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Spectrum policy in emerging markets

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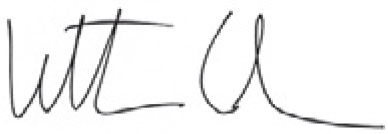
Welcome

From **Vittorio Colao**
Chief Executive, Vodafone Group Plc

Welcome to the latest publication in Vodafone's long-running series of Policy Papers. Our aim is to provide a platform for leading experts to express their views on issues that are important to us at Vodafone. One such issue is the significant positive impact of mobile communications around the world in terms of economic development and social benefit. Spectrum policy is central to determining the magnitude of these effects and the aim of this report is to further a debate that is critical to realising the potential of mobile in emerging markets. The opinions expressed are not ours, but those of independent experts whose views we respect even if we do not always agree with them. I believe these studies will be of interest to anyone concerned with the development of good public policy and I hope you enjoy reading them.



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Executive summary

By **Matthew Kirk,** Group External Affairs Director, Vodafone Group Plc

Around the world, the use of communications technology is driving economic growth and social benefits. It is for this reason that governments are keen to secure large-scale and widespread investment in broadband to bring its benefits and potential to as many people as possible. Spectrum policy is fundamental to achieving these ambitions – especially in emerging markets where far-reaching access to communications is set to remain mobile.

Vodafone commissioned one of the earliest and most influential studies of the economic impact of mobile communications, in which it was estimated that a 10 percentage point increase in mobile penetration is associated with a 0.6 percentage point increase in GDP growth.[1] Subsequent studies have suggested even larger effects, between 0.8 and 1.2 percentage points.[2] Today mobile penetration is so extensive – often well beyond the reach of national energy grids and social security systems – that it is not only driving growth, it is one of the most effective platforms for distributing economic opportunity.

The opportunity for businesses and governments to transform sectors such as financial services, healthcare and agriculture, through mobile communications is already apparent. Innovation and business growth in emerging markets will depend on enough spectrum being allocated for mobile broadband, as well as on significant investment in wireless networks to meet the growing demand for capacity. Failure to allocate spectrum effectively could set back, by many years, hopes of achieving the widely-shared benefits from broadband access. Spectrum decisions are not a matter for sector specialists alone; these decisions are as fundamental to a country's long-term prospects as those which traditionally received far more attention and public debate, such as budget allocations, liberalisation and foreign investment rules.

This is a pivotal time for those shaping spectrum policy in emerging markets. Many of the licences issued in the first phase of liberalisation soon fall due for renewal and policymakers are considering models for allocating new spectrum for LTE services. Yet there is little research on the main issues, risks and opportunities. There is a wealth of research on spectrum policy in advanced markets available, including Vodafone's Policy Papers published in 2006 and 2012.[3] This SIM Panel Report starts to fill the gap. The contributors to this report identify salient points for realising the greatest economic and social potential from mobile broadband access.

A key finding of the report is that **delaying the use of spectrum for mobile broadband networks comes at a significant cost** to the economy. In two case studies, the loss of GDP growth is estimated to be a few percentage points over a decade, equating to hundreds of thousands of lost job opportunities (Plum Consulting, page 13). It is because of mobile communication's huge and proven potential to strengthen growth across the economy and in all geographic regions of the country that the major economic gains from spectrum will come from its exploitation. Policies that restrict the release of spectrum to maximise upfront revenue generation for the government are shown to be short sighted. To realise the full economic advantage that spectrum can provide in emerging markets, policymakers must take the decisions that **ensure that more spectrum is released quickly, in sufficient quantities to avoid over-fragmentation, and at the right price** (Dan Lloyd, page 23).

Another finding of the report is that good auction design can help to identify those organisations best placed to realise the full potential of new spectrum allocation and encourage investment. The best-placed firms will often be ones with existing networks, who can make services and devices more affordable for those on the lowest incomes by virtue of economies of scale and scope (Martin Cave, page 17). **Excluding existing operators from auctions, or other methods of assignment, risks missing out on the economic and social gains that are achievable from**

affordable mobile broadband access. Such measures have been considered by some policymakers in order to pursue more specific objectives, such as local economic participation and economic transformation to redress the legacy of colonialism. Echoed throughout this report, however, is the finding that there **are more effective policy levers to achieve additional economic and social objectives**. Attempting to use spectrum policy to do so can prove counter-productive due to the unintended distortion of mobile broadband rollout, which slows down the advantages that are brought to the local economy and delays the extension of new services to rural areas. Taking direct measures to address such important policy aims can ensure that these are achieved at the same time as the broader economic rewards that come from widespread, affordable broadband access (Pygma Consulting, page 27).

Innovation, investment and efficiency will be essential for achieving the economic and social benefits of affordable mobile broadband access in emerging markets. The final finding of this report is that **competition for spectrum between wireless networks is the best starting point** for achieving each of these elements (Richard Feasey, page 31). Additional policy tools, tower-sharing deals and an element of fixed infrastructure may be required to fulfil the entirety of a nation's broadband ambitions but rather than a single national wireless network, the best place to start is with a model that has already taken mobile access in emerging markets further than policymakers thought possible, and see how far and how fast it can deliver.

Key findings

- **Delaying the use of spectrum for mobile broadband networks comes at a significant cost to the economy**
- **Policymakers must ensure that more spectrum is released quickly, in sufficient quantities to avoid over-fragmentation, and at the right price**
- **Excluding existing operators from auctions, or other methods of assignment, risks missing out on the economic and social gains that are achievable from affordable mobile broadband access**
- **There are more effective policy levers to achieve additional economic and social objectives**
- **Competition for spectrum between wireless networks is the best starting point for achieving the benefits of affordable mobile broadband access**

Notes

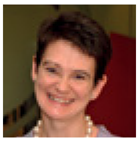
1 'Africa: The impact of mobile phones', Vodafone Public Policy Report No.2, March 2005. http://www.vodafone.com/content/dam/vodafone/about/public_policy/policy_papers/public_policy_series_2.pdf

2 'What is the impact of mobile telephony on economic growth?', Deloitte for GSM Association, November 2012 http://www.gsma.com/newsroom/gsma-and-deloitte-release-comprehensive-research-into-the-impact-of-mobile-telephony-on-economic-growth.

3 http://www.vodafone.com/content/index/about/about-us/policy/policy_papers.html.

Contributors' biographies

The 'Socio-Economic Impact of Mobile' Panel (SIM Panel) provides independent, expert advice on the impact of mobile communications in emerging markets with the support of Vodafone. The SIM Panel was established in 2004 to advise on what was then a nascent technology in emerging markets, but already a significant one. The SIM Panel's purpose is to contribute to the public policy debate with high-quality research, going beyond anecdotes to provide a rigorous analysis of the impact of mobile communications. The topics covered by SIM Panel reports over the past decade include: mobile communications in Africa and India; mobile money transactions; mHealth; and broadband access. The contributors to this SIM Panel report on spectrum policy are economists, academics and development and regulatory experts. The SIM Panel is chaired, as it has been throughout, by Professor Diane Coyle.



Diane Coyle

Diane Coyle is Professor of Economics at the University of Manchester. She runs the consultancy Enlightenment Economics and has held a number of public appointments, including on the UK Competition Commission, the independent Migration Advisory Panel and the Browne Review of Higher Education Funding. Diane has chaired Vodafone's SIM Panel since 2005.

Howard Williams

Howard Williams is Professor Emeritus at the University of Strathclyde. He has extensive knowledge of the ICT sector and has worked across many emerging markets implementing policy development. He has worked at the World Bank, European Commission and the International Telecommunications Union.

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Martin Cave is a regulatory economist specialising in competition law and in the network industries, including airports, broadcasting, energy, posts, railways, telecommunications and water. He has published extensively in these fields and has held professorial positions at University of Warwick, UK, Brunel University, UK and the LSE where he was the BP Centennial Chair. Currently, he is a Deputy Chair of the Competition Commission.

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Mandla Msimang and Leona Mentz have worked in the Sub-Saharan communications industry for over a decade. Mandla has more than 12 years of experience in communications policy and regulation, including having worked in senior roles in the Independent Communications Authority of South Africa (ICASA) and its predecessor. Leona was formerly Head of Regulatory Compliance at one of South Africa's major mobile operators and Advisor to the Council of ICASA.

Richard Feasey

Richard Feasey was Group Public Policy Director at Vodafone from 2001 to 2012. He has been involved in telecoms policy and competition since 1991. He continues to consult and lecture and is an associate at Frontier Economics.

Matthew Kirk

Matthew Kirk was appointed Group External Affairs Director of Vodafone and a member of the Executive Committee, with effect from 1 March 2009.

Matthew joined Vodafone in 2006. Before that, he was a member of the British Diplomatic Service for more than 20 years, with diplomatic postings in New York (UN), Belgrade, Gibraltar and Paris, and a number of positions in the Foreign and Commonwealth Office (FCO) and Cabinet Office in London. Matthew led the FCO's programme in investment in IT and telecommunications for three years, and prior to joining Vodafone served as Her Majesty's Ambassador to Finland.

Bailey Ingram

Bailey Ingram is Group Public Policy Senior Manager at Vodafone and the editor of this latest SIM Panel report. Bailey is engaged with current policy issues across all of Vodafone's emerging markets and has recently returned from secondment to Vodafone Ghana.

New issues in spectrum policy

By **Diane Coyle and Howard Williams**

This is a key time for spectrum policy in emerging markets, where wireless services will be crucial to governments' ability to achieve their national broadband aims. This report sets the context for the main issues in the policy debates, as demand for broadband grows and at a time when earlier mobile licences are up for renewal in many countries.

The widespread adoption and use of communication technologies drives economic growth, as numerous studies have now confirmed.[1] Broadband offers great potential to enhance this impact. Ensuring widespread, affordable access to mobile broadband is an important driver of growth, especially in emerging markets where it can help to 'leapfrog' the inherited weaknesses in fixed communications and other infrastructure. According to one estimate, Africa needs $25 billion invested in the next 10 years to build next-generation, internet-ready networks.[2] Wireless and mobile services will play a vital role in enabling this access because extending fixed-line broadband may not be viable in markets where there is a limited existing network and penetration is often declining.[3]

There are ever more examples of the providers of important services, such as healthcare and education, as well as businesses and entrepreneurs embracing the capabilities offered by data and internet services from mobile communications operators. Just a few of these are described in the box on the facing page. The economic and social potential of these applications, and of future services that will use wireless broadband, is increasingly clear.

This report aims to identify the policy approaches most likely to ensure that substantial economic gains can be achieved in emerging markets through mobile broadband. It also seeks to identify the potential obstacles to broadband rollout that would have an adverse effect on growth and jobs. A consistent theme from all of the contributions here, and specifically underlined in the empirical study by Plum Consulting on Kenya and South Africa, is that the opportunity cost of delays in terms of the foregone economic growth and jobs could be very large (on page 13).

This chapter looks at the context for the contributions: the evolution of spectrum policy and the reasons why this is a key stage for policy decisions on new licences. We set out the main issues facing policymakers as they consider how to achieve rapid and broad-based rollout of broadband.

Spectrum policy to date

Since the dawn of the radio age, governments have been involved in allocating radio spectrum to different uses and users, as various uses of the airwaves have the potential to interfere with each other.[4] But spectrum policy is no longer just a technical issue. The potential contribution of communications to economic growth has increased and making sure the poorest members of society have access to communications technology is particularly important for long-term economic development.[5] The central policy issue – how best to manage spectrum for the maximum benefit to the economy and society – is becoming increasingly important for growth and social justice and, for that reason, more complicated.

Until the 1990s, governments allocated spectrum in different bands (usually chosen on the basis of international harmonisation) and assigned its use to particular operators. The selection of the operators was an administrative decision, sometimes following a 'beauty contest' in which applicants outlined in detail how they would use the spectrum. This was, for example, the approach by which Vodafone gained its first mobile licence in the United Kingdom in 1982.

The approach started to change from 1989 as developments in the policy context and advances in economic theory meant spectrum was increasingly assigned through auctions. New Zealand was a pioneer, with the United States and then other countries following. These included many emerging markets – indeed India was one of the first to award licences by competitive tender in 1994 (although it has used a multiplicity of policy approaches since).

Emerging app economies

The mobile explosion in emerging markets has resulted in mobile technology becoming a vital tool for addressing other social needs. There are already many examples of internet services and apps targeting the needs of local populations. However, the vast majority of mobile phones in these markets are feature phones, which can access the internet but are slow to browse and therefore have higher data costs. Smartphones remain out of reach for most citizens and as a result, the predominant way to reach consumers is currently via SMS.

Economic innovation via M-Pesa

One of the most successful examples of SMS-based services in Sub-Saharan Africa is M-Pesa, the mobile payment system launched in Kenya by Safaricom, which now processes more transactions domestically than Western Union does globally.[6]

Agriculture

With 70% of the population in Kenya working in agricultural-related businesses, local designers of mobile apps are also finding novel ways to tackle some of the challenges that agricultural workers face. iCow, for example, is an easy to use, affordable, SMS-based mobile application platform aimed at promoting smart dairy farming and animal husbandry. iCow was launched in a partnership between Safaricom and Green Dreams Ltd and was rated Africa's best mobile agricultural application by IT News Africa in 2013. M-Farm is another example of an SMS-based service that enables small-scale farmers to maximise their income potential by providing farmers with access to the latest crop prices, while also enabling individuals to club together to sell crops, improving their bargaining power in relation to middle-men.

Transport

In Kenya, app-based services are flourishing due to increasing adoption of smartphones and, with them, more affordable data services.[7] In Nairobi, for example, matatus (public minibuses) carry a third of the city's residents to and from work each day – a journey that can take up to two hours, depending on the traffic. Vuma Online, launched in April 2013 by Safaricom, now enables passengers with a smartphone to check the latest news, watch videos online and catch up on emails. More than 1,000 matatus are now equipped with free WiFi and in addition to introducing passengers to the internet, it is giving the drivers and conductors an edge in the intense competition for passengers.

Education

Examples from other countries further indicate the development potential of mobile broadband services. The Vodafone Egypt Foundation launched an illiteracy eradication initiative in 2011, in association with UNESCO, the Department of Education and a number of Egyptian NGOs, aimed at helping an estimated 17 million adults in Egypt learn how to read and write. As part of the campaign, the Foundation developed a smartphone app, which works using a talkback function and picture association, to help users learn Arabic. This technology has already enabled thousands of women to learn at home, in their own time and at their own pace and, in all, over 127,000 people have enrolled in the programme so far.

In India, a partnership between Vodafone, the Vodafone India Foundation and the Pratham Education Foundation aims to improve the quality of India's primary school education by introducing mobile internet to help children learn.

The 'Learning out of the Box' programme introduced Vodafone's innovative, low-cost mobile digital teaching tool. The WebBox – which contains state-aligned curricula – brings the internet to a standard TV via a plug and play, internet enabled keyboard. A pilot proved that providing digital learning content for the classroom improves learning prospects for children and enables teachers to use rich multi-media content, facilitating innovative teaching styles; 90% of teachers said that the performance and involvement of students had increased as a result of the scheme.[8]

The Vodafone India Foundation has now committed to provide learning solutions for 50,000 children across 1,000 low income schools in five major states, over three years.

Health

Health applications are another area where mobile technology can help with the delivery of more effective services and better outcomes. South Africa's largest HIV prevention initiative for young people, loveLife, equips their field workers with a Vodacom mobile data-monitoring and reporting system. The system guides health workers in their questions, helping them to identify the relevant health risks, and supports decision-making. It also significantly reduces the time taken to capture and report information (which is quality assured), enabling field workers to complete more visits and allowing any issues in performance or delivery of the service to be spotted quickly and tackled.

Mobile Spectrum Assignment – Milestones

1980s: The first commercial licences

First generation of analogue commercial mobile licences issued
- Eg USA 1978, Finland 1980, UK 1982, Australia 1987.

1990s: Move to 2G

Move to 2G GSM – Licences granted for 900 MHz & 1800 MHz
- GSM 900 MHz licences granted early 1990s, mainly through beauty contests
- In the late 1990s, a second set of GSM 900 MHz/1800 MHz licences granted through a mixture of beauty contests and auctions.

2000s: 3G licences

3G spectrum licences issued
- 2.1 GHz auctioned 2000–1 in Europe, Australia and Asia. Record fees paid
- Beauty contest and administrative processes also used, eg Finland, France, Ireland, Portugal, Spain and African nations apart from Nigeria and Egypt
- Auction subsequently became the common method, eg Brazil 2007, India 2010.

