Making Broadband Accessible For All

Welcome

This is the twelfth in our series of Policy Papers. Our aim is to provide a platform for leading experts to write a point of view on issues that are important to us at Vodafone. The opinions expressed are not ours but those of independent experts whose views we respect even if we do not necessarily always agree with them. I would like to thank all those who contributed for their support. I believe these essays will be of interest to anyone concerned with the development of good public policy and hope you enjoy reading them.

Vittorio Colao, Chief Executive, Vodafone Group

Since 2004, our research on the socio-economic impact of mobile (SIM) has aimed to provide systematic analyses of the impact of mobile connections in key areas. In 2011 we now expand the analysis to look at the impact of internet access. The findings of this research can be used to assist policymakers in providing a regulatory environment that stimulates growth and economic development. The areas of research are decided upon in conjunction with the group of experts on the Advisory Panel, comprising academics, officials and representatives of NGOs. The Advisory Panel peer review each chapter before publication.

Diane Coyle OBE, Enlightenment Economics & Chair SIM Advisory Panel

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Introduction

Most governments rightly see getting people online as the next step in delivering the expected economic and social benefits of IT and telecommunications. This is as true in the emerging markets as in the developed markets. The benefits of doing so are in some ways more pronounced in the emerging markets. The success story of mobiles in the emerging markets is already well known: this should soon extend to data services. Yet in the case of extending data services, there is a real danger of some serious policy mistakes.

As in developed markets, broadband strategies in emerging markets have tended to focus on investment in fibre. However this focus on fibre may miss an opportunity for a quicker and more cost-effective transformational change built on the capabilities and in particular accessibility of mobile broadband.

The early evidence suggests that mobile internet is spreading as quickly, in some emerging markets, as mobile telephony did originally. Mobile broadband use is already more extensive than realised by policymakers. By contrast, fixed internet access is stagnant.

This report looks at the conditions for growth in access to data services and the internet. It considers the potential for extending access beyond affluent urban users to the wider population and contains key findings for network service providers, data service businesses, governments and regulators.

If the goal is universal access to data services then the critical issue is affordability. The economic evidence to date indicates that the benefits of broadband services derive from universal access.

Several critical factors will drive affordability in emerging markets.

The first is innovation by service providers and content developers in terms of their pricing and business models. Affordability for low income users will require innovation that does not place most of the burden of access costs on the user. Regulators must enable this innovation to flourish and not inhibit it by preconceived notions of the right model or pricing.

The second is the power of content. Increased availability of Web content and services that are valued by people, and which can be viewed on prevalent devices and in local languages, will act to drive demand for access to data services to that critical point where network effects and economies of scale accelerate. Services that improve the social and economic well being – such as those that help people find jobs, sell goods, access health and education resources – could drive demand across a wide range of income levels. In addition, social networking is already emerging as an important driver of network effects in use of the internet.

The third factor is data pricing and the affordability of internet services for the mass market. The 'calling party pays' model and highly innovative pricing plans were essential for the spread of mobile to users who have limited ability to pay. A similarly radical and innovative model has not yet emerged in data markets, both fixed and mobile. Further innovation in data pricing is needed to enable viable delivery of access and services to low-income users. This is a complex area in any competitive market and the risk for policy makers is that policy action, or inaction, may confine access to data services to the more privileged.

Another key finding of this report is that sufficient spectrum must be made available for service providers. The regulatory challenge lies in enhancing the supply of spectrum, given that mobile broadband services will place enormous pressure on the existing spectrum capacity. Spectrum policy in many emerging markets is characterised by short term government revenue-raising objectives and these lead to policies such as 'warehousing' spectrum and spectrum caps. As the demand for spectrum takes off, these restrictions will become even more tempting but they will ultimately limit growth and raise costs and prices for users.

Finally, and most importantly, in order to ensure that the maximum number of people irrespective of income can benefit from the next generation network services, we believe it is vital that the policy debate in emerging markets should change quickly. The current vision dominating policy debates is one of fibre optical cable delivered to every rural community. But this glosses over many important issues, not least the comparative costs of different technologies. The political clamour for high-profile investment in fibre could ultimately prove expensive and inefficient.

The answer is not simple and it would be a mistake to conclude that there is a 'one size fits all' network architecture, especially if that equates to 'fibre, fibre everywhere'. That over-simplified conclusion could lead to a serious misdirection of national resources: policymakers should remain neutral in technology choices.

The following papers are designed to articulate the challenges policy makers face when considering how to facilitate the extension of data services. We hope you find them a useful addition to the debate as we work together to shape the future of our communication infrastructure and ensure that the widest number of people in all countries have access to the invaluable resource of the web.

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Overview

1. What is broadband?

Traditional definitions of broadband have a narrow focus on bandwidth and speed. We use a wider definition, as broadband policy needs to consider the entire 'eco-system' of internet and data services from both a demand and supply-side perspective. The wider focus is necessary for policies to deliver immediate and sustainable broader economic and social development goals. This might sound obvious, but in itself it is a significant shift in policy thinking, which so far has had a largely supply-side perspective. The current focus in many emerging markets is on specific issues such as available broadband speeds and regional/household diffusion targets, rather than on broader economic and social objectives delivered through a wider mix of technologies and policies.

The shift to a wider focus helps underline an important difference between broadband policies and earlier telecommunications policies. The transformation of voice telephony markets and the consequent growth in mobile came about through the adoption of a simple and widely accepted regulatory model of competition, with relatively limited and straightforward regulation. This model was applied successfully on a global basis. But such a simple policy recipe will not work for broadband, as in this case the nature of demand and supply is so different as between emerging and developed markets.

On the demand side, broadband can be seen as a continuum ranging from information services with relatively modest bandwidth needs to those that are bandwidth intensive and involve real-time transmission. These demands are not globally uniform.

On the supply side, the context could not more different. Developed markets have extensive, almost complete, household penetration of fixed lines; in emerging markets almost no fixed networks exist outside the heart of the most urban areas. In short, there is no definitive set of broadband policies that can be transferred internationally.

But the debate about which policies are appropriate for emerging markets has not yet really started. For the model currently is emulation of the policies applied in developed markets, for want of a more appropriate analysis for the emerging market context. The need to start that debate motivates this report.

Broadband should be seen as the capability to deliver data and foster innovation, rather than a specific data transfer speed, and still less a specific technology. In other words, the definition of broadband has to be in terms of a capability that is "fit for purpose", not just in the immediate market context, but also in a dynamic context that allows capabilities to expand in line with user needs and changes in relative prices, as well as supply-side improvements and technical innovation.

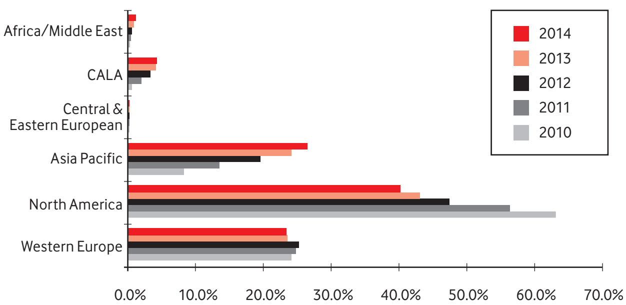
Table 1: Broadband policy objectives

Country	Policy Objective
United States	At least 100 million homes have access to actual download speeds of 100 Mbps and actual upload speeds of 50 Mbps.[1]
United Kingdom	Extend next generation broadband to 90% of households by 2017.[2]
Australia	Fibre-to-the-home (FTTH) technology to deliver 100 Mbps to 90% of the Australian population.[3]
Germany	50 Mbps service to 75% of households by 2014.[4]
Finland	100 Mbps network available to 99% of households, by end of 2015.[5]
New Zealand	FTTH broadband service providing downlink speeds of at least 100 Mbps and uplink speeds of at least 50 Mbps, to 75% of the population within 10 years.[6]
India	2 Mbps to 10 Mbps open access optical fibre network connecting all habitation with population of 500 and above.[7]

The delivery of broadband has several enabling components:

- *International connectivity*; in some countries international connectivity remains a significant constraint, although this is being eased by new investment in international gateways. The public policy debate on this front concerns the choice and effective implementation of investments; perhaps best recent example of implementing different models is East Africa, where private sector-led and government-led new investments co-exist and are starting to create new supply. For example, Seacom's privately-funded 1.3 Tbps cable opened in mid-2009 bringing additional bandwidth to South Africa, Mozambique, Tanzania and Kenya; the public-private 1.4 Tbps EASSy cable, which opened in mid-2010 and whose capacity is due to be doubled this year, is a consortium serving nine coastal and ten landlocked countries in eastern Africa. Many of these countries have their first international cable connectivity, having relied previously on expensive satellite connections. Initial estimates suggest wholesale bandwidth prices fell by 60-90% in Kenya and Tanzania following the opening of Seacom, the size of these declines indicating the tightness of the previous constraint.[8] The IFC estimates that on opening, EASSy reduced the price of international connectivity by two-thirds.[9] More investment is planned: the 13 submarine cable systems landing in sub-Saharan Africa as a whole have a capacity of up to 14.0 Tbps, which is due to reach 25.8 Tbps by the end of 2012.
- *National connectivity*: within a country the availability and quality of service in backbone networks is becoming an increasingly significant issue. Consumer access to high quality broadband services are predicated on national backbone networks capable of supporting the rapid growth in traffic at competitive prices. Much investment (and developmental assistance) in emerging markets has centered on providing national fibre optic backbone networks – for example, in Kenya (US$60 million)[10], Tanzania (US$170 million over two years)[11] and the Central African Backbone Project (up to US$ 160 million)[12].
- *Local access/connectivity*: the capacity in the 'local loop' to support multiple broadband users is a significant policy issue. In the developed world this is synonymous with regulatory prescriptions defining ways of giving access to the incumbent's copper access network e.g. local loop unbundling. Such an approach is neither a sound policy option nor technically feasible where local telecommunications connectivity is largely provided through mobile – as is the case in emerging markets. Nevertheless it is assumed in many emerging markets that connectivity will be provided through fibre, even though there exists no legacy fixed telephony network. Policy debates often do not distinguish between national backbone investment and the investment in local access needed to connect end-users – in effect policy-makers overlook this fundamental issue.
- *End user devices*: here the conventional focus is on personal computers. Innovation has driven PC prices down in real terms whilst increasing their functionality, with the availability of these benefits to consumers in national markets determined by government policy on issues such as taxes and import duties. However, PCs remain a high cost device in an emerging market context. Innovation has tended to divide the functionality of the personal computer into services (e.g. software as a service and cloud computing applications). Such developments, in conjunction with growing access to broadband, are potentially remodeling the nature of consumer access and placing the emphasis on services rather than devices. Moreover, PCs are far less widespread in emerging markets than mobiles; the functionality of mobile handsets is increasing while the prices of smartphones are falling. It is becoming increasingly clear that a PC-only based vision of broadband may well miss the mark. It is also likely that, for the foreseeable future, costly 'tablet' devices will by-pass most emerging markets, whose share in the global market for these devices is minimal. We need to start thinking about access and content on user devices that are not PCs or tablets, but the more affordable handsets.

Figure 1. Regional market share of tablet unit sales



Source: Strategy Analytics, Global Tablet Sales Forecast by Country, December 2010.

A review of country case studies reveals some common elements in policy and market development.[13] One common feature is the adoption of comprehensive broadband strategies. The case study evidence shows that broadband policies are developed and revised in response to the different stages of market penetration. The resulting policies have three stages:

(i) enabling the market, where supply and demand side policies are enacted to reduce barriers to entry and increase demand;

(ii) sustaining the market, where regulation may be reduced and increasing competition is focussed on; and

(iii) tackling exclusion, where focus shifts towards achieving universal broadband access.

It is important to note that developed and emerging markets are embarking on the broadband journey at the same time but of course in completely different contexts. Emerging markets can therefore learn little from developed market precedents. What's more, the policy recommendations typical in developed markets are fundamentally different from those relevant for emerging markets. For example, one of the key market and policy challenges in most developed markets is how to manage/promote the transition from existing copper-based fixed networks (and access based regulatory regime that is used by alternative providers) to the next generation fibre networks. But these policy debates have no relevance for emerging markets that have no legacy copper networks.

2. Current broadband access in developing markets

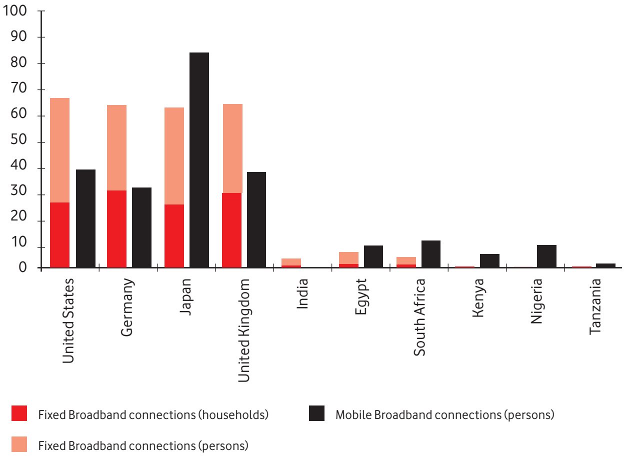
Mobile data traffic globally has been growing rapidly. It rose 2.6-fold in 2010, nearly tripling for the third year in a row.[14]

Emerging markets start with a lower level of broadband diffusion and a greater reliance on data services over mobile networks, compared to developed markets. Mobile data usage in the emerging markets has been increasing rapidly. For example, official Kenyan industry statistics show that mobile internet subscribers grew by 843% for the 12 months to September 2011.[15]

In terms of *fixed* broadband connections, there is a large disparity between the two groups of countries due to the near non-existence of fixed line connections in emerging markets. There are also large gaps between groups of non-OECD countries. The ITU stated that for 2010: "internet user penetration in Africa will reach 9.6%, far behind both the world average (30%) and the developing country average (21%)"[16] Figure 2 gives an indication of these disparities.

A simple comparison between fixed and mobile broadband connections overlooks the fact that fixed connections are typically per household, supporting multiple users, while mobile connections typically relate to individual users. The chart below scales up the figures for fixed subscriptions by the average number of people per household in each country (the lighter shaded area shows the scaling up). This then makes clear the relative importance of mobile connections in emerging markets.

Figure 2. Subscriptions per 100 people (ITU)



Source: ITU, 2009, Fixed Broadband Subscriptions, Mobile Broadband Subscriptions. National statistics on persons per household. Nigeria data not available, assumed same as Kenya.

In addition, alternative wireless technologies supply a significant proportion of total connections from country to country. ITU mobile broadband statistics, most frequently referred to in discussions of broadband policy, tell only part of the story because they capture only the number of 3G subscribers.

For example, according to the ITU data there were no mobile broadband users in India in 2009, reflecting the fact that no 3G networks were launched. This suggests that not a single one of the 700 million wireless subscribers in India (as at December 2010) accessed the internet. This is simply incorrect, as Vodafone Essar had, on its own, 13.5 million active data users in December 2010 (and growing significantly). This was around 11% of the company's subscriber base at the time.[17] Other emerging markets show a similar disconnect between market reality and official government statistics on the broadband market: for example, 38% of Vodacom's subscriber base in South Africa were active data users in December 2010; and Safaricom Kenya had 21% active data users.[18]

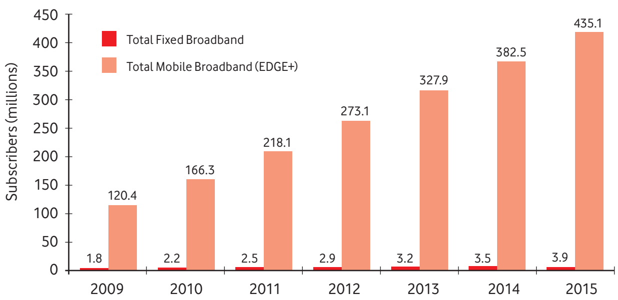
Inappropriate policy recommendations will follow from reliance on misleading statistics. Neither a focus on fixed provision of broadband nor a static definition of wireless broadband is adequate.

To obtain a more useful snapshot of wireless broadband use in emerging markets, we could look at a larger range of data sources, including industry analysts and operating companies. But the calculation is not simple. We need to look at networks capable of delivering the service; end-users with a suitable handset; and finally end-user subscriptions that permit data usage. However, it is possible to estimate the number of subscribers able to utilise data speeds that, combined with software advances (such as the Opera Mini browser), deliver acceptable broadband internet browsing.

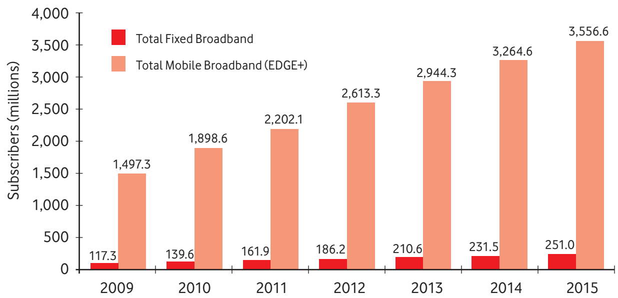
The two panels of Figure 3 show for two regions the number of subscribers with 2G EDGE capable handsets and above.[19] As can be seen from the charts, by excluding the contribution of 2G data to internet connectivity, the reported ITU statistics are blind to the reality of how the majority of end-users in emerging markets can and actually do connect with the internet.

Figure 3. Internet subscriptions by access network

Sub-Sahara Africa



Emerging Asia-Pacific



Source: Analsys Mason Fixed Broadband Worldwide Forecast 2009-2015; and Strategy Analystics, Cellular User Forecasts, 2010-2015.

