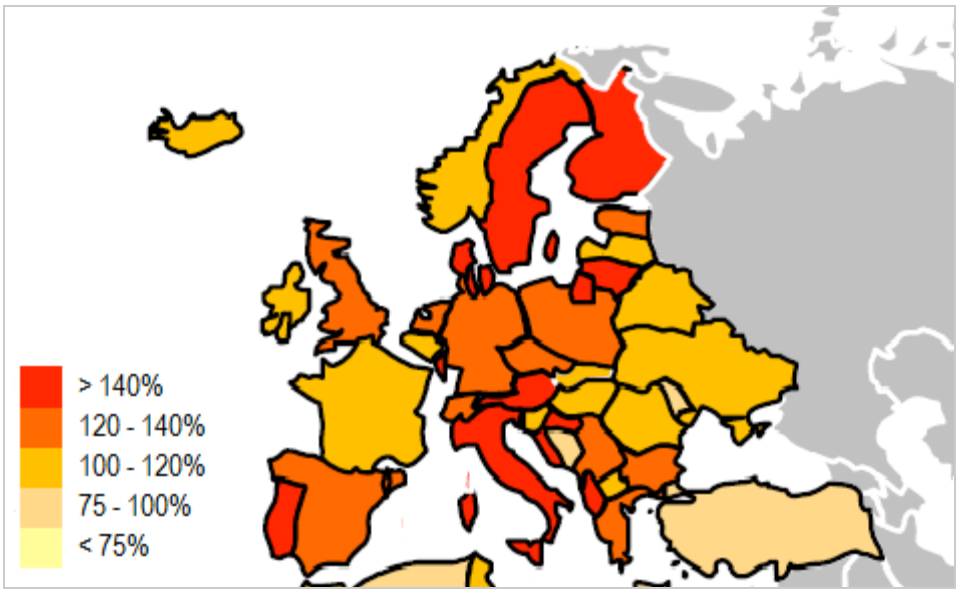
8.4. Europe

Mobile communication is a relatively large industry in Europe. Mobile coverage is nearing 100 per cent, and mobile penetration is 128 per cent. In many socio-economic groups it is the only regular communication services.[78]

As mentioned above, Europe has a very high mobile penetration rate, also relative to other parts of the world. This is illustrated in

Figure below. Several countries in Europe, including Sweden, Finland, Denmark, Italy and Portugal have a mobile penetration rate of over 140 per cent. Mobile penetration rates of selected countries in the Europe region are summarised in the regulatory scorecard (Table 8).

Figure 9: Mobile penetration in Europe



Sources: Merrill Lynch (2011) and ITU (2010)

Wireless service revenue growth in the Europe region has been declining slightly since early 2009, with the wireless service revenue growth from data steadily increasing, but the wireless revenue growth from voice steadily declining.[79]

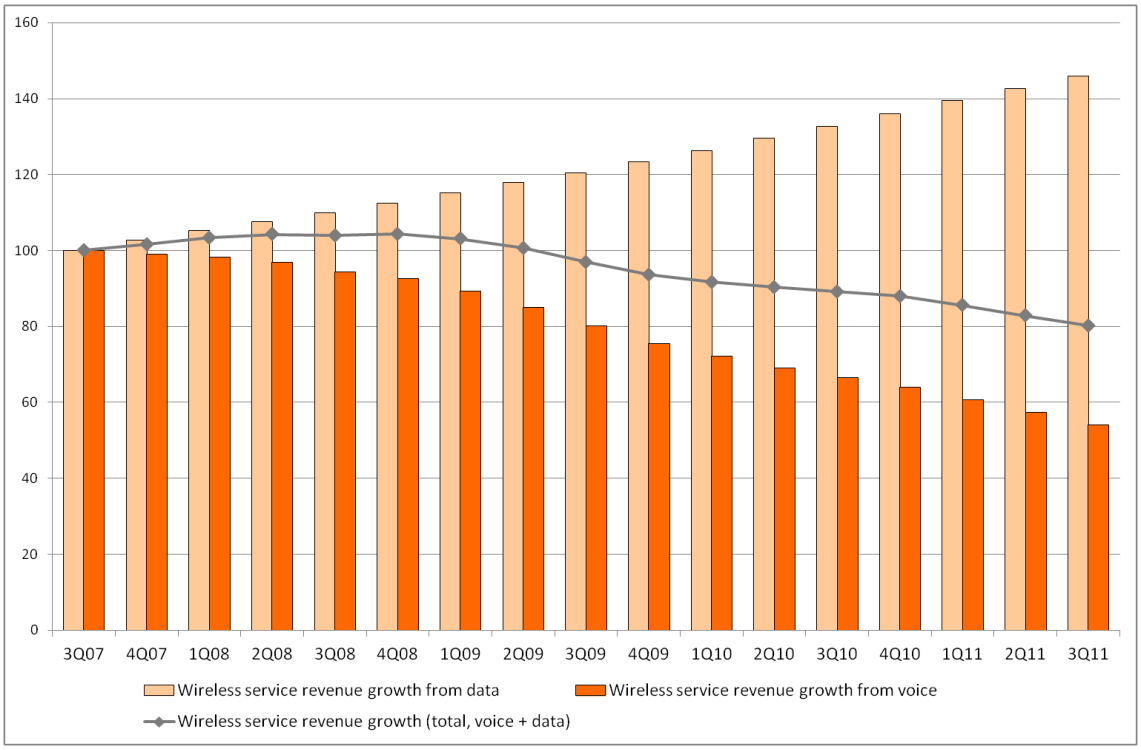
Cisco forecasts that the mobile data traffic will grow at a CAGR of 68 per cent between 2011 and 2016 in Western Europe, and 83 per cent in Central and Eastern Europe (see Figure 1)[80]. This indicates that the trend towards strong growth in revenues derived from data will continue.

[78] GSMA (2011) *European Mobile Industry Observatory,* p. 3

[79] Merrill Lynch (2011) *Global Wireless Matrix 4Q2011,* p. 43

[80] Cisco (2012) *Visual Networking Index: Global mobile data traffic forecast update, 2011 – 2016*, p. 24

Figure 10: Wireless service revenue growth in the Europe region

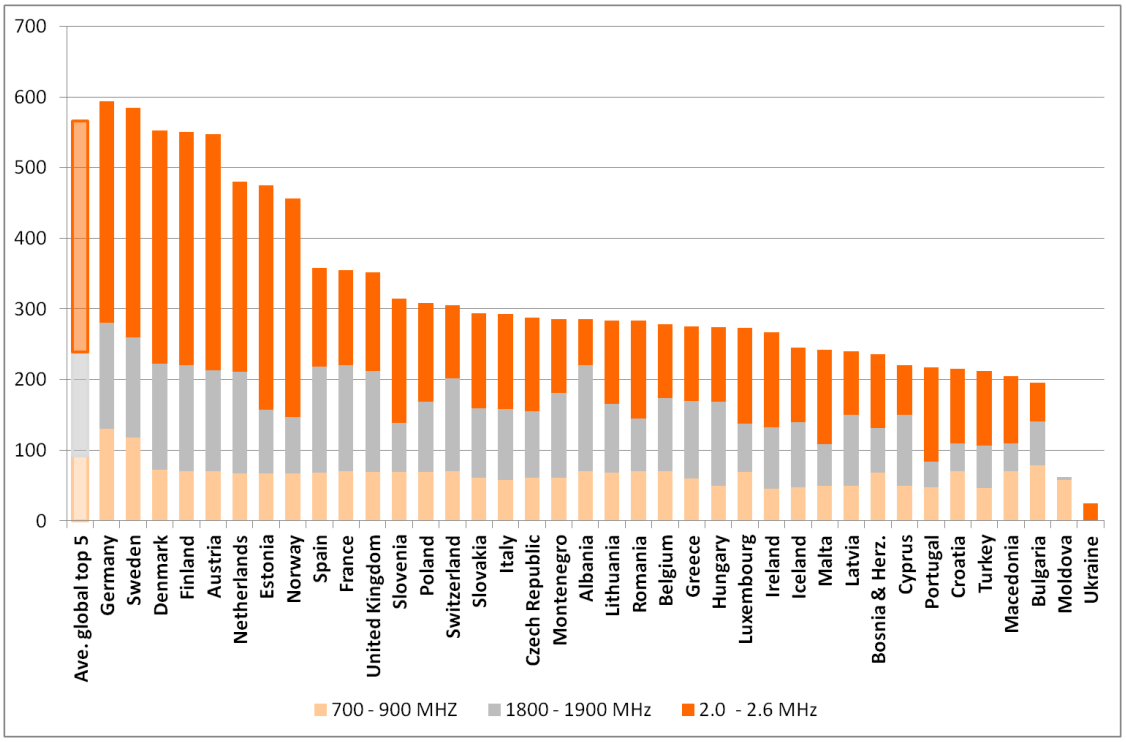


Source: Merrill Lynch (2011)