2010 + : Licence renewals and Digital Dividend for 4G

900/1800 MHz licence renewal/reauction
- At end of first licence period, some extended, eg Egypt, France, UK. Others extended licences but operators gave up some spectrum in return for 4G refarming eg Italy, Spain
- Some countries reauctioned spectrum eg Netherlands, Ireland

Digital Dividend spectrum auctioned for 4G
- Germany 2010; Spain, Portugal, Italy, Greece 2011; Romania, Netherlands 2012; UK, Czech Republic 2013
- Under review in many other countries, eg Australia, South Africa, Kenya, India.

Auctions have a number of inherent advantages over administrative decisions, as Martin Cave describes in this report (page 17). Above all, an auction process is most likely to mean that the scarce resource of spectrum is used in ways that will add the greatest value to the economy. However, careful attention to the design of auctions is needed. Some of the lessons from past experience are discussed in the box on the facing page.

In a more recent development, some governments have begun to permit 'secondary markets', in which a company can sell or lease spectrum it does not use to other companies (subject to regulatory oversight to ensure competition). A secondary market reduces the risk of the spectrum being tied to existing uses that are made redundant by technological developments, which can therefore keep the spectrum being used for the most economically valuable services, or not used at all.

Current spectrum policy questions

Policymakers have been re-evaluating the best way to approach the management of spectrum for well over a decade. But the question has a new urgency for several reasons.

Key upcoming spectrum decisions

The first wave of licences date back to the early or mid-2000s. A discussion of the best approach to spectrum policy is timely now because the timetable for licence renewal or extension means there are decisions on the process due in a number of countries in the next few years, in particular India, South Africa and Kenya, in addition to the 'digital dividend' decisions facing most emerging markets.

Digital dividend

The digital dividend of spectrum is released when broadcasters switch from analogue to digital because digital television transmission requires less spectrum. The particular spectrum bands concerned (at 700/800 MHz) have significant potential to increase the coverage and capacity of mobile broadband and at much lower costs. These efficiency savings appear to be greatest in geographically large markets with areas of sparse population. The actual costs will differ from market to market, depending especially upon the amount of spectrum given to operators and therefore whether they can harness the substantial potential for economies of scale; some estimates indicate that the costs could be up to 70% less than would be the case for broadband over existing 3G spectrum.[9] The World Radio Conference 2012 decided to allocate spectrum in the 700 MHz band (UHF 694–790 MHz) band in the Europe/Africa region to mobile as a second digital dividend, from 2015. The driver for global harmonisation is the large economies of scale in the manufacture of equipment, including consumer equipment, benefiting consumers through lower prices and higher quality. Hence, the existence of harmonised GSM spectrum around the world is seen as a precursor to the rapid spread of mobile in developing markets at affordable prices.

In certain emerging markets, such as in India, there is a real opportunity to make additional spectrum available for mobile broadband straight away, as broadcasters do not currently make substantial use of the spectrum.

Lessons from spectrum auctions

There have been a number of recent spectrum auctions that have failed in whole or in part. These include several where the process was abandoned or simply no bidders turned up – such as auctions in Hungary and Mozambique in 2011 or in both India and the Czech Republic in 2012/2013. However, there is not much literature on why some auctions fail. This is primarily because participants are typically bound by non-disclosure clauses. So what are some of the lessons to be drawn from what we do know about the less successful examples of auctions?

Some auctions have suffered where policymakers sought to encompass much broader mandates than the pricing and assignment of spectrum. The auction in the Czech Republic in 2012/13 mandated new entry; the result was that the potential new entrant drove the prices to uneconomic levels through excessive aggressive bidding. The auction was abandoned following legal interventions and a court ruling. The proposed re-run again seeks to influence market structure, this time by restricting the ability of the winners to merge their businesses for at least 15 years. The Netherlands also sought to assign spectrum to a new entrant in its 2012 auction; the outcome suggested that the entrant, Tele2, had secured spectrum, although the existing players had paid much higher prices for their spectrum than anticipated. For the Government, the auction results created an immediate windfall, but the high prices may have inhibited investment.

Certain auctions have suffered from unrealistic revenue expectations on the part of policymakers. In the November 2012 auction for 1800 MHz spectrum in India, the reserve price was set by the Government at a 22% discount to the 2010 3G auction reserve price. The auction failed in many areas of the country: no spectrum was sold in Delhi or Mumbai and only one operator acquired spectrum in Kolkata, although some spectrum was sold in a number of less populous regions. In the re-auction in March 2013, a further 30% discount was applied to the November 2012 reserve price but it remained at such a level that no operator could or would bid for spectrum. Sale of the majority of spectrum was therefore delayed until the Government approved a further reduction to the reserve prices in advance of the auction of 1800 MHz and 900 MHz spectrum in February 2014. The impact of India's inconsistent approach to spectrum licensing is described in more detail later in this report (page 23). The difficulty caused by the limited availability of spectrum also indicates that where spectrum is not available in sufficient quantities it is particularly important that auction design carefully accommodates this and permits arrangements such as spectrum sharing and trading to enable greater deployment of communications with limited resources.

In other cases, the broader communications policy framework, including interconnection charges and roaming agreements, have led to auction outcomes different from those which were expected. Many recent 4G auctions have emphasised as their aim the rapid deployment of LTE networks in order to ensure the spread of mobile broadband – yet in France, national roaming agreements have meant that Orange carries much of the traffic of its competitors and network rollout of competitive infrastructures has been limited. One industry insider suggested that over 95% of Free's traffic was carried initially by Orange. A similar situation has occurred in the Democratic Republic of the Congo (DRC), where national roaming agreements have enabled new entrants to 'build' national presence while introducing intense price competition in key cities. This can seem attractive in terms of short-term retail pricing for customers but may limit network investment and the rollout of future broadband services.

In addition to the digital dividend, there are other spectrum bands that are no longer reserved for official uses, or are underused by the government. In some cases, there is a strong argument for the reallocation of reserved 'official' spectrum (often reserved for the defence forces) for commercial use, in order to speed wireless broadband rollout.

New concepts in spectrum management

In the light of growing demand (explored in the next section), the thinking about the best way of using spectrum continues to evolve. One possible outcome is greater unlicensed use of spectrum. Some parts of the spectrum are assigned for unlicensed communications uses, such as cordless phones and WiFi devices. Interference between these uses of spectrum is limited by regulatory standards on range and power which all hardware manufacturers are required to build into the consumer devices, rather than by licences limiting use of the spectrum to one operator.[10] In the case of WiFi, since the industry adoption of a suitable technical standard (802.11) in 1999, there has been a proliferation of devices and access. In the US, the Federal Communications Commission (FCC) had certified 2,000 WiFi devices by 2004 and 3,500 by 2007. Global sales of WiFi devices went from a low base in 2004 to an estimated 900 million units by 2011.[11]

The success of WiFi in almost every market has prompted some researchers to argue that more spectrum should be allocated for unlicensed use. Other novel proposals include spectrum 'parks' or bands set aside by regulators or private licence holders to allow for potential innovative (currently unproven) uses.[12] Similarly, technical improvement in compressing signals has led to proposals for the innovative use of the 'white spaces' within existing spectrum bands – the small gaps currently left unused between frequencies to avoid interference.

While such discussions are welcome, new models need to be carefully assessed in the context of the whole framework of spectrum policy. The case made for unlicensed spectrum must be part of an overall approach that ensures that there are incentives for investment in networks, which unlicensed spectrum cannot provide. There is also a risk that unproven regulatory approaches will delay or inhibit broadband rollout.

Demand pressures on spectrum

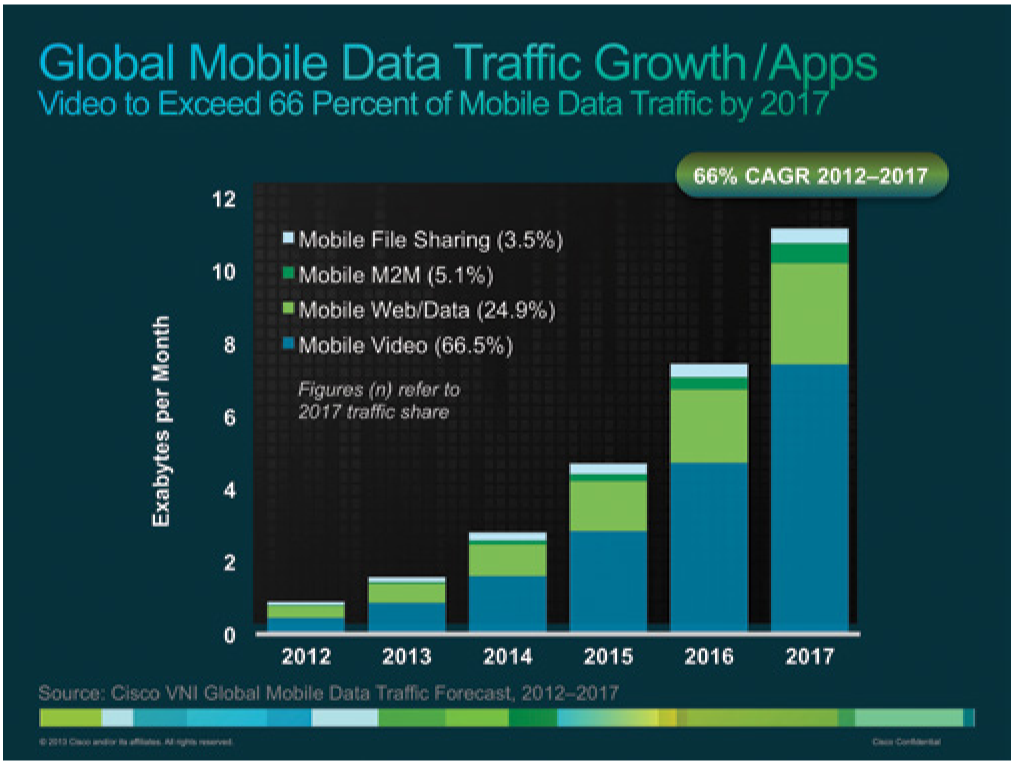
The most significant single reason for the new importance of spectrum policy is that innovations in technology and services are driving increased demand for broadband services. This creates a corresponding need for additional spectrum. The pressure of demand is increasing faster than anybody envisaged just a few years ago.

One important trend is the improving capability and declining prices of new types of consumer devices as competition intensifies. Smartphones and tablets are now the major consumer devices in volume terms and twice as many of these as PCs will be shipped in 2014.[13] By 2011, an estimated 19% of mobile phones in Africa were smartphones.[14] Global smartphone shipments reached over 1 billion in the year 2013,[15] with Android phones (the most common in emerging markets) taking a 75% market share.[16] As with 'feature phones', the existence of a global market is forming the basis for lower cost versions; smartphones are available for less than US$70 and recently Motorola announced its Moto G (a smartphone with functionality comparable to leading high-end branded products) would be available in Latin America for less than US$179.[17] Many manufacturers see emerging markets as an attractive opportunity. As a result, low-end smartphones and high-end feature phones are converging, allowing lower-income customers to benefit from the scale economies of large manufacturers serving a global market with global technical standards, albeit built to a lower specification.[18]

'Cloud services' are another driver of bandwidth demand. These leverage the internet to locate software, databases and other forms of information on a remote server rather than on end-user devices and can have important implications for emerging economies because of the reduced costs involved, offering the potential for greater affordability.[19] Low-cost smartphones and high-end feature phones, when used in conjunction with cloud services, provide a compelling new platform for service delivery and wireless-based connectivity to the internet.[20] Cloud-based services can dramatically reduce the costs of building and running an ICT infrastructure and this route opens global distribution channels at a fraction of the cost that would be otherwise incurred.[21]

The shift in traffic to data, especially video, from voice will increase the pressures on quality of service and thus on the amount of spectrum and bandwidth that needs to be made available. Furthermore, as demand for high bandwidth services grows, so too does the concentration of users in specific locations, thereby exposing the bottlenecks in networks due to insufficient spectrum.[22] These issues are more acute where wireless broadband traffic is growing and spectrum-based capacity constraints exist.

Unsurprisingly, these demand drivers are reflected in usage data. According to the Cisco 2012 Visual Networking Index, global IP traffic has increased eightfold since 2007, and is projected to grow at an annual rate of 29% through to 2016. The Cisco 2013 Visual Networking Index Global Mobile Traffic Forecast Update concludes that the share of mobile data traffic will increase, with 13-fold growth in volumes expected between 2012 and 2017 (a 66% compound annual growth rate (CAGR)). As the chart on page 9 shows, the demands on communications networks are growing exponentially.



Spectrum policy: aims and challenges

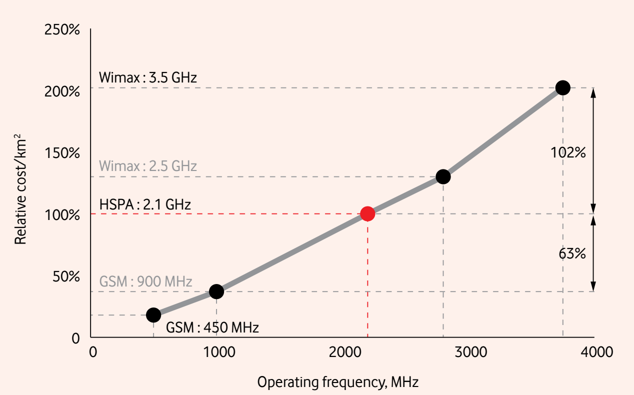
Regulators and policymakers are tasked with pursuing many objectives. They need to make their choices guided by the underlying criterion of the widest possible affordable access to broadband to maximise economic and social development. This requires weighing a range of intermediate factors:

Investment

Continuing investment in network rollout and upgrades (both in-country networks and international connectivity) is an essential pre-requisite to extending broadband access. An important enabler of increased data usage and internet access has been the installation of the necessary terrestrial and submarine cable transmission capacity. One consequence of increased international capacity has been significant reductions in international bandwidth costs, eg in the year between 2011 and 2012, the submarine international link leasing costs between Nairobi and London dropped by 50%.[23] The likely return on the investment in building out the appropriate combination of fixed and wireless network infrastructure will depend upon supply side variables such as geography, population density and spectrum policy, as well as upon demand-side variables such as income distribution, service uptake and potential expenditure. There are also a number of legacy issues, such as the existing infrastructure and confidence in a stable regulatory framework that will influence actual investment.[24] Any decision that risks delaying or undermining investment incentives must be fully justified.

It should be noted that not all spectrum bands are equally capable of sustaining business models that deliver affordable services to consumers. The cost differences between bands are amplified once the total cost of the investment and life cycle costs are factored into the network investment. The diagram below sets out an estimate of the cost differences. Although 450 MHz presents the lowest cost in this analysis, lower frequencies have implications for antenna and terminal costs, which make 900 MHz the most attractive frequency band for mobile communications.

Wireless cost as a function of operating frequency



Source: Booz Allen Hamilton analysis, assuming an urban to suburban Morphology Class

The cost structure will determine the pricing policies and options that operators can offer to consumers. In some cases, the least-cost solution to meeting consumer demand may be via a single technology, such as LTE, while in other cases a mix (eg LTE and WiFi) may be more appropriate, to meet high demand at certain times. Therefore, the policy framework will need to facilitate investment decisions that can serve the consumer demand in each market rather than prescribing specific network investments. There is no one-size-fits-all network architecture.

The operational and capital costs of network deployment are significantly increased if an operator is allocated insufficient spectrum. There is no single answer to the question "how much is enough?", but comparisons between countries can demonstrate the effects of inadequate amounts of spectrum (see the comparison between China and India, on page 23).

Innovation

Policy should enable the adoption of innovative technologies. This may include the immediate use of additional spectrum bands for the provision of broadband communications (from 700 and 800 MHz to 2.6 GHz), as long as they are made available in blocks wide enough to incentivise network investment. Policy can also foster innovation through approaches such as technology-neutral spectrum (which is not restricted to a specific technology but can be used for a wider range of purposes).

For example, 3G services can be deployed over lower spectrum bands (such as 900 MHz) rather than the higher bands (especially 2.1 GHz) over which they were originally deployed, thus substantially increasing coverage. Longer-term, these approaches could encourage and allow broader technological advances in cognitive radio, traffic management and offloading between bands (eg mobile and WiFi). The alternative of 'picking winners' in technology, often 20 years in advance, by policy decree, places enormous pressure on policymakers and forces them to make decisions that are almost certain to prove incorrect over time.