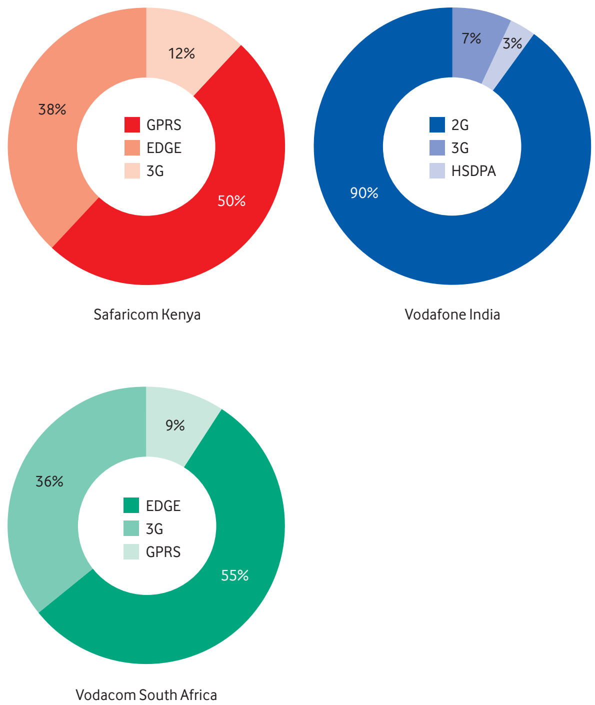
Analysts' forecasts estimate the number of subscribers capable of accessing internet services through their mobile device. This should be considered an upper bound of internet users, as not all subscribers who are able to access the internet will choose to do so.

In terms of mobile data traffic, one respected forecast estimates that: "Global mobile data traffic will increase 26-fold between 2010 and 2015. Mobile data traffic will grow at a compound annual growth rate (CAGR) of 92 percent from 2010 to 2015." Within this total, the Middle East and Africa are expected to see the strongest growth of any regions, growing at a compound annual rate of 129%. "The emerging market regions (Central and Eastern Europe, Latin America, and Middle East and Africa) will have the highest growth and will represent an increasing share of total mobile data traffic, from 12 percent at the end of 2010 to 20 percent by 2015."

Cisco expects the Middle East and North Africa to have more mobile-only internet users than North America by 2015.[20]

In addition to forecasts showing the expectation of rapid growth, we can look at actual operator data to show the extent to which active data users are now using different wireless technologies. Figure 4 below shows the proportion of active data users in December 2010 using basic 2G data handsets (GPRS), enhanced 2G data (EDGE) handsets, or 3G handsets (3G and HSDPA) for Vodacom in South Africa, Vodafone in India and Safaricom in Kenya. In all three networks, the majority of active data users were using one of the 2G handset technologies, 64% in South Africa, 88% in Kenya and 90% in India.[21] Excluding basic GPRS handsets from the definition of wireless broadband, some 50% of Safaricom and 91% of Vodacom data users have access to broadband.

Figure 4



Source: Vodafone Essar, Safaricom, Vodacom.

While broadband access is clearly far from ubiquitous in emerging markets, it is clear that internet access and data usage is not as restricted as suggested by the official statistics. Wireless broadband is providing important connectivity in emerging markets, and greater connectivity than is acknowledged in the policy debate. The answer to the access problem should be staring policy makers in the face but is disguised by the use of inadequate data. Emerging markets need to break quickly and decisively with the developed market mindset that equates internet access and broadband with a fixed connection.

3. Why does broadband matter?

The policy interest in extending broadband access and use derives from the presumption that it will greatly benefit economic growth. It is also assumed that wide broadband adoption will help close the digital divide, and guard against other forms of social exclusion. Whilst there is an emerging body of evidence that broadband does positively affect growth, it is likely to have a range of social and economic impacts on emerging markets. As broadband services are still in their infancy, there is little evidence available on their effects over time. Direct effects on economic growth are anyway only part of the story; for example, little if any attention has been paid to the trade effects associated with growth of broadband market.[22]

Equally, naïve optimism about the impacts of broadband would be misplaced. There is little doubt that broadband investment is an enabler of economic growth – but that does not imply that emerging market governments should spend billions of dollars on broadband investment if done at the expense of other government investment in other potential economic enablers. But in order to evaluate these trade-offs, we need a better understanding of how broadband and associated services impact businesses, institutions and individuals and the resulting economic impact. None of this analysis from OECD countries is readily available or replicable. Yet interestingly, and perhaps disturbingly, that is not inhibiting the enthusiasm of governments for multi-billion dollar investment visions. For example, the Indian regulator (TRAI), upon release of the Indian National Broadband Plan, estimated to cost around US$13 billion, confidently stated that:

"ICT in general and broadband in particular contribute substantially to growth of GDP and towards poverty elevation by improving access with equity. As per study, 10% increase in broadband penetration accounts for 1.38 percentage increase in the per capita GDP growth in developing economies."[23]

The research indicating that improved access to telecommunications will have a strongly positive effect on economic growth is robust and consistent across developed and emerging markets. But what additional impacts does broadband access have on the economy beyond the existing impacts of telephony, fixed and mobile? That is a more difficult question.

The scope for additional effects stems from the way access to more data and information much more quickly can improve firm productivity and consumer welfare. The existing empirical research on OECD countries suggests that broadband uptake does in fact have a large positive economic impact. Two papers using differences amongst US states to assess the links between broadband and growth find a positive link, but do not fully resolve the question of causality (does growth drive broadband uptake or does broadband drive growth?).[24] Another US-based study confirmed this positive link, tentatively supporting the existence of a causal link from broadband to growth, and found the growth impact was stronger in less densely populated areas.[25] A recent study of 25 OECD countries in the decade to 2007 concludes: "We find that a 10 percentage-point increase in broadband penetration raises annual per-capita growth by 0.9-1.5 percentage points."[26] The study specifically accounts for the separate impact of broadband on top of other technologies diffusing at the same time, computers and mobile telephony. Growth impacts arise from the productivity benefits of broadband use by individual firms.[27]

The other question is whether the efficiency gains derive from broadband access per se or the business re-engineering that may accompany broadband.

However, this research is a long way away from providing good evidence on the impacts in emerging markets. What research there is finds large positive growth impacts. According to a recent World Bank econometric analysis of 120 countries, for every 10-percentage-point increase in the penetration of broadband services, there is an increase in economic growth of 1.3 percentage points. This growth effect of broadband is significant and stronger in emerging than in developed economies, and also higher than the growth impact of telephony and the internet. This study, too, finds an acceleration of the impact once broadband penetration reaches a critical mass.[28] The econometric challenges of identifying a specific, causal role for broadband in driving growth, given the limitations of aggregate data for developing countries, and the current low level of broadband penetration, underline the need for caution about this result. The headline figure is very large indeed, by the standards of regression analysis of this kind. What's more, it is hard to be confident about the magnitude of the impact without having identified the mechanisms by which broadband affects economic growth.

These studies are thus generally unsatisfactory in several respects and the interpretation of the studies even more so. Firstly, the research has taken place at a very high level of aggregation but the results are being applied universally. A research result that supports a hypothesis of broadband penetration driving GDP growth is being translated by policy makers to an economic case for universal broadband access. The consequence is that plans for rural broadband rollout are, for example, being placed on a par or in some cases elevated above rural electrification or sanitation programs. This prioritization surely does not make sense.

Secondly, the research falls into the trap of treating broadband as an homogeneous service. Unlike voice telephony, broadband comes as a continuum and it is unhelpful to use this broad-brush research to draw fine distinctions subsequently between different technological solutions that deliver broadband (or close substitutes) for broadband. The term "broadband" has become an unhelpful overarching label that masks important choices. Broadband and fibre have become synonymous. We don't think that makes any sense especially in emerging markets. The investment case is not "Broadband – yes or no?" – but more complex than that.

Further refinements of the economic research suggest that once consumers and businesses are using broadband, the value they derive from it seems to increase over time.[29] For individual firms there is a clear benefit to productivity. Firms adopting broadband change their organizational structure, becoming more decentralized, and enable individual workers access to information to become more productive. The scope for new business models based on rapid information access, the reduction of entry barriers enabling new competition and the greater transparency in many markets also contribute to increased productivity.[30] There is every reason to believe that the substantially greater access to data and information would deliver strong productivity benefits in emerging markets, especially given the relative paucity of information as compared with OECD countries. For example, one study of ICT use by small companies in Mumbai found that greater use of the technologies increased enterprise size.[31] A further issue is the likely impact on the extent of the informal economy in many emerging markets; reduced information and transactions costs should enable the unorganized sector to transition to the formal economy and should enable typically small firms to grow.

But inevitably these macro studies raise questions about the micro impacts of broadband availability in emerging markets – what are the specific benefits and who gains them?

One hypothesis is that the benefits of broadband investment will be maximised through the provision of broadband services to as many people as possible. Where there is a trade-off between speed and coverage, coverage should be the priority.[32] Recent research shows that most productivity-enhancing benefits of the internet come through relatively low-bandwidth connections.[33] The benefits of broadband do not depend on a high bandwidth connection. In fact, many applications could be and indeed are supported by currently available wireless technologies (such as EDGE and 3G HSPA), or relatively low-cost fixed line technologies (such as ADSL) – making all the more relevant our earlier discussion of the statistics – although in future some uses (perhaps by high-tech businesses or universities) may require more bandwidth. Conversely, entertainment services such as video and gaming currently requiring higher bandwidth generate relatively little direct economic benefit compared to other applications, although they may drive demand, so whether they need to be supported now is open to question.

We conclude from this review of the economic impact research that it is impossible to form a definitive and unambiguous view of the likely impact of broadband in emerging markets let alone the critical transmission mechanisms by which the benefits of broadband are delivered. The research results are preliminary and hence not a foundation of knowledge or understanding on which to build critical policy choices about major infrastructure investment programs. Greater circumspection and policy dialogue within individual countries is needed, in particular to avoid the spending of large sums of public money on stranded assets that will generate poor returns.

4. Drivers of demand for broadband in developing markets

Given this evidence that broadband – appropriately defined and understood as an eco-system of services rather than just a specific technology and bandwidth – has potentially large but uncertain economic benefits, we turn next to some of the practical policy debates. These issues are discussed in detail in the subsequent chapters of this report. The first set of policy issues concerns the drivers of demand for broadband in developing markets.

One clear theme emerging from the research described above is the importance of content in driving demand and broadband penetration rates.[34] Some survey results suggest that the unmet demand for internet access in developing countries is large, although respondents tend to emphasize entertainment, social communication and access to information ahead of practical commercial or economic uses.[35] One survey in India and Uganda concluded there was latent demand for mobile internet, but again the users surveyed did not identify specifically 'economic' activities. Entertainment services such as TV, music and sport were ranked by the largest proportions of users.[36]

These results, emphasizing the role of demand for services such as entertainment and sport, are consistent with the role of leisure and social activities in driving the spread of earlier waves of technology. The research presented in this report adds further weight to the importance attached to the use of broadband for entertainment and social purposes.

However, a stronger theme that emerges here is the importance of social networking platforms, especially Facebook (see Chapter 1). The purely social functions are important as a driver that could take demand for broadband quickly to the critical mass through network effects. Social networks could do for data services what network effects have done for voice communications – provide a reason why everyone wants to be connected. The scale of the potential economic benefits of data services, described in the previous section, depend on markets reaching this critical mass. However, it may not be the services delivering the most compelling economic gains that provide the engine of penetration growth to get to that tipping point. This is an important new finding. Policy makers might have to reposition the role of social networks in their policy frameworks.

Users and developers are also adopting social networks as platforms for applications that can drive productivity changes and deliver local content (see chapter 2). The role of local content in defining the value of broadband applications has been widely debated as the lack of local content has often been identified as an inhibiting factor in broadband adoption. The research reported here suggests that the early adopters of broadband appear to use international sites to access a wide range of content, some global but some important local content. Chapter 2 discusses the way local developers can take advantage of the big international platforms to reach a wide market at low cost, 'localising' them for that purpose, and the scope for a local content industry to progress to developing local content on local platforms. The focus of the development community on local content may a classic case of putting the "cart before the horse". The all important "horse" in this case is the initial impetus to growth in penetration/access due to the operation of network effects.

The nature of the 'device' is also an important element in shaping demand. The mobile smartphone appears to be gaining significant advantages over access driven from PCs. Consumers see smartphone handsets as multi-purpose devices. PCs – probably accessed in a cybercafé – will be preferred for some functions but for many the smartphone trumps the laptop as the preferred device for internet access. High-end handset costs have already started to decline but will remain out of the reach of the majority of citizens in emerging markets. Policy makers need to be thinking of the majority of citizens accessing broadband services through a more basic handset device. That has implications for broader policy as, for example, a vision of e-government built on a PC based platform would be a terrible mistake.

The research presented here shows that the early adopters of broadband are spending significant sums on broadband access (as would be expected of any early adopters of a new technology). However, as described in Chapter 1, the affordability of access is important to them, and a central issue for take-up in the wider market. It is clear that innovative pricing packages for broadband access and use are going to be critical – much as pre-pay was a vital innovation for mobile voice and text services. Chapter 2 describes some early examples of pricing innovation in access and services, although more will be needed to drive wider market demand.

Appropriate pricing policies depend on the price and income elasticity of demand for mobile telephony and mobile broadband – these will be noticeably different between emerging and developed countries. Price elasticities seem to be high in emerging markets, given the very low average income levels. Competition policy and regulation has had an important part to play in delivering affordability. Introducing competition into telecommunications puts downward pressure on prices and encourages businesses to innovate. Kenya's communications sector was opened to new entry in 2008 and now, four phone companies now vie for customers by offering premium services such as Safaricom's MPESA, and pricing innovations such as its 8/- (US$0.09) per day flat rate data package.

The aim of competition policy is to ensure consumers are well served by prices and quality of service, but in addition that innovation and long-term investment in the industry are sustained. There have recently been price wars in Kenya, DRC, Uganda, Tanzania and Sri Lanka. Some African countries[37] have introduced retail price floors to limit the damaging effects of these price wars. In OECD markets the need to invest means there has been a recent trend towards consolidation of network operators, such as the recent mergers between third and fourth operators in the UK & Australia and the proposed merger between second and third operators in the US. The need to invest in data networks and extend into rural areas across developing markets highlights the importance of competition policy finding the right balance of incentives.

5. Drivers of investment in broadband networks

Other aspects of regulation affect incentives to invest in broadband networks and also have a direct bearing on costs and affordability.

Without question spectrum availability is the key determinant, on the supply side, of broadband availability for mass market adoption and diffusion. Fibre will remain a small part of the access network in developing markets for some considerable time. Moreover, a policy focus on fibre could have the unintended consequence of limiting the development and geographic spread of commercially viable broadband wireless access networks.

Chapter 3 of this report argues that governments in developing markets should seek to release as much spectrum into the market as possible, in large and usable amounts. This recommendation runs counter to the views held by many policy makers, namely that they should seek to maximize the short term tax and revenue gains in spectrum assignments , or that they should withhold spectrum to police the market. In many countries, despite the seemingly high figures for spectrum assignments, the current approach to spectrum management is damaging as it prevents innovation and investment in broadband networks and increases in consumer welfare. The losses from the missed opportunity for economic growth far exceed the short-term revenue gains to the finance and telecommunications ministries. Liberal licences permitting secondary markets will ensure that spectrum is allocated to the most productive uses, while competition policy is a far better tool than bureaucratic management for ensuring that the market works effectively.

It is tempting to see the spectrum challenge as being the same in developed and emerging markets. That would be fundamentally wrong. The reason is that the widespread fixed networks offer the possibility in developed markets of carrying a sizeable proportion of the data traffic (e.g., via WiFi). But those possibilities just do not exist in the emerging markets and therefore all that traffic will fall on the mobile networks. Absent plentiful spectrum, the traffic will suffocate service quality. Emerging markets are going to need large and appropriate spectrum assignments to deliver their data applications.

Incentives for investment in broadband also depend on pricing policies appropriate to data services. In arguing for the need to rethink mobile regulation for a 'data age', this report notes that the welfare gains associated with mobile telephony have been realised because of an efficient pricing structure for the mobile market. The costs of mobile voice calls are shared between the originator and end-user, and the structure of call termination charges mean that end-users have been able to receive calls at no cost. On the other hand, at present the costs of mobile data service fall entirely on the end-user. Introducing data as well as voice services into the 'two-sided' market of mobile networks means regulators face a complex task in providing operators with the incentive to invest in data networks and to keep prices affordable for low-income customers. For example, mandating reductions in wholesale and retail voice charges may have unintended consequences for data services; the two are inter-dependent.

Our conclusions are that the market participants will solve the problem through innovation and new business models. That innovation needs competitive markets and a liberal regulatory environment. Regulators run the risk of a substantial error of judgment if they think that intervening to reduce the price of data services is a short-cut route to accelerate access expansion. These issues are discussed in detail in Chapter 4.

The final policy issue affecting prospects for the widespread use of broadband in emerging markets concerns the architecture of future broadband networks. The existing policy debate is almost entirely focussed on investing in fibre, and specifically investment in international fibre optic capacity and national fibre optic backbone networks. Far less attention is paid to the 'access network' connecting end-users to the backbone network, and the potential for wireless technologies to form part of this access network is usually overlooked in official debate.

Chapter 5 therefore discusses the incentives for investment in economically sustainable broadband access networks which are 'fit for purpose' depending on the specifics of each national market. The drive for ever-increasing bandwidth and speed in OECD countries, coupled with an almost ubiquitous legacy copper network, has shaped the broadband infrastructure debate around fibre at the expense of hybrid and wireless broadband networks. Chapter 5 shows that the economic drivers for commercially viable investment depend on population density, diffusion rates, potential revenues and the costs of building the network. The geographical and economic conditions in emerging markets mean that, in contrast to OECD experience, the initial commercially sustainable rollout of broadband networks will include an important role for wireless technologies. In the short term, almost all consumer applications (save HD IPTV) can be delivered with a wireless access network. The evidence cited above on the value of universality rather than speed underlines the relevance of this argument.