Spectrum awarded to mobile services in Europe

Most European countries have awarded significant amounts of spectrum to mobile services. The most spectrum has been awarded to mobile services in the frequency bands 700-900 Hz, 1800-1900 MHz and 2.0-2.6 GHz by national authorities in Germany, Austria and the Scandinavian countries, all of which have awarded over 540 MHz to mobile services in these frequency bands. National authorities in Moldova and Ukraine have awarded the least spectrum to mobile services out of any European country in the same bands. The spectrum awarded to mobile services in selected European countries is illustrated in Figure 9. The top 5 average is an average based on the five countries which have released the most spectrum worldwide – all of which are located in Europe.

Figure 11: Spectrum released to mobile in selected European countries



Source: GSMA (2011)

In December 2009, TeliaSonera launched the first commercial LTE network in the world in Sweden and Norway. Since then commercial LTE networks have been launched in several European countries including Austria, Finland, Germany, Poland, Denmark, Estonia, Lithuania and Latvia[81]. Several more commercial LTE network launches are planned for 2012.[82]

In Europe, several countries such as Norway, Denmark, Finland, Germany, the Netherlands, Sweden and Spain have already completed the analogue switch off, and are now in the process of allocating of the digital dividend to mobile broadband services. Germany was the first country to award spectrum in the 800 MHz band in an auction which was completed in May 2010.[83]

In May 2010, the European Commission adopted a decision which established measures for technical harmonisation for Member States opening up the 800 MHz band for networks other than terrestrial broadcasting. The digital dividend resulting from an analogue switchover should, according to the European Commission decision, be made available to wireless broadband applications such as LTE.[84]

[81] In several countries commercial LTE networks have been launched in the 1800 frequency band, including in Poland, Lithuania, Germany, Latvia, Finland and Denmark.

[82] GSA (2011) *Evolution to LTE report 2011*

[83] GSMA (2011) *The digital dividend in Europe,* p. 1

[84] European Commission (2010) *Radio Spectrum: harmonised EU rules to foster high-speed wireless internet services and avoid harmful interference*

Bands to be allocated in the digital dividend spectrum, and possible award dates, for selected countries in Europe are summarised below:

Table 7: Bands (to be) allocated in the digital dividend spectrum

Country	Band to be allocated	Possible award date
Austria	790 – 862 MHz	2012 auction
Bulgaria	790 – 862 MHz	2015
Czech Republic	790 – 862 MHz	2015
Denmark	790 – 862 MHz	2012 auction
France	790 – 862 MHz	2011 auction
Finland	790 – 862 MHz	2013 auction
Germany	790 – 862 MHz	2010
Hungary	790 – 862 MHz	2012 auction
Italy	790 – 862 MHz	2011 auction
Ireland	790 – 862 MHz	auction
Netherlands	790 – 862 MHz	2011 auction
Poland	790 – 862 MHz	2013
Portugal	790 – 862 MHz	2011
Romania	790 – 862 MHz	2013
Slovenia	790 – 862 MHz	2012
Spain	790 – 862 MHz	2011 auction
Sweden	790 – 862 MHz	2011 auction
Switzerland	790 – 862 MHz	2011 auction
United Kingdom	790 – 862 MHz	2012 auction

Source: GSMA (2011)

Spectrum licensing in Europe

Allocating and assigning spectrum in Europe is the responsibility of national authorities, also with the EU Member States. However, in the case of EU Member States, the processes are also subject to the constraints of EU laws on the single market and international radio spectrum agreements.[85]

Alternative methods of spectrum allocation include auctions and beauty parades. Auctions can take many different formats, which are more or less relevant depending on the circumstances of the auction. Beauty contests have generally been used by national authorities when objectives such as competition; quality of service obligations; speed of roll-out; and technical innovation are more important than revenue generation. Licenses can also come with a variety of different licensing conditions, which can include deployment conditions such as legal coverage requirements and network-sharing conditions.

[85] European Commission (2011) *Managing and monitoring the radio spectrum*

3G auctions in Europe

In Europe, different countries took very different approaches to the awarding of 3G licenses in the early 2000s. Some national authorities raised exceptional amounts through rents in auctions for 3G licenses, but some others raised effectively no revenue. At the extreme, the United Kingdom raised £22.5 billion through an auction, and Finland took only an administration fee from the operators through a comparative bidding process. The licensing conditions varied greatly between different countries, including the deployment conditions.[86]

The awards of 3G licenses demonstrated that 'one size does not fit all'. Auction formats that were successful for some countries were not successful for others. Also the sequencing of the European 3G auctions had an impact on the outcome, as bidders for later auctions could learn from earlier auctions in other countries and adjust their strategies accordingly.[87]

Coverage obligations in digital dividend auctions in Europe

As at mid 2011, two auctions had been completed in the digital dividend (the 800 MHz band) in Europe. These auctions took place in Germany and Sweden respectively. Both of these auctions included specific coverage obligations. In Germany, licensees were obliged to roll out to rural areas before urban areas. The coverage obligations were shared between the licensees , however it was up to individual operators to co-ordinate with regard to rolling out to particular areas (and thereby avoiding costly duplication of infrastructure).[88]

The German 800 MHz auction was concluded in May 2010. In December 2011, the German regulator, the Bundesnetzagentur, reported that mobile companies had met the coverage obligation in the 800 MHz band in seven federal states (North Rhine Westphalia, Schleswig Holstein, Hessen, Bavaria, Baden-Württemberg, Rhineland Pfalz and Saarland). The regulator noted that the network operators were obligated to provide broadband connections progressively to towns and cities in line with individual priority stages. Only when the licensee has provided 90 per cent of the population with coverage in the previous stage, can it move on to the next level.89

Sweden was the second country in Europe, after Germany, to auction the digital dividend spectrum. The Swedish regulator PTS announced in March 2011 that the auction raised SEK 2.05 billion (€233 million), and that three operators had won 2 x 10 MHz of paired spectrum each. One operator in particular, Net4Mobility, was subject to significant coverage obligations in order to promote mobile broadband development in rural areas. Specifically, Net4Mobility was required to cover all permanent homes and fixed places of business that do not have data services with a bit rate of 1Mbps by the end of 2013.[90]

In deciding whether to impose specific license obligations on mobile operators it is important for regulators or national authorities to consider both: (i) the benefits of such obligations and (ii) if there are less costly ways to achieve the objectives of coverage.

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86 European Commission (2001) *The introduction of third generation mobile communications in the European Union: State of play and the way forward*

87 Klemperer, P (2002) *How (Not) to Run Auctions: the European 3G Telecom Auctions*

88 Analysys Mason (2011) *Mobile broadband coverage – Balancing costs and obligations*

89 BNetzA press release 28.12.2011

90 Ovum (2011) *Swedish regulator promotes rural mobile broadband in the digital dividend auction*

There are potential risks with coverage obligations, for example if they force operators to deploy networks and/or services faster than is economically or commercially sensible. Obligations could also force operators to incur losses, or, if operators fail to meet their obligations, result in a dilemma for the regulator on how to impose penalties. Relaxing coverage obligations retrospectively can also lead to legal challenges from operators who did not bid initially on account of the coverage licensing conditions. Alternatives to coverage obligations include allowing for refarming and facilitating greater network sharing.