Affordability

Innovation in business models, which serve different consumer needs through the offer of services and pricing policies, is vital in emerging markets. To date, service innovation has been driven by competition between multiple providers of wireless infrastructure. As broadband services expand, the business model innovation is increasingly likely to come from these service providers – and there are already many examples of promising applications. The innovative pricing models of the past, such as pre-pay, have helped to address access for low income users, as well as narrowing the urban-rural divide. Affordable pricing models are fundamental to the spread of broadband, just as the business model innovation of pre-pay was to the spread of mobiles. Innovation in business models and service offerings to consumers has brought about benefits for consumers in a way that a regulatory focus on costs could never achieve.

Growth and government revenues

Different approaches to assigning spectrum result in different profiles for government revenues. Finance ministries often see spectrum auctions as an enticing source of immediate revenue, but if this becomes the main focus of policy decisions it will distort communications markets and reduce economic growth. For example, the restricted amount of spectrum made available in India's 3G licence auction in May 2010 (30 MHz in total compared to 140 MHz in the UK's first 3G auction in 2000), contributed to the high prices paid. The resulting scarcity restricted internet access and raised the price of services to consumers – what was good for the government's short-term revenues was bad for society in the long term. Short-term revenue raising also reduces growth compared to what it might have been and therefore restricts future government revenues. A previous report commissioned by Vodafone estimated that the delayed launch of 3G services in India permanently cost the economy as a whole US$61 billion a year, or a cumulative total of US$1.25 trillion, compared to a one-off government revenue gain of US$14.5 billion.[25] Higher economic growth due to wider broadband use will have a much greater benefit for government finances in the long run.

Competition

Competition is an important aspect of the regulatory framework that can encourage innovation and affordability. In relation to spectrum policy, as leading US expert Thomas Hazlett put it:

"Perhaps the most important step the government can take to enhance competition is making more spectrum available and making the spectrum available sooner rather than later...There is strong empirical support for the hypothesis that additional spectrum enhances competition, lowers consumer prices and increases economic welfare."[26]

Thomas Hazlett

For effective competition between networks, operators entering the market must be capable of building and launching extensive networks and attracting customers in an environment with relatively high levels of mobile penetration. This is a significant hurdle. Based on experience to date, policymakers should be aware that investment in broadband cellular networks will require serious financial commitment as annual investments in new networks can run into hundreds of millions of dollars and need to be undertaken by entities with experience of building networks (either directly or through strong relationships with global vendors) and which have access to a scalable retail customer base.

Licensees without these characteristics are likely either to fail commercially or focus only on the most profitable opportunities for market entry, such as urban areas.

There is no evidence, however, that a single wireless network provider, at either the wholesale level or across wholesale and retail markets, delivers greater benefits to consumers (on page 31). Equally, licensing too many operators risks that they have insufficient spectrum to provide affordable services at adequate quality (on page 23).

Wider economic and social aims

An appreciation of the importance of broadband has led to interest in whether spectrum licences could be used to achieve more diverse social aims such as local equity or empowerment of previously economically disadvantaged groups. In theory, many types of conditions could be attached to the licensing of new spectrum, but the risk of unintended consequences is also high.

Of particular concern is that such consequences, including the cost of delay and lost economic opportunities, could fall unevenly on the most economically marginal communities, such as those in rural areas and lower-income urban residents. The broader economic and social policy aims, including for the most marginal groups, may be served best by ensuring the fast rollout of competing wireless services – such as those described on page 8 'Lessons from spectrum auctions' – rather than by attaching novel obligations to new spectrum.

Conclusion

As we have shown, decisions about spectrum go far beyond issues of cost and technical matters; they determine the size of the welfare gain for the economy and its distribution among different groups of people. With spectrum identified as a key economic resource, economic ministries have an important stake in the outcome of the licensing process.

Several other sector regulators may also be involved in the decision about how to license spectrum – for example, broadcasting, as well as telecoms regulators. Policymakers and regulators will be weighing up several trade-offs: delivering returns high enough for network investment versus reducing consumer expenditures; serving rural areas that are not profitable as well as urban areas; achieving higher government revenues in the near-term from licence fees versus enabling economic growth that will deliver greater long-term revenues; and maximising spectrum use today versus future uses.

Notes

1 The research on the impact of ICTs and specifically mobiles on growth is surveyed in 'Maximizing Mobile', World Bank, 2012. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/0,,contentMDK:23190786~pagePK:210058~piPK:210062~theSitePK:282823,00.html

2 Booz, 'Connecting Africa: The Next Ten Years of Mobile Growth', 2011.

3 'Building next-generation broadband networks in emerging markets', Luke van Hooft in *Making Broadband Accessible for All* Vodafone Public Policy Paper No. 12, May 2011. http://www.vodafone.com/content/dam/vodafone/about/public_policy/policy_papers/public_policy_series_12.pdf

4 The Annex to this SIM Panel Report sets out the technical basics of spectrum.

5 See, for example, 'A Causal Panorama of Cross-Country Human Development', David Mayer-Foulkes, División de Economía of the Centro de Investigación y Docencia Económicas, Mexico; and 'Information Economy Report 2011 – ICTs as an Enabler for Private Sector Development', UNCTAD.

6 IMF Report, 2011.

7 See for example http://www.bbc.co.uk/news/world-africa-19903839

8 Vodafone India Foundation.

9 http://www.gsma.com/spectrum/wp-content/uploads/DigitalDividend/DDtoolkit/importance-of-harmonisation.html

10 'Spectrum Management: Property Rights, Markets, And The Commons', Gerald R. Faulhaber And David Farber, *Telecommunications Policy Research Conference Proceedings*, 2003.

11 'Efficiency Gains and Consumer Benefits of Unlicensed Access to the Public Airwaves', Mark Cooper, University of Colorado, January 2012.

12 The approaches are surveyed in 'Spectrum Management: Property Rights, Markets and the Commons', Gerald R. Faulhaber and David Farber; and 'Some Economics of Wireless Communications', Yochai Benkler, *Harvard Journal of Law & Technology* Volume 16, Number 1, Fall 2002.

13 IDC data.

14 2012 African Mobile Factbook http://www.africantelecomsnews.com/Factbook_form.shtml

15 IDC, http://www.idc.com/getdoc.jsp?containerId=prUS24418013

16 IDC, http://www.idc.com/getdoc.jsp?containerId=prUS24442013

17 http://www.ft.com/cms/s/0/1cdb1ce4-4d70-11e3-bf32-00144feabdc0.html?siteedition=intl#axzz2na0He05o

18 See for example 'Scaling Mobile for Development', GSM Association, August 2013 https://gsmaintelligence.com/files/analysis/?file=130828-scaling-mobile.pdf

19 See for example http://unctad.org/en/Pages/Publications/InformationEconomyReportSeries.aspx

20 http://bits.blogs.nytimes.com/2012/08/29/cloud-computing-for-the-poorest-countries/

21 http://www.nytimes.com/2012/08/28/technology/active-in-cloud-amazon-reshapes-computing.html

22 Some of these issues and related matters have been explored by Ofcom in the UK, see for example, http://stakeholders.ofcom.org.uk/consultations/spectrumlib/

23 Bandwidth Pricing Report October 2012: African Bandwidth Pricing Review.

24 *Making Broadband Accessible for All* Vodafone Public Policy Paper No. 12, May 2011.

25 Thomas Hazlett, 'Spectrum Policy and Competition in Mobile Services', in *Making Broadband Accessible for All*, Vodafone Public Policy Paper No. 12, May 2011.

26 Hazlett and Munoz, 2009.

Consequences of new spectrum assignment approaches for growth and jobs

By **Phillipa Marks, Yi Shen Chan and Sarongrat Wongsaroj,** Plum Consulting

The first phase of mobile licensing in Africa enabled the widespread take-up of affordable services. Recently, different approaches to assigning spectrum have been proposed in a number of countries. This section estimates the potential costs of adopting new approaches that could delay the take-up of affordable broadband, in terms of the significant missed opportunities for growth and jobs.

A number of new spectrum assignment approaches have been proposed in Africa over the last two to three years. This paper reviews some proposals for assigning the 'digital dividend' spectrum at 800 MHz, and the 2.6 GHz spectrum in Ghana, Kenya and South Africa.

While the detail of each proposal differs, there are two broad themes across all of them – encouraging local equity participation in mobile networks, and different models which either aim for greater competition at the retail or the network layer or aim to introduce one or more open access networks:

- In Kenya, the Government is considering offering a licence for a single wholesale LTE network using a private public partnership model which may include mobile network operators (MNOs), vendors and local players.
- In South Africa, the earlier proposals for the award of 800 MHz and 2.6 GHz bands made by the Independent Communications Authority of South Africa (ICASA) would have facilitated entry (as mobile network operators) by up to four additional companies. These proposals are now under review.
- In Ghana, the main focus was on encouraging entry by local firms. When this failed, established mobile licensees were allowed to bid for spectrum provided they met local ownership requirements set at a higher percentage equity level than they were required to have previously.

To assess the impacts of these new approaches to spectrum assignment, they need to be compared to a 'base case' or counterfactual. What should that base case be?

The one used here is based on the outcomes of the digital dividend and 2.6 GHz tenders conducted elsewhere in the world: competitive auctions of spectrum packages with most licences won by incumbent operators. These outcomes are likely to be the most economically efficient because:

- Incumbent operators can use much of their existing infrastructure and expert staff to provide new broadband services;
- There are large costs associated with acquiring and retaining a customer base and incumbent operators have already incurred these; and
- There are significant economies of scale in the purchase of consumer devices and transmission equipment that are available to existing operators, especially those with international operations.

The GDP and employment impacts of the proposed policies in the three countries are compared with this base case in which incumbent operators are awarded the spectrum. The analysis extends to 2022 and so there is inevitably considerable uncertainty around the specific estimates presented here. A range of values is therefore provided. However, the key conclusion is that the potentially much slower rollout of broadband under the new approaches has a significant negative effect on employment and growth, and therefore broad-based economic empowerment, in each of the three countries.

Kenya

In Kenya, the key proposal being considered is a licence for a single, monopoly wholesale LTE 800 MHz/2.6 GHz network using a private public partnership (PPP) model, with the spectrum provided free by the Government. We compare this to the competitive provision of LTE networks by established mobile licensees. The comparison depends crucially on the nature of the PPP contracts and on the Communication Commission of Kenya (CCK)'s ability to regulate the wholesale monopoly so that it invests efficiently and provides access on non-discriminatory terms.

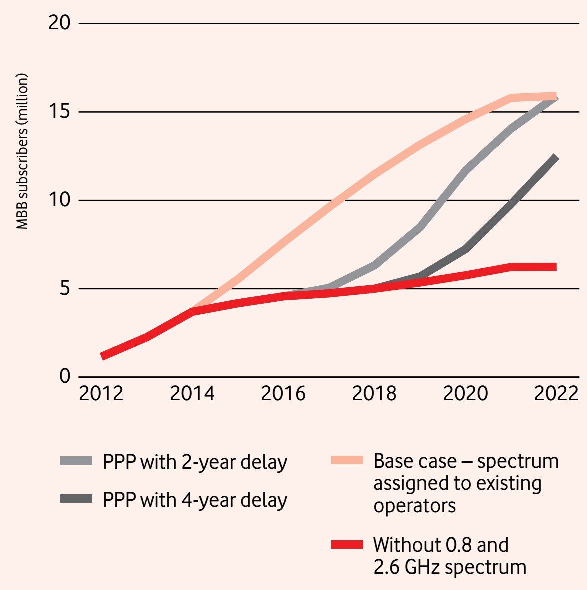
Given the complexity of this model, the CCK's relative lack of experience in this area and the absence of any significant precedent, risks of delay in network rollout, underinvestment and inefficient operation by the monopoly provider are anticipated – factors that are likely to affect service quality and service providers' ability to meet demand. This is evidenced in the lack of progress since the PPP tender process in 2011. The Kenyan Government had selected a nine-member consortium to deploy the LTE network based on the structure of The East African Marine System (TEAMS), a PPP initiative by the Kenyan Government to deploy a submarine cable system connecting Kenya to United Arab Emirates through the port of Mombasa. However, uncertainty over spectrum access has delayed the rollout. In November 2013, Safaricom reportedly quit the project and is planning to proceed with its own rollout instead.[1] As of early 2014, the status of the PPP project is still unclear.

To give an indication of the scale of impact of delays in network rollout, three scenarios have been modelled: base case, PPP with two-year delay in rollout relative to the base case and PPP with a four-year delay. In the base case, the spectrum from the 800 MHz and 2.6 GHz bands is divided roughly equally among the existing operators, who use their own sites to deploy a LTE network starting in 2015. In the PPP with a two-year delay, the network is not fully rolled out until 2017, and a four-year delay means that LTE service over the PPP's network is not fully rolled out until 2019.

In the long term, it is assumed that the competitive and the PPP approaches will each support similar levels of traffic, or in other words, the operating inefficiencies in the PPP are offset by the more efficient use of spectrum by a single network. This is considered to be an optimistic view of the outcomes under the proposed PPP approach. In all scenarios, a take-up of at most 50% for urban dwellers and one subscription per household in rural areas, is assumed for reasons of affordability.

What are the impacts of the proposed new approach on GDP and jobs? The forecast take-up of mobile broadband under the three scenarios over the next 10 years is shown in Figure 1.

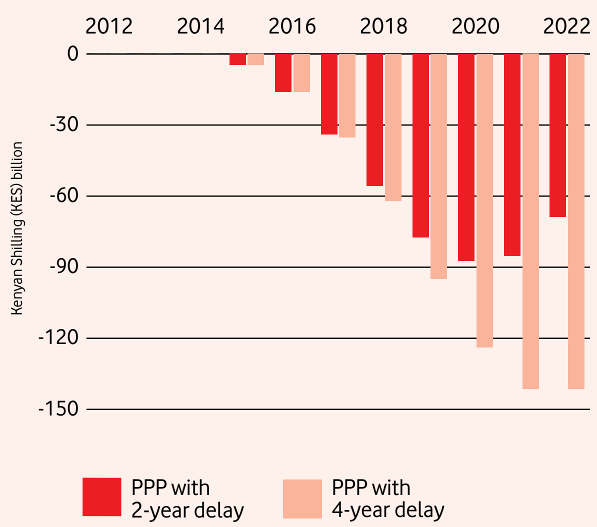
Figure 1: Number of effective mobile broadband (MBB) users in Kenya by scenario



Source: Plum Consulting

As spectrum is deployed and the number of effective broadband users (a subscriber that makes significant use of data services ie 1 GB/month in 2012 rising to 3.3 GB/month in 2022) increases, this will stimulate economic growth. Forecast GDP is highest under the base case as compared with either of the two wholesale PPP network scenarios. Figure 2 shows the loss of GDP from adopting the wholesale PPP approach rather than the base case of a competitive market.

Figure 2: Loss of GDP relative to base case



Source: Plum Consulting

Broadband is a general purpose technology that has the potential to bring significant benefits across the whole economy, so the release of spectrum for mobile broadband is likely to have a positive impact on employment across agriculture, industry and services sectors. It is estimated that in 2020 there would be a loss of GDP of between Kenyan shilling (KES) 80–120 billion (see Figure 2), or 1.9–2.7% GDP, based on 2010 constant prices. This is the equivalent to the loss of around 600,000 jobs, using the current jobs to GDP ratio (ie assuming no labour productivity growth). The net present value of the total loss in GDP is in the range of KES 310–440 billion. These numbers are indicative, but they suggest the new proposals could lead to significant delays in broadband rollout with considerable consequences for employment and growth.