Of course, to present the issue as 'fibre vs. wireless' broadband networks is a false dichotomy. The policy challenge is to create an incentive structure for the competitive development of sustainable networks, which will vary with circumstances. A policy specifying a particular technological outcome is unlikely to be optimal. Policy must ensure that network development is evolutionary and capable of responding to changing consumer demands.

6. Summary

Access to broadband creates opportunities for increases in consumer welfare and in productivity and economic growth. In the developing world there is little access to fixed-line broadband, but the use of mobile internet and broadband has been growing rapidly. Mobile offers the potential for mass market access to the internet in the emerging markets, building on the acknowledged success of mobile telephony. However, realising this potential will depend both on growing demand for internet access and on incentives for the creation of broadband networks which can extend access. Neither will come about without innovation by businesses and an appropriate policy framework. Policymakers in emerging markets need to base their broadband ICT strategies on mobile internet access, and all that this involves, as their current focus on fibre and on backbone infrastructure could have the perverse consequence of inhibiting the very outcome they want to achieve.

Notes

1 FCC, National Broadband Plan, Chapter 2, Goal 1. Available at: http://www.broadband.gov.
2 UK Government, Digital Britain Final Report, June 2009, p.64.
3 Conroy, S, (2009), Joint Press Release: New National Broadband Network, 7 April. Available at: http://www.minister.dbcde.gov.au/media/media_releases/2009/022.
4 UK Government, *op. cit.*, p.61.
5 *Ibid.*
6 Ministry of Economic Development, Ultra-Fast Broadband Initiative. Available at: http://www.med.govt.nz/templates/ContentTopicSummary____41902.aspx
7 TRAI, Recommendations on National Broadband Plan, 8 December 2010. Available at: http://www.trai.gov.in/WriteReadData/trai/upload/Recommendations/124/Broadbandrecommendation08_12_10final.pdf
8 http://africanextgroup.com/blog/?tag=seacom
9 IFC, 'East Africa Submarine Cable System', http://www.ifc.org/ifcext/africa.nsf/Content/67F6E68AE58F9CA9422573E1002BA155?OpenDocument
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11 http://www.i-policy.org/2010/05/tanzania-launches-first-phase-of-national-fibre-backbone.html
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13 In preparing this paper an extensive review of broadband policies in a number of countries (France, Finland, Japan, Korea, Australia, UK, USA). The common lessons from these case studies have been reduced to their bare minimum in the main text. This review is available at http://www.vodafone.com/content/index/about/about_us/policy/policy_papers.html
14 Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015, February 2011
15 Communications Commission of Kenya, Quarterly Sector Statistics Report, 1st Quarter July-Sept 2010-11, Table 6.
16 ITU, The World in 2010: Facts and Figures.
17 Source: Vodafone India.
18 Company Data from Vodacom and Safaricom.
19 Enhanced Data Rates for GSM Evolution. EDGE allows for data rates up to 238.7 Kbps and up to 473.6 Kbps for a data-dedicated node. This technology combined with better compression through browser software such as Opera Mini, allow for browsing speed at or close-enough to ITU/OECD definition of broadband (256 Kbps).
20 Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015, February 2011
21 The higher level of 2G usage in Kenya and India reflects that 3G investment has only just occurred, or in the case of India, yet to occur.

22 The authors note that the trade impacts of broadband access in emerging markets will be different than for OECD countries – there are clearly trade effects to be taken into account and not only in the initial stage of network investment but also in the patterns and use of e-commerce, services and other applications enjoyed by broadband users. The authors also note that the trade effects of broadband will be different to voice networks

23 TRAI, TRAI issues Recommendations on 'National Broadband Plan', Press Release No. 64/2010. Available at: http://www.trai.gov.in/WriteReadData/trai/upload/PressReleases/778/prcndiv8dec10.pdf

24 Crandall, R., W. Lehr, and R. Litan (2007). The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data. Issues in Economic Policy, Number 6. Washington, DC: The Brookings Institution. Also Gillett, S.E., W.H. Lehr, C.A. Osorio, and M.A. Sirbu (2006). Measuring the Economic Impact of Broadband Deployment. Final Report, National Technical Assistance, Training, Research and Evaluation Project #99-07-13829.

25 Kolko

26 For example, a 2008 study carried out for the European Commission cites productivity improvements from the adoption of broadband averaging 5% in manufacturing and 10% in services, with a further productivity improvement of 0.15% a year from the switch of resources into more knowledge-intensive activities. Broadband Infrastructure and Economic Growth, by Nina Czernich, Oliver Falck, Tobias Kretschmer, Ludger Woessmann CESIFO Working Paper No. 2861 December 2009 *www.CESifo-group.org/wpT*

27 (The Impact of Broadband on Growth and Productivity, Fornfeld, Delaunay and Elixman)

28 Qiang, Christine Zhen-Wei. 2009. "Telecommunications and Economic Growth." Unpublished paper, World Bank,

29 Roseton, Savage and Waldman

30 See for these results Bloom, N., and J. Van Reenen (2007). Measuring and Explaining Management Practices Across Firms and Countries. *Quarterly Journal of Economics* 122 (4), 1351-1408; Bresnahan, T., E. Brynjolfsson, and L. Hitt (2002). Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm Level Evidence. *Quarterly Journal of Economics* 117 (1), 339-376; and also Bloom, N., T. Kretschmer, and J. Van Reenen (2009). Determinants and Consequences of Family-Friendly Workplace Practices: An International Study. *Strategic Management Journal*: forthcoming.

31 This applies also to the OECD countries. For example, recent research shows that the provision of basic internet to the last 3% of the UK population would bring greater benefits to society then extending superfast broadband to suburban areas.P.V Ilavarasan and M. Levy [complete ref]

32 Kenny, R, *Optimal Investment in Broadband : The Trade-Off Between Coverage and Network Capability, Vodafone Policy Paper Series*, Number 10, March 2010.

33 http://www.commcham.com/publications/Overselling_Fibre_1127.pdf?attredirects=0

34 See eg Plum Report, Crandall

35 BBC Internet Poll 8 March 2010

36 Assessment of M-Content Requirements in India and Uganda, survey by Commonwealth Technology Organization for Ericsson. 2010

37 Specifically, DRC & Uganda. Also note that Sri Lanka introduced price floor regulation to remedy destructive competition.

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Mobile internet usage and demand in Kenya: The experience of early adopters

1. Introduction

Mobile handsets are now widely used in emerging markets to access the internet, extending the value of mobile telephony and providing a relatively low cost and effective alternative to PC-based internet access. Mobile internet subscriptions already far outstrip fixed broadband connections, and rapid growth is expected in the years ahead. Policymakers and businesses therefore need to understand the drivers of demand, barriers to use and the usage patterns of different groups. A better understanding could improve the design of handsets, networks and services, and assist policymakers concerned with both the ICT sector itself and the potential of the mobile web for social and economic development.

This paper explores the behaviour, motivations and aspirations of some mobile internet users in urban Kenya, as described in focus group discussions. Users of mobile internet in Kenya, which has a dynamic communications market, are early adopters whose experience and usage offer indications of how populations in comparable emerging markets may behave. The research suggests that:

- Mobile telephones are now prevalent in urban Kenya, and seen as multipurpose devices - handsets with a number of functions, of which telephony is one. The mobile internet is proving to be a highly attractive addition to the mobile handset experience, greatly valued by those that make use of it. Its use is growing rapidly.
- Social networking emerges from the focus groups as an important driver of mobile internet usage. For a significant number of participants – which suggests a significant number of people in urban Kenya – mobile internet and Facebook have become default pastime activities. More attention should be paid by policymakers and businesses to the role of social networking as a driver of adoption and use, and to the network externalities that may result. Network externalities have in the past been decisive in driving growth in access and usage.
- On the evidence here, the advent of mobile internet may be removing historic class barriers to internet access, representing the internet's transition from a minority to a mass market activity. Activities such as social networks and the applications that enable them may be gateways that accustom users to mobile and personal internet access – in short, they may be effective routes to developmental outcomes. Development policymakers and practitioners need to rethink their assumptions about the extent to which internet will become available, including to the poor, and the kinds of applications and services which can help achieve developmental goals in a mobile internet-enabled context, including social networking and Web 2.0 resources.
- Cost issues are fundamentally important for demand and therefore growth prospects, including handset costs and charges for mobile internet access. Flat rate internet tariffs and other smart pricing options should also encourage use, particularly inessential or default use for which no extra cost is then incurred, as may market initiatives such as Facebook Zero. Government policies in areas like spectrum allocation also have an impact on pricing, access and congestion.

2. Background

The rapid growth of mobile telephony in developing countries over the past decade is a familiar story. The International Telecommunication Union (ITU) estimates that there were, by October 2010, 333 million mobile telephone subscriptions in Africa, excluding Arab states, equivalent to 41.4 per

100 inhabitants.[1] In Kenya, the focus of this chapter, the number of mobile phone subscriptions grew from 2.55 million in 2005 to 11.99 million in March 2008 and 22.0 million in September 2010.[2] This was approximately one subscription for every inhabitant aged 15 or over.[3]

There are far fewer internet users than mobile phone subscribers in Africa. By October 2010, the ITU estimated that there were 77 million internet users in Africa, excluding Arab states – a user density of 9.6%. The Kenyan regulator, CCK, estimated that there were 8.9 million internet users in the country in September 2010, a user density of 22.1%, including 3.2 million internet subscribers, a subscription density of 7.9%[4] These are still relatively low subscription and usage densities by global standards. Broadband penetration in Africa is also low.

However, there is rapid growth in the adoption and use of mobile phones to access the internet in Africa. In Kenya, CCK reports[5] that mobile internet subscriptions approximately doubled to 3.1 million in the twelve months to June 2010, representing 98.8% of all internet subscriptions. Other evidence on the dynamics of mobile internet in Kenya and elsewhere in Africa can be found in data from Opera, which publishes regular information on usage trends for its popular mobile browser Opera Mini.[6] Reported growth in the number of unique Opera Mini users in Kenya in the year to June 2010 was 172%.[7 8]

3. Research and methodology

The available data suggest rapid growth in mobile rather than PC-based internet use in emerging markets. This paper explores the drivers of this growth, as the business and policy implications of internet usage are likely to differ for access which is primarily mobile. Focus group discussions (FGDs) provide an opportunity for participants, in a moderated environment, to debate with others who share common characteristics but are not personally known to them, and so provide indicative evidence on perceptions, attitudes and experiences within society. Focus group discussions with early adopters of mobile internet, in a dynamic market like Kenya, offer signals which can shed light on the drivers and barriers to adoption and on the likely impact of behaviour and usage patterns at later stages of market development.

The aim of the focus group discussions in this study was to gather perceptions and experiences from people who are currently using mobile internet. Most participants in these FGDs were specifically selected as early adopters and users of mobile internet, although two groups of non-users (H and K) were included in the study in order to explore barriers to use. In total, there were 88 participants from a range of social categories with different professional experience and lifestyles. All of the participants came from urban communities, where the majority of Kenyan internet users currently live.[9] The composition and location of the focus groups is set out in Table 1.[10]

Table 1. Focus group composition

Group ID	Composition of the FGDs	Mobile internet usage	Location	Participants
A	Young people (aged 16-25)	users	Nairobi	8
B	High School Students	users	Nyeri	8
C	Middle ranking business managers (male)	users	Nairobi	8
D	Middle ranking business managers	users	Nyeri	8
E	Middle ranking professionals	users	Nairobi	7
F	Middle ranking professionals	users	Kisumu	7
G	Shop Keepers	users	Nairobi	7
H	Shop keepers	non users	Kisumu	7
I	Taxi drivers (male)	mixed	Nairobi	8
J	Middle ranking managers and professionals (female)	users	Nairobi	8
K	Middle ranking business managers and professionals	non-users	Kisumu	7
L	Cybercafe managers	users	Nairobi	5
	Total			88

Participants were also asked to complete a questionnaire concerning their use and perceptions of mobile telephony, internet and mobile internet, and to maintain a diary of mobile phone use during three days prior to participation in their group discussions.

4. Characteristics of FGD

Mobile phone ownership characteristics of FGD participants – not representative of the population as a whole – in the study were as follows. All participants in the groups were mobile phone owners, and the large majority had owned phones for more than one year. This compares to the Kenyan market penetration of 55%. As Kenya has a significant level of multiple SIM ownership, the true level of phone ownership is below the reported penetration rate. Among the FGD participants 51% had more than one network subscription (38% having two subscriptions, 13% three or more).

Ownership of 3G phones, at 10%, was slightly above the national average. Among the participants, 42% said they had GPRS handsets and 30% GSM handsets; 19% did not know. Handset turnover among participants was high. Only 24% had owned their current phone for more than two years. Almost all participants expected to replace their handsets within the next year.

88% of participants regarded Safaricom as their main service provider. This compares with a national market share for Safaricom of 75.9% in mobile subscriptions and 92.2% in internet subscriptions.[11] Participants said that they chose Safaricom because of its position in the market and its breadth of network coverage. Safaricom's 8/- (US$0.10) flat rate daily mobile internet package was also mentioned by a number of participants (see below), though it is not clear how far this was a factor in choice of network.

84% of participants said that they had prepaid accounts, lower than the 99% average for the market, while 13% said that they had postpaid (contract) accounts.[12] In line with the high proportion of Safaricom subscribers in the groups, 95% of participants made use of Safaricom's (SMS-based) MPESA mobile transactions service at least once a month. Of these 74% said that they used it once a week or more, 22% more than once each day.

Participants were asked about their average weekly spending on mobile telephony; the answer stated was 811/- among men (US$10.06), and 609/- (US$7.55) among women. Average stated expenditure was highest among 25-34 year olds (1015/-, US$12.59) and full-time employees (1334/-, US$16.54), but significantly lower among the self-employed (715/-, US$8.87) and among 16-18 year olds (239/-, US$2.96).[13] A direct comparison is not possible because of the distinctive characteristics of the focus groups, and dual subscriptions, but these figures are higher than the weekly spend implied by the average monthly APRU of 450/- (about $22) for Safaricom customers nationwide.[14]

The FGD participants were significantly more likely than the national average to have computer and internet access, reflecting the composition of the groups. 41% claimed to own or have access to a desktop computer, and 34% to a laptop computer (including access at work). The penetration rate for PCs in Kenya has been estimated at around 8%.[15] 7% had a personal landline telephone subscription, whereas the number of fixed lines in Kenya was equivalent to 0.96 per hundred people. 53% claimed to have internet access at work, and 90% to make use of cybercafés. However, the majority – 56% – said that they most often accessed the internet on their mobile phones. 43% said that they usually accessed it in cybercafés, 20% at work and 16% at home (participants could give more than one answer to this question). Most participants claimed lengthy experience of the internet (which would therefore have been fixed line access at workplaces or cybercafes). 29% said that they first used the internet five years or more before the study; 70% two years or more beforehand. Only 9% said they had first used the internet less than six months beforehand. 6% said that they had not used the internet (a subset of those who had not used mobile internet).

These features show that participants in the ten groups differ from the typical Kenyan. They are early adopters of the internet, including mobile access, and may be expected to be enthusiasts. They spent a significant amount of money of mobile phone use, using devices with relatively high levels of functionality including slightly higher than average 3G handset ownership,[16] and they described a relatively high degree of technical and digital expertise in using their devices. The majority appear to attach very high value to internet connectivity.

5. Findings

The following sections summarise findings from the FGDs under four headings:

5A. Mobile phone usage
5B. Mobile internet usage
5C. Mobile internet costs and cybercafés
5D. Drivers and barriers to use.[17]

5A. Mobile phone usage

Mobile phones were highly valued by all participants in the FGDs, including both users and non-users of mobile internet, due to a mix of communications and other uses.

The majority – 64% – of participants identified "making voice calls" as their most important single use of the phone, and high usage levels were recorded for other communications activity (receiving voice calls and SMS, email, internet and chat services). However, handsets were also used extensively for non-telephony purposes, in particular for financial transactions (86%), as a radio receiver (76%), a camera (68%), a music player (68%), a games console (66%) and a television (21%). The handset might be better described as a multipurpose device which is (among other things) a phone, rather than a phone which is also capable of other functions.

"A mobile phone is three in one, a communication device, can entertain, and you can not get bored."
Kelvin, age 16, school student, Nyeri (group B)

For many FGD participants, this multipurpose character of the handset means that it has become more than just a useful asset which adds to their quality of life. Rather, it has become something without which they feel that life would now be difficult to manage – a device that is essential rather than merely desirable, and is essential because it draws together this variety of functions. One Nairobi shopkeeper (group G) expressed it as: "It is the other part of you." A professional from Nyeri (group D) said:

"Basically it's become life. It's the bank, your link to the family, your access to internet and other forms of communication, so basically it's your life."
Lawrence, age 25, lawyer

A significant number of participants across the groups described handset usage that has become a default pastime, i.e. a regular means for passing the time and avoiding boredom, for example when travelling by matatu (informal bus). Facebook, in particular, was described by many as a default pastime use.[18]

Participants generally felt positive about the impact of the phone/handset on their work and leisure lives and social interaction.

"My relationship between me and my cousins who are abroad. I feel like they are near because we communicate daily through internet, Facebook, message. Because a letter, it used to take like a month, so I feel like I am with them."
Eunice, age 28, nurse counsellor, Kisumu (group F)

Nevertheless, a significant number were also concerned that it had become too important or intrusive and for some, this caused anxiety. Often, these participants specifically associated this with social networking.

"It is very addictive, especially Facebook, if you know what I am saying. Once you are in it, coming out of it is quite difficult. So there is that urge and it is very interactive."
Daudi, age 23, music producer, Nairobi (group C)

Most participants used their mobile phones for both social and non-social (business, professional or educational) purposes. Business and professional participants in one group (E, middle ranking professionals, Nairobi) reported a 50:50 or 70:30 split between professional and social use. However, in discussions, questionnaires and diaries, their responses suggest a preponderance of networking and leisure use.