Regulatory scorecard

Table 8 below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the European region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

Table 8: Regulatory scorecard, selected countries in Europe

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
Germany	High	137%	38%	19.0%	Launched 2010
Sweden	High	145%	32%	25.0%	Launched 2010
Denmark	High	144%	20%	25.0%	Launched 2010
Finland	High	168%	30%	23.0%	Launched 2010
Austria	High	153%	41%	20.0%	Launched 2010
Netherlands	High	121%	36%	19.0%	Launch date TBC
Estonia	High	123%		20.0%	Launched 2010
Norway	High	117%	29%	25.0%	Launched 2009
Spain	High	125%	22%	18.0%	2011
France	High	100%	28%	19.6%	2012
United Kingdom	High	122%	37%	20.0%	2012
Slovenia	High	105%		20.0%	2012
Poland	High	127%	26%	22.0%	Launched 2010
Switzerland	High	131%	30%	8.0%	2011
Slovakia	Medium	108%		19.0%	Pre-commit trial
Italy	Medium	151%	31%	24.4%	Launch date TBC
Czech Republic	Medium	130%	28%	20.0%	Pre-commit trial
Montenegro	Medium	185%		17.0%	2012
Albania	Medium	142%		20.0%	No plan / info
Lithuania	Medium	147%		21.0%	Launched 2011
Romania	Medium	115%		19.0%	Launch date TBC
Belgium	Medium	114%	31%	21.0%	Launch date TBC
Greece	Medium	138%	16%	30.4%	Pre-commit trial
Hungary	Medium	112%	24%	25.0%	2012
Luxembourg	Medium	143%		15.0%	Launch date TBC
Ireland	Medium	105%		21.0%	2011
Iceland	Medium	107%			No plan / info
Malta	Medium	109%		18.0%	No plan / info

Latvia	Medium	102%		21.0%	Launched 2011
Bosnia & Herzegovina	Medium	83%			No plan / info
Cyprus	Medium	94%		15.0%	No plan / info
Portugal	Medium	161%	27%	21.0%	2011
Croatia	Medium	144%		27.9%	2012
Turkey	Medium	90%	24%	48.2%	Pre-commit trial
Macedonia	Medium	105%			No plan / info
Bulgaria	Low	136%		20.0%	Pre-commit trial
Moldova	Low	89%			Launch date TBC
Ukraine	Low	117%	33%	20.0%	Pre-commit trial

Sources: [1] GSMA (2011) and regulators' website, [2] Merrill Lynch (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

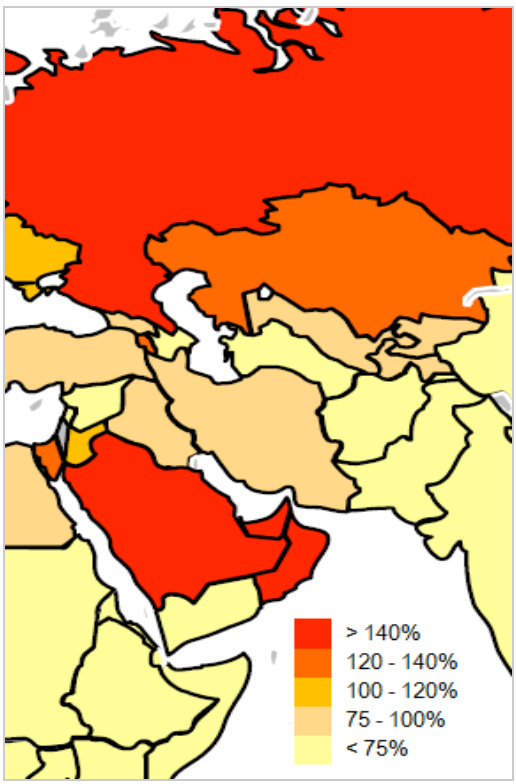
8.5. Middle East & Central Asia

During 2012, the number of mobile subscriptions in the Middle East will cross the 250 million mark, and rise to over 350 million by 2016. The biggest mobile market in the Middle East by subscriptions is Iran, followed by Saudi Arabia. The market is growing on account of increasing competition, availability of new data-based services, increasing affordability and population growth.[91]

The mobile penetration in the Middle East and Central Asia varies significantly throughout the region. Some countries, such as the United Arab Emirates, Saudi Arabia and Russia have a very high mobile penetration rate (over 140 per cent). However many countries in the region have a much lower mobile penetration rate. This is illustrated in Figure below.

[91] ITU (2011) *Middle East's mobile-subscription count will cross 250 million mark in 2012*

Figure 12: Mobile penetration in the Middle East & Central Asia



Sources: Merrill Lynch (2011) and ITU (2010)

Data services only make up a relatively small proportion of mobile revenues in the Middle East region. In 2Q2011, data accounted for 13 per cent of mobile revenues. This is the lowest percentage for any region in the world except Africa. However, there are still substantial markets, such as Iran and Iraq, which have yet to introduce 3G networks, so the potential for growth in data services is significant.[92]

Cisco forecasts that the mobile data traffic will grow at a CAGR of 104 per cent between 2011 and 2016 in the Middle East and Africa (grouped as one) (see Figure 1)[93]. This indicates that the worldwide trend towards revenues being derived from data as opposed to voice services is likely to continue in the Middle East and Central Asia region[94].

Spectrum awarded to mobile services in the Middle East and Central Asia

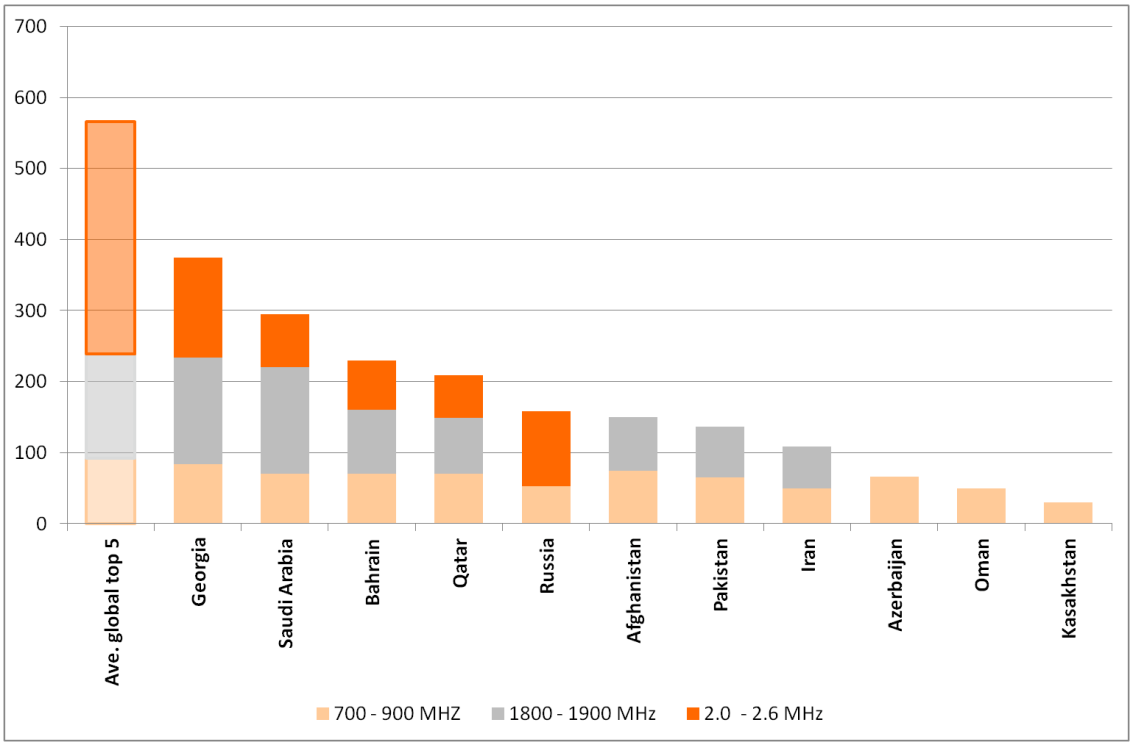
Countries in the Middle East and Central Asia have in general awarded less spectrum to mobile services than countries in other regions of the world in the frequency bands 700-900 MHz, 1800-1900 MHz and 2.0-2.6 GHz. Only one of the countries in the Figure below has awarded more than 300 MHz to spectrum in these frequency bands. Three countries; Azerbaijan, Oman and Kazakhstan, have all awarded less than 100 MHz to mobile services in the same frequency bands.