Impact in Kenya

- **Loss of GDP: KES 80–120bn or 1.9–2.7% of GDP**
- **Equivalent to 600,000 jobs.**

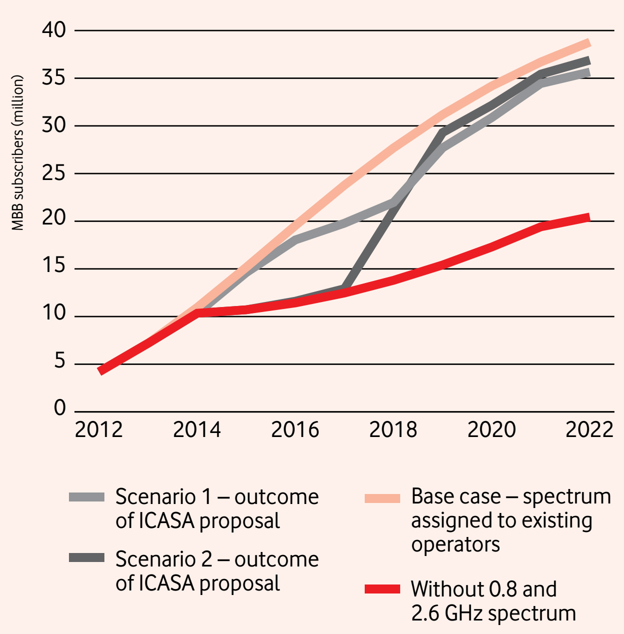
South Africa

ICASA's proposals in 2011 for the award of the 800 MHz and 2.6 GHz bands in South Africa involved (1) an increase in the number of mobile networks (from four to eight), (2) the award of up to four licences to local businesses with little or no existing infrastructure and/or no retail customer base, and (3) a wholesale model for the only network that could be operated by any of the incumbents. While the proposals have not been adopted, it is informative to look at the likely impact of a policy that would have led to fragmentation of the spectrum and the award of much of it to inexperienced companies. This could have led to increased costs of service provision and/or reduced capacity available to support growth in demand for broadband services.

The results of two likely outcomes of the ICASA proposals as shown in Figure 3 are as follows: in Scenario 1 it is assumed that the new entrants are reasonably successful in developing their businesses and in Scenario 2 it is assumed that they fail after several years and the spectrum is assigned to incumbent MNOs. As before, this is compared with a base case in which spectrum is assigned to the four existing operators.[2]

Figure 3 shows the estimated impact on mobile broadband take-up over the period to 2022 – an effective broadband user in South Africa is defined as a subscriber that makes significant use of data services ie use 1.5 MB/month in 2012 rising to 8 MB/month in 2022. The number of effective broadband users would be significantly reduced by the ICASA proposals.

Figure 3: Number of effective mobile broadband users in South Africa by scenario



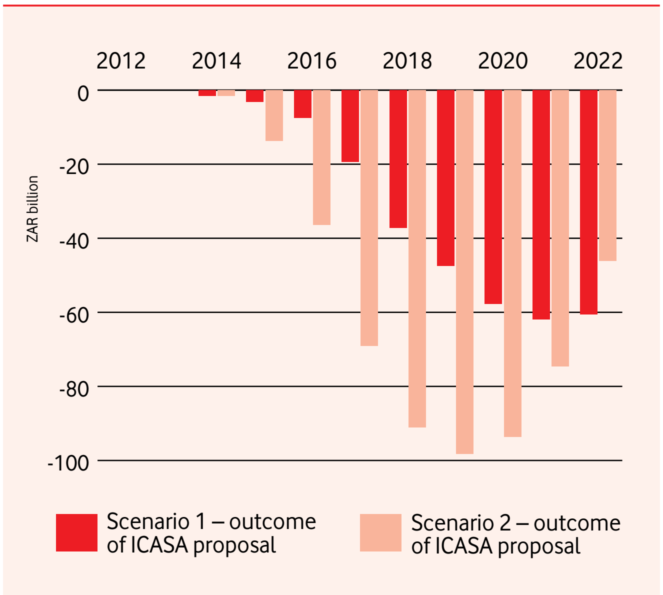
Source: Plum Consulting

The reduced number of effective mobile broadband users could have a negative effect on GDP growth and jobs. The results for Scenario 1 illustrate the impact of the fragmentation of spectrum, while those for Scenario 2 include the effects of both fragmentation and poor performance by the new entrants. The loss of GDP relative to the base case is shown in Figure 4. In 2020, we estimate the loss in GDP to be South African Rand (ZAR) 60–90 billion based on constant prices, which is the equivalent to the loss of around 500,000 jobs. The net present value of the total GDP loss is ZAR 210 billion under Scenario 1 and ZAR 390 billion under Scenario 2 (0.9% and 1.7% of GDP respectively).

Impact in South Africa

- **Loss of GDP ZAR 60–90 bn or 0.9–1.7% of GDP**
- **Equivalent to 500,000 jobs.**

Figure 4: Loss of GDP relative to base case



Source: Plum Consulting

South Africa's Minister of Communications announced that the Spectrum Policy is to be finalised in early 2014 and this will address the issue of high demand spectrum for broadband.[3] ICASA is expected to license the 800 MHz and 2.6 GHz bands in the first half of 2014 although the 800 MHz band will not be available until after the completion of digital switchover and disputes over access could lead to delays in the switchover.[4]

Ghana

In Ghana, there has been a delay of more than two years in the 2.6 GHz spectrum licence award and service rollout due to the failure of the initial 2010 award process, which prohibited the participation of incumbent MNOs. The two companies which were issued with the licences failed to meet the financial obligations of the award. The second licensing process was concluded in February 2013.[5] Three licensees won spectrum licences – Surfline and Goldkey Properties were each awarded 2x15 MHz, while G-Kwiknet won 30 MHz of unpaired spectrum. As of the second half of 2013, only Surfline has commenced deployment of its 4G network.[6] In this case, the earliest widespread deployment of 2.6 GHz networks in urban areas is likely to be in 2014 or later.

At present, operators around the world use the 2.6 GHz band predominantly to support traffic generated by PCs and laptops using dongles in locations that are capacity constrained. Coverage, not capacity, is the main issue for mobile networks in Ghana, and sub-1 GHz spectrum is more suitable for this respect. PC/laptop penetration in Ghana is reported to be around 14% while household internet access is around 11%.[7]

In this case, the economic and social impacts of the delay in licence assignment seem likely to be negligible because (1) there is no ecosystem of low-cost handsets, (2) a relatively small number of households have PCs but do not have internet access, (3) the 2.6 GHz band is a capacity band and it is understood that network capacity constraints are not a problem in Ghana at present and (4) the Government took appropriate and timely action when new licensees failed to make payments.

Conclusion

Experience so far suggests that facilitating local equity involvement in mobile networks by excluding incumbent MNOs from access to spectrum for mobile broadband is likely to fail. The networks, customer base and scale economies enjoyed by incumbent MNOs are all necessary to develop mobile broadband networks and services. The broader aim of the economic empowerment of the population is best served by extending broadband rollout as quickly as possible, while the aim of achieving greater equity ownership for local investors could arguably be achieved in other ways.

The three mobile markets under review variously have four or five incumbent operators. We report evidence that points to an optimum number of operators as being between three and six.[8] Our modelling suggests that both proposals in Kenya to reduce competition at the network level for LTE, and in South Africa to increase competition by doubling the number of network operators, could lead to significant economic losses. This paper estimates that the increased complexity and likely delays in Kenya could lead to a loss of up to 2.7% of GDP year on year by 2020. It also estimates that assignment of spectrum in South Africa to a large number of new entrants could lead to a loss of up to 1.7% of GDP by 2020. On standard 'jobs to GDP' ratios, these impacts are equivalent to approximately half a million jobs in each.

Notes

1 Business Daily, '4G joint venture suffers setback as Safaricom pulls out', 6 November 2013. http://www.businessdailyafrica.com/Corporate-News/4G-joint-venture-suffers-setback-as-Safaricom-pulls-out/-/539550/2063148/-/bpu16u/-/index.html

2 The details can be found in 'Economic impact of ICASA's proposals for assignment of 800 MHz and 2600 MHz spectrum in South Africa', Executive Summary, Plum for the GSM Association, February 2012. http://www.plumconsulting.co.uk/pdfs/Plum_Feb2012_Executive_Summary_Economic_Impact_ICASA.pdf

3 Y. Carrim, 'South Africa's Broadband Policy – too many delays, now for progress together', speech at Southern Africa Telecommunication Networks and Applications Conference, 2 September 2013. http://www.doc.gov.za/index.php?option=com_content&view=article&id=231:south-africas-broadband-policy-too-many-delays-now-for-progress-together&catid=41:press-realease&Itemid=66

4 See http://mybroadband.co.za/news/broadcasting/86369-sa-digital-tv-war-must-end-carrim.html

5 National Communications Authority, 'BWA licence winners', 14 February 2013. http://www.nca.org.gh/73/34/News.html?item=291

6 'Surfline. Alcatel-Lucent and Surfline Communications Ltd deploy first 4G LTE network in West and Central Africa', 9 July 2013. http://www.surflinegh.com/alcatel-lucent-and-surfline-communications-ltd-deploy-first-4g-lte-network-in-west-and-central-africa/

7 *ITU Yearbook of Statistics*, 2012.

8 D. Rogerson, and R. Hall, 'Mobile licences: how many to grant?', 2009 http://www.incyteconsulting.com/papers/Optimal_number_of_mobile_networks_(final).pdf

Lessons of a decade of spectrum management reform: 'Don't mess with input prices'

By **Martin Cave**[1]

Regulators should be cautious of using spectrum assignment as the vehicle for achieving other policy aims. Not only is there a high cost of doing so in terms of foregone economic growth, but other unintended consequences are likely. The proven approach of assigning spectrum by auction has placed licences in the hands of efficient operators who are more likely to deliver a broad rollout of services faster.

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

This review was not the only one addressing these issues and countries other than the UK also sought a better way of assigning spectrum. In the US, Thomas Hazlett powerfully and successfully argued the case for auctions; policy developments and early trials in New Zealand also shaped international thinking. As a result, the auction idea took off around the world. The questions we face now, more than a decade on, are how well reforms to date have worked, whether more reform is needed and whether emerging economies should follow the same path as advanced economies.

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

Cisco forecasts global demand for mobile data services will increase mobile data traffic 13-fold between 2012 and 2017.[4] The actual figures will inevitably be different but the trajectory is clear. The estimates by Plum Consulting (on page 13) indicate just how much economic growth and how many new jobs will be foregone if demand for mobile broadband is not met. Since the penetration of communications services quickly reaches high levels even in emerging markets, the growth it enables is likely to be distributed throughout the economy rather than captured by those who already have greatest access to economic opportunity. It is an opportunity therefore not only for growth, but also for growth distributed throughout the economy and society.

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

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

These days, when operators compete in auctions for a specified number of licences, the licences tend to go to the operators that are likely to use the spectrum most efficiently. An auction also captures some of the investors' profits for the government, which benefits consumers as taxpayers – as long as governments are not tempted to use the auction primarily to raise revenues. If spectrum is withheld or the auction otherwise designed to artificially increase auction revenues, the harm done to users through higher prices and less innovation invariably far outweighs the short-term finance ministry gain.[5] Auctions now offer a tried and tested set of procedures. The evidence from the many spectrum auctions that have taken place suggests that they are a better and faster way of allocating spectrum licences.[6]

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

Beyond secondary trading, a further reform is the adoption of the notion of 'spectrum-neutrality' or 'technology-neutrality', whereby spectrum is not restricted to a specified use but can be deployed by operators to maximise its value in a wide range of possible uses. Spectrum neutrality can make interference management more complicated, but this is not an insurmountable problem.[7] This reform would allow operators to deploy the most efficient technology and service configuration at any given point in time.

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

In recent years, many governments have become preoccupied with the need to develop national broadband plans, often in a top-down way. The ability to direct resources and investments through these plans is seen as a key lever of government policy.

Market-driven approaches to spectrum assignment do not always sit comfortably with highly directive national broadband strategies. Most emerging economies have been occupied simultaneously with devising a national broadband policy and with the demanding task of deploying 2G and 3G in traditional spectrum bands, to meet the dramatic increase in consumer demand for services. Yet the simple ability to deploy high bandwidth services on low frequency spectrum, made available by extended spectrum markets, could pay significant long-term growth dividends and side-step a potentially complex policy debate.

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

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

The key point is that spectrum needs to be understood as an input like any other, the use of which will be improved by efficient market-based assignment rules. Regulatory interventions via input prices, eg the price of energy, are obviously not a sensible way to shape the services available to customers of firms that use energy. Changing the price firms pay for a single input, whether energy or spectrum, will cause all sorts of unanticipated and unintended distortions. Government policy has better tools at its disposal for achieving its objectives, such as subsidies or taxation of the end use. The well-established economic policy principle is to let input markets operate efficiently to avoid waste of scarce resources. "Don't mess with input prices" is the lesson both in theory and practice.[8]

There are other examples of governments pursuing policy outcomes through restrictions or obligations placed on particular spectrum bands. One example is favouring a particular kind of operator, eg by including additional requirements for local ownership above and beyond those contained in general legislation or the licensing regime. I would encourage policymakers to find different ways of pursuing these broader policy goals. Attaching more and more restrictions to individual spectrum assignments is likely to be one of the most costly ways of pursuing these objectives. It may diminish inward investment, restrict access to global economies of scale available only to international operators and deprive the economy of expertise. As a result, such additional obligations can jeopardise the health of a whole sector to the detriment of broader economic growth. At the very least novel conditions are likely to cause significant delays. The recent Ghanaian 2.6 GHz spectrum auction appears to be an example of this (see page 16 for more detail). Rules of this kind need to be weighed up carefully – the trade-offs can be hidden, but are likely to be large.

Another example is coverage obligations. Quite rightly, governments want to bridge any 'digital divide'. However, policymakers should be cautious in imposing different requirements on different operators. It is difficult for governments to calibrate the additional costs they impose through such an approach and so they risk a substantial distortion of competition, which is the primary driver of extended coverage. It is less distorting of market competition to impose the same coverage obligations on all operators while allowing them to share networks in high-cost or non-commercial areas, reducing costs and enabling deployment of national coverage.

The most widespread example of government policy influencing market behaviour is the use of spectrum caps, which restrict the amount of spectrum an operator can hold in a particular spectrum band or in total. This is intended to enhance competition and in particular to avoid 'warehousing', a contemporary version of 'hoarding' that bedevilled allocations by beauty contest. However, services at different frequencies have different characteristics, and impose different costs on the operators, so working out how to apply caps so that they are neither too tight nor too loose can be complicated.[9] Caps can confer benefits on end users, but getting them wrong will have unintended consequences.

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

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

Regulators should be cautious, though, about seeing spectrum auctions as the vehicle for achieving other policy aims. The costs of doing so in terms of inefficiencies, foregone economic growth and unintended consequences could be high.

Notes

1 The views in this article are the author's alone and do not reflect those of any organisation with which he is associated.

2 Martin Cave, *Review of Radio Spectrum Management*, HM Treasury and DTI, 2002 The same proposal was extended to spectrum use by public bodies in Martin Cave, 'Independent Audit of Spectrum Holdings: Report to the Chancellor', HMSO, 2005.

3 World Bank, *Information & Communication for Development Report*, 2009.

4 See the Cisco 'Visual Networking Index: Global Mobile Data Traffic Forecast Update', 2011–2016, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-520862.html

5 See Hazlett, 'Spectrum policy and competition in mobile services' in *Making Broadband Accessible for All* Vodafone Public Policy Paper No. 12, May 2011.

6 M. Cave, C. Doyle and W. Webb, *Essentials of Modern Spectrum Management*, Cambridge University Press, 2007, Ch. 5; P. Milgrom, 'Putting Auctions to Work', Cambridge University Press. 2004.

7 See Ofcom, *Spectrum User Rights: A Guide*, 2008

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

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

What principles of governance does spectrum policy need?

By **Professor Kevin Tsui**

What lessons can be learned for spectrum policy from the management of other natural resources? Here, an expert on resource management says good governance depends on a transparent, rules-based approach that will minimise regulatory uncertainty. This stability is key to encouraging the necessary investment in networks.

Introduction

In the information age, spectrum has become an increasingly valuable resource and one vital to national interests.[1] The right to use vital national resources has been decided using a variety of approaches, including first-possession rules (granting ownership to whoever got there first), administrative assignments, lotteries and auctions organised by governments.[2]

The use of auctions to assign spectrum rights is a relatively recent method. Yet between 1994 and 2009 the US Government had realised $53 billion from spectrum auctions. Unlike taxes, revenues from a well-designed auction (not one geared toward short-term government revenues) do not distort economic incentives. This is a big advantage – it is estimated that every tax dollar costs another 33 cents to society due to this distorting effect.[3]

A number of countries, such as India, South Africa and Ghana, will soon seek to use spectrum assignments to achieve a range of aims, including raising funds for the government. What lessons can be drawn for spectrum from the economic literature on the importance of institutions for development, especially in the management of natural resources?

Natural resources: curse or blessing?