Business uses of the phone described by FGD participants fall into three main categories, each of which has potentially positive impact on business performance, including time and cost savings:

- transactions – the SMS-based mobile banking/transactions service MPESA was important and extensively used by participants in the study;
- procurement and supply chain management;
- customer contact and relationship management.

5B. Mobile internet usage

Participants observed that internet use, both in general and on mobile phones, had grown markedly in their communities during the past year or so. Some went so far as to describe this as a shift away from historic class divisions, with the poor now able to join the better-off as regular users of the internet. Several of the participants observed that they thought mobile internet was part of a change in internet access in Kenya from something that was an elite resource to something that was available to all, including the poor. This indication of a wider social shift in adopting new technologies is potentially significant and may hold an important message about the drivers for mobile internet adoption.

"It's changing because it's favouring the poor. Long time ago, when it came, only the rich would access it but now even the poor can access."
Besma, age not given, accountancy student, Kisumu (group K)

Once suitable handsets are bought, mobile internet usage is attractive for a mix of reasons to do with functionality, convenience and economy. Mobility itself is a significant part of this appeal. But with mobile internet, as with mobile voice, it is difficult to tell how far behaviour is driven by the service itself and how far by its mobility. While the "mobility" of mobile internet clearly adds convenience and enables internet use in more diverse locations, this does not mean that the handset is used more for internet access when on the move than when users are at home. A 2008 study of (self-selected) mobile internet users found that more than 75% of its Kenyan mobile internet respondents went online at home, a figure comparable with that in other surveyed countries.[19]

As with mobile telephony in general, the mobile internet was described as a good way of passing time when nothing better was available:

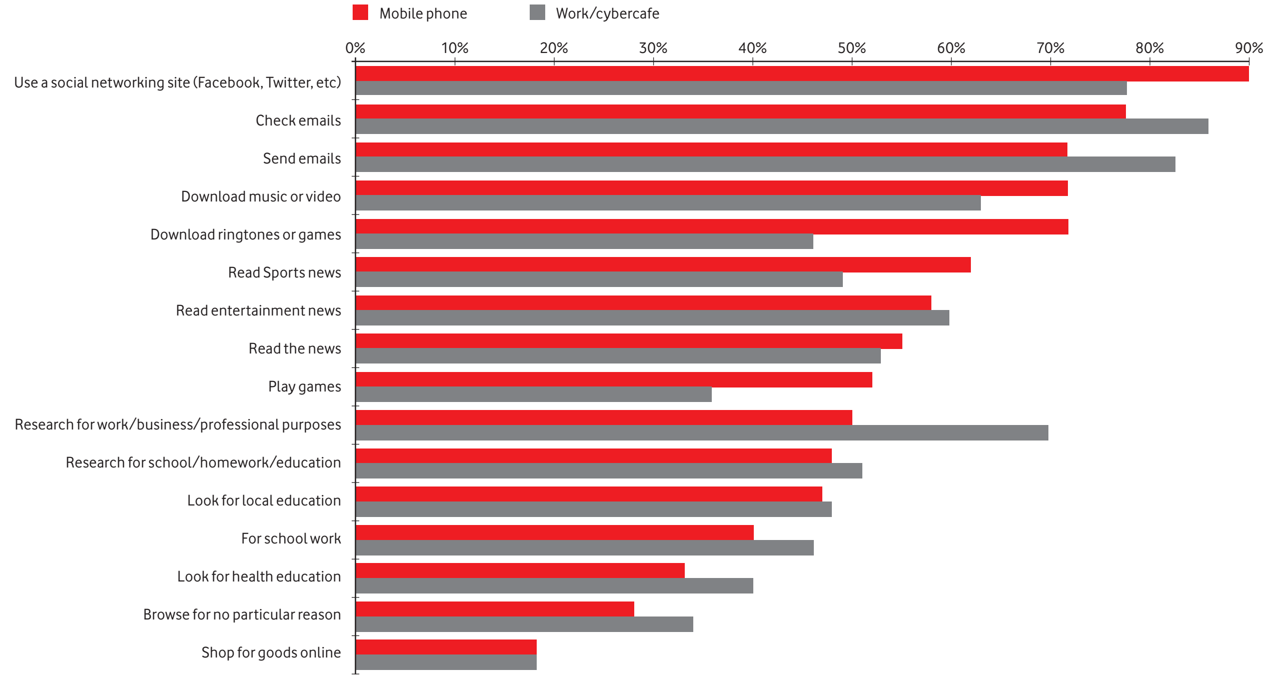
"Personally I use it mostly when I'm free - like during the day when I'm relaxing, like when I'm in a bus. I just can't stop doing my job so as to surf, unless there's some important information I need to get from the internet. Other than that, I mostly use for passing time, like during lunch hour or when I'm not doing any work."
Samuel, age 30, taxi driver,Nairobi (group I)
[translated from Kiswahili]

As a result, the adoption of mobile internet seems to be changing the way in which the internet is being seen and used, from something that requires special circumstances (computer, workplace, cybercafé) to something that is available at any time in any place. Instead of being a special activity, internet use for many participants has become commonplace, displacement or default pastime activity.

Mobile internet activities frequently cited by participants included extensive use of social networking sites, music (downloads and streaming), film and games download sites, sports news sites (including those of UK football teams), mobile phone enhancements (notably from Waptrick and Getjar) and social networking entertainment sites (notably YouTube).

Figure 1 compares participants' declared internet use on mobile phones with that on PCs available to them at work and in cybercafés. It shows significant use - in both access modes - for both leisure and non-leisure purposes, the latter including business and educational research and searches for local and health information. Not surprisingly, non-recreational uses of the internet, in particular professional activities, rank more highly in PC use (reflecting workplace usage) than on mobile phones, while the opposite is true of pure leisure uses such as playing games.

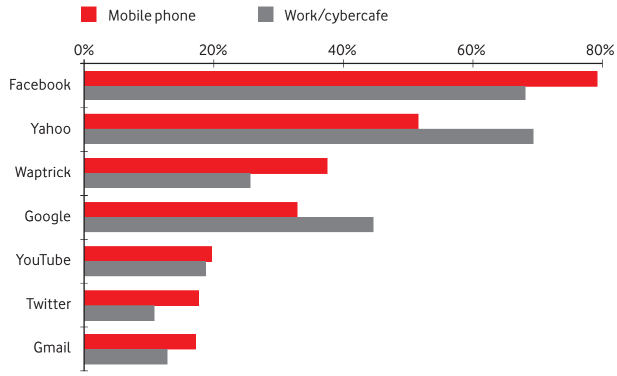
Figure 1. Responses to the question "What do you do when you are using the internet on your cellphone?"



Social networking driving adoption and usage

The individual websites most commonly accessed by FGD participants on their mobile phones and at cybercafés are illustrated in Figure 2.

Figure 2. Responses to the questions "Which five websites do you most often visit on a computer ... on your cellphone?" and "... at work or at a cybercafe?" (results above 10% threshold)



The website that was most widely used by participants was Facebook. This was accessed by the large majority, and was far more popular than other social networking sites (although there was significant use of Twitter and MySpace). These sites were notably more likely to be accessed on mobile phones than on PCs (probably because they are less accessed on workplace PCs). The quality and user-friendliness of the Facebook mobile interface was praised by some participants and has presumably contributed to its popularity.

The other websites that were most commonly accessed by participants on PCs were Google (as a search engine) and Yahoo! (probably mostly as an email gateway, but perhaps also as a search engine). These were also widely accessed by mobile internet users, but the third most popular site for mobile use was Waptrick, which offers access to free mobile phone software (including ringtones, wallpaper, games and "adult" content). For a good many FGD participants (and, these data suggest, more widely), Facebook has become a very frequent use of mobile phones. Some used the word "book" or "facebook" as a verb, as in "to google".

Social networking and its potential for network effects may be a driver of growth in mobile internet use. Some participants indicated that peer pressure was important for them.

"Personally I can say that I was influenced by friends and the inconvenience of accessing internet at the cyber. Maybe I'm bored and just want to pass the time, so I chat with my friends. Basically keeping abreast with what is happening was what made me want to have an internet enabled phone."

Ndolo, age 27, taxi driver, Nairobi (group I)

"Most of my friends have these phones and they would say that their phones had internet and that made you feel real down."

Paul, age 27, self-employed businessman, Nairobi (group C) [translated from Kiswahili]

Facebook use was described as having value both as a networking medium and as a source of recreation. It seems to have been integrated within friendship groups alongside other means of social communications, including SMS, emails, instant messaging and perhaps YouTube. The ability to engage in social networking activities has the power of extending social networks and leveraging network externalities even though, as indicated above, users do also perceive some negative as well as positive implications. The evidence of these groups suggests that it is a significant accelerant of mobile internet adoption and use.

Some participants also said that social networking played a role in their business and professional work - for example, in building their customer base and relationships.

"To me internet is very important because, first of all, it has made a contribution to my job. This Facebook thing has helped me to get customers."
Ndolo, age 27, taxi driver, Nairobi (group I)

Relevance of 'local' content as a driver of demand

Much has been written about the importance of "local" content in unlocking developmental value from the internet. It is notable that none of the fifteen most accessed sites among FGD participants, and only one of the ten most accessed sites among Opera Mini users in Kenya (that of the newspaper *The Nation*), is a local, Kenyan site.

However, this definition of local content may be too narrow. Popular sites such as Facebook, Google and Yahoo! are essentially gateway sites which facilitate access to a wide range of content, both local and global. The predominance of Google and Yahoo! as content gateways may mask usage of "local" sites and of local content which are accessed through them. More assessment is needed of the ways in which local content is being accessed in today's internet/Web content markets before firm conclusions can be drawn, but it would be hasty to conclude that the content on these international websites is only international.

Although business and "developmental" uses of mobile internet were less widespread than networking and recreational uses among participants, they were reported in a number of FGDs and in user questionnaires and diaries. Business and professional people in these groups recognised that they were making significant use of mobile internet for professional purposes and that this had positive business value. As noted above, in one group, these users identified at least 50% of their use of mobile phones as being for business purposes. While much of this business use would be non-internet – e.g. voice and SMS traffic managing the supply chain and customer relations, and mobile transactions through the (SMS-based) MPESA service – significant business use of mobile internet is also indicated. Some participants commented on productive business uses of social networking sites, as noted above.

Non-users of mobile internet

Two of the FGDs in the study comprised non-users of mobile internet. Most of these were enthusiastic users of mobile telephony, and some were also users of cybercafés and PCs. The principal reasons which they gave for non-use of mobile internet were:

- preference for accessing internet in cybercafés or through personal laptops;
- having mobile phones which could not be used to access internet;
- lack of interest in social networking and other lifestyle uses of the internet;
- presumed cost of mobile internet;
- uncertainty or anxiety about how to use the internet.

A few of these non-users were internet-rejecters, or fearful of engaging with an unfamiliar technology. Others, however, expressed the sense that they were missing out on opportunities and particularly social interaction as a result of not having access to mobile internet – albeit sometimes mingled with a sense of anxiety that mobile internet could lead to overuse and waste of time.

"Yes, I feel that I am missing out on opportunities, and there are many times that I end up in a cyber café. I have to look at my mails, sneak a little bit on Facebook. You know, I am just from college, so my friends are still posting things, but with time I think I will change. I feel I miss a lot of things."
Lenah, age 25, hairdresser, Nairobi (group J)

While the market for mobile telephony has expanded very rapidly in Kenya and Africa over the past ten years, very few people on the continent yet have PCs at home. While mobile internet clearly has some advantages over cybercafé use (see section 5C below), there are also reasons for the continued use of cybercafés and other available PCs alongside mobile Internet.

5C. Mobile internet costs and cybercafes

Until recently, most use of internet by the general public in Kenya has been through cybercafes (locally called "cybers"). Participants in these FGDs reported their belief that mobile internet is gaining usage at the expense of cybercafés, which they attributed to greater convenience and lower costs of the former. Mobile internet is seen as cheaper than cybercafe use for most purposes (though not necessarily for large downloads).

"You can put 20 shillings on your phone and surf the whole day and night, but when you go to cyber it will take you only 20 minutes."
Kelvin, age 16, school student, Nyeri (group B)
[translated from Kiswahili]

Those who commented thought it easier to manage internet usage costs on mobiles than in cybercafés (and so avoid excess expenditure), although this was not a universal view.

"I'd say you can control …; if I want to use [my phone] for one call and internet; if I load like let's say 20 bob [shillings] I know that it will be enough for the call and internet browsing for maybe a day or so. Then I'll know that I will have saved; so I think the credit bit is a way of controlling your internet usage."
Newton, age 39, restaurant supplier, Nyeri (group D)

One of the probable reasons for different perceptions is that the price model varies between different modes of internet access. Cybercafes charge by minute of use while charges for mobile internet are based on the amount of data used. In late 2010, cybercafes in Nairobi were typically charging 50 cents or 1/- per minute.[20] Safaricom's offer of a daily 8/- per Mb flat rate for internet access was cited as encouraging a shift to mobile internet.

"Even now with Safaricom, you can get internet for 8/- unlimited for a day. That means that every single person who has a phone that is enabled can get internet. One year ago, it wasn't like that, and for you to get internet you would really have to comb for a cybercafé somewhere and it was charging 3/- per minute, so it has really grown."
Ann, age 22, hospital receptionist, Nairobi (group E)

This model of flat rate charging is likely to increase usage (though perhaps at a cost in network congestion and lower profitability). Participants in several groups also urged network operators to foster demand through special offers.

The study coincided with a period in which prices for mobile voice telephony have been falling rapidly in Kenya.[21] This fall in the cost of voice traffic may, in practice, release funds for increased use of mobile internet amongst end-users, although from a network perspective, falling voice prices put upward pressure on data prices. Cost management is obviously an important issue for mobile internet users.

"What can make us to use it is when they lower the cost. The way the rates are going for calls, the same might happen for internet."
Samuel, age 30, taxi driver, Nairobi (group I)

A further distinction driving mobile internet as opposed to cybercafé use is privacy.

"When you are using your line you are safer actually. When you go to the cyber, is like you're telling the world all your secrets."
Kelvin, age 16, school student, Nyeri (group B) [translated from Kiswahili]

For many participants, cybercafés still have advantages for certain purposes, such as watching TV on the larger screen, large downloads and more complex browsing or keyboard use.

One of the FGDs within the study (group K) brought together managers of five Nairobi cybercafés to discuss the impact of mobile internet on their businesses. Their discussion suggested that the complementarities just discussed between growth of internet in general and growth of mobile internet as an alternative access mode were having mixed impacts on the cybercafé business model.

On the one hand, cybercafé managers were encouraged by the growth in internet use within society, in particular increased familiarity with computing and the internet, and by recent reductions in ISP prices. They also reported an increase in teenage custom, fostered by the popularity of social networking.

"Before, the literate used to come and use the internet, but nowadays even high school kids are coming to access internet. In my days when I was in high school I didn't know how to operate the computer, but that is not the case right now. Now you even find primary school kids coming to visit the social sites."
Charles, age 25, cybercafé manager, Nairobi (group L) [translated from Kiswahili]

Another factor which they cited as encouraging internet use was increased availability of e-government services.

Cybercafé managers felt that increased demand for internet – together with recent reductions in ISP charges, falling computer prices and the lifting of taxation of computer equipment – had enabled cybercafés to maintain or even increase profit margins, and even fostered the opening of new cybercafés. On the other hand, they were conscious of the drift of some customers away from cybers towards accessing internet on their own devices, both mobile phones and laptops. They anticipated that their existing business models would be unsustainable in the medium term due to competition from mobile internet usage.

"If that trend of accessing internet via mobile phones continues, it will finish the cyber business and we will be left with printing and photocopying service."
David, age 27, cybercafé manager, Nairobi (group L) [translated from Kiswahili]

5D. Drivers and barriers to use

Discussions in all FGDs suggested that the barriers to greater mobile internet adoption and use fall into three main categories: handsets, networks and service factors. Cost was a common theme under each of these headings.

Handset factors

Users said that they want to pay lower prices for higher quality handsets which addressed current limitations, five of which were identified in discussions:

- small screen size and poor screen resolution;
- small keyboard and/or complex keyboard functionality;
- limited memory size (preventing access to some websites and inhibiting large downloads);
- poor battery life;
- lack of durability (perceived as a particular problem with cheaper handsets).

"There are sites you cannot go to like watching YouTube on your phone. And also the screen is too small and if you are accessing site like CNN it has so many things you have to keep scrolling, it is slow and tedious."
Maxwell, age 25, owner of printing business, Nairobi (group C)

Handset prices have fallen substantially, and it is now possible to gain internet access on low cost telephones. In saying that, however, the cost of 3G (UMTS) enabled handset is still 4 times greater than the cost for a basic GSM-only handset.

Grasson Communications Meru, near KCB

Table 2. Cost of new handset

Technology	Phone	Unsubsidised Cost
GSM	Vodafone 150	$ 12.50
GPRS	Alcatel OT 305	$ 25
EDGE	Samsung stratus bar	$ 62.50
UMTS	Huawei U3100	$ 50

Source: Safaricom

Not all participants were aware of this, however, and the perceived need for a more expensive handset was associated in some people's minds with unaffordability and risk of theft. One compared the cost of handsets with that of (presumably pre-used) computers, suggesting that they might be coming to be seen to some extent as substitutes.

"They should make phones more affordable. I don't see the need of buying a phone at 20,000 [shillings] while a computer I need only 15,000."
Dickson, age 49, cybercafé manager, Nairobi (group L)

A final factor is that, as in other countries, some participants were prepared to pay a premium for more stylish handsets.

Network factors

The second set of factors identified as drivers and barriers of use concerned the network. In discussions, the cost of usage was considered too high (even though mobile internet was cheaper than cybercafés), perhaps because of the high level of casual use associated with mobile internet. As noted above, participants commented favourably on Safaricom's flat rate charge. Another issue was congestion and speed of access. Like cost, this was seen to have improved recently, but there were still many complaints about congestion and resulting slow access speeds. A third issue was the poor level of network connectivity in some areas outside the major cities.