[92] ITU (2011) *Middle East's mobile-subscription count will cross 250 million mark in 2012*

[93] Cisco (2012) *Visual Networking Index: Global mobile data traffic forecast update, 2011 – 2016,* p. 24

[94] The corresponding number of the Asia Pacific number is a CAGR of 84 per cent.

Figure 13: Spectrum released to mobile in selected countries in the Middle East and Central Asia



Source: GSMA (2011)

A commercial LTE network was first launched in the Middle East and Central Asia region in Uzbekistan. In July 2010, MTS launched a commercial LTE network, followed by UCell in August 2010. Commercial LTE networks were also launched in Saudi Arabia, by three separate operators in September 2011, and in the United Arab Emirates by Etisalat in September 2011.[95]

However, it might take some time before the commercial LTE networks take off in the Middle East. Informa forecasts that LTE subscriptions in the Middle East will amount to only 1.94 million at the end of 2013, but will grow to 15 million by the end of 2016.[96]

[95] GSA (2011) *Evolution to LTE report,* p. 1

[96] ITU (2011) *Middle East's mobile-subscription count will cross 250 million mark in 2012*

Bands to be allocated in the digital dividend spectrum, and possible award dates, for selected countries in the Middle East and Central Asia are summarised below:

Table 9: Bands to be allocated in the digital dividend spectrum

Country	Band to be allocated	Possible award date
Bahrain	790 – 862 MHz	2012/12
Egypt	698 – 806 MHz	2015
Jordan	790 – 862 MHz	2015
Lebanon	698 – 806 MHz	2015
Saudi Arabia	790 – 862 MHz	2015
UAE	790 – 862 MHz	2013

Source: GSMA (2011)

Regulatory scorecard

Table 10 below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the Middle East and Central Asian region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

Table 10: Regulatory scorecard, selected countries in Middle East and Central Asia

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
Georgia	High	91%		18.8%	Pre-commit trial
Saudi Arabia	Medium	188%			Launched 2011
Bahrain	Medium	124%			Launch date TBC
Qatar	Medium	132%			Launch date TBC
Russia	Low	158%	23.5%		2011
Afghanistan	Low	41%			No plan / info
Pakistan	Low	63%		31.6%	No plan / info
Iran	Low	91%		6.2%	No plan / info
Azerbaijan	Low	99%		18.9%	No plan / info
Oman	Low	166%			Pre-commit trial
Kazakhstan	Low				Launch date TBC

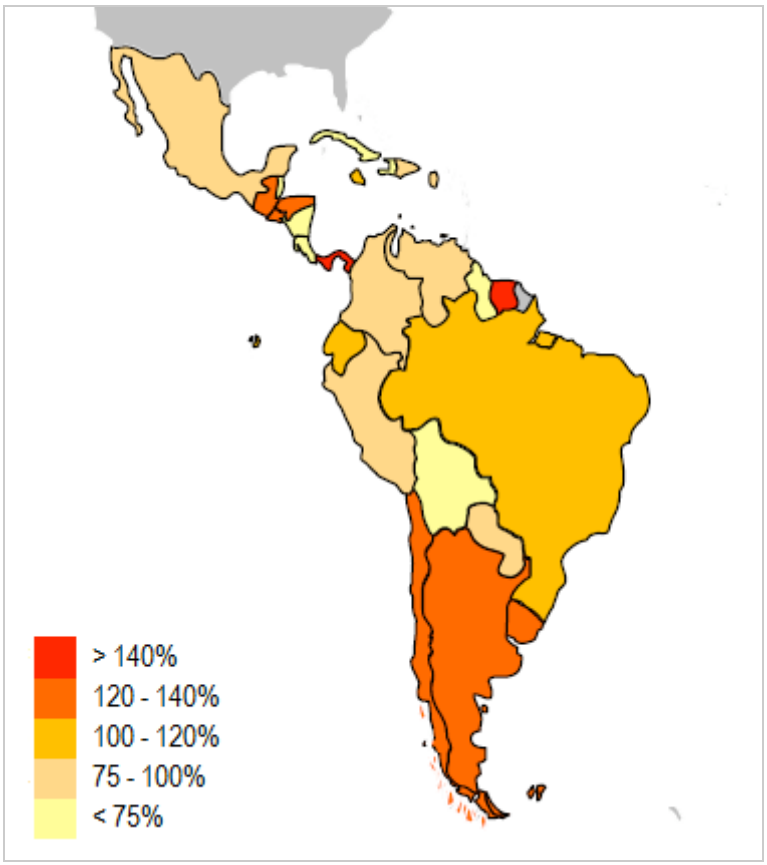
Sources: [1] GSMA (2011) and regulators' website, [2] Merrill Lynch (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

8.6. Latin America

Latin America is the third largest mobile market after Africa and Asia Pacific. The market has been growing rapidly, and there are over 630 million connections as at 3Q2011.97

Latin America has a varied mobile penetration rate, as is illustrated in Figure 14 below. For example Chile and Argentina have a mobile penetration rate of over 120 per cent, whereas Bolivia has a mobile penetration rate of less than 75 per cent. Mobile penetration rates of selected countries in the Latin America region are summarised in the regulatory scorecard (Table 12) at the end of section 0.

Figure 14: Mobile penetration in the Latin America region



Sources: Merrill Lynch (2011) and ITU (2010)

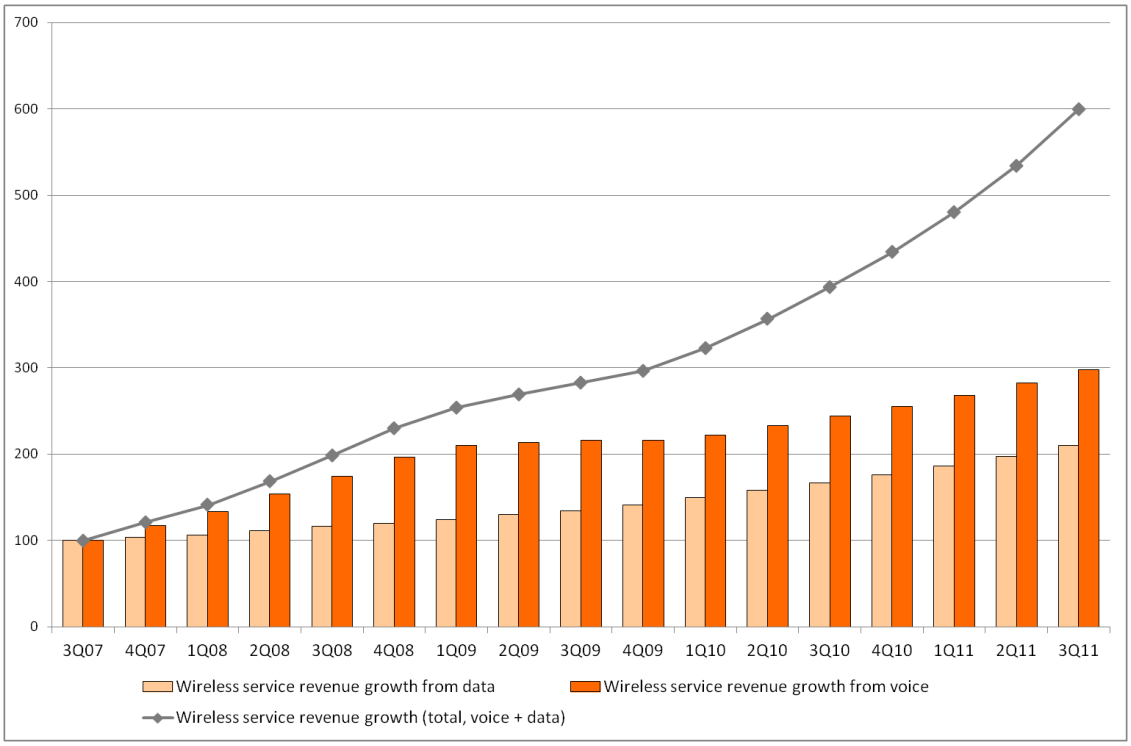
Wireless service revenue growth in the Latin America region has been increasing steadily over the last few years. This can be attributable to strong growth in service revenue from both voice and data.