The disappointing growth record and reported corruption in many resource-rich countries in Africa and Latin America has led many economists to describe natural resource abundance as a 'curse' for development. There is some evidence of a negative statistical relationship between natural resource dependence and economic growth. One possible reason is that resource booms relieve the pressure to drive other sources of wealth and growth, such as manufacturing activity, sometimes due to a higher exchange rate.[4]

Another possibility, which has been the focus of recent research, is that the exploitation of resources leads to rent-seeking and corruption, with damaging effects on the quality of government and political institutions.[5]

Yet natural resource wealth can sometimes improve economic growth and health outcomes.[6] Natural resource abundance need not be a curse, but the economic and social benefits will depend on the quality of institutions, such as government accountability in handling money, property rights protection and contract enforcement. To benefit fully from the revenues from natural resources, corruption, boom-bust cycles in commodity prices and volatility in government spending and debt all need to be addressed.[7]

Managing revenues from spectrum assignment

An important lesson from the 'resource curse' literature is therefore that institutions and government policies can help ensure society achieves the full potential of natural resource abundance. How can this be achieved in the specific context of wireless spectrum?

Corruption

To get the maximum possible benefit to society from this resource, well-defined spectrum rights need to be established. Non-price mechanisms, such as administrative assignments, lack transparency, can undermine competition and can be more vulnerable to corruption and favouritism. The use of auctions instead to assign spectrum is particularly desirable in emerging markets that have poor governance and weak institutions.
To ensure the most efficient assignment of the spectrum, as well as to limit potential corruption and favouritism, spectrum auctions should be open to all players in the industry.

Spectrum auctions should also be designed in ways that reduce the risk of corruption. According to auction theory, a sealed-bid design is less susceptible to collusion among bidders. However, open bidding is generally better than a single sealed bid because the bidding process reveals information about other bidders' valuations and hence promotes the efficient assignment of licences. In emerging markets with weak governance, an additional benefit of non-discriminatory open bidding is that it increases transparency and is less vulnerable to corruption. Furthermore, independent third-party auction managers can help by monitoring all aspects of the process.

Political risk

It is also crucial for emerging markets to create a credible and stable regime for private investment to exploit any natural resources. It is hard for private investors to take on a government in the courts if it alters the terms of a contract. Yet although a host country can get an immediate benefit from adverse renegotiation of licences, it will pay the price long term. A central and persistent problem in encouraging investment to exploit natural resources in countries with weak institutions is, therefore, to provide a legal framework that seeks to reduce political risk and retrospective actions. While there is little a country can do in the short term to reduce perceptions of political risk, companies' fear of expropriation can be sometimes be mitigated through the structure of the contract terms.

In the case of oil, for example, emerging markets need multinational corporations to discover and develop the oil. Heavy reliance on royalties or production-sharing is therefore common because these payments are not due until after revenues have been received by the oil companies. In India, all spectrum holders are required to pay a spectrum usage charge as a percentage of revenue but for those who acquired 3G spectrum by auction, this was levied in addition to the up-front spectrum acquisition fees. In India, the process for allocating spectrum has changed frequently (see page 24), but in order to continue attracting investment, a host country needs policy stability with no ex post changes in order to establish a reputation for not expropriating private investments.

Volatility of government revenues

Greater volatility in government spending is clearly linked to lower growth.[8] The 'curse' of natural resources is first and foremost a problem of volatility.[9] Unlike commodities, spectrum is not traded in world markets, so volatility ought not to be a problem, and yet FCC spectrum auctions have resulted in highly volatile government revenues in the US.[10]

What can be done to manage the revenues from spectrum auctions? In many resource-dependent countries, natural resource funds are used to help smooth government spending. The volatility of spending has been greater in countries with weak political checks and balances.[11] The weaker the governance, the stronger the scope and incentive for one political constituency to use windfall revenues as soon as they come in. This can be limited if the fund has rules about how it can be spent, if decisions on spending can be shared by different political groups and if there is greater transparency.

Finally, good auction design can also help. What does that involve? The timing of an auction can be as much a political choice as an economic one, because there is a conflict between raising the maximum government revenue in the short run and creating the maximum benefit for the economy in the long run. For instance, in the US a spectrum drought for the decade 1996–2005 was caused by a political calculation that a delay would increase auction revenues.[12]

In general, the timing of auctions can also be subject to the influence of electoral cycles. Running auctions sequentially may produce a steadier flow of auction revenues over time. Arrangements for profit or revenue sharing with winning bidders can also result in a less volatile contribution to government revenues than auctions with a one-time payment.[13]

Concluding remarks

Spectrum can be a useful development resource when spectrum rights are assigned appropriately. Lessons from countries with abundant natural resources suggest that resource rents can be all too easily dissipated through corruption and a volatility in government spending that hinders growth.

To exploit the full potential of rents from spectrum, institutions that support good governance are key. Good governance is based on rules rather than discretion. Informal processes, such as negotiation on a first-come-first-serve basis, and other formal administrative processes, lack transparency and are vulnerable to favouritism, corruption or simple mistakes. Auctions provide a transparent and fair means of awarding spectrum licences. However, they must create a stable environment for investment. Auction rules intended to increase short-term government revenues by limiting spectrum access, either by restricting participation of some potential bidders, delaying new licence sales, or other restrictions, will harm social welfare from a long-term perspective. The design of auctions can limit this damaging volatility.

Notes

1 Patrick S. Ryan 'Treating the Wireless Spectrum as a Natural Resource.' *Environmental Law Reporter*. 35, September 2005: 10620-10629.

2 Gary D. Libecap 'Assigning Property Rights in the Common Pool: Implications of the Prevalence of First-Possession Rules for ITQs in Fisheries.' *Marine Resource Economics*. 22(4), 2007: 407-423.

3 Thomas W. Hazlett and Roberto E. Muñoz. 'A Welfare Analysis of Spectrum Allocation Policies.' *RAND Journal of Economics*. 40(3), Autumn 2009: 424-454.

4 Jeffery D. Sachs and Andrew Warner. 'The Big Push, Natural Resource Booms and Growth.' *Journal of Development Economics*. 59(1), June 1999: 43-76.

5 Halvor S. Mehlum, Karl Moene, and Ragnar Torvik. 'Institutions and the Resource Curse.' *Economic Journal*. 116, January 2006: 1-20.

6 See Anca M. Cotet and Kevin K. Tsui. 'Oil, Growth, and Health: What Does the Cross-Country Evidence Really Show?' *Scandinavian Journal of Economics*. ISS(4) October 2013, 1107-1137. See also Frederick van der Ploeg 'Natural Resources: Curse or Blessing?' *Journal of Economic Literature*. 49(2), June 2011: 366-420, for a recent survey.

7 See Mehlum, Moene, and Torvik, (2006), van der Ploeg and Poelhekke, 2009), and Manzano, Osmel and Roberto Rigobon. 'Resource Curse or Debt Overhang?' in Daniel Lederman and William F. Maloney (eds.) *Natural Resources and Development: Are They a Curse? Are They Destiny?* Stanford University Press, 2003.

8 Ramey, Garey & Valerie A. Ramey. 'Cross-Country Evidence on the Link between Volatility and Growth.' *American Economic Review*. 85(5), December 1995: 1138-1151.

9 Frederick van der Ploeg and Steven Poelhekke 'Volatility and the Natural Resource Curse.' *Oxford Economic Papers*. 61(4), October 2009: 727-760.

10 See Thomas W. Hazlett 'U.S. Wireless License Auctions: 1994-2009.' ACCC Conference, Brisbane, Australia. July 1, 2009.

11 Macartan Humphreys and Martin Sandbu. 'The Political Economy of Natural Resource Funds.' in Macartan Humphreys, Jeffrey Sachs, and Joseph Stiglitz (ed.), *Escaping the Resource Curse*. Columbia University Press, 2007.

12 See Hazlett (2009), ibid.

13 Jean-Jacques Laffont and Jean Tirole. 'Auctioning Incentive Contracts.' *Journal of Political Economy*. 95(5), October 1987: 921-37 explains how auctioneers can also profit from contracting a cost-sharing arrangement with the winning bidder in procurement auctions.

A tale of two countries: spectrum policy outcomes in China and India compared

By **Dan Lloyd**, Strategy and Corporate Affairs Director, Vodafone Hutchison Australia
Research by **Meiqin Fang**, K-Island Consulting

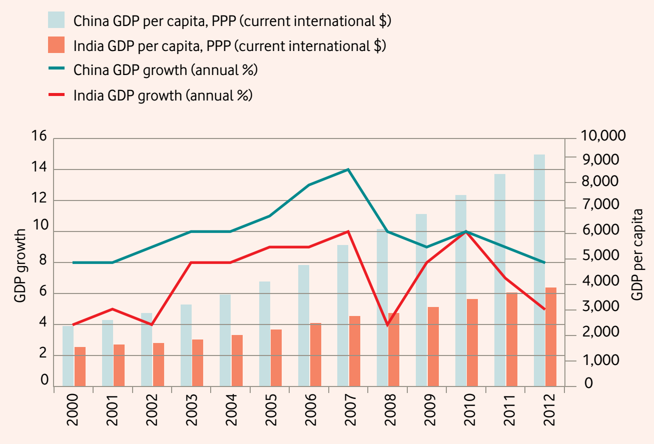
A comparison between China and India reveals the two countries to have taken contrasting approaches to spectrum policy. China's strategic decision to provide low cost and ample spectrum to its mobile operators has resulted in continuing rapid growth in take-up of services, even though it has an extensive fixed-line network. While India has from time to time sought to make spectrum available to the industry, it has had a highly variable approach to spectrum policy, which appears to have left it lagging far behind China.

India's and China's broad economic performance, and economic and political systems are often compared. However, it is rare to see a detailed comparison of their respective approaches to the regulation of major sectors of the economy such as the communications sector. The comparison in this report aims to give some insights into the implications of contrasting policy approaches to the sector, specifically with regard to spectrum policy, in these two major emerging markets.

India and China make for a particularly interesting comparison in the communications sector since they have similarly large populations, large geographic areas that make coverage a challenge and because both have stated that a key policy aim is to increase access to communications services as rapidly as possible, in order to drive economic growth. India's weaker economic performance over the past decade indicates that it could benefit from strong strategies in the policy environment to address current growth trends.

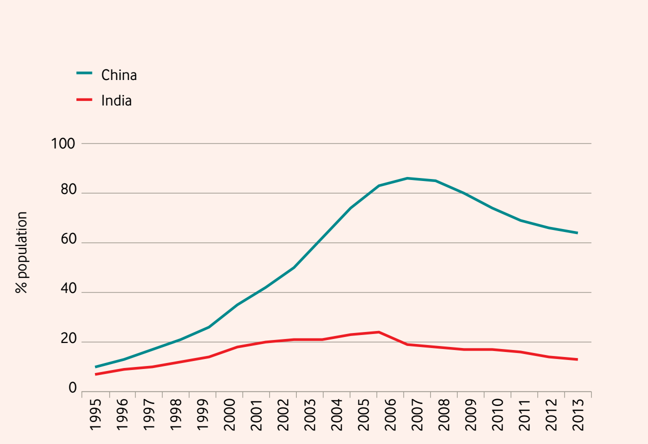
One significant difference between the communications sector in the two countries is the success China has had in driving fixed-line penetration, probably giving it the highest fixed-line penetration among the emerging markets. Although both countries have seen substantial fixed-to-mobile substitution, over 60% of China's population has access to a fixed-line. Indian fixed networks on the other hand never reached more than 4.5% of households (or 24% of the population). This makes spectrum policy far more critical for India, as there is little alternative to wireless broadband for the vast majority of the population.

China and India GDP growth and GDP per capita purchasing power parity (PPP)



Source: World Bank data

China and India fixed-line teledensity (% population)



Source: Telecom Regulatory Authority of India and Ministry of Industry and Information Technology data

Contrasting policy approaches

India and China have taken very different policy approaches to the communications sector, including spectrum allocation and pricing, which has resulted in market structures that are poles apart. China made an explicit decision to pursue scale and to provide its telecoms operators with the maximum possible inputs, including spectrum, to increase coverage and drive economic growth.

The Chinese operators therefore have access to unmatched quantities of prime spectrum at some of the lowest prices in the world. Although it is tempting to conclude that this is only possible due to state-ownership, substantial stakes in China Mobile and China Unicom are publicly listed on the Hong Kong Stock Exchange and both have had substantial foreign strategic partners from time to time. The Government therefore could have been tempted to impose substantial fees on the listed companies (since part of those fees would be paid by other shareholders, including private and foreign investors), while the remainder would merely be a transfer from one part of the state to another. The incentives have not affected the fact that Chinese policy has remained quite consistent: to provide inputs, including spectrum, at low cost to drive expansion of coverage and services, as well as quality of service and innovation.

The Indian approach has been less consistent. India gradually licensed multiple operators from 1994 to the point where it had, by 2008, as many as 14 operators in some regions. This is three times as many as any other market has managed to sustain, regardless of its scale.

India has struggled to free spectrum from other users (particularly defence and space agencies) and so has substantially less spectrum available in total than many other markets, including China. This shortage is compounded by policies that have fragmented scarce spectrum across multiple operators – China's main mobile spectrum bands are split between 3 operators while India's have been, at times, split across up to 14 operators. Even following the cancellation of many licences and the 2012 re-auction of 1800 MHz spectrum, in India a smaller amount of spectrum is still split across 9–10 operators.

What's more, India has adopted a wide variety of approaches to spectrum allocation and pricing over time. The first two licences in major cities were awarded through a technical and financial beauty contest, while the first two licences in other regions were awarded by single-stage competitive tender. The third licences were granted without any competitive process to the state-owned fixed-line incumbent MTNL/BSNL. A fourth operator was introduced through a multi-stage bidding process. Subsequent licences failed to be sold at auction. Indian policymakers assumed this was because there was not enough demand for them from operators and allocated licences to any companies meeting the threshold criteria on a 'first-come, first-served' basis at the fixed price determined by the last competitive process in each circle.

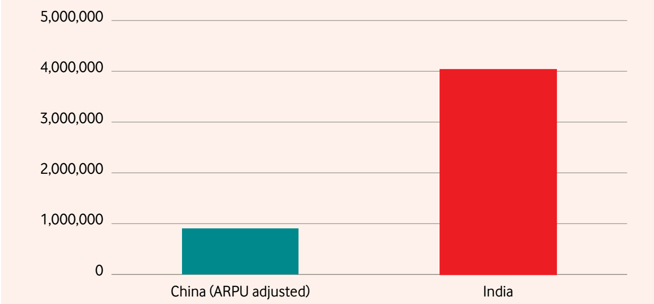
While applications for additional spectrum were pending, new licences were issued on the 'first-come first-served' model in India in 2008 but were cancelled by the Supreme Court 2012 as the process appeared to be the result of unlawful collusion. Part of the cancelled spectrum was put up for allocation, once again through an auction process, in 2012. Given the high reserve prices set by the Government most of the spectrum remained unsold until 2014. As a result of this controversy and delay substantial amounts of spectrum have been largely lying idle for years in a market where the four largest operators each have a customer base in excess of 100 million, high voice usage and rapidly growing data usage, but probably the lowest spectrum allocations per operator in the world.

Spectrum prices compared

India and China have also taken substantially different approaches to spectrum pricing. China's approach has been clear and consistent – providing spectrum at a relatively low cost – virtually free or a relatively modest fee per MHz, per year. This was the result of a strategic decision by the Government to prioritise investment in long-term national infrastructure and the long-term economic benefits that this brings, over short-term revenue generation to government through spectrum fees. For 3G spectrum, further reductions to annual spectrum fees have even been granted, provided licensees meet coverage rollout targets.

Recent Indian spectrum prices have been incredibly high by any comparison, let alone with China's consistent policy approach. A comparison of the February 2014 Indian price for 900 MHz spectrum and the Chinese price for 900 MHz spectrum shows a stark difference:

China and India 900 MHz spectrum prices per (unpaired) MHz, per year, average revenue per user (ARPU) adjusted (US$)



Source: Vodafone

Indeed, Indian spectrum prices, adjusted for population and the potential ARPU, probably make Indian spectrum the most expensive in the world. The chart below shows the Indian 1800 MHz and 900 MHz auction prices paid in 2014 in two of the metro areas compared to recent auctions in other countries.