Service factors

The third set of factors raised concerned the services available through the internet. Particularly noteworthy were concerns about risks such as viruses, malware and fraud. In addition, although most FGD participants were confident about their use of mobile internet, some argued that more help could be offered by service providers to others in the community who were less confident, such as those with low literacy or low educational qualifications.

6. Analysis

The value of focus group studies lies in the way that they allow some of the nuances of participants' opinions, perceptions and experiences to emerge, to be tested in further research. In this study, the evidence of drivers and barriers among early adopters of mobile internet can help to identify ways in which markets are likely to develop and ways in which policymakers and businesses can stimulate diffusion.

Equally, current patterns of mobile internet adoption and behaviour may not remain consistent over time as early adopters will use the mobile internet in specific ways.

With that caveat, the following conclusions can be drawn from the study.

Mobile telephones are now prevalent in urban Kenya, and highly valued by consumers as aids to life and work. The many applications available on mobile handsets mean that these are seen as multipurpose devices - handsets with a number of functions, including:

a. traditional communications functions (telephony, SMS, email, instant messaging);

b. substitution for functions which previously required non-telephony equipment (radio, TV, camera, music player, games console, notepad); and

c. services which enable interaction between communications and non-communications functions (e.g. electronic transactions, sharing of photographs, online gaming).

The mobile internet adds what might be called a "cybercafé" function to the handset rather as mobile banking adds an "ATM" function or mobile transactions a "wallet/purse" function. This is proving to be a highly attractive addition to the mobile handset experience, and is highly valued by those that make use of it.

Social networking emerges as an important driver of usage. Some other uses are of direct economic value (e.g. financial transactions, supply chain management, price comparison) while others again are essentially entertainment (e.g. music player, games console). For a significant number of participants – which suggests a significant number of people in urban Kenya – mobile internet and Facebook have become default pastime activities. Some participants were concerned that their behaviour on Facebook was 'addictive'. More attention should be paid by policymakers and businesses to the role of social networking as a driver of adoption and use, and to the network externalities that may result from it. Network externalities have in the past been decisive in driving growth in access and usage.

There is the strong likelihood of continuing high growth rates for mobile internet use which may replicate – in speed and range - the previous experience with mobile voice. Significantly, as perceived by a number of participants, the advent of mobile internet may be removing traditional class barriers to internet access, and demystifying the technology, representing the internet's transition from a minority to a mass market service.

Cost issues are fundamentally important for usage prospects, including handset costs and charges for mobile internet access. Adoption of the mobile internet has been facilitated by improvements in the availability of handsets, reductions in handset and usage prices, and improvements in connectivity. Flat rate internet tariffs and smart pricing options should also encourage use, particularly inessential or default use for which no extra cost is then incurred, as may market initiatives such as Facebook Zero.

Mobile internet has become a significant reality in the communications market in Kenya. While there is a high degree of enthusiasm for it, users can readily identify improvements which would encourage higher levels of adoption and use. These include costs and charges but also handset improvements, content configured for mobile use, and network problems. Manufacturers, network and service providers could stimulate greater usage by concentrating on consumer offers that meet these requirements. Government decisions in areas such as spectrum policy will also affect pricing, access and network quality. Policymakers should seek to ensure that an environment which fosters mobile internet adoption is sustained through appropriate supporting measures and instruments – for example access to radio spectrum and legislative frameworks that enable innovations such as cloud computing.

The focus groups offer weak but significant signals of other trends which may be taking place and which are worth further investigation.

The internet enables both lifestyle and business activities, social networking and entertainment pursuits, on the one hand, and on the other, information gathering and interactive communications that are of value to business or professional life. Policymakers, especially in the development field, have been more interested in the latter, and the opportunities they offer for empowerment and improving livelihoods, than in the former. However, entertainment has been a principal driver behind adoption of most communications media. While the adoption of mobile internet may be fuelled by social networking and leisure activities, in practice these activities and the applications that enable them may be gateways that accustom users to mobile and personal internet access, providing a base from which they move on to explore more functional and developmental applications over time. Entertainment and social networking, in short, may be effective routes to developmental outcomes.

The preponderance of mobile internet access in countries such as Kenya suggests that content providers need to reconfigure their approach to end-users, making their content more effectively available through mobile internet devices and services. Part of this involves reconfiguring website design so that it can be readily used on handsets as well as on PCs. In addition, however, it should be recognised that apparently global sites such as Facebook, Google and YouTube are widely used to share information within social and geographic communities. Content providers – in the public sector and civil society as well as private companies – should make more use of gateway sites such as Facebook and YouTube as portals for local content, alongside or even as alternatives to conventional websites.

Mobile telephony was adopted much more rapidly by consumers in developing countries than policymakers in the ICT and development sectors expected during the first decade of this century. Adoption of mobile internet may be just as fast. ICT policy and regulation need to adapt to the new demands which consumer adoption of mobile internet will place on networks and to changes in competitive markets as businesses compete to maximise returns from changing patterns of behaviour. Governments have a crucial role, not only in regulatory and spectrum policy, but also in the provision of e-government services adapted for mobiles.

Development policymakers and practitioners need to rethink their assumptions about the extent to which internet will become available, including to the poor, and the kinds of applications and services which can be used to achieve developmental goals in a mobile internet-enabled context, including social networking and Web 2.0 resources.

Notes

1 Data published 10 October 2010 at http://www.itu.int/ITU-D/ict/statistics/at_glance/KeyTelecom.html.

2 Data from the Communications Commission of Kenya statistical reports, available at www.cck.go.ke.

3 2009 census population = 38.6m (http://www.mwakilishi.com/content/articles/2010/08/31/census-2009-kenyas-population-reaches-386m.html), implying a population of about 39m by June 2010. Age structure in 2006 stood at 55.1% aged 15 and over (http://en.wikipedia.org/wiki/Demographics_of_Kenya).

4 Sources as in footnotes above.

5 Data from Communications Commission of Kenya, Quarterly Sector Statistics Report, available at http://www.cck.go.ke/resc/statcs.html.

6 Opera Software, State of the Mobile Web, available at http://www.opera.com/. Most recently available data for Kenya at the time of writing were those for October 2010; for other African countries, June 2010.

7 The June 2010 growth rate may have been accelerated by the football World Cup.

8 These data need to be treated with some caution, especially in a cross country comparative context, as each country has experienced the diffusion of mobile internet in different ways, while the initial availability of Opera was not the same in all countries.

9 It should be noted that the majority of the national population lives in rural areas, and rural use of mobile internet, as it develops, may differ significantly from that in urban areas.

10 These groups were moderated by personnel from the Kenyan research company Synovate, who worked with the author in design and implementation of the study. Particular thanks are due to Fred Imbo, Maggie Ireri and Patrick Maina.

11 Data from Communications Commission of Kenya, Quarterly Sector Statistics Report, July-September 2010, as above.

12 The balance was unsure or did not declare.

13 Exchange rate = K/-=USD0.0124 = average rate during period of FGDs. These are significant expenditures in relation to average income in Kenya, whose GNI p.c. in 2009 was US$770 (equivalent to about US$1550 per adult).

14 Early adopters of mobile telephony are likely to be more prosperous than society as a whole, not least because they are disproportionately urban, better educated and employed However, studies of expenditure on mobile telephony in Africa show a willingness to spend high proportions of disposable income, particularly among the poor (where the phone may be used to substitute for other expenditure such as transport costs). Kenyan respondents to a household survey conducted by Research ICT Africa in 2007 reported monthly mobile expenditure averaging 16.7% of income and 52.5% of disposable income – which are high figures, though not the highest in that survey of seventeen African countries See Alison Gillwald & Christoph Stork, ICT Access and Usage in Africa, 2008, available at http://www.researchictafrica.net/publications/Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_1/RIA%20Policy%20Paper%20Vol%201%20Paper%202%20-%20ICT%20Access%20and%20Usage%20in%20Africa%202008.pdf.

15 http://allafrica.com/stories/200910271173.html

16 Although this is not statistically significant.

17 As is often the case with FGDs, the most useful quotations tend to come from the more articulate and self-confident participants. Care has been taken to ensure that this does not distort the overall presentation of findings.

18 Similar levels of pastime use have been identified among young users in Cape Town: see Tino Kreutzer, Generation Mobile: Online and Digital Media Usage on Mobile Phones among Low-Income Urban Youth in South Africa, available at http://tinokreutzer.org/mobile/MobileOnlineMedia-SurveyResults-2009.pdf.

19 Buzz City, 'Who uses the mobile internet? And what do they do?', December 2008, available at http://www.buzzcity.com/l/reports/WhoUsestheMobileInternet08.pdf, Chart 4.

20 Research by Monica Kerretts-Makau.

21 See e.g. http://www.guardian.co.uk/world/2010/sep/07/kenya-mobile-operator-price-war.

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The potential of mobile web content in East Africa

1. Introduction

Increased access to the internet has the potential to influence the economy and society positively in any country. East African countries are no different. What is distinctive about the East African countries, like other emerging markets, is that the computer is not the primary interface for users to access the internet; rather, it is the mobile phone.

This makes mobile web content (MWC) immediately interesting as it is valued content that drives internet adoption. Mobile web content is already driving the diffusion of mobile broadband use in East Africa.

At present this diffusion process is led by international content sources and global internet platforms. Popular global content and platforms are extending internet usage from innovators, to early adopters and now to early majority users. International content is also helping to stimulate capacity in each country, allowing local content providers to reach users at a lower cost than if they had to do so from scratch on their own.

This paper explores the progression from the prevalence of international content on global platforms to the localization of content available on them, and ultimately the potential scope for the development of local content on local platforms. Content demand is a vital driver for broadband take-up, and thus consumers' demand for highly valued content and services tailored for each market is what begins the localization process. A key question discussed here is how mobile broadband use could reach the critical mass capable of sustaining local content on local platforms, and whether there are any steps either East African developers and entrepreneurs or governments could take to encourage this.

Currently, mobile phone penetration rates are continuing to climb, mobile broadband prices are decreasing, government organizations and large corporations are pushing for local content creation, and capital is being invested in new local content-focused companies. While there are still challenges to overcome, the picture for the internet user in East Africa looks bright.

However, government regulators and policy makers should be paying closer attention to the institutional and business context for local content development. The more local content is generated, the more revenues stay in the country and the more realistic it will be to formalize this sector. This paper focuses on the conditions for this progression.

Latent demand for local web content and services is high, as demonstrated by thriving local markets in other media. Government services accessible via mobiles could be of especial value to end-users and could drive a local content sector. However, the costs of mobile web access are currently borne entirely by consumers. The vital step will be for providers to deliver mobile web content priced so as to be affordable for the majority of consumers, requiring cost-sharing models. There are a small number of exceptions, but for the most part, these conditions have yet to be met.

Structure of the paper

We explored these issues through a series of interviews with executives from technology companies in Kenya, Uganda and Tanzania about their views on the mobile web content space, and the challenges and opportunities they identify. (A list of interviewees is given in the Appendix.) The structure of the paper is as follows.

First we set out a framework for analysis, looking at:

- **Mobile Impact**: mobiles in the East African context as the primary means of internet usage;
- **Content as a Diffusion Driver**: how mobile web content is acting as a driver of internet diffusion in East Africa;
- **Content Types**: the links between international content and platforms and local content.

The following section looks at the drivers and inhibitors of mobile web content. The final section addresses the opportunities and challenges.

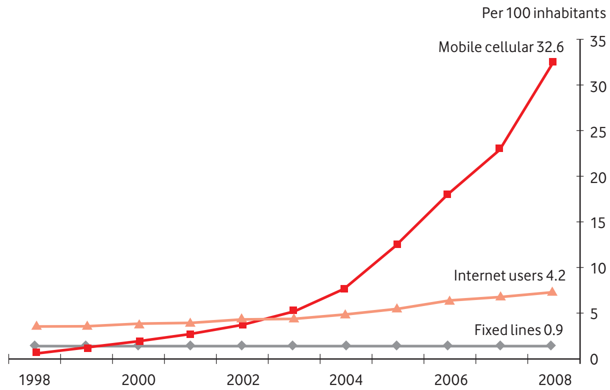
2. Framework

Mobile impact in Africa

The extraordinary story of mobile growth in the developing world has become a familiar one. Africa has (as we write) 415,010,625 mobile phone subscribers and has become the fastest growing mobile market in the world with mobile penetration in the region ranging from 30% to 100%.[1] The average mobile penetration rate is predicted to reach 50% by 2012, from just under 33% in 2008.[2]

Although mobile phone subscriptions in Africa are growing at a rate of about 50% per year,[3] faster than that of any other continent, by 2008 only 4.2% of the population were Internet users compared with 32.6% with a mobile phone subscription (figure 1).[4]

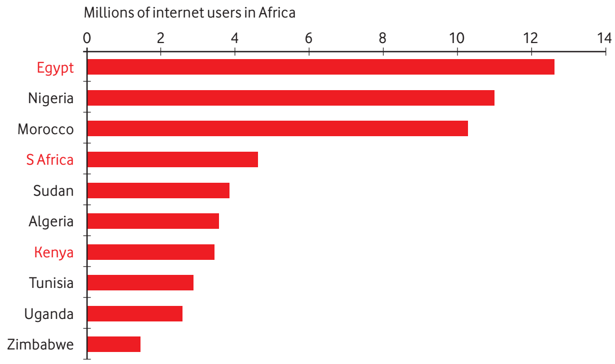
Figure 1. Cellular, fixed and internet penetration in Africa between 1998 and 2008



Internet access is rising. By June 2009, Africa had 86.2 million internet users, representing an 8.7% penetration rate, or 4.8% of the world's Internet users.[5] The largest numbers of Internet users are found in Egypt, followed by Nigeria and Morocco.[6] A significant proportion of Internet usage in Africa is through public locations, mainly cafés. Fixed broadband Internet services were first launched in Africa in 2000, and by 2008 the region had 635,000 fixed broadband subscribers. The fixed broadband penetration rate was one subscriber for every 1,000 people, though it is one of the most expensive regions in the world, with the cost of the ICT price basket representing 41% of a person's monthly average income.

Mobile broadband was first launched in 2004 and penetration in Africa had reached 0.9% in 2008. As an increasing number of countries in Africa are deploying 3G networks, and wire line networks remain underdeveloped, mobile broadband has the potential to become Africa's main broadband Internet access method in the future.

Figure 2. The top ten internet countries in Africa as of June 2009[7]



Egypt, South Africa and Kenya are Vodafone markets.

International connectivity hampers the growth of the internet in Africa. In 2008, Africa as a whole had around 12 Gbps of international bandwidth, which corresponds to less than one-third of India's total international connectivity. Historically, most countries had only satellite connectivity or a connection to a single submarine fibre cable. The situation has changed in the last year or so.[8]

There has also been innovation in Africa, from inexpensive terminals adapted to harsh environments, to renewable, self-contained energy sources, to new distribution channels and operational procedures to enable affordable and useful services for the low-ARPU users. Text message phone apps now help African people check market prices, transfer money, learn languages and alert authorities to the need for food or other aid in the event of a disaster. In some ways Africa is taking the lead in developing apps that can be used in rural locations. Thus in Kenya, and increasingly the rest of Africa, users can transfer money, check stock prices, get exam results, do mobile banking, get ring tones, and surf websites. African farmers can decide what crops to plant by checking prices at local markets using their cell phones. Physicians can help nurses in rural clinics diagnose patients by telemedicine.

This paper focuses on East Africa, where mobiles are becoming close to ubiquitous. Mobile phone penetration in Kenya and Tanzania will exceed the 100% mark by 2013, with a higher than 90% penetration predicted for Uganda.[9] Increasingly, there is a decreasing emphasis on the device used to access the internet; access per se is the important issue. It is important to understand the implications of the mobile phone being the delivery channel in East Africa.

Content as a diffusion driver

In East Africa, the availability of mobile web content is encouraging consumers to take up data-enabled services. Along with falling data costs for mobile broadband offered by the network operators, there is growing demand by consumers for content on their mobile phones.

The primary sources of content to meet this demand currently are international. While there is a lack of local content available, the international providers serve as a capacity builder for local content providers to get their work online. This synergy between international and localized content is critical in understanding the diffusion process of mobile web and data services in the region. Without international content to drive usage and bring down costs, local content is not viable. However, without local content that is relevant to users, international content will not be enough to drive usage in East Africa to a tipping point. The highest penetration rate of internet usage in East Africa is Kenya at approximately 8.9% of the population in 2009.[10] We can consider that true diffusion of web services is not reached until 30-40% of the population is using online services daily. The question is how content sufficiently highly valued by East African consumers to drive usage to this critical mass can be developed and made viable.

The leapfrogging effect of mobile operators and the services they provide, around data especially, is a new phenomenon in East Africa. Concurrently, the surge in mobile phone penetration compared to computer penetration means that many East African internet users will only ever experience the web via their phone. Content needs to be suitable for this primary access device, but even more crucially, mobile web content in these markets needs to find a sustainable business model. To explore this issue, we need to distinguish between different types of content and providers.

Content types

Mobile web content has been defined as any internet-connected, or browser-based access, to the internet, and as digital content connected to a database that passes through a handheld device connected to a wireless network. In either case, at least a WAP-enabled phone is required. We distinguish between three different types of content, according to their provider and platform or publisher.

International content is any information that is served in the same format around the world, regardless of location, and provided by an international developer on an international platform.

Localized content is created for local users, but provided by an international developer or publisher and customized for local tastes, generally with the input of some locally-created material.

Local content can be defined as content wholly developed for, and by, the local community, or in other words, content for a local user with relevance to local material that reflects and is obtained from their day-to-day life.