Cisco forecasts that the mobile data traffic in Latin America will grow at a CAGR of 79 per cent between 2011 and 2016 (see Figure 1)[98]. This indicates that the trend towards strong growth in revenues derived from data will continue.

[97] GSMA (2011) *Latin American Mobile Observatory 2011*, p. 5

[98] Cisco (2012) *Visual Networking Index: Global mobile data traffic forecast update, 2011 – 2016*, p. 24

Figure 15: Wireless service revenue growth in the Latin America region



Source: Merrill Lynch (2011)

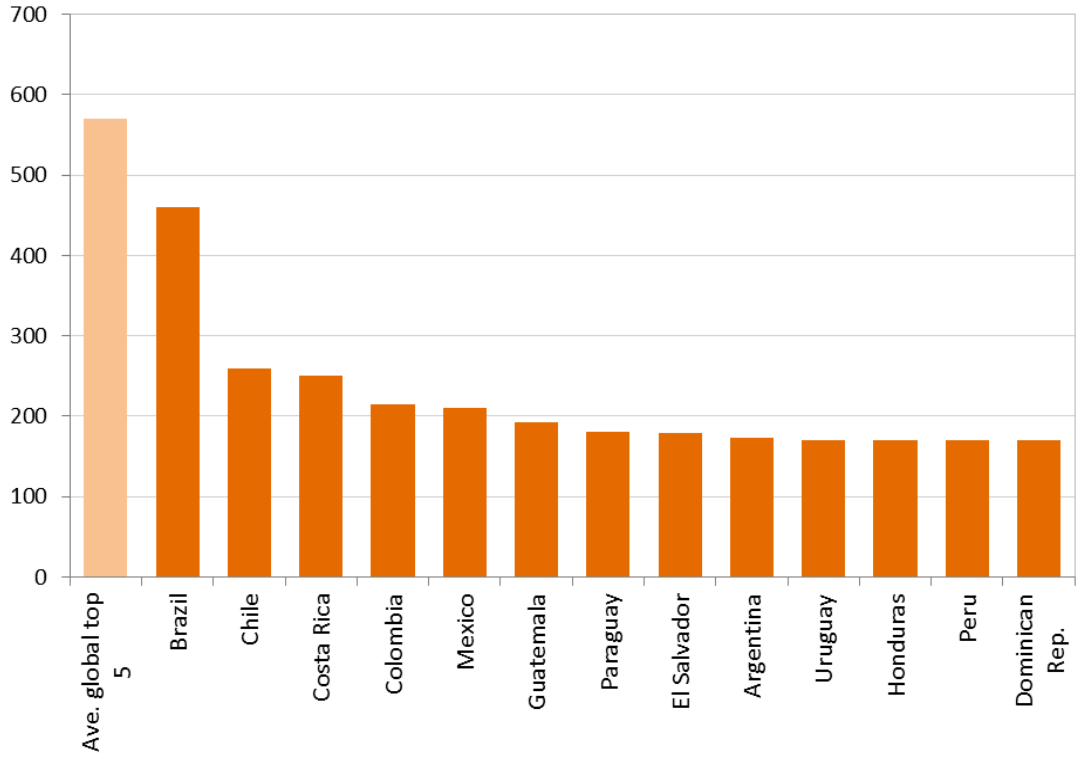
Spectrum awarded to mobile services in Latin America

The amount of spectrum allocated to mobile services is more limited in Latin America than in Europe and North America.

Figure 16 below shows the spectrum allocated to mobile services in several countries in Latin America, as well as an average of the top 5 countries in the world (i.e. the countries that have released the most spectrum in total). It shows that most countries in Latin America have released less than 250 MHz of spectrum to mobile services. The most spectrum has been released to mobile operators in Mexico in these frequency bands – 360 MHz in total. In other countries much less spectrum has been released to mobile services in the same frequency bands. However, regulators in Latin America are continuously allocating more spectrum to mobile broadband.[99]

[99] GSMA (2011), *Latin American Mobile Observatory*, p. 62

Figure 16: Spectrum released to mobile in selected Latin American countries



Source: GSMA (2012)

The first live trial for LTE was held in January 2010 with Entel PCS in Chile. A trial was also held in June 2010 with Telecom Personal in Argentina, followed by many others.[100] Commercial LTE networks are expected to be launched in Colombia, Mexico, Puerto Rico and Uruguay in 2012.[101]

Many Latin American governments are in the process of deciding on the allocation of the digital dividend spectrum to broadband. Analogue switchover is scheduled for 2015 in Uruguay and Mexico, 2016 in Brazil and 2017 in Chile. However, most of the UHF band is relatively clear in many countries in Latin America[102], so therefore there should be no major obstacles in allocating the spectrum to mobile broadband before the switchover. Brazilian regulator is studying alternatives to clear the band from existing broadcasting occupants so as to optimize DTT use as well as greater broadband access[103]. Mobile broadband will be key for Latin American countries to achieve their goals defined in their national broadband plans, digital agendas of universalizing broadband connectivity. With large extensions of land wireless is the most cost-effective option to expand existing coverage.[104]

[100] GSMA (2011) *Latin American Mobile Observatory*, p20 LTE Network Tracking

[101] GSA (2011) *Evolution to LTE report 2011*

[102] Aegis (2010) *Digital TV Spectrum Requirements, WP4: Status of Digital TV Spectrum in Latin America* .

[103] See CPqD (2011) *700 MHz Spectrum Utilization Analysis in Brazil* for options being suggested to clear the band.

[104] See TAS (2011) *Economic Benefits of the Digital Dividend for Latin America*, for coverage expansion estimations.

Colombia, Uruguay and Chile are expected to be the first to assign digital dividend spectrum to mobile services as this is part of their spectrum allocation roadmap set out in different official statements. Uruguay, Peru, Colombia and Mexico have already allocated the 700 MHz band on a primary basis for mobile services and begun clearing it.[105] Current discussion within these leading countries is around the band plan that should be used that, based on CITEL resolution PCC.II/REC. 30 (XVIII-11), should be either the USA or the APT arrangement.[106] Prospects indicate that Latin America is leaning towards APT 2x45MHz band channelization. In April and May 2012, Chile, Costa Rica and Colombian regulators expressed their preference for aligning with Region 3.