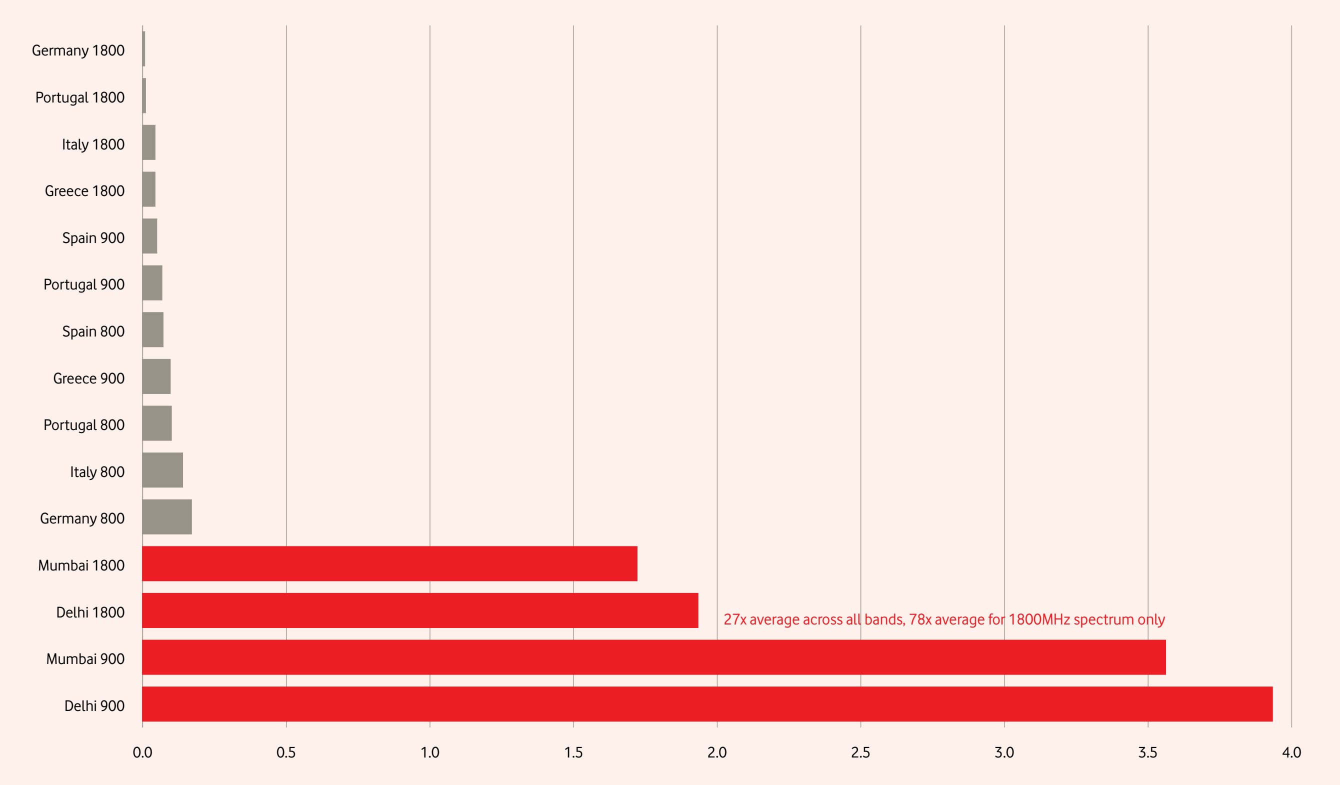
In contrast to China, India's approach to spectrum has changed significantly over the years and even though the first set of licences were issued in 1994, the basic principles of spectrum pricing are still not settled. The evolution of India's spectrum charging has been as follows:

- Initially, in the major metro areas, a licence fee based on a fixed fee per subscriber;
- From 1999 a fixed upfront fee for licence/spectrum combined with ongoing spectrum usage charges as a percentage of revenue, which increased as arbitrary blocks of new spectrum were granted (4.4 MHz, 6.2 MHz, 8 MHz etc);
- In 2010 the percentages of revenue charged for annual spectrum usage charges were arbitrarily raised (resulting in substantial litigation);
- An auction of 3G spectrum in 2010, with ongoing spectrum usage charges of up to 6% of revenues. However, the increasing percentage of revenue was determined not on the basis of the quantum of 3G spectrum but on the basis of the amount of 2G spectrum held by that operator;
- Auctions were held in 2012 and 2013 of some of the 1800 MHz spectrum that was issued in 2008 then cancelled by the Supreme Court. These auctions failed to sell much of the spectrum due to artificially high reserve prices (set on the basis of the final prices in the 2010 3G auction);
- In February 2014, an auction was held for spectrum in major metro areas and some other regions. This auction saw spectrum sold at prices several times the international average, which was in large part due to fears and uncertainties among operators of future spectrum supply and their concern to maintain continuity in the major metro areas where some of the existing licences were due for extension in November 2014; and
- The Indian Government also introduced a flat rate of spectrum usage charge of 5% of revenues, but only for the spectrum auctioned in February 2014, which added further complexity to the already convoluted landscape.

It is difficult to argue in this context that there is a settled market price for spectrum. Operators are instead required to make large assumptions as to the supply and price of spectrum when determining their rollout plans and spectrum strategies.

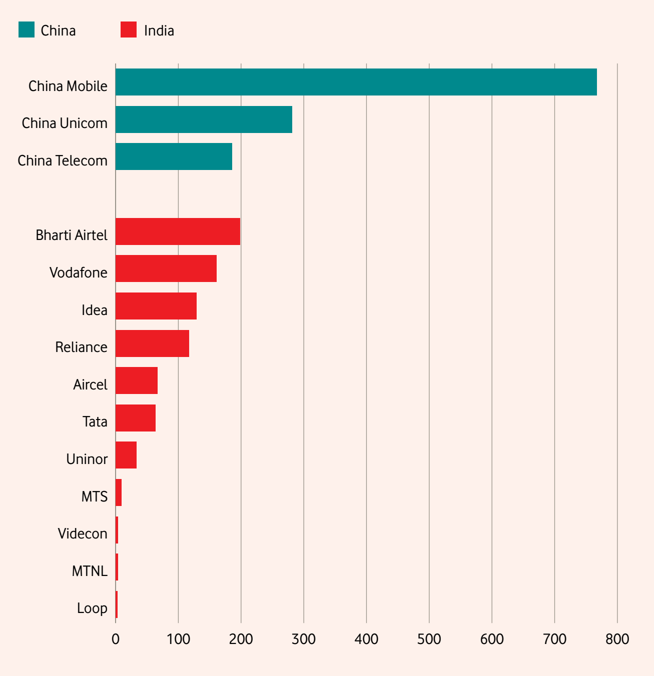
The result of the contrasting Chinese and Indian policies is that China has three large-scale operators while India has a long string of sub-scale operators, each with a small amount of spectrum. The largest Indian operators have around a fifth of the spectrum available to the largest Chinese operator and half of the spectrum available to even the smallest Chinese operator.

Prices paid internationally compared to Indian prices adjusted for ARPU (€/MHz/population/ARPU)



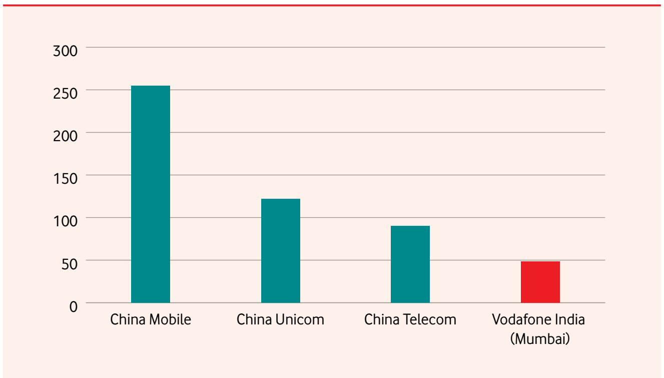
Source: Vodafone

Millions of subscribers – China and India (Q4 2013)



Source: Telecom Regulatory Authority of India and Ministry of Industry and Information Technology data

Total spectrum by operator paired and unpaired (MHz)



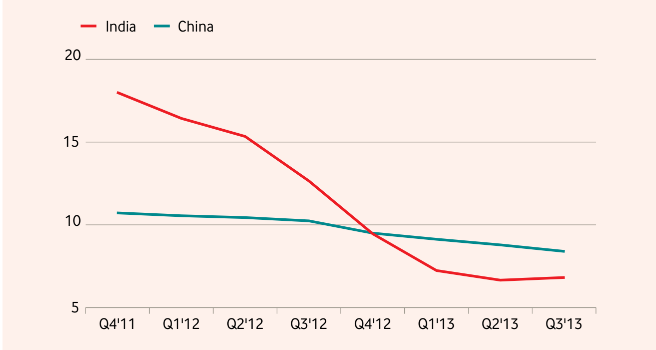
Source: Chinese Ministry of Industry and Information Technology and Vodafone India data

Contrasting outcomes

It is worth asking whether the very different approaches to spectrum policy have produced significantly different outcomes for consumers in China and India. Comparing headline subscriber numbers can be misleading as many subscribers use multiple SIMs, especially in highly price-sensitive markets such as India. Nor does the headline number of SIMs capture coverage or quality or other important aspects of service. SIMs are also put to very different uses with different economic effects. On a range of measures, though, including headline subscribers, it is clear that outcomes are significantly different in India and China:

- While the headline subscriber numbers in both India and China have shown robust growth for some years, the most recent figures show that India's growth rate has been decelerating rapidly:

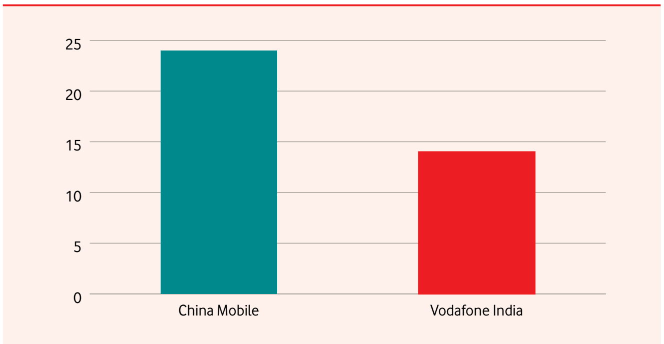
Subscriber growth on previous year (annual % change in subscribers)



Source: GSMA Wireless Intelligence 2014

- The Chinese networks have achieved 99.5% population coverage over a land area of 9.5 million square kilometres and coverage of all villages with a population of 20 or more. The Indian networks have covered approximately 85% of the population over a land area that is one third the size of China (3.2 million square kilometres).
- The uptake of non-voice services indicates the extent to which the communications industry is moving beyond voice services. The availability and cost of data services is related to access to and price of spectrum. On this metric, there is a marked contrast between the two countries:

China and India: data services as a percentage of revenue (Q1 2013)



Source: Vodafone

Conclusions

India and China have very different political and economic models and this report does not take a view on the respective merits of those broad systems. However, it is reasonable to compare the economic growth that the policy environment enables and to note that India has struggled by comparison with China's phenomenal growth record.

China's mobile subscriber growth is continuing at a relatively steady pace, while India's declined rapidly throughout 2012 and into 2013. China has delivered far superior coverage of a land area three times the size of India's, delivering three times the penetration and far higher use of data services. China made a clear choice to forego short-term revenues (including from private and foreign shareholders) in order to drive sustainable long-term growth of the communications sector and the economy. It is reasonable to conclude that a more strategic policy approach to communications policy in India could deliver greater long-term growth potential.

Spectrum licensing in three African countries: a catalyst for growth, and a policy conundrum

By **Mandla Msimang** and **Leona Mentz**, Pygma Consulting

Africa's 2G 'mobile miracle' was underpinned by a spectrum licensing regime that combined licence obligations with a range of other regulatory and policy instruments to attain broader economic aims. Spectrum assignment will again play a critical role in providing the infrastructure to enable the broadband revolution in African countries, but should not be seen as a 'silver bullet' for hitting a range of economic and social targets when other policy tools can target these wider aims more directly.

Introduction

African policymakers and regulators have been assigning and licensing spectrum for mobile services for almost 20 years. The policy environment has been an important catalyst for the 'mobile miracle' in Africa. In the three countries considered here, mobile SIM penetration had reached 70% in Kenya, 98% in Ghana and 129% in South Africa by the end of 2013.[1] This compares to a decline in the take up of fixed services: Kenya's fixed-line penetration decreased from 1.2% in 2007 to 0.6% in 2012, Ghana's from 1.7% to 1.1% and South Africa's from 9.2% to 7.9% over the same period.[2] Thus, the spread of mobile in all three countries has been significant. It has not only given millions of people access to telecommunications for the first time, but also shaped a vibrant communications market structure in an environment where there is no fixed-line alternative.

In order to create the same kind of success in broadband, new spectrum will need to be made available. With the advent of broadband and the challenge of licensing additional spectrum, policymakers and regulators are aiming at two objectives simultaneously: meeting the basic voice communications needs of those still unconnected to 2G mobile services and addressing the much larger broadband divide through the assignment of new spectrum for broadband services (primarily in the 800 MHz and 2.3–2.6 GHz ranges). These twin aims are evidenced in the recent proposals on the licensing of broadband spectrum and are influencing current policy dialogue and decisions on spectrum, especially in the context of national broadband strategies.

Approaches to licensing and spectrum assignment are being constructed around three objectives: (1) improved affordability, quality and innovation of services through effective competition; (2) increased participation by local players in the Information and Communications Technology (ICT) sector; and (3) universal service and access.[3] These objectives are unarguable; however, seeking to address them disproportionately through the spectrum licensing process is opportunistic and misplaced. Furthermore, there are risks of overcomplicating the design of licensing processes and causing delays and other challenges in the assignment of broadband spectrum. Drawing on the lessons learnt from the three case study countries, this paper concludes that addressing the above-mentioned policy and regulatory ambitions primarily through licensing could even be counterproductive, undermining the achievement of these objectives in relation to broadband services.

Enhancing competition

The three countries adopted liberalisation processes for mobile services in their previous licensing rounds, which occurred at a time when mobile services in Africa were new. Ghana and South Africa issued first and second mobile licences in 1994; Kenya's first and second mobile licences were issued in 2000. This initial licensing approach was aligned with the liberalisation model for mobile services adopted in many countries and was consistent with the World Trade Organization's Telecommunications Services Reference Paper.[4] Key aspects of this model were: introducing licensees with sufficient spectrum assignments to meet their initial requirements; allowing them to deploy their own competing infrastructure; and a reasonable period of time to establish themselves in the market.

Subsequently, the growth of mobile services and the increased understanding of its potential socio-economic contribution have paved the way for a second phase, with policymakers deciding to introduce additional players, sometimes in conjunction with the assignment of 3G spectrum to (in the main) the existing mobile licensees.[5] A third phase of licensing since 2005 has followed, with South Africa, Kenya, Tanzania, Uganda and other African countries changing from technology-specific to converged technology neutral licensing regimes. This resulted in new entrants at network level (for example, Telkom South Africa converted its fixed licence to enable it to launch 8ta (now Telkom Mobile, its mobile provider) and also service-level licensees. There are now therefore more licensees and increasing demand for spectrum by new entrants. As outlined below, this has presented challenges for policymakers.

In designing their spectrum licensing processes, governments have had to consider the trade-off between maximising up-front revenues on the one hand and, on the other hand, the broader economic and social development benefits of increasing competition, introducing new services, and enabling mobile operators to invest in expanding their coverage and increasing their capacity. African governments and regulators largely rejected auctions for the next wave of spectrum assignments (ie later 2G licences and 3G licences) on the basis that they might discourage operators from investing in infrastructure, limit competition by excluding smaller players without the deep pockets to participate in the bidding process, and result in an increase in the costs of communications through the passing on of high licence fees to consumers.[6] Thus in Nigeria, in 2001, three GSM licences were auctioned for $285 million each compared to the less than $12 million achieved for the third mobile licence in South Africa in 2003 (issued for R100 million plus 1% of net operating income each year) and $22.5 million in Ghana in 2010 using 'beauty contests' or other administrative processes.