Content in East Africa

International web content is by far the most widely available and used in East Africa. This is in large part due to the ease of finding and disseminating this content, as well as its normalized licensing schemes and reliability. International platforms also carry a majority of the content that is currently being viewed on mobile phones. The following are the types of content that are most important to consumers in East Africa, according to our interviewees:

1. International entertainment news (sports, gossip, lifestyle)
2. Local news
3. Breaking news
4. Facebook (and to a lesser extent other social network tools such as Mig33, Mxit and Twitter)
5. Jobs
6. Dating (chat and relationships)
7. Religion
8. Local video/media

This is supported by a survey of internet use in Kenya, which found the top sites accessed were:[11]

- Top e-mail sites: Gmail, Yahoo, Facebook, MSN;
- Top social networks: Facebook, Google, Yahoo, YouTube;
- Top knowledge sites: Google, Wikipedia, Yahoo, DailyNation;
- Top news sites: Google, BBC, Standard, Daily Nation;
- Top multimedia sites: YouTube, Google, Capital FM, Facebook.

Everyone we interviewed said that international content and platforms were the primary ones used. However, this was because there was so little local content available. All interviewees felt strongly that what consumers are in fact interested in is not always available locally, and hence they have no choice other than to view international sites.

Top Ten Websites – Safaricom Kenya

All sites		Kenyan sites	
Site Name	Mobile site	Site Name	Mobile site
facebook.com	✓	www.nation.co.ke	✓
google.com	✓	www.standardmedia.co.ke	✓
wapdam.com	✓	www.kenyanlyrics.com	✗
yahoo.com	✓	www.kenyanjobs.blogspot.com	✗
wikipedia.org	✓	www.home.co.ke	✗
youtube.com	✓	www.kra.go.ke	✗
bbc.co.uk	✓	www.nyerionline.com	✗
my.opera.com	✓	www.capitalfm.co.ke	✗
reference.com	✓	www.brightermonday.com	✗
nation.co.ke	✓	www.businessdailyafrica.com	✗

The reasons are, first, international platforms, such as Facebook, Yahoo!, BBC, CNN, Google and Wikipedia, have already been tailored to work on the most widely used data-enabled handsets. This contrasts with local content providers, many of whom have yet to tailor their websites for mobile access. In addition, local content is less available at present, not as easy to license, and often cannot be reliably guaranteed as a long-term source.

What's more, the international platforms anyway offer scope for localization, to varying degrees. Facebook offers a good example. It is an international platform, yet with much local (social/community interaction) content provided by its users.

As of August 2010, 15.9% of Africa's internet users were on Facebook, despite no marketing and very little attention paid by the Facebook management. However, Facebook is available via almost any WAP enabled phone. Since 2009, its engineers had been working to make it faster and less bandwidth heavy for mobile users in low-bandwidth countries. Crucially, in May 2010 Facebook launched "Facebook Zero", 0.facebook.com, enabling anyone in the 50 countries where they had advertising or revenue sharing deals with the mobile operators to log into Facebook (minus images) for free. This innovative pricing model has been fundamental to Facebook's wide use in East Africa and elsewhere.

Another example of international platform plays can be found by looking at Google and Yahoo!. In the 1990s many East Africans signed up for Yahoo! accounts for email, and many still have them, with even high-level government officials still using Yahoo! as their primary email. They also look at Yahoo! news to get their international information each day. In the mid-2000s Google started to address the market in Africa, noticing the growth potential and lack of any strategic activity by Yahoo!. Now university students in Kenya and Uganda get a Gmail account automatically, and their entry into Google's universe of free applications, gadgets and search home page is thus solidified. Government entities too are increasingly signing up for Google services.

In 2009 Google launched the G-Africa Initiative, a series of events in Sub-Saharan Africa for software developers, and has held local content forums. In October 2010 Google started testing a new service for Swahili speakers in East and Central Africa. Tentatively called Baraza ("meeting place" in Swahili), it will allow people to interact and share knowledge by asking and answering questions, many of them of only very local or regional interest. The company's continuing focus on growth in Africa is evident.[12]

Localization of this kind on an international platform is attractive to the platform provider as it increases its relevance for local consumers. It also has benefits for local developers because their costs are lower and their access to consumers far greater than if they acted alone. The cost of entering the market in competition with a major international player is clearly prohibitively high.

However, while local content developers lack scale they have advantages that the global platforms do not. For one, they understand the local tastes and culture so customers value their content more. The consumer benefits of truly local content and platforms could be large. One early example of this is seen in the way that Safaricom, which started at the same time as Zain in Kenya, captured almost 80% of the local mobile market. Safaricom made effective use of listening and iterating quickly on local needs, humor, slang and culture, while Zain (now Bharti Airtel) was running their marketing, services and offers from afar.

It is still an open question as to whether localization via an international platform or more truly local content development and dissemination is more beneficial. However, in all the interviews we conducted, there was a clear belief that while international content, increasingly localized for the market, is currently king, local content has the greatest growth potential because it is more highly valued by consumers.

The importance of local content for driving demand – views of our interviewees

"People want to have something of their own that applies to them, such as news, real time information, day to day aspects that apply to them." – Kahenya Kamunyu, Virn

"Mostly local content is widely used. This is due to the fact that it generates more revenue." – Daniel Kamau, InMobia

"Local content on international platforms has mostly been used. However, it should be the other way round, where local content is on local platforms." – Mbugua Njihia, Symbiotic

"With local content providers not thinking downwards, the normal person is getting left out of the digital age, thus widening the digital divide gap." – Karanja Macharia, Mobile Planet

"Local players are not putting local content out there, nor are they building apps to do this. When applications go online, then local content to support this will come up." – Agosta Liko, PesaPal

"Push focuses on providing good quality, licensed localized content." – Sandra McDonald, Push Mobile

However, local content will not succeed unless it can be accessed through the mobile phone. As Karanja Macharia of Mobile Planet (Kenya) emphasized to us, the key will be for local companies already creating online content to tailor their websites for mobile phone browsers.

Our interviews revealed examples of local developers embracing the use of the mobile to promote local online content:

- In Tanzania, Millicom gives subscribers a one-stop shop where they can access Tanzanian Kiswahili entertainment services. They also have a free games portal called "Cheza Games" where subscribers can download games for free.
  [Access to local music and ringtones and entertainment]
- Ushahidi is a crowdsourcing platform originating from Kenya that collates 'user-generated' reports and was used to gather information after the 2007 post election violence. It has since been used globally for everything from the Haiti earthquake aftermath to tracking London's Tube strike, as well as dozens of other East African deployments, including elections and wildlife tracking.
  [News on local current issues]
- In Kenya, examples of aggregated content include "Snaptu" which has many applications together such weather, chat and others.
  [Communication applications such as chat and free or inexpensive web-to-SMS]

- Inmobia worked with The Monitor in Uganda to create a micro site on which they can upload their content. Inmobia have also created a WAP site for Kenya Buzz which provides information for all the local happenings, places for entertainment, what movies are showing on the local scene and so forth.
  [News on local current issues and sports]
- "TumaSMS" is a Kenyan-developed application that uses a free gateway or API switch to be able to send SMS.
  [Communication applications such as chat and free or inexpensive web-to-SMS]
- "Ukurasa" is a Kenyan-developed online bookstore that can be used to find books that other people are supplying.
  [Online information such as online access to local books and religious content]

In sum, large incumbents currently provide the most mobile web content in East Africa. They also provide a ready platform for some localized content. However, local, inevitably smaller content providers have the best chance of creating relevant local content. We turn next to how far and fast this content progression can proceed.

3. Drivers and inhibitors of mobile web content

Our interviews revealed the belief among local entrepreneurs, developers and business executives that there is latent demand for locally provided content. The growth potential is demonstrated by the success of other local content markets (such as films and radio). There are other drivers of growth including falling handset prices and, at least in Kenya, supportive government policies. In this section we discuss these potential enablers of local MWC development.

Market dynamics

Despite the relative lack of local MWC provision at present, there is scope for a virtuous circle, such that the more that is available, the faster demand will grow. If this dynamic progresses enough, a tipping point in internet usage could be reached.

Local radio and TV stations discovered this market-building effect in the late 1990s and early 2000s, taking a good portion of the entertainment market. Local filmmakers could profitably create movies, selling them at low prices on DVDs. As these local film, TV and radio industries have shown, there is a viable local content market. Of course, this does not mean that demand for international content goes away; Premier League football and Hollywood movies will always be around, nor are DSTV and movie theatres disappearing. It indicates, however, that there is a market for both, and that the local MWC market is a vacuum waiting to be filled.

Most of our interviewees across Kenya, Uganda and Tanzania, indicated they are aiming for a younger age set, in urban areas. Their target demographic is urban 18-29 year-olds. Generally, they have data-enabled phones, with the know-how to operate them. Some providers are targeting predominantly tourists in the age group 25-55. In all cases, developers are still targeting the more affluent consumers, the middle classes, although aiming ever lower down in the income scale as more people can afford the data-enabled handsets. Push Mobile in Tanzania is a good example. Their target consumers are predominantly young males between the ages of 18 and 30. The downloadable content retails for 500 to 1000 Tanzanian Shillings, or the equivalent of $0.40 to $0.80 US cents. For users to access the Push portals they must have at least a WAP-enabled phone.

The marketing strategies used to reach these mainly young and affluent target groups vary widely. Zain's strategy has included activities such as sponsoring the MAMAs, a music award ceremony. It has also introduced specific tariff packages for the youth market, at affordable rates. An example is the Zain Club 20 campaign, introduced in late 2008, where consumers could subscribe daily for 20 Kenya Shillings for unlimited free SMS for the whole day. Similarly, in September 2010, Safaricom introduced its Masaa ya SMS campaign whereby subscribers (pre-paid or post-paid) are able to send text messages for as little as 20 cents each, depending on the bundle they choose.

One exception is found in Uganda, where Grameen App Lab's target consumers are generally poor people who tend to live in villages or urban slums, with incomes less than $4 per day. In 2009, Google and Grameen partnered with MTN Uganda to release 4 tools:

- **Farmer's Friend**: a searchable database with both agricultural advice and targeted weather forecasts
- **Health Tips**: provides sexual and reproductive health information
- **Clinic Finder**: helps locate nearby health clinics and their services
- **Google Trader**: matches buyers and sellers of agricultural and other commodities. Local traders, such as small-holder farmers, are able to broaden their trading networks and reduce their transaction costs. (known locally as "Akatale SMS")

The focus on urban, above-average income, high-usage subscribers reflects the current revenue structure of the internet requiring the end-user to pay the full cost of mobile internet access. However, no mechanisms commonly exist through which the cost of mobile internet access can be shared between content providers and consumers even though both reap benefits from internet usage. This internet pricing structure, putting the full cost on the end-consumer, contrasts with the pricing model that for voice services, and is a barrier to mobile internet access for lower income subscribes. We discuss the implications of devising alternative pricing mechanisms later in this paper.

Institutions

Given these existing market dynamics, we turn now to discussing the role of different institutions in the further development of mobile web content – in particular, the extent to which they can and do promote local content.

Government

In Kenya, the Kenya Information and Communications Act[13], makes provision for broadcasters to incorporate local content into their broadcasting, which may be accessed through mobile phones. But there is still a lack of concrete government policies for government services or content to be made available or accessible via the mobile in any country in East Africa, even though this is the primary channel by which citizens could access services online.

While no mobile-specific policy is evident, governments have made some strong pushes into e-government services, digitization of content and schemes for PC-based access in rural areas. Some content is difficult to provide via a mobile device and therefore more likely to be used on a PC. Yet many services could be offered via mobiles.

For example, the most popular Kenyan Government website (Kenyan Revenue Authority) is shown below as seen on a PC screen, a smartphone (HTC Desire) and a typical 2G internet enabled handset (Vodafone 350).

DELL Laptop PC screen

HTC Desire Smartphone 3G HSPA + WiFi

Vodafone 350 2G EDGE

The website is most clear and easily accessible via a PC interface (and consumer interaction primarily is through downloadable pdf files). There are no browsing problems when accessing through a PC-based browser. The KRA website is also accessible via the native Android browser in the HTC Desire Smartphone. The HTC Desire also allows downloading and viewing of pdf files. However, the native browser on the Vodafone 350 (a basic 2G EDGE handset) does not present the KRA website in a usable format. As can be seen, the website is badly rendered and quite impossible to navigate.

The evidence gathered in this paper and previous chapters indicate that the majority of internet surfing will likely occur through handsets similar to the Vodafone 350. It is fair to say that the internet experience is quite limited through basic handsets like the Vodafone 350 when accessing sites that have been designed for PC-based access.

The government could benefit from much greater efficiencies associated with m-government services, and citizens could benefit too. For example, there would be less need for people to travel all the way to a government office in person (with the corresponding staffing requirements that are needed). M-government is a good example of what local content really can be, something that no global provider could offer, and of immense importance to individuals and businesses alike.

Some examples are:

- Paying bills
- Service delivery questions and concerns
- Taxes – access, information and filing
- Health – access or appointments, information
- Public job search

Many of the services would be useful for small and medium-sized businesses. An argument can be made that m-government services would have a greater impact if the focus were on supplying tools for small businesses to interact with government, rather than only making services available for citizens in general. By removing the barriers to entry for small businesses, the government would be providing a service that increased usage, decreased business costs and had a potential tax revenue increasing effect due to filing and paying on time.

Governments could also move towards zero-rating certain government services that are accessed via the mobile device (just as Facebook does with 0.facebook.com). With a great percentage of individuals on prepaid plans, and with no credit on their phones, it would make sense to make many government websites freely available. There appear to be few barriers to governments negotiating with mobile network operators in order to enable no-cost access for subscribers, especially given the potential efficiency savings for the government.

Finally, if East African governments do not begin making their services mobile web enabled, there will be an increasing number of marginalized communities and individuals, and a larger gap between how the government serves those who can afford PCs and those who cannot.

In terms of wider government support for MWC, national government ICT bodies, such as the Kenya ICT Board, have been pushing hard to overcome the lack of local content. The Kenya ICT Board has created the Tandaa Symposium events, which bring together different types of content creators, including web designers, corporates, film, animators and entrepreneurs. They have even gone so far as to create a sizable $4 million grant process, distributing $50,000 grants to digital content creators. The Tandaa grants are excellent examples of the drive for local content, by local content developers. In the first round, there were 8 private sector winners, and 7 public sector winners:[14]

It is instructive that six of the eight private sector grant winners related to the development of mobile applications. None of the government projects relate to mobile applications. While this is a snapshot, the lack of mobile-specific projects by government is indicative of a lack of focus on mobile solutions.

In Kenya, Tanzania and Uganda, there is a need for the government to pay much greater attention to the broadband market, whether mobile or terrestrial. But – as noted above – East Africans do not see the web as PC-related, but rather access the internet via their mobile phones.

The East Africa Community has had discussions on ICT policy and regulatory harmonization, with to the aim of creating a framework for regional ICT policy integration.[15] At present, the regulatory frameworks differ somewhat between the countries, but all make commitments in principle to supporting local technology industries. Import taxes for electronics, spare parts and accessories differ between the three countries. Reducing, or removing, duties on this equipment, and standardization across the region should be considered as part of this debate.

Business

While most East African governments have been slow to recognize the importance of mobile internet, many global private sector organizations are cognizant of the demand for local content. Google Africa, led out of Kenya, has been active, as described above. They partnered with Wikipedia to create more Kiswahili content on the online encyclopedia. They have also done a great deal of work in localizing their popular Gmail service into local languages, and doing a much more detailed job of mapping Africa's roads, beyond the cities. Google Africa represents perhaps the best example of *localizing* content, using a mixture of their international technology mass and expertise with local hires, interns and volunteers.[16]

Company name	Project title	Category
Media Edge Communications Ltd	Farmer Mobile banking and mobile e-Services Transaction Platform	Private Sector
Kenya School of Technology Studies	Development and Implementation of Mobile Learning in Kenya	Private Sector
KenyaBuzz Ltd	Mobile phone applications to promote events, business and social networking in Kenya	Private Sector
Jumuika Media Solutions Ltd	Jumuika Mobile Advertising and Marketing	Private Sector
Ask a Doc Limited	Project Afya: AskaDoc.co.ke	Private Sector
Mediae Company Ltd	Makutano Junction and Development of Digital Content for TV series	Private Sector
Outside The Box Africa Ltd	JAMOBI – Empowering The Jua Kali Sector Through Mobile Software	Private Sector
Dr Peter Wagacha	Mobile phone utilities for the blind and visually impaired.	Private Sector (individual)
Octopus ICT Solutions Ltd	HIV and AIDS in the workplace e-Learning course	Government Information Portal
JBA Advertising Ltd	Lost and Found Project	Government Information Portal
Rivercross Technologies Ltd	EDUWEB: Education Institution Listing and Interactive Mapping Portal	Government Information Portal
Ibid Labs	Kenya Online Museum	Government Information Portal
BTI Millman Company	eMazingera Software Application	Government Information Portal
Infotrack Strategic Solutions Ltd	Teacher's Portal	Government Information Portal
Foundation Support Services Ltd	IVR Tax Filling Solution	Government Information Portal

Corporations are also starting to invest time and money in university relationships, as the Nokia and University of Nairobi relationship has shown. Nokia has invested both time and money into working with UoN, working jointly on social media related mobile products The application, co-created with a Finnish university, is called Nairobi Sizzle (www.nairobisizzle.com), and enables the study of user behaviour in a social network. A number of universities in the region are helping build the skills necessary for a local content industry.

There are an increasing number of non-traditional institutions that have started changing the content landscape in the past year or so, working with business. The iHub, Nairobi's innovation hub for technologists, and the Hive Colab in Kampala are two of these (the author of this paper is associated with iHub). Corporations are working with these new instititions to promote local developers. For instance Safaricom is working with both the iHub and Strathmore University to provide access to its infrastructure. This will give local developers a way to try out new applications and services on Safaricom's network. In return , Safaricom gets to see potential innovations on its network first-hand, and will have the opportunity to work directly with the entrepreneurs. At the same time, it has launched the Safaricom Innovation Board, whose purpose is to make it easier for developers and startups to access the network. Collaborations of this kind may prove a good way of providing local developers with the necessary scale to compete with global players.