Bands to be allocated in the digital dividend spectrum, and possible award dates, for selected countries in Latin America are summarised below:

Table 11: Bands to be allocated in the digital dividend spectrum

Country	Band to be allocated	Possible award date
Argentina	698 – 806 MHz	2016
Brazil	698 – 806 MHz	2016
Chile	698 – 806 MHz	2014
Colombia	698 – 806 MHz	2013
Mexico	698 – 806 MHz	2014
Peru	698 – 806 MHz	2014
Uruguay	698 – 806 MHz	2013

Source: GSMA (2011)

A study commissioned by the GSMA and AHCIET, conducted by Telecom Advisory Services LLC (TAS) in the economic impact of the digital dividend in Latin America suggested that allocating the digital dividend spectrum in the 700 MHz band for the deployment of mobile services could contribute near US$15 billion to the economies of Latin America. Additionally, it would increase the mobile broadband coverage to near 93 per cent of the population, helping to further improve broadband access in this region[107].

Spectrum licensing in Latin America

One of the most used methods of spectrum allocation in Latin American countries is through auctions. However, there are countries like Chile that make their allocations through beauty contests. Recently, auctions have taken place in for example Mexico and Colombia. In Mexico, an auction of 30 MHz in the 1900 MHz (PCS) band took place in June 2010, followed by an auction of 90 MHz in the 1.7 GHz and 2.1 GHz (AWS) in which 30MHz resulted vacant.[108]

In Colombia, an auction took place in May 2010 in the 2500 MHz band. The 50 MHz auction was won by Une-EPM Telecomunicaciones, The company was one of the first companies to deploy LTE services in the region, in July 2012.

[105] GSMA, The Digital Dividend in Latin America, p. 1

[106] See CITEL Recommendation PCC.II/REC. 30 (XVIII-11) "Frequency arrangements of the 698–806 MHz band in the Americas for broadband mobile services".

[107] GSMA (2011) *Allocating digital dividend spectrum for mobile broadband could contribute up to $15 billion to the Latin American Economy*

[108] Martyn Roeter (2011) *Spectrum for Mobile Broadband in the Americas: Policy Issues for Growth and Competition*

Spectrum caps in Latin America

In Latin America, many regulators have advocated spectrum caps to increase competition in mobile markets. The use of such spectrum caps is not uncontroversial, as they involve a balancing act between competition between operators and enabling larger operators to improve speed and capacity within their network.

It is important that caps, if enforced, are set in relation to the total spectrum which is on offer, taking into account technology availability now and in the future as well as expected user demand. Sufficient continuous bandwidth is required to achieve higher speeds and exploit efficiencies made possible by new technologies.

In a 2009 beauty contest in Chile of the 1.7 / 2.1 GHz AWS band, the regulator imposed a 60 MHz cap. The contest included three blocks of 30 MHz each, which the incumbent operators were unable to bid for because of the spectrum caps. This resulted in the entire spectrum in question being allocated to two new entrants.[109]

Incumbents in Mexico were also unable to buy a national license during 2010 AWS spectrum auction as they would have surpassed the cap of 80 MHz set by the regulator. They were only able to buy spectrum on a regional basis at much higher prices than entrants.

Spectrum caps, if consider critical to foster competition, should be set on a flexible basis allowing all incumbent operators to have access to spectrum as well as entrants. Subscribers and data use growth makes it necessary for incumbents to have access to new spectrum. In some Latin American countries, there has not been any new spectrum allocation in the last 12 years although subscriber's grown very significantly.

[109] GSMA (2011) *Latin America Mobile Observatory 2011*, p. 67

Regulatory scorecard

Table 12 below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the Latin American region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

Table 12: Regulatory scorecard, selected countries in Latin America

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
Mexico	Medium	88%	24%	16.0%	2012
Brazil	Medium	119%	15%	25.2%	2013
Chile	Medium	133%	17%	19.1%	2013
Ecuador	Low	107%	24%	12.8%	No plan / info
Costa Rica	Low	85%			No plan / info
Colombia	Medium	96%	17%	16.2%	2012
Guatemala	Low	97%		12.4%	No plan / info
Argentina	Low	132%	36%	22.5%	Pre-commit trial
Peru	Low	85%	15%	19.2%	Pre-commit trial
Trinidad & Tobago	Low	141%			No plan / info
Venezuela	Low	96%	33%	12.4%	No plan / info
Bolivia	Low	72%		13.4%	Pre-commit trial
Bahamas	Low	125%			No plan / info

Sources: [1] GSMA (2011) and regulators' website, [2] Latin American Mobile Observatory (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

8.7. North America

The mobile penetration in North America is relatively high, albeit not as high as in parts of Europe and Asia Pacific. In the United States, mobile penetration is about 103 per cent, and in Canada mobile penetration is about 76 per cent.[110]

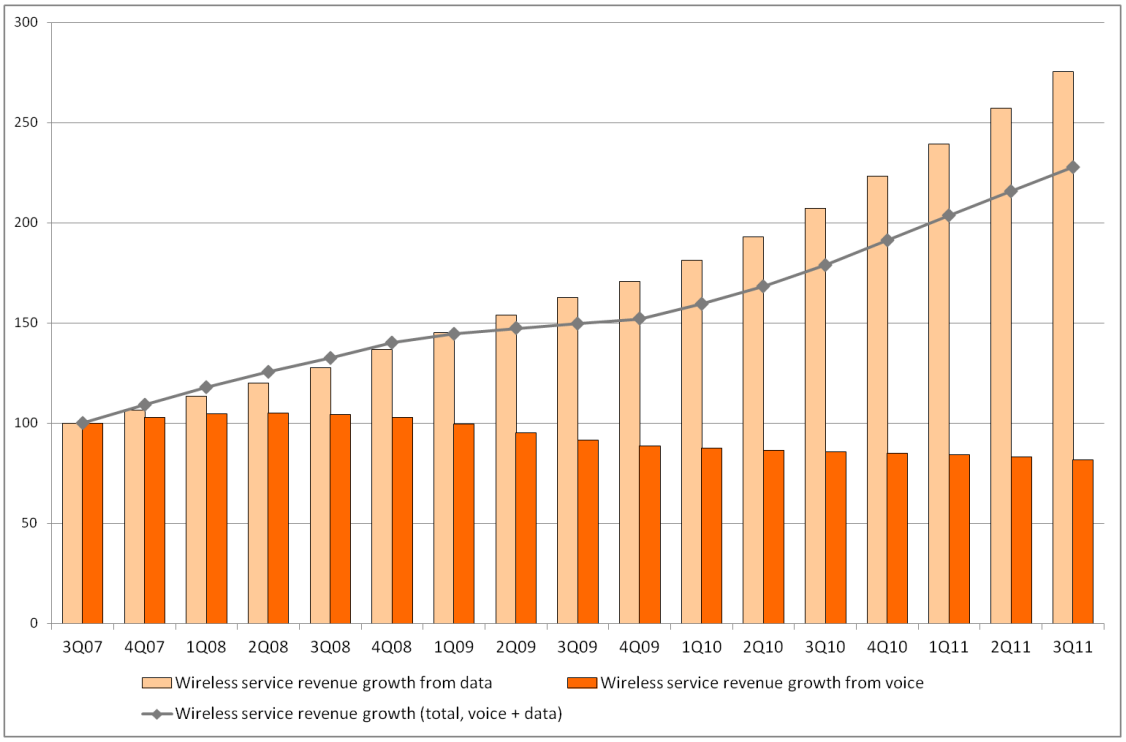
Wireless service revenue growth in the North America region has been declining slightly over the last four years, with the wireless service revenue growth from data steadily increasing, and the wireless revenue growth from voice steadily declining. This is illustrated in Figure 17 below.

Cisco forecasts that the mobile data traffic in North America will grow at a CAGR of 75 per cent between 2011 and 2016 (see Figure 1)[111]. This indicates that the trend towards strong growth in revenues derived from data will continue.