Whether licences and spectrum are assigned by auctions or by administrative processes, strong institutional capability remains important in the design, decisions and administration of the assignment of spectrum. The experiences in the case study countries have illustrated this, as government decisions to introduce competition and facilitate market entry through beauty contests (South Africa third mobile licence), on a 'first-come first-served' basis (Kenya 3G licences, South Africa first 2.6 GHz licences) and hybrid auction/beauty contests (South Africa current proposals for 2.6 GHz, 3.5 GHz and 800 MHz licences, Ghana 2.6 GHz licences) have been accompanied by long delays, lack of transparency, rigidity, legal challenges or patterns of over- and under-allocation of spectrum to users.[7] For example:

- South Africa's three most significant licensing processes, the licensing of a third mobile operator (2001), the licensing of a second national operator (2005) and the conversion of over 300 Value Added Network licences to full telecoms licences (2009), were beauty contests/administrative processes that were characterised by lengthy delays and legal challenges;
- In South Africa, the 3.5 GHz and 2.6 GHz broadband spectrum, proposed to be allocated by a hybrid auction/administrative process, is still pending six years after the announcement of this process. This is partly due to decisions that needed to be made on what to do with spectrum that was held (but generally not utilised) by iBurst and Sentech in the 2.6 GHz band and Sentech, Telkom and Neotel in the 3.5 GHz band. Some of this spectrum has since been returned to the regulator, thus increasing the pool of spectrum available for licensing;
- Kenya's 'first-come first-served' issue of 3G licences to Airtel and Orange (2010) is still under dispute on the basis that the fee paid by the two operators in 2010 was 60% less than the fee paid by Safaricom for the same spectrum in 2007; and
- In Ghana, initial 2G licences were issued by auction. It has been alleged that the licensing process lacked transparency because the public was not consulted prior to the auctions and the terms and conditions were not publicly made known.[8]

The challenges with respect to the assignment process have served, in many cases, to turn spectrum from a catalyst into a conundrum, and in so doing have often delayed the very competition that the processes sought to introduce.

These past experiences – whether based on unrealistic expectations and misunderstandings, less than successful assignment processes, or the perception that the industry has underperformed in some way – have paved the way for a recent trend of reserving spectrum for players who have not previously had access to it; and also, more controversially, for governments or state-owned entities. In many ways, without evidence of market failure, the assignment of spectrum to government entities can be seen as the antithesis of the successful liberalisation efforts of the last two decades. As shown by Plum Consulting (on page 13), who in their contribution to this report assess the potential impact of delaying spectrum allocation in the case study countries, the consequences of changing the approach must be carefully considered.

Increasing local participation

In Ghana, Kenya and South Africa, although there are competitive mobile markets, many successful ISPs and the participation of local enterprises in an increasingly vibrant sector, the respective governments have the objective of further enhancing local empowerment.

New proposals have considered spectrum licensing processes that support this objective. For example, in Kenya, a recent 20% local ownership requirement was introduced to enable participation in the LTE consortium (2011)[9], which contrasts with the dilution of local ownership to below 20% in Essar Telecom Kenya, Yu and Airtel Kenya in 2010; and the dilution of Airtel's local ownership to 5%.[10] Ghana's recent 2.6 GHz licensing process required that participants have at least 30% local private shareholding.[11] In South Africa, the inclusion of 'historically disadvantaged individuals' in the sector has been a government objective since the introduction of competition in the mid-1990s. Therefore, in the licensing of the second fixed-line and third mobile operators, participation of local, historically disadvantaged or 'Black Economic Empowerment' (BEE) players was essential – in the mobile licensing process a 40% BEE shareholding (among other requirements) ensured a winning bid.[12] However, so far the South African Government has sought to implement BEE requirements via licence conditions and legislation rather than applying them directly to spectrum.

The spectrum licensing process in all three countries is now being considered as a vehicle for this policy objective as it seems to offer a relatively direct means of enforcing it. However, what appears to be a direct tool for enhancing empowerment could prove counterproductive. It does not take into account the fact that the positive socio-economic outcomes of broadband diffusion depend not just on the mobile network operators, but also network vendors, application providers, service providers, content providers, device manufacturers and users themselves. In fact, affordability, to the benefit of the wider population, will be driven more directly by these other types of provider.

For instance, Kenya has earned a reputation as an innovation hub and a centre for the development of relevant African applications and content. Initially developed on narrowband mobile and SMS platforms, many of Kenya's innovations, such as *Ushahidi*, an open-source application used in conjunction with Google Maps, using crowd sourcing for social activism, have had a regional and global impact. M-Pesa is another example. The impact of services and applications like these on local economic participation has been significant and must be taken into account in considering how mobile and broadband services will impact the underlying policy aim of empowerment.

This is of course not to say that local ownership of the mobile network operator is undesirable, but simply that the introduction of specific ownership requirements without taking into consideration the wider context, risks delaying the deployment of broadband and the wider socio-economic growth it drives. One of the key pillars of the initial liberalisation phase in all three countries was that licensed operators had a combination of local and experienced (at the time mainly international) telecom shareholders. This combination of local understanding and operator experience is one of the key contributors to the success of the mobile industry to date.

Ownership of the network, achieved via new spectrum, would be an indirect way of achieving the ultimate aim of economic empowerment. As well as ownership of providers in the broader eco-system, there are other policy approaches available to government such as the broad-based scorecard and ICT sector charter, which was adopted and applied to all ICT companies in South Africa.

Universal service and access

The goal of increasing universal service and access, and in particular increasing affordability, availability and accessibility of digital technologies to all population groups, is espoused by all governments.

A common approach and proven effective method in the case study countries, as elsewhere, is to include network coverage obligations in licences. For example, in Ghana mobile operators had to meet a six-region 2G coverage requirement within the first three years, leading up to full national coverage (active presence in all regions of the country) by year eight.[13] In South Africa, the initial mobile licensees were required to provide 60% population coverage in two years; and 70% population coverage in four years in terms of the licence conditions.[14]

Another common approach has been the introduction of Universal Service Funds, financed mainly though fees paid by mobile licensees. Looking at the three case study countries, the effectiveness of these funds to support policy objectives is questionable and has been characterised by delays in implementation in the case of Kenya,[15] and failures in governance and project design and implementation in the case of South Africa.[16] To a large extent, these Universal Service Funds and other 'universal service' mechanisms, such as licence conditions, over the last decade or so have failed to fully address universal access/services objectives. Yet these mechanisms are nevertheless being carried over into national broadband strategies, including decisions on spectrum allocation.

Lessons from this experience must be considered when setting national ICT strategies including broadband rollout. A new set of long-term targets and objectives should be defined in terms of coverage and access to focus on the fundamental aim of economic development. If there are objectives that cannot be achieved commercially, then appropriate universal service mechanisms may be considered – these may include fund contributions, or the seemingly more effective rollout and coverage obligations, or a combination of both. The lesson of the 2G and 3G experience is that mechanisms, like Universal Service Funds, need a clear and transparent plan for supporting specific schemes with a high likelihood of delivering coverage. As shown by experiences to date, the importance of strong institutional capability in the design, decisions and administration of such mechanisms will be crucial to their impact and sustainability.

Conclusion

The 'mobile miracle' saw the rapid diffusion of 2G services across Africa. The transformation of the communications landscape was brought about by competition between operators who combined local shareholders and management with those experienced in telecoms and who made significant investments. Mobiles now serve over 600 million users in Africa. Underpinning this miracle was a spectrum licensing regime that, while including certain specific obligations, balanced the attainment of broader economic policy objectives through licensing, with the use of a range of other regulatory and policy instruments.

Lessons from this success, and also the fact that some goals are yet to be achieved, should be considered in the current policy dialogue and decisions on spectrum assignments as part of new national ICT policies. Spectrum assignment will play a critical role in providing the infrastructure to enable the broadband revolution in African countries. However, conditions on spectrum assignment should not be seen as the only or the most direct mechanism for achieving economic transformation. Simply making enough spectrum available for broadband services will help drive broad-based economic empowerment and growth. Spectrum licensing is not a 'silver bullet' for hitting a range of economic and social targets – on the contrary – and complicating the spectrum assignment process could do more harm than good when there are better policy tools available to achieve the wider aims.

Notes

1 GSM Association Wireless Intelligence

2 International Telecommunications Union, http://www.itu.int/ITU-D/ict/statistics/

3 See for example (South African) Minister's Draft Policy Direction, *Government Gazette* 34848, December 2011, and (Ghana's) Public Consultation on the Selection and Award Procedure for Licences in the 2500 MHz – 2690 MHz Band, National Communication Authority, November 2009.

4 http://www.wto.org/english/tratop_e/serv_e/telecom_e/tel23_e.htm

5 See, for example, South African Invitation to Apply for the Third Mobile Cellular Telecommunications Licence, *Government Gazette* number 19806, on 26 February 1999 (GGN 314/1999) and Invitation to Prequalify for the International Tender of licence to Construct and Operate a National GSM Cellular System in Kenya, see: www.ictregulationtoolkit.org/en/Document.748.pdf

6 See Minister's Policy Direction, South Africa Government Gazette 34848, December 2011.

7 Johannes M. Bauer, 'A Comparative Analysis of Spectrum Management Regimes'.

8 '3G Mobile Policy: The Case of Ghana', New Initiatives Programme of the Office of the Secretary General of the International Telecommunication Union (ITU).

9 http://www.telegeography.com/products/commsupdate/articles/2011/09/15/kenyan-cellcos-give-lte-consortium-the-cold-shoulder/

10 http://www.telegeography.com/products/commsupdate/articles/2011/09/05/airtel-yu-face-foreign-ownership-lte-licence-freeze/

11 Public Consultation on the Selection and Award Procedure for Licenses in the 2500 MHz – 2690 MHz Band, National Communication Authority (Ghana), November 2009.

12 www.link.wits.ac.za/news/v3_12.html (citing reasons for SATRA's selection of Cell C)

13 Ghana Standard Mobile Telecommunications Licence, http://nca.org.gh/downloads/Licence_for_Mobile_Telecom_Network.pdf

14 MTN and Vodacom Licences, Issue of Licences to Provide National Cellular Telecommunications Services GN 1078/1993 GG. 15232 dated 29 October 1993, as amended by Issue of Licence in terms of section 37(1) of the Act to provide National MCTS GN 1483/2002 GG 23760 (Vodacom Licence) and GN 1484/2002 GG 23760 (MTN Licence).

15 The Fund was established in law in terms of the Kenya Communications (Amendment) Act of 2009; Universal Service and Access Regulations making the Fund operational were published in 2010.

16 USAASA Annual Report 2011/12 (see page 29).

Models of competition for broadband wireless

By **Richard Feasey**

Competition between wireless networks has proven successful as the model which achieved the economic and social benefits of widespread affordable access to mobile communications in emerging markets. Though networks required for broadband access are likely to require greater network sharing and potentially monopoly provision in remote rural areas, there appears to be insufficient reason to favour alternative models based heavily on fibre networks in advanced markets.

Policymakers in a number of emerging markets, such as Kenya, Rwanda, Turkey and Mexico, are considering whether to abandon the traditional approach to wireless market development, which has relied upon competition between infrastructure providers. They propose adopting a single national wireless infrastructure intended to meet the broadband needs of the population. This would mark a radical departure from the model of wireless network competition that has prevailed around the world for the last 20 years. Instead, it borrows heavily from models of monopoly infrastructures, which a small number of advanced country governments have adopted in order to develop next-generation fixed broadband networks (most notably Australia), and which was used by all governments to build the original fixed communications networks in the twentieth century.

Policymakers around the world are rightly focused on broadband network deployment as a driver of economic growth and development. In emerging markets, this generally means wireless infrastructure. Finding the right model for wireless network competition is therefore critical.

Operators in emerging markets have already taken innovative approaches to network investment – the creation of separate, jointly funded, 'tower companies' in India and Africa (but increasingly in Europe and the US as well) is one example. This paper considers whether the recent proposals to develop national monopoly mobile broadband networks are more or less likely to ensure faster investment and wireless broadband rollout than the more traditional models of infrastructure competition.

Monopoly or competing infrastructures

There is no golden rule that says that competition is superior to monopoly in the case of infrastructure development. Many infrastructures with high fixed costs and relatively low rates of innovation, including energy, water and transport networks around the world, are supplied by monopolists. This is because it would be both prohibitively wasteful for society to duplicate the infrastructure and because it would be hard to finance such infrastructures privately if the suppliers had to compete. Infrastructures typically have high fixed and sunk costs and very low marginal costs. In addition, private investors would know that competition would be likely to drive prices down to marginal cost, bankrupting everyone. Therefore, sometimes monopolies are needed to get major infrastructure projects built at all.

The drawbacks of monopoly are also well known and generally provide the basis on which the case for competition is made. Monopolists, particularly if they have duties to shareholders, will be willing and able to exploit their customers. Networks may be built, but customers will pay more than they should (or there will be fewer customers able to use the network than there otherwise should). This creates a need to regulate prices. Monopolists also have little or no incentive to be efficient or to innovate. Regulators can try to direct the management by setting performance or efficiency targets, or by scrutinising the company's investment plans and budgets. But the regulators are unlikely to be better placed to judge what might be possible and it is very difficult for regulators to force firms to innovate or even to know what innovation might look like.

Competition between networks addresses these problems. Less regulation is required because the firms themselves will constrain each other in pricing and have incentives to be efficient and reduce costs as a result. Firms facing competition also have strong incentives to innovate in order to gain customers or stop losing them. Of course, competition is rarely perfect and comes with some disadvantages. Competing networks require more economic resources in total to build (since there is some duplication and loss of scale) and may also impose greater environmental and other costs. Competitors might go bankrupt and disrupt the supply of services to customers. Or they might try to collude to exploit customers.

The conventional view of telecommunications infrastructure was that fixed networks are better developed as a monopoly whereas wireless networks were better suited to competition. This is an over-simplification. There has been network competition in the fixed sector from cable networks in some developed markets; and elements of mobile networks are often shared by operators who otherwise compete. Masts and other 'passive' assets, which have little relevance to innovation or service differentiation, are shared by mobile operators in most markets. Similarly, while there has been more innovation in mobile network technologies, the industry has often used global standards, such as GSM or WCDMA, to ensure that competition does not lead to an inefficient fragmentation of rival technologies and a consequent loss of scale.

The increasing convergence of capability between fixed and mobile infrastructures (and the fact that mobile networks have a large fixed-line component behind the radio network and fixed networks increasingly have a wireless connection to the user equipment) also means that distinctions between fixed and wireless are becoming increasingly blurred. In practice, a combination of fixed and mobile infrastructures is likely to be needed to deliver affordable broadband access, dependent on specific drivers of costs such as geography and population density and demand.[1]

Overall, the network competition model has been inherently better suited to the development of mobile infrastructure than fixed and the monopoly model has been better suited to fixed networks than mobile. This is because fixed networks, whether copper or fibre or a mix of technologies, are generally much more expensive to build than wireless networks. A fixed infrastructure network may cost 10 to 20 times that of a wireless network in a similar market. That means that the costs of duplication that would arise if the competition model were to be applied to fixed networks would be much higher, or conversely that the costs of duplication in the wireless sector

are much lower. In large part this is to do with the fact that more of the mobile infrastructure is shared among more users than in fixed networks, where each household requires a dedicated connection.

Equally important, innovation and investment have proved to be much more important in mobile than in fixed networks. The mobile industry has undergone four major network technology upgrades in two decades. Many of the major gains in the performance of wireless networks arise because of competing investments in the core radio components (although these have also been driven by, and have driven, much more rapid innovation in mobile devices than we have seen in fixed devices).

Brief evidence

In assessing the merits of competing wireless networks against monopoly provision, it is important to remember how effective the competitive market structure has been. Total mobile connections overtook fixed connections on a global basis in 2002 and are projected to reach almost 7 billion this year. Fixed connections have been in decline in most parts of the world for much of the past decade. There are now twice as many mobile devices as fixed lines in developed markets such as the US or Europe, and at least 20 to 30 times as many in most emerging markets.

This massive surge in demand for mobile communications has been financed by private investors who have been unconcerned by the costs of duplication or bankruptcy that are used to justify an infrastructure monopoly. The operators have moved quickly from analogue to digital and from narrowband to broadband mobile networks, driven by consumer demand and competition.

On the other hand, the fixed network monopolies have been struggling for a decade to transition from the copper-based environment of the past century to the fibre-based infrastructure of the future. In some cases, governments have intervened directly to subsidise the construction of new monopoly infrastructures that the private sector were unwilling to finance. In others it has been a competition model – between cable and telecoms firms – that has driven investment. In neither case has this driven the massive consumer demand for new fixed services that is needed to properly exploit these networks. Rates of adoption for new fixed broadband services lag the very rapid adoption rates of new mobile services. Penetration levels among fibre to the home networks typically remain at 20–30%, although can be much lower.[2] Penetration of mobile broadband devices is typically well above 50% in comparable markets and growing fast.[3]

The competition model adopted in the mobile sector has driven innovation not only in network technologies but in the commercial models the operators employ to encourage the adoption of services. For example, mobile operators around the world have often subsidised mobile handsets so that new users with limited budgets can afford to get onto the network. In general, we have seen much more innovation in tariffs by mobile operators than we have seen with fixed, resulting in greater affordability of new mobile services and much higher levels of adoption across the board. While this was clearly true of traditional voice services, it applies to broadband and data services in equal measure.

There are few examples of mobile network monopoly to compare with the many examples of competition. Ethio Telecom in Ethiopia is one example which, as the chart below shows, appears to lag its regional peers.

Implications for policymakers

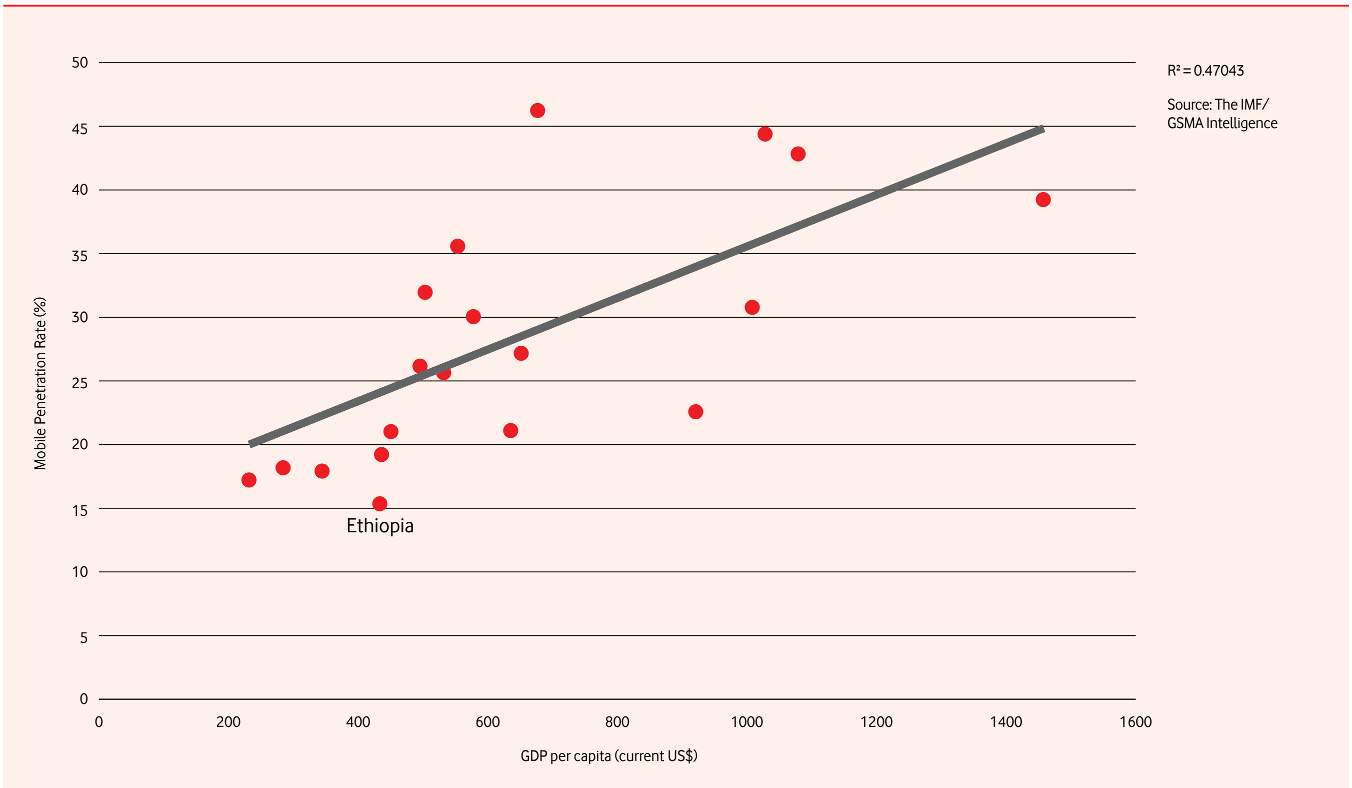
The fact that the fixed monopoly network model has been outperformed by the mobile competition model in every market in the world over the past 20 years does not necessarily mean that we can or should abandon the monopoly model for fixed networks. There may, for example, be good reasons for governments to worry about the difficulty of financing costly fixed networks. I have argued elsewhere that a jointly owned monopoly infrastructure can be a good model for next-generation fixed broadband.[4]

But the evidence does suggest that we would need to find very good reasons to abandon the competition model when it comes to the development of new wireless networks. What reasons might these be?

Universal access

The best argument in my view is that although network competition has delivered widespread wireless coverage, there are remote regions where the costs of duplication would otherwise mean that there is no coverage at all. But this is not an argument to abandon the competition model and replace it with a *national* monopoly network. It is a mistake to think, for example, that 'savings' from monopoly networks in urban areas can be used to fund more extensive rural coverage by the private sector. The case for rural coverage depends solely on the expected returns from investment in those areas. There are much better ways of addressing the concern. For example, spectrum licences may contain coverage obligations requiring one of the licensees to build out a network in the remote regions and allow the others to

Mobile penetration rate and GDP per capita Q4 2012



The sample comprises Ethiopia; Kenya; Tanzania; Senegal; Chad; Côte d'Ivoire; Zambia; Rwanda; Uganda; Guinea-Bissau; Mozambique; Guinea; Mali; Togo; Malawi; Central African Republic; Niger; Burundi; and Democratic Republic of Congo.

roam on it. Or all operators may be required to jointly build a single network, which they will all share. A third option is simply to allow one operator to monopolise the rural areas, but rely upon national pricing and competition in the urban areas to prevent abusive consequences. Note also that this is not a challenge that is unique to developing markets: a single network to serve remote rural regions has been adopted in developed markets like France and Sweden, while Telstra is sole provider in many of Australia's most remote communities.

The wise approach to the challenge of extending wireless coverage is not to abandon the competition model from the outset, but first to see how far competition can take us. In most cases, competition has driven mobile operators to cover areas that policymakers never thought they would serve. Competition has driven the efficiencies and the innovation needed to accomplish this and it is impossible for regulators to anticipate in advance the nature of the innovation that could occur. Most rollout obligations in spectrum licences – which represented what policymakers thought were reasonable targets for the operators at the time – have been substantially exceeded. Rural areas that might need monopoly provision can be covered in a targeted fashion once it becomes clear where the limits of competitive networks are. In the meantime, competitive networks should be allowed to deliver broadband rollout with the same vigour and success as it has delivered voice communications to the world over the past 20 years.

Spectrum availability

A second argument is that there is something different about wireless broadband that makes the monopoly model appropriate for the future, even if it clearly was not appropriate for the wireless voice era of the past 20 years. This is normally where there is a claim that there is insufficient radio spectrum to support competing wireless broadband networks that require very large channels (typically of 20 MHz of more). However, fragmenting the spectrum among competing networks so that nobody has enough spectrum means compromising the broadband performance of the country as a whole. A monopoly network with all the spectrum could build a much better network than any competitor who holds only a fraction of the spectrum.

While there is also something to this argument (although less than in the first, in my view) it cannot justify abandoning the competition model for wireless. The best solution here is simply to make more spectrum available – as others have argued in this Policy Paper and elsewhere. But even if that is not possible, there are reasons to doubt whether the benefits of very wide channels will be very significant in practice. The global wireless broadband technologies will be designed for the spectrum that is available to operators in the majority of the world's wireless markets – and those will be the bands that result from the 'fragmented' competition models.

Furthermore, even if a monopoly network could deliver better performance, experience from the rollout of 'superfast' fixed fibre monopolies suggests that few citizens will get to enjoy those benefits. Monopoly models have been very reluctant to price their services to drive rapid take-up of new services, certainly in comparison with wireless network competition.

Nor are any of the traditional arguments in favour of monopoly network models – the costs of duplication and waste, an inability to finance competition, or a lack of concern about innovation – any more compelling in relation to the development of broadband wireless networks than they were in the case of narrowband wireless.

One further consideration is that implementation of a monopoly network is likely to prove much more challenging for regulators than continuing to allow competition to drive network rollout. The proposals to introduce the new arrangements have to take account of the existing legal and property rights of operators and the fact that they are already providing services to their customers. Existing operators are either likely to be reluctant to participate at all, or will disagree about the value of the assets they are being asked to contribute to. Attempting to build a new network that is wholly independent of the existing operators is likely to be prohibitively expensive. The models for governance of the network, the coverage targets and the ongoing investment requirements over time all need to be agreed. Introducing government and public funding is only likely to make the process more difficult. Experience to date in Kenya, Mexico and Rwanda certainly suggests the negotiations are very challenging.

Conclusion

Consumers around the world are abandoning fixed networks in favour of mobile, and policymakers are struggling to find ways to encourage further investment in fixed networks. Operators in some developed markets are making plans to switch them off altogether. In these circumstances it is odd to find policymakers proposing to apply the fixed network monopoly model to wireless broadband networks.

This paper does not claim that mobile network competition solves all the challenges of affordable broadband access in emerging markets. In practice, a large amount of sharing already occurs between wireless networks to avoid costly duplication, without intervention by policymakers. A combination of wireless and fixed infrastructures may be needed; and, for example, there may be remote rural areas for which a monopoly network is required. There are, however, a number of different ways in which this can be done and it is generally better to see how far competition can deliver access, through wireless network investment and innovative commercial models, before other models are imposed.

Notes

1 See 'Building next-generation broadband networks in emerging markets' by Luke van Hooft in *Making Broadband Accessible for All*. http://www.vodafone.com/content/dam/vodafone/about/public_policy/policy_papers/public_policy_series_12.pdf

2 See, for example, 'Country report data annex: Australia', Analysys Mason, March 2013.

3 Wireless Intelligence, GSM Association.

4 See, for example, http://www.vodafone.com/content/dam/vodafone/about/public_policy/netco_oxera_final.pdf

Annex: spectrum basics

Electromagnetic radiation, from long-wave radio to gamma rays, moves through space or the air in waves. The term 'radio spectrum' refers to radio waves, the range of frequencies useful for communication. It ranges from long-wave, very low frequencies as low as around 10 kHz (10,000 cycles per second), to an extremely high frequency 300 GHz (300,000,000,000 cycles per second).

These waves are measured by:

- Their **frequency** (the number occurring in a given time period), measured in Hertz (Hz). 1 Hz means one wave per second. 1 kHz means 1,000 waves per second, 1 MHz 1,000,000 waves per second and so on;
- Their **wavelength** (the distance between two waves) – wavelength and frequency are linked, the higher the frequency, the shorter the wavelength; and
- Their **amplitude** (the 'height' of the wave).

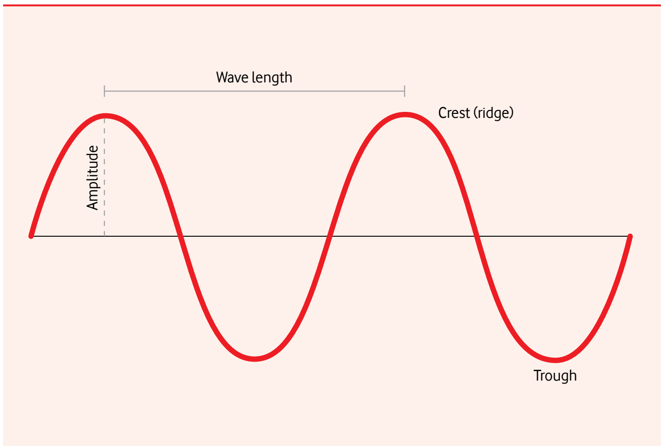
Lower frequencies generally travel further before the received signal level becomes inadequate. Information is encoded in radio waves by **modulation**, for example changing the amplitude or the frequency of the wave. Earlier (analogue) forms of communication modulated the radio wave directly with a sound wave. Sound waves are pressure variations in air in the frequency range up to about 20 kHz. These can be converted to electrical signals with a microphone and used to modulate the amplitude or frequency of the wave. Amplitude modulation is used for AM radio stations, operating at low frequencies, covering large areas. Frequency modulation is used for FM broadcasting, with better sound quality than AM radio but at higher frequencies with less range.

Modern communications use digital modulation. In any digital communication, the information is coded into a pattern of binary digits (1 or 0, 'on' or 'off'). These are used to modulate either the amplitude of the wave, the phase (a variant of frequency) or nowadays frequently both.

Communication via radio waves requires **bandwidth**, depending how much information is being transmitted. Bandwidth means the range of frequencies in the spectrum needed to carry a given signal. There is a fundamental limit to how much information can be transmitted in a given bandwidth. Modern technology is getting quite close to this limit, so communication of more data tends to need more bandwidth (ie more spectrum). Higher frequencies have more bandwidth capacity than lower frequencies, so it makes sense to put forms of communication with a lot of information (TV, broadband, mobiles) in higher frequencies than the less information-heavy radio broadcasts. TV and radio broadcasts are one-way whereas mobile is two-way and requires both capacity for 'downlink' (base station to mobile) and 'uplink' (mobile to base station). As radio waves at different frequencies cannot be fenced off from each other, any given use needs enough bandwidth that it does not **interfere** with neighbouring uses. The attractive combination of range and bandwidth requirements for communication is known as the **'sweet spot'**, which lies between 300 MHz and 3 GHz.

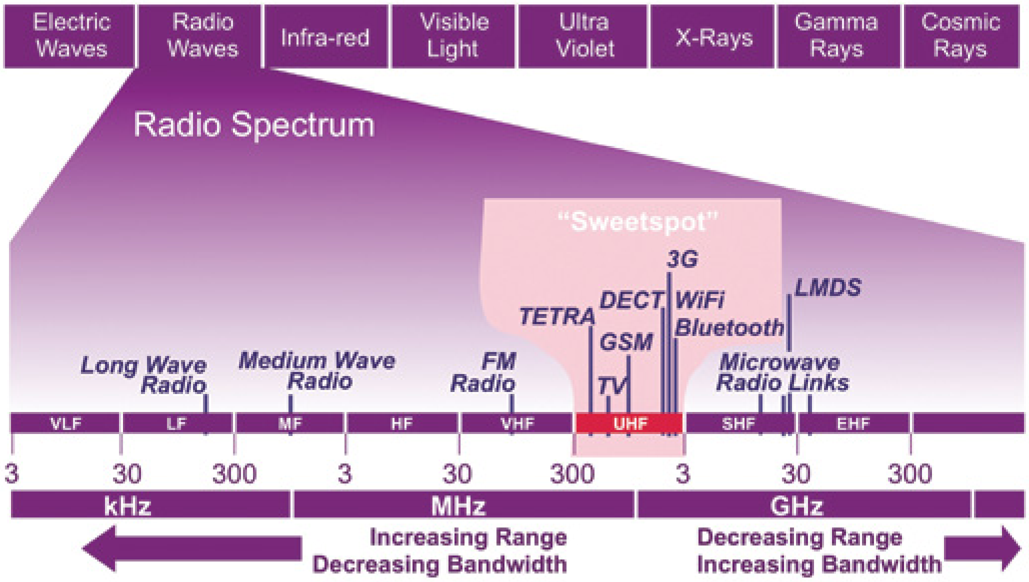
Finally, all uses of the radio waves require a transmitter and a **receiver**. The latter consists of an antenna to pick up the waves and a tuner to tune in to the right frequencies where the information is encoded. The specific technologies involved differ at different frequencies. Lower frequency signals need bigger antennae and different transmitters have different power needs.

Characteristics of radio waves



Source: Vodafone

The electromagnetic spectrum



Source: Office of Communications

Use of radio waves for communication

Since the first discovery of radio waves by James Clark Maxwell in 1867, there has been rapid technological change in all the elements of wireless communication. This includes huge improvements in the efficiency with which spectrum is used – especially the use of digital technologies. Even so, there has been increasing demand for access to spectrum as new communications technologies have developed, and the use of wireless communications has expanded with the move from voice and text to data, and growing demand for music and video.

Radio waves do not stop at national borders, so spectrum use is harmonised internationally. Harmonisation enables economies of scale in the manufacture of equipment. It is easier and cheaper to manufacture equipment that works on a few spectrum bands globally, than to manufacture equipment that needs to work across many spectrum bands, or at different spectrum bands in different countries. Changing the uses of spectrum, or how it is allocated between uses and assigned to individual providers, can involve requiring commercial providers and all the users of a service to buy and install new transmitting and receiving equipment. This, along with the risk of interference, means that many uses of the spectrum are licensed by national governments, and changing the allocation proceeds cautiously.