4. Opportunities and challenges

The growth drivers of mobile web access include lower tariffs or new pricing structures, lower costs of handsets, new under-sea fibre-optic cable, and sustainable competition among the mobile phone operators. However, there are also inhibitors such as high taxation, low-income levels amongst consumers, regulatory policies, a lack of business acumen among tech entrepreneurs, and corruption.

Handset costs

One of the largest growth inhibitors for MWC uptake, and hence the growth of the content industry, is affordability. It is a key issue for both current and future subscribers. There needs to be a good deal of device subsidization, data cost decrease, innovative business models and cross-media partnerships to reach beyond the middle and upper classes in East Africa.

East Africans generally lack sufficient disposable income to purchase smartphones. Manufacturers of these richer data enabled phones are working closely with the local operators to offer cheaper versions of the entry-level smartphones to consumers, but they still are not at the price point that will see mass adoption.

The price of mobile handsets in general has plummeted. The cheapest GSM handset cost as little as $12.50 new, much less if second hand. However, handsets that enable better mobile internet connectivity still cost upwards of $50.

African Digital Art meeting at the iHub in Nairobi, Kenya.

Mobile phone operators are also devising new ways of making handsets available to their consumers – for example, Safaricom's "Bonga Points" which can eventually be redeemed for a new handset. In February this year, Vodafone launched low cost mobile handsets, the launch supported by an extensive logistics infrastructure to reach the rural areas where mobile penetration remains low. On the other hand, Samsung and Sony Ericsson have seen consumers seeking Web and other PC-like functions increasingly turning away from their higher-end phones to computer-like smart phones from vendors like Nokia and Apple. Demand for smartphones is growing but will depend on lower prices.

Mobile data access costs

Mobile data access charges have already fallen drastically, in large part due to the SEACOM undersea cable arriving and increased competition between operators, both mobile competitors and ISPs. However, the full cost of mobile data access and usage falls upon the end-user – there exists little market acceptance by content providers of a model that shares the cost burden.

Yet in Kenya, for example, approximately 40% of mobile users do not keep a balance on their mobile phone. This means that they might top up with 10-20 Ksh from time to time to keep their phone active, but most of the time they have the phone for people to call them. At the same time, there is a burgeoning opportunity and demand for mobile web content. So, the question is, how do you get that 40% active on the web with the current pre-paid model in Africa, where everything has a cost? The answer is most likely to come from the development of charging mechanisms that enable the cost of providing mobile internet access to be shared between both parties that benefit – end-users and content providers.

Facebook is the first major content provider to crack this issue. As described above, even users with no phone credit can browse for free basic functionality on the social network. Facebook and the mobile operator do a revenue-share deal for advertisements or work out a paid traffic model, depending on the country.

For publishers of mobile web content, there is a large untapped market which cannot be reached any other way than by letting end-users access content for free and monetizing in some other way, such as advertising or a revenue share option with the mobile operators. Surprisingly few others have made inroads into this Facebook Zero-style approach. This may be because type of deal lends itself well to publishers with a great deal of content and the ability to scale to millions of users quickly in order for advertising revenues to be worthwhile. Yet more organizations will need to look towards innovative business models, such as this one, to be successful.

There could be many more MWC business success stories in East Africa if entrepreneurs were to realize the potential size of the market using 2G and Opera Mini enabled handsets. However, technologists who know how to build the tools generally are not trained or skilled in business. Those who understand business have little understanding of what the technology available can do. Mxit, a mobile social chat application in South Africa that was launched in 2006, is a good example of the impact of this gap. It currently has 27 million users.[17] They took advantage of the drastically lower mobile data costs compared to SMS for chat, and took the market by storm. Why hasn't this been imitated in East Africa?

5. Conclusions

East Africans are accessing the web primarily through their mobile phones. The new medium is enticing them online with the new services and content provided through a new medium. Broadband penetration rates are low enough in this region that we are not yet seeing the displacement of newspapers, radio and TV seen in other, more connected regions of the world. However, as with all network technologies, there is the potential for reaching a tipping point. This will depend on the provision of enough mobile web content that is valued by East African consumers.

The content driving East African users online is currently largely provided by international news and content sources, such as Yahoo! and the BBC, and also by global internet platforms, such as Facebook and Google's Gmail. Even taking into account the decreasing data costs, falling data-enabled handset costs, and the increased availability of broadband, there would not be enough traction locally to get to the critical point if the content were not available.

These international content sources and global web platforms generate demand, and therefore allow the mobile network operators to decrease costs as more users come online. International content is thus providing a pathway for local content creators. While local content is in high demand and there is a rapidly increasing user base, the mobile web content space in East Africa is in its early stages, and there are no clear leading content providers. At present the key trend is the provision of increasingly localized content by the leading global companies.

This paper has identified two important barriers to the further diffusion of mobile internet usage across East Africa: lack of m-government policies; and, more important, an absence of charging mechanisms which share the cost of mobile internet access between end-users and content providers. If governments embraced mobile-based provision of services and provided access free of usage charges to end-users (sharing the efficiency gains through payments to network operators), the potential impact on internet access could be dramatic. The challenge for governments and local developers of mobile web content is to utilize their local cultural understanding and ability to maneuver quickly to make their content more relevant and affordable to end-users. There are a few examples of innovative pricing driving content and therefore internet use, but if mobile web content in East Africa is to move from the current stage of predominantly global content and global platforms, the lessons of these examples will need to be implemented widely.

Appendix

Interviewees

Name	Organization	Country
Karanja Macharia	Mobile Planet	Kenya
Moses Kemibaro	Dotsavvy	Kenya
Paul Kukubo	Kenya ICT Board	Kenya
Joshua Wanyama	Pamoja Media	Kenya
Chris Kiagiri	Google Kenya	Kenya
Agosta Liko	PesaPal & Verviant	Kenya
Mbugua Njihia	Symbiotic	Kenya
Kahenya Kamunyu	Virn	Kenya
Daniel Kamau	Inmobia	Kenya
King'ori Gitahi	Nokia Research Centre	Kenya
Eric Cantor	Grameen AppLab	Uganda
Jon Gosier	Appfrica Labs	Uganda
Eric Kamau	True African	Uganda
Annie Smith	Millicom (Tigo)	Tanzania
Sandra McDonald	Push Mobile	Tanzania

Notes

1 http://www.telecomsmarketresearch.com/research/TMAAASXY-Blycroft-Africa-Middle-East-Mobile-Telecoms-Market-Subscriber-Numbers-2Q-2009.shtml

2 African Mobile Factbook, 2007.

3 ITU, "The World in 2009: ICT facts and figures", Geneva, October 2009

4 ITU, "Information society statistical profiles 2009 – Africa", Geneva, 2009

5 "Internet usage statistics for Africa", Internet World Stats, http://www.internetworldstats.com/stats1.htm

6 Nigeria is the most populous country in Africa. Internet access is estimated to be 7% and 1% is broadband. Information from Digital Sense Africa Forum, 17-18 April, 2010.

7 Ghana has a Internet user base of about 1m subscription with a population penetration of 4.2%

8 In 2009, the Seacom cable connected eastern and southern Africa with Asia, and the TEAMS cable reached Kenya. Additional cables Glo-1, Main-1, EASSy and LION all came online in 2010, with WACS and ACE are planned for 2011-12. Satellite operators are planning to launch more satellites to refresh the capacity in the region. At least 36 new satellites are due to be launched by 2013, bringing the equivalent of 26,325 MHz of capacity.AllAfrica.com, "Satellite to fibre", April 23, 2010, http://www.dishtracking.com/forum/satellite-to-fibre-t-7636.html

9 http://www.itnewsafrica.com/

10 http://www.internetworldstats.com/af/ke.htm

11 TNS Kenya Digital Life survey http://discoverdigitallife.com/

12 See http://google-africa.blogspot.com/

13 Chapter 411A of the Laws of Kenya

14 https://sites.google.com/a/ict.go.ke/tandaa/grants-round01/2010-grantees

15 See "The Use an possibilities of m-applications in East Africa" paper by Johan Hellstrom of UPGRAID.

16 Naspers, the South Africa-based multimedia group, has multiple web-based services growing from South Africa into East Africa with *Dealfish*, for local classifieds, and *Kalahari*, an ecommerce site. However, *Mocality*, their mobile and web-based listing service and directory application for Kenyan businesses, is perhaps the best example of hyper-local content being driven by a local team and the "crowd".

17 http://memeburn.com/2010/10/why-mxit-is-south-africas-largest-social-network/?utmsource=rafiq

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Spectrum policy and competition in mobile services

Radio spectrum is the critical scarce input into wireless services. Government regulation often makes its natural scarcity even more acute.

For OECD countries, the challenges in managing spectrum are formidable. For example, the March 2010 National Broadband Plan for the U.S. claims a severe bandwidth shortfall awaits the mobile market in the immediate future. Without an additional 500 MHz – much more space than is effectively utilized today – advanced wireless networks will be stymied.

Emerging markets face even more daunting dilemmas. There, far less spectrum is typically allocated for mobile services. Although mobile services have become extremely popular in these markets, spurring entrepreneurship and efficiency, network expansion has been thwarted. Additional bandwidth, now being wasted, could be productively utilized, boosting economic growth. Yet productivity-creating outcomes are blocked in each of the three key policy stages: the allocation of bandwidth; the assignment of licences; and the misuse of spectrum 'caps' to counter potential market power of carriers.

This paper offers an economic analysis that links the social benefits of wireless services to spectrum policy choices. The examples of India and Mexico are used to show how regulators can lose focus on the primary objective, facilitating efficiency in output markets, resulting in a loss of welfare.

Three types of standard policy errors are observed, and illustrated here:

- over-protecting, or "conserving," spectrum to prevent "warehousing;"
- equating auction revenues with regulatory "success"; and
- using spectrum caps to micro-manage competition.

Each produces perverse, anti-consumer consequences, limiting productivity, reducing market rivalry, and blocking the emergence of advanced wireless services.

1. Why policy makers should not withhold spectrum from the market

Mobile networks are bringing revolutionary changes to economies throughout the world. This makes it curious that public policy is often so careless about nurturing the emergent marketplace. The most basic ingredient in the mobile network is radio spectrum. More spectrum yields greater bandwidth, and therefore brings enhanced opportunities to provide both existing and innovative services.

There are substitutes for the availability of more frequency space, most notably cell-splitting. By creating more cells within a given geographic area, whatever bandwidth is available can be more intensively exploited, as given frequencies are re-used from cell to cell. Yet cell-splitting is costly, requiring the construction and operation of additional base stations and associated networking ("backhaul"). And increasing cells will never change the reality that, for any given level of infrastructure investment, more spectrum would enable more traffic to be transported over the network.

Hence, to restrict the spectrum available to mobile networks is to reduce the value of the services they provide. If there were other uses of spectrum that, at the margin, yielded better returns than mobile networks, then spectrum resources could be most productively utilized in the alternative employment. But the restrictions that policy makers consistently impose on spectrum for mobile services most often simply freeze virtually unused bands in place. These actions do not enable alternative wireless applications of higher value, they simply squander bandwidth. This does yield regulators option values, as they can decide what to do with unused frequencies at a later date. But these options have negative value to society. The bandwidth that lies idle is not saved but destroyed, as the opportunities not used are gone forever.

The greater missed opportunity occurs in emerging markets. A recent study of wireless markets in Latin American countries shows that governments there usually impose far stricter limits on spectrum access than governments in more affluent markets. Using 2003 data on bandwidth allocations for mobile telecommunications services, the study found that the unweighted average mobile services allocation in Latin America was just 102 MHz. Members of the European Union, by contrast, managed to allocate 266 MHz on average.[2] Mexico allotted just 120 MHz to cellular services and India just 100 MHz.

The far higher totals in the E.U., where the U.K. managed to make 340 MHz available for mobile, and the Netherlands some 355 MHz, were not achieved by social sacrifice.[3] The opportunity costs of using more spectrum for mobile paled in comparison to the highly valued outputs lost by walling bands of spectrum off from mobile subscribers. On the contrary, as wireless networks were given greater scope to grow in the E.U., technological advance and entrepreneurial activity delivered innovative services that generated large new benefits. Allowing idle spectrum to be deployed to create valuable services does create something akin to the proverbial "free lunch."[4]

Categorically blocking access to airwaves in order to maintain "spectrum inventories," as so many governments do, thwarts this process. It warehouses valuable inputs, increasing network costs and depriving emerging innovations of the bandwidth they need to prosper. The one way to reliably waste spectrum is to make it unavailable to the market. Nevertheless administrative systems used to allocate frequency rights typically attempt to "conserve" spectrum by allocating bandwidth only for specific identified purposes. This is a policy fraught with danger.

First, the policy does not derive from a careful balancing of different uses of spectrum over time; indeed, this kind of assessment is discouraged. Instead, due to political pressures and limitations on the capabilities and interests of administrative personnel, agencies pursue policies that retain agency discretion. Putting out only as much bandwidth as it determines is "needed" allows the agency to control the pace of investment and growth, and to favor certain industries or firms (receiving airwave rights) over others (denied such rights). This guarantees that the agency will continue to be at the nexus of an important, high-stakes lobbying game in which rival economic interests and political constituencies bid for its favor.

Second, "conserving" spectrum is unnecessary. Markets routinely save resources for future employments without government inventories. With land, for example, owners hold vacant parcels until profitable opportunities for development arise, depending on costs and demand and the current and future value of alternative uses.

Similarly, mobile carriers plan and continually adjust their "upgrade path," selecting technologies, network architecture, equipment, application platforms, and infrastructure investments. This process incorporates their estimates of how customer demand will grow and how new applications will evolve. When new licenses bring additional bandwidth into the market, networks are built and/or upgraded. Network owners' aim is to use cost-effectively the resources that are available, not to achieve "maximum traffic" at a single point in time.

One rationale sometimes given for the policy of "conserving" spectrum is that it is said to be due to concern among regulators about marketplace "warehousing." In other words, they believe that private firms will acquire spectrum rights in order to deny the bandwidth to their competitors.

Yet firms have no incentive actually to leave spectrum idle – "in the warehouse." It is the acquisition of the wireless license, denying rivals the opportunities to use incremental bandwidth, that benefits the firm. Once they have achieved this, it makes financial sense to optimize resource use, lowering costs (for a given level of service) by deploying all of the spectrum they have available.

Furthermore, there is thus no reliable way a government agency can distinguish supposed warehousing from efficient use.[5] Rules that mandate deployment at a certain level are inherently ineffective and can, in any event, be evaded by sub-optimal investments in infrastructure. This is socially inefficient.

In order to eliminate the perceived risk of enterprises warehousing spectrum, the *government* often warehouses it instead. The outcome is perverse. Government decision-makers pay none of the costs their policy incurs, while their action increases the marginal value of the assets that the agency allocates. This enhances the political importance of the agency, intensifies rent-seeking, and prolongs agency influence (as well as that of the officials who run it). Conversely, a private firm withholding useful spectrum resources pays for this privilege even if it acquired the bandwidth without charge. That is because the firm sacrifices whatever returns it could have earned during the period in which the assets are held idle. What is a free gambit for regulators is a profit-loser for private licensees.

The pro-consumer policy remedy for warehousing is to put abundant spectrum resources into the marketplace via licenses affording flexible use. This was the economic logic put forth by Ronald Coase in a classic 1959 essay.[6] Instead of planning markets (inefficiently) from the centre, let competitive markets move spectrum to where it generates the highest marginal product.

Making more spectrum available increases the scope of this optimization. It relaxes a critically important constraint, reducing the cost of wireless services and expanding the size of the market. This frees competitors to do what government regulatory agencies cannot. As Coase's landmark 1962 study for the Rand Corporation put it:

"There are various combinations of resources – transmission power, antenna height and directivity, frequency of transmission, method of propagation, etc. – that can be utilized to achieve a given level of (received) power at a point distant from the point of transmission. The range of alternative combinations is determined by technology – the state of the arts – and is an engineering problem. The "proper" combination actually to use to achieve a given goal is, however, an economic problem and is not (properly) soluble solely in terms of engineering data."[7]

One objection often made against a policy of maximizing spectrum availability is that it risks spectrum becoming "trapped" in lower-value uses even as new technology develops. But this reasoning confuses rigidities in traditional licensing regimes, which dictate how wireless operators may use spectrum, with market outcomes. Where regulators grant licensees flexible spectrum use, firms widely substitute into emerging technologies, liberating "trapped" spectrum. For instance, first-generation (1G) U.S. mobile carriers were mandated to provide analog telephone service, but were later permitted to upgrade to digital systems. They were given no new bandwidth. Over time, however, nearly 100 million analog subscribers migrated to digital networks, as mobile carriers – granted flexible-use of designated air waves – invested heavily to upgrade base stations and handsets.

Secondary markets can help spectrum escape the "trap." Regulators in the U.S.,[8] E.U.,[9] and elsewhere have sought rules enabling "spectrum trading." In the U.S., for example, new rules have made it easier for wireless licenses to be transferred in market transactions, but they do not permit owners (new or old) to change the use (services, technologies, or business models) prescribed in the license. This restriction is a notable, and costly, shortcoming; the right to use spectrum in different ways promises the greatest productivity gains.[10]

In mobile services, licensees typically receive broad authority to use specific bands flexibly, developing services and business models according to competitive conditions. In these markets, active "secondary market" trading of spectrum rights develops. Carriers make large, sunk investments to improve the value of radio spectrum via creation of extensive network facilities. This combination – *frequency spaces plus network services* – is then sold to end users and other wireless service providers in wholesale markets. These myriad spectrum users access frequencies under the "exclusive use" regulatory model.[11] In fact, the bands so allocated are the most *intensively shared* bands, and generate the highest economic value added.[12]

These secondary markets do not operate like commodity exchanges trading raw spectrum resource rights in large volumes. Far greater "spectrum trading" occurs via the sales of *access*. This bundles frequency and network utilization rights. It reflects, not market failure, but market efficiency:

> Let's say you're an HNO [host network operator] targeting business users, and I'm an MVNO [mobile virtual network operator] trying to target the youth market. Your traffic will be very heavy 9 a.m. to 5 p.m., and my traffic will be heavy 5 p.m. to 10 p.m. and on the weekends. That takes advantage of the empty capacity on the network.[13]

This is one example among thousands. A "wireless ecosystem" has emerged in which networks acquire spectrum rights, build physical infrastructure, and manage operations. They then supply – "host" – network access for diverse users. Wholesale intermediaries spring up, creating their own wireless services with the networks created and managed by the host carrier. Hence, end users often access the underlying network through retail sales of rival firms.

The scope of these wholesale markets is not widely appreciated. MVNOs, which resell mobile phone services, routinely buy millions or billions of minutes of use in well-developed wholesale markets, shopping among host networks. Networks trade access rights back and forth via roaming agreements; a single carrier may strike such deals with hundreds of other carriers. Machine-to-machine (M2M) wireless services, as used when a vending machine signals a server that it requires restocking, or a Kindle downloads a book from Amazon, are also constructed by wholesale contracts. Research in Motion (RIM) constructs terms for the use of its Blackberry handsets, also using secondary market transactions. Rival handset makers, including Apple, and mobile software developers, such as Google, have modified the RIM business model to create their own platforms. Customers elect to buy (or not buy) into a set of wireless options – hardware, software, network services, and applications – coordinated by such companies, which often do not own any spectrum assets or network infrastructure.[14]

These markets form, not due to regulatory rules creating secondary markets, but spontaneously following the issuance of liberal licenses.[15] The greater the bandwidth made available by regulators, the wider the scope of this market, and the lower the incremental price of access, all else equal. Where regulators instead attempt to micro-manage markets, supplying conservative allocations predicated on what administrative proceedings determine is "needed" for a given technology at a given time, bandwidth is needlessly restricted and investment in new services inhibited. Public policy ought to focus on creating broad, flexible-use allocations for competitive licensees, and not planning markets, either primary or secondary.

2. Why high auction revenues may not generate social welfare

Another area of policy confusion concerns the question of license auctions. Initially, competitive bidding was quite controversial. As late as the 1980s, U.S. policy makers proposing them were ridiculed.[16] The counter-argument was that radio waves could not be defined as private property, and that therefore rights could not be assigned to high bidders.[17]

The argument failed on multiple levels. First and foremost, since auctions were first instituted by New Zealand in 1989, over thirty country governments have sold licenses without the predicted market chaos.[18] The experiment, once conducted, produced evidence firmly rejecting the hypothesis that spectrum rights could not be assigned. Second, well before government auctions, wireless licenses were traded in secondary markets. Auctions simply moved transactions up to the initial stage of government rights assignment. Third, the rights embedded in these licenses will solve – or fail to solve – coordination problems in the *use* of radio waves. How the rights are *assigned* is a different issue, one concerned with the distribution of valuable assets.

Fourth, the efficiency case for using auctions rather than administrative fiat – so-called "beauty contests" – is strong. Specifically, auctions bring four sources of social gain:

- Licenses are assigned more quickly;
- Licenses are assigned to more productive service suppliers;
- License assignments are made objectively, reducing rent seeking costs;
- Revenues from auctions can substitute for government taxes.[19]

When licenses are assigned more quickly, bandwidth can be more productive. Experience in the U.S. suggests that delays can be substantially reduced when assignments are done by competitive bidding rather than by administrative fiat.[20]

Similarly, because market bidding favors the most efficient users of the licenses, those expecting to generate the highest returns from operations, awarding licenses to high bidders tends to increase social efficiency. Regulators do not otherwise know which recipients are the most efficient, and tend to base their choices on more political criteria. Moving assignments to the market not only makes awards transparent, a shift towards better governance, but also increases economic efficiency.

Finally, license rents are captured by governments when auctions are used. This may constitute more than a pure transfer. When the revenues from license sales offset taxes, eliminating the wasteful distortions associated with tax collections generates efficiencies. While circumstances vary from country to country (and tax to tax), a rule of thumb in the U.S. is that every dollar raised by taxation costs the economy about $1.33 – setting the tax distortion loss (and potential efficiency gain from using auction proceeds instead) at about a third of the revenues received.

Economists and government policy makers have been understandably excited about the gains associated with auctions.[21] In many instances, however, the revenues raised have exerted a mesmerizing influence. So long as bids are for pure rents, their capture by the state does not distort economic activity. But when regulators seek to increase revenues by delaying auctions, reducing market competition, or handicapping rivals so as to squeeze more money out of bidders, they distort market outcomes. Even parameters that are socially harmless when used in private auctions, such as reserve prices, can reduce social efficiency when employed in wireless license assignments.

Most to the point, the deliberately slow release of additional spectrum, a strategy sometimes undertaken to inflate license revenues, is perverse. It turns what should be the capture of rents by government instead of by private businesses into an exercise instead in the creation of artificial scarcity. By eliminating productive use of the withheld bandwidth, the savings from reduced tax distortion are outweighed by a far larger distortion in wireless markets. What looks like "free money" captured by the state turns into the most expensive taxes the government will collect. Estimates for the U.S. put the consumer welfare gain from mobile usage at more than $200 billion a year, whereas the one-off bids for bandwidth – reflecting expected profits – generate government revenues that are a small fraction of that.

It is possible for regulators to increase license auction bids by withholding spectrum from the market. A monopoly license will presumably generate the highest bid. But this is the "starving man" theory of spectrum allocation. The true object is not to generate the highest sales prices for licenses. Spectrum is an input into wireless services and increasing its marginal value raises costs, reducing outputs. It is the social value of these outputs that pro-consumer policy makers ought to seek to increase.

Indian spectrum allocation

India offers a good illustration of the issues being discussed here. There, regulators have attempted to extensively manage wireless markets. In particular, the regulators seek to ensure that they maintain a "reward and punishment regime for efficient usage of spectrum by the service providers, use of technology and refarming to bridge the gap between availability and requirement …"[22] This is done, in large part, by sharply restricting the bandwidth a given operator may control, and releasing new bandwidth to the market very slowly.

In general, owners of productive assets seek to maximize returns. This objective forces them to embrace innovative opportunities where incremental capital outlays create value for consumers, net of all costs. Such optimizing strategies apply to resource inputs, such as spectrum, as well as to man-made capital, such as wireless network infrastructure.

Many frequency regulators, including in India, displace this market discipline by determining how much bandwidth they believe wireless operators need, and then distributing licenses to maintain these input levels. Sometimes they then go further, imposing charges (or other sanctions) on firms thought to be under-utilizing bandwidth. Determinations may vary, based on how many subscribers operators serve, what services they offer, and which technologies they deploy. The licensing agency then seeks to impose not just rules ensuring efficiency, but also horizontal fairness among operators:

"The spectrum management regime should be able to handle the increasing growth of subscribers in a fair and equitable manner. It is important to ensure a level-playing field, while encouraging competition amongst those seeking to access this resource."[23]

The paradox is apparent. Competitive rivalry is, at bottom, a race for advantage. Firms attempt to develop superior products and lower-cost methods for supplying them. Deploying technologies that use bandwidth efficiently is socially desirable, wealth-creating – and will "tilt" the "playing field. For the entrepreneurial firm striving for competitive superiority, that is its point. The handicapping of markets to favor "equity" among rivals counters the very essence of the competitive process, lessening its power and blocking its efficiencies.

Moreover, spectrum is strategically withheld as regulators attempt to discern the evolving needs of the market. This places a drag on network development. In fact, there is no given "need" for frequencies. Rather, there is a demand for use of frequency spaces that depends on how it is priced, what is available, and the prices and availabilities of a matrix of complements and substitutes. Designing allocations as though they are restricted to serving demonstrated needs will cause service providers to reduce their "needs," as they adjust to the scarcity artificially imposed on inputs.

Through 2009, Indian regulators made just 100 MHz[24] available for mobile networks.[25] After a delay of many years, 3G license auctions were held in May 2010, awarding three licenses (in most markets) and permitting access to 2 x 5 MHz of paired spectrum per license – 30 MHz total.[26] In contrast, five 3G licenses in the United Kingdom auctioned in April 2000 allocated 140 MHz (2 x 70) in aggregate – and brought the mobile market total to 340 MHz.[27]

Beyond the artificial scarcity imposed by limited allocations of bandwidth, license restrictions cause further rigidities. By imposing rules that determine what services can be supplied with 2G, as opposed to 3G licenses, Indian regulators have effectively blocked the deployment of advanced mobile data networks and deterred the development of broadband in general. This wastes valuable frequencies, as well as key opportunities for economic development. India's wireless voice services, even though suffering from overly tight input constraints, have proven that enormous social gains are possible by building out advanced communications systems.[28] Restricting further gains imposes large social costs without any offsetting benefits – as frustrated stakeholders in the Indian market note.[29]

Curiously, however, some take the relatively high prices paid for 3G licenses in India as proof of policy success. Investment analyst Kotak, publishing predictions about expected bids in the May 2010 auction (forecasting revenues of $10.3 billion, against the actual total of $14.5 billion), went so far as to describe the government's licensing scheme an "optimum." This, due to a "spectrum-scarcity driven fear factor," and an auction design that forced licensees into a desperate battle to acquire regional or national spectrum assets (pieced together from licenses issued for 22 "circles"), would prove a "win win for Government and customers."[30]

This conclusion employs a very strange accounting standard. Customers are hurt by the delays in spectrum allocation and the restrictions on licenses. High-speed data services could have been well-developed by now, but instead are only just emerging in the Indian market. This has restricted internet access and a host of wireless applications that have great value to Indian consumers. Moreover, by inducing scarcity with intentionally small bandwidth allotments, capacity will be at a premium for networks and users. Access services will enjoy less capacity, and cost more, than if the additional airwaves were made available.

Figure 1. Mean license price forecast in Indian auction ($US mil.)[31]

Figure 1 shows estimated license values in India under different scenarios. Produced by consulting firm Kotak, the pre-auction forecasts yield plausible estimates of the winning bids for 3G licenses under alternative market structures.[32] The more operators are issued licenses, each of a fixed spectrum allocation, the less the expected price. This is unsurprising. Economic theory suggests that retail prices will be highest under monopoly, that profits will increase with price, which will increase input prices (for licenses).[33]

Hence there is a temptation to conclude, as this analyst does, that: "The government has created a reasonably optimum amount of scarcity in each of the circles so as to maximize its revenue."[34] But the "optimum" here is *not* optimal for society. It is unlikely even that the government wins, and certain that consumers do not. The enhanced license extractions do increase license sale revenues. But the spectrum restrictions, pumping up bids, result in greater revenue losses. For government revenues are reduced in future periods when tax revenues are lower than they would otherwise be, due to reduced economic activity and licensee payments (part of the license receipts are effectively tax prepayments, as they reduce corporate profits and thus lower tax liability). And consumers lose unambiguously, as the spectrum input market is constrained, reducing the capacity of networks, limiting services and increasing costs.

Social losses from delaying spectrum allocations are highly likely to overwhelm whatever social gains are associated with the immediate public finance dividend from auctions. Assume that India had distributed 3G licenses in, say, 2005 (five years after the U.K., Germany, and many other countries), instead of 2010. Assume further that this permitted networks to develop such that today's 3G penetration rate in India, instead of approximately 0%,[35] were 10%.[36]

This gap implies a substantial difference in productivity. Consensus estimates of the relationship between broadband access and economic growth suggest that each ten percent increase in broadband penetration is associated with GDP growth of between 0.1 and 1.4%.[37] Taking the midpoint estimate of 0.75%, Indian GDP – US$1.25 trillion in 2009, or about $3.5 trillion calculated at purchasing power parity – would have been higher by an estimated $26.3 billion (at PPP). Mobile voice services would likewise benefit were spectrum, for 3G licenses or others, made more readily available.

Were mobile penetration to also experience a 10% increase (year-end 2008 penetration stood at 30%[38]), over 100 million new users would be served. This also spurs GDP growth. According to the ITU, there is approximately a 1% gain in GDP with each 10% rise in the mobile penetration rate.[39] This implies income gains of $35.0 billion per year (PPP).

Summing up, the mid-point estimates yield income increases of perhaps $61.3 billion (PPP) *annually* from the more productive use of radio spectrum. In contrast, India's 3G auction of May 2010 – heralded as reaping a bounty for the Government – captured $14.5 billion as a one-time payment to the state.[40] Of course, license bids are largely transfers from private players to the state. They generate a public finance dividend perhaps equal to one-third the size of the total; here, about $5 billion. Annualized at 10% (a high rate for this purpose), suggests yearly efficiency gains of just $500 million (see Table 1).

Meanwhile, the benefits of using competitive bidding to assign licenses quickly, and to those firms that are most productive in using them, have largely been lost. Instead, lengthy delays occurred, and the eventual auction featured licenses that were few in number and difficult to efficiently aggregate across regions. Said one wireless operator following the sale:

"The auction format and severe spectrum shortage along with ensuing policy uncertainty drove the prices beyond reasonable levels," said Bharti. "As a result, we could not achieve our objective of a pan-India 3G footprint in this round."[41]

Sometimes service suppliers are disgruntled about competitive market forces, while consumer welfare is well served. But the problems stated here – frustration over the difficulty in expanding the scope of service rivalry given parsimonious license allocations – are key to economic efficiency. Unfortunately, India is not alone. Developing countries, which clearly gain with the advance of modern communications systems, often burden their development for the short-sighted benefit of license auction revenue maximization.

Figure 2 shows mobile license prices paid in a sample of 25 developing and developed countries. Prices are given (in constant 2002 US$) on the vertical axis, with per capita GNI (in constant 2002 US$) on the horizontal. The striking aspect of the chart is that it does not suggest a positive relationship between income and license price. Normally, prices for productive, localized assets – say, land – are positively correlated with the income of the market in which the assets are located. But these prices indicate that Swiss mobile telephone license is actually worth less than the Indian wireless license. This is not a good sign. Higher input costs reduce welfare in output markets.

There is no doubt that multiple factors explain price variance, including the timing of sales (for example, auctioning licenses during a stock market bubble tends to increase prices), and the use of alternative auction mechanisms (some are more successful in extracting rents from bidders than others). Yet it remains highly likely that developing countries enhance license prices by under-allocating bandwidth, creating "spectrum-scarcity driven fear" in the competition to acquire licenses.[43]

3. How confused competition policy creates inefficient barriers

Spectrum allocation rules often embed provisions such as "spectrum caps" which limit the bandwidth a firm is permitted to control. This policy is driven by concerns that authorizations may confer market power on licensees. Allowing one firm to monopolize licenses, for example, could result in supra-competitive retail prices and inefficient utilization of spectrum resources.

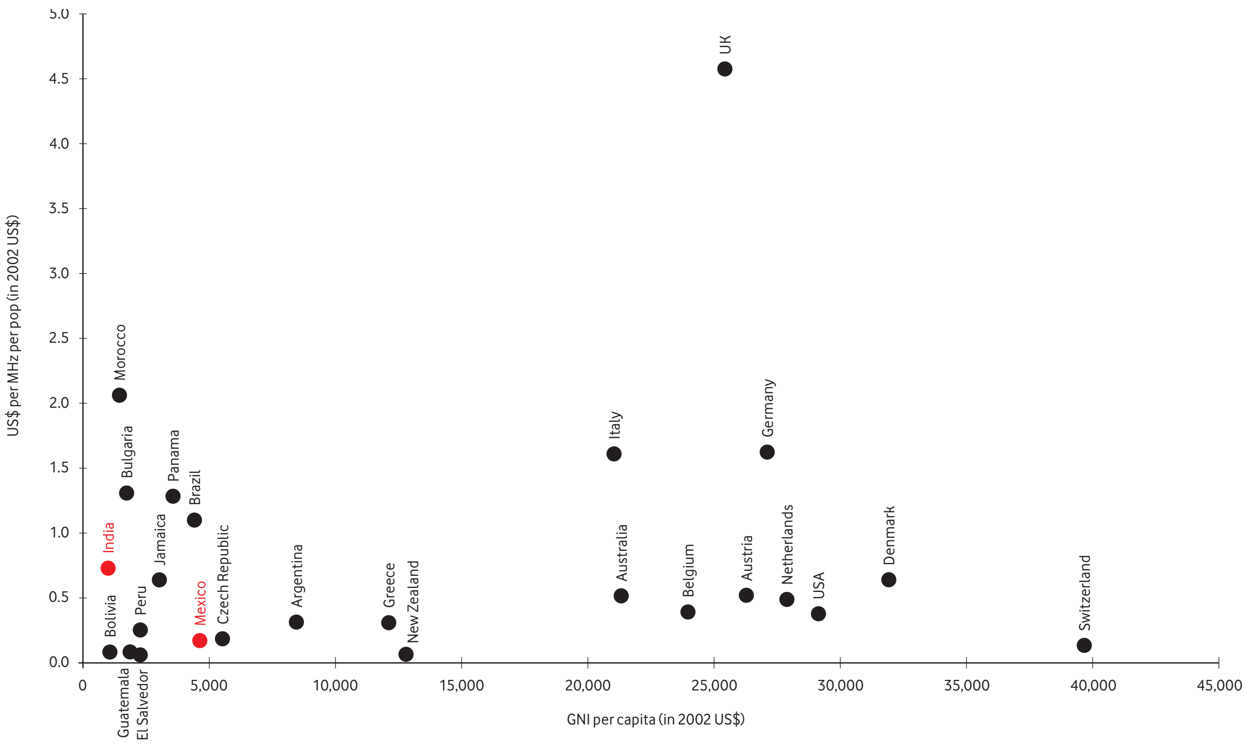
In short, spectrum caps are used as a form of competition policy. Such