[110] Merrill Lynch (2011) *Global wireless matrix 4Q2011*, p. 2

[111] Cisco (2012) *Visual Networking Index: Global mobile data traffic forecast update, 2011 - 2016*

Figure 17: Wireless service revenue growth in the North America region

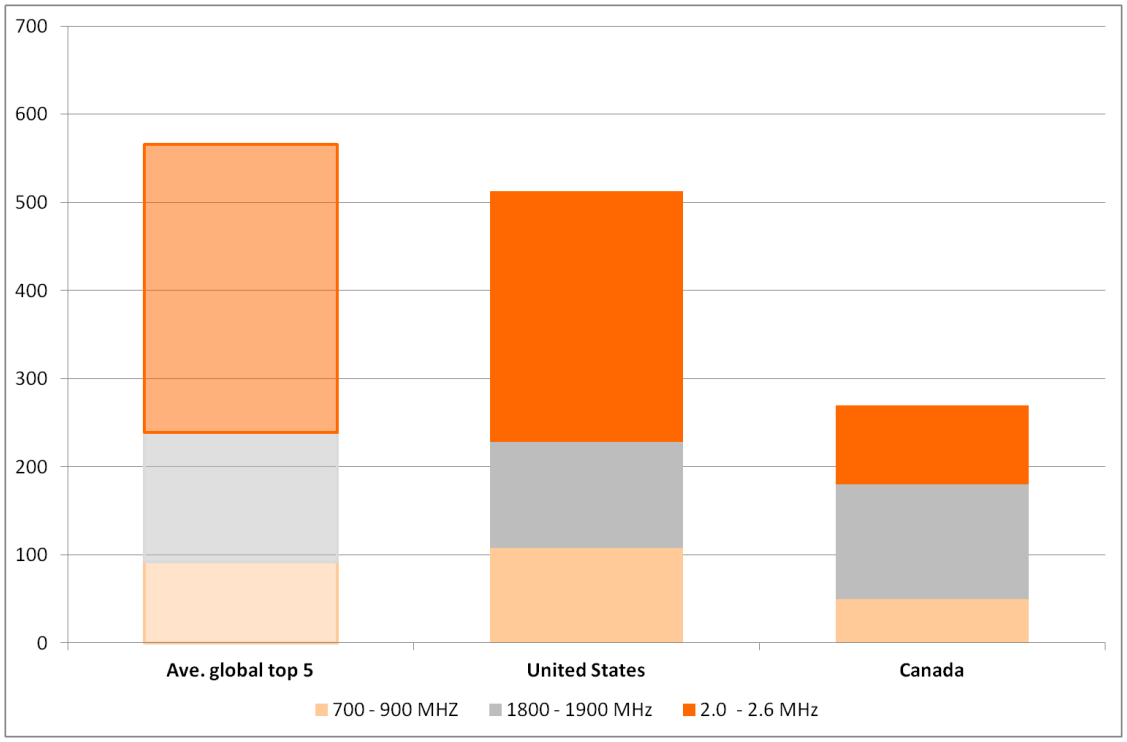


Source: Merrill Lynch (2011)

Spectrum awarded to mobile services in North America

Just over 500 MHz of spectrum has been allocated to mobile services in the United States in the frequency bands 700-900 MHz, 1800-1900 MHz and 2.0-2.6 GHz. This is a relatively large amount, and only a handful of countries in Europe have allocated more spectrum to mobile services (see Figure 18). In Canada, less than 300 MHz of spectrum has been released to mobile services in these frequency bands. This is significantly less than that released by the top 5 average and the United States. The amount of spectrum allocated to mobile services in the relevant frequency bands is illustrated in Figure 18 below.

Figure 18: Spectrum released to mobile in selected North American countries



Source: GSMA (2011)

In the US, three operators, MetroPCS, Verizon Wireless and AT&T, have launched commercial LTE networks. A further three operators, Sprint, US Cellular and Leap Wireless are expected to launch commercial networks in 2012. Research indicates that the US will have two thirds of total global LTE subscriptions by the end of 2011.[112]

In Canada Rogers Wireless announced the launch of the first commercial LTE service in July 2011 in Ottowa, to be followed by a further 20+ markets in 2011 and 2012. Also other operators are expected to launch LTE networks in 2012.[113]

The United States completed its analogue switchover in 2009, and auctioned the associated 700 MHz spectrum in 2008. The US 'Auction 73' involved two months of multi-round bidding, and the principal winners were Verizon and AT&T. The auction raised a total of $18,957,582,150 in net winning bids.[114]

In Canada, the regulator set 31 August 2011 as the deadline for broadcasters to complete the transition from analogue to digital television. However in early August 2011, the regulator gave the Canadian Broadcasting Corporation (CBC) permission to continue broadcasting analogue television in 22 markets until 31 August 2012, to give CBC an additional year to find solutions to viewers who may lose access after the transition. CBC, as the national broadcaster, has a mandate to serve the entire Canadian population. The transition however went ahead in 28 Canadian markets, and the government has reserved channels for public safety and advanced wireless services.[115]

[112] GSMA (2011) *European Mobile Industry Observatory 2011,* p. 26

[113] GSA (2011) *Evolution to LTE report 2011*

[114] GSMA (2011) *Making sense of the digital dividend spectrum, auctions summary*

[115] Canadian Radio-television and Telecommunications Commission (CRTC) (2011), *CRTC allows CBC to continue broadcasting analog television signals in 22 markets until August 2012*

Spectrum licensing in North America

In the US, the Federal Communications Commission (FCC) conducts auctions of licenses for spectrum. The FCC generally relies on simultaneous multiple-round (SMR) auctions. These auctions have discrete, successive rounds, and the FCC announces the length of each round in advance. Bidding continues, round after round, until all bidder activity ceases. The auction design can also be modified by the FCC to allow combinatorial or "package" bidding.[116]

In Canada, the regulator relies on a first come, first-served licensing process when the demand for spectrum is not expected to exceed supply. In the cases when demand is expected to exceed supply, a competitive allocation process such as an auction is generally relied upon. An auction may also be preferably if government policy objectives can be fully met through this process. The regulator also has measures available to it to promote a competitive post-auction market-place, including the options to restricting the participation of certain entities and/or limiting the amount of spectrum allocated to any one entity (i.e. spectrum caps).[117]

The US 'Auction 73' of the 700 MHz spectrum

The US auction of the 700 MHz spectrum was the first spectrum of the digital dividend spectrum in the world. The auction started on the 24 January 2008 and finished two months later on the 18 March 2008. The auction took the form of multi-round bidding.

The auction offered 62 MHz of spectrum. Five blocks were sold: two blocks of 2 x 6MHz dividend into 176 and 734 geographic areas respectively, one block of 6 MHz unpaired divided into 176 geographical areas, one block of 2 x 11 MHz divided into 12 geographical areas and one block of 2 x 5 MHz as nationwide. The provisionally winning bid for the D block did not meet the applicable reserve price and therefore did not become a winning bid. As such, only 52 MHz of spectrum were auctioned. The auction concluded with 1090 provisional winning bids across 1091 licenses, and raised $18,957,582,150 in net winning bids.

The licenses involved specific coverage roll out obligations which were specifically designed for different licenses sold. The licenses were of the duration of 10 years and could be used for flexible fixed, mobile and broadcast uses. They may also include two-way interactive, cellular and mobile television broadcasting services. Further to this the licenses were tradable.[118]

[116] Federal Communications Commission (FCC) (2006) *About auctions*

[117] Industry Canada (IC) (2011) *Framework for Spectrum Auctions in Canada*

[118] GSMA (2011) *Making sense of the digital dividend, auctions summary*

Regulatory scorecard

Figure 13 below is a regulatory scorecard, summarising the level of paired spectrum which has been awarded to mobile services in selected countries in the North American region. It also summarises the mobile penetration, the percentage of revenue derived from data, the taxation of mobile services and LTE launches or launch commitments in the same selection of countries.

Table 13: Regulatory scorecard, selected countries in North America

Country	Spectrum to mobile[1]	Mobile penetration[2, 3]	Revenue from data[2]	Mobile taxation[4]	Expected LTE launch[5]
United States	High	103%	38.6%		Launched 2010
Canada	Medium	76%	33.5%		Launched 2011

Sources: [1] GSMA (2011) and regulators' website, [2] Merrill Lynch (2011), [3] ITU (2010), [4] Deloitte (2011), [5] GSA (2011). For the allocation of spectrum to mobile services in the regulatory scorecards, we assumed that less than 200MHz was low, between 200 and 300MHz was medium and over 300MHz was high - this breakdown roughly corresponds to the bottom third, middle third and top third of countries around the world.

Appendix A. Sample licence to use radio frequencies

This appendix sets out a sample spectrum licence and the conditions that could be attached to the licence in line with the proposed approach discussed in the report.

Sample licence for the [enter relevant frequency] band

This licence is issued under **[**the relevant Act**]** to the licensee named at Item 1 of Licence Schedule 1 of this licence.

1. The licensee is authorised to operate radiocommunications devices in accordance with:

   (a) the Act; and

   (b) the core conditions set out in Licence Schedule 2; and

   (d) the other conditions set out in Licence Schedule 3.

2. This licence shall be in force from the dates of licence effect shown at Part 1 of Licence Schedule 1 and shall continue in force until revoked by **[**the Regulator**]** ("the Regulator") or surrendered by the Licensee.

Licence Schedule 1 - Licence details, bands and areas

Part 1: Licence Details

1. Licensee Details

Name of licensee	**[**xxx**]**
Address of licensee	**[**xxx**]**

2. Licence Details

Band release	**[**relevant frequency band**]**
Date of licence effect	**[**dd/mm/yyyy**]**
Licence number	**[**xxx**]**
Date of licence issue	**[**dd/mm/yyyy**]**
Date of licence renewal	**[**dd/mm/yyyy**]**

Part 2: Frequency bands

For core condition 1, this licence authorises the operation of radiocommunications devices in the frequency bands that consist of the frequencies between the lower and upper limits subject to adjacent frequencies unwanted emission limits as described in Schedule 2 below.

Upper band

Lower frequency limit	**[**xxx MHz**]**
Upper frequency limit	**[**xxx MHz**]**

Lower band

Lower frequency limit	**[**xxx MHz**]**
Upper frequency limit	**[**xxx MHz**]**

Part 3: Geographic Area

The operation of radiocommunications devices is authorised by this licence in the **[**specified geographic area**]**.

Licence Schedule 2 - Core Conditions

Frequency band

1. This licence authorises the operation of radiocommunications devices in the frequency bands set out at Part 2 of Licence Schedule 1.

Emission limits outside the frequency band

2. Core conditions 3 to 11 apply in relation to those frequencies that are outside the frequency bands set out in Part 2 of Licence Schedule 1.

3. Where a written agreement exists between:

   (a) the licensee; and

   (b) the affected licensees of frequency-adjacent and area-adjacent spectrum licences;

   specifying the maximum permitted level of radio emission for frequencies described in core condition 2, the licensee must comply with that specified maximum permitted level of radio emission.

4. Where there is no written agreement for the purposes of core condition 3 in force, core conditions 5 to 11 apply.

Non spurious emission limits

5. The licensee must ensure that radiocommunications devices operated under the licence do not exceed the non-spurious emission limits in core conditions 6.

6. The non-spurious emission limits in Table 1 apply at frequencies outside **[**the frequency bands of the licence**]**.

Table 1: Non spurious emission limits

Frequency offset range	**Radiated maximum true mean power (dBm EIRP)**	**Specified Bandwidth**
[xxx**]**	**[**xxx**]**	**[**xxx**]**

Licence Schedule 2 Core Conditions (cont)

Spurious emission limits

7. The licensee must ensure that radiocommunications devices operated under the licence do not exceed the spurious emission limits in core conditions 8.

8. For radiocommunications transmitters operated under the licence, the spurious emission limits in Table 2 apply at frequencies outside **[**the frequency bands of the licence**]**.

Table 2: Radiocommunications transmitter spurious emission limits

Frequency offset range	**Radiated maximum true mean power (dBm EIRP)**	**Specified Bandwidth**
[xxx**]**	**[**xxx**]**	**[**xxx**]**

Emission limits outside the geographic area

9. Core conditions 10 applies in relation to those areas that are outside the geographic areas set out at Part 3 of Licence Schedule 1.

10. The maximum permitted level of radio emission for an area described in core condition 10 caused by operation of radiocommunications devices under the licence must not exceed a radiated maximum true mean power of **[xxx]** dBm EIRP per 1 MHz. The licensee complies with this sub-condition by ensuring that no radiocommunications device is operated under the licence in excess of a radiated maximum true mean power of **[xxx]** dBm EIRP per 1 MHz.

Licence Schedule 3 - Other Conditions

Liability to pay charges

1. The Licensee shall pay the Regulator the relevant fee on or before such date as shall be notified in writing to the Licensee. In case of failure to pay the fee on the due date, interest shall accrue from the due date until the date on which payment is effected. If the Licensee fails to pay the relevant fee and accrued interest after three months from the due date, the Regulator may revoke this Licence.

Radiocommunications transmitter registration requirements

2. The licensee must not operate a radiocommunications transmitter under this licence unless:
    (a) the radiocommunications transmitter has been exempted from the registration requirements under condition 3 below, or:
    (b) both:
        (i) the requirements of the Regulator under the Act relating to registration of the radiocommunications transmitter have been met; and
        (ii) the radiocommunications transmitter complies with the details about it that have been entered in the register.

3. The following kinds of radiocommunications transmitters are exempt from the registration requirement in statutory condition 3: a radiocommunications transmitter that operates in the **[**relevant frequency band**]** with a horizontally radiated power of less than or equal to **[xxx]** dBm EIRP per 1MHz.

Responsibility to manage interference

4. The licensee must manage interference between radiocommunications devices operated under this licence including by:
    (a) investigating the possible causes of the interference;
    (b) taking all steps reasonably necessary to resolve disputes about interference;
    (c) taking steps (or requiring persons authorised to operate devices under this licence to take steps) reasonably likely to reduce interference to acceptable levels; and
    (d) negotiating with other persons to reduce interference to acceptable levels.

Licence Schedule 3 - Other conditions

International coordination

5. A licensee must ensure that operation of a radiocommunications transmitter under this licence does not cause harmful interference to a receiver that operates in accordance with International Telecommunication Union Radio Regulations and is located in a country other than **[**the country issuing the licence**]**.
6. The Licensee shall comply with international agreements on frequency coordination for the bands **[**the relevant frequency bands**].**
7. The Licensee shall comply with relevant international agreements on telecommunications as advised by the Regulator.

License Variation and Revocation

8. The Regulator may not revoke or vary this Licence save at the request or with the consent of the Licensee except:

    (a) in accordance with clause 1 of this Licence Schedule;
    (b) for reasons related to the management of the radio spectrum provided that in such case the power to revoke may only be exercised after five years notice is given in writing and after the Regulator has consisted any pertinent factors; and
    (c) if there has been a breach of any of the terms of this Licence.

Trading

9. A licensee may assign or otherwise deal with the whole or any part of a spectrum licence provided that this is done in accordance with any rules determined by the Act.
10. The Licensee must give prior or immediate notice to the Regulator in writing of any change in details of the name and/or address recorded in paragraph 1 of the Licence.

Access and Inspection

11. The Licensee shall permit a person authorised by the Regulator:

    (a) to have access to the Radio Equipment; and
    (b) to inspect this Licence and the Radio Equipment,

    at any and all reasonable times or, when in the opinion of that person an urgent situation exists, at any time to ensure the Radio Equipment is being used in accordance with the terms of the Licence.

Appeals

12. An application may be made to the Regulator for reconsideration of the Regulator's decisions. A person affected by and dissatisfied with the Regulator's decision may seek a reconsideration of the decision by the Regulator. This decision can be subject to further reconsideration by [an authorised appeals body].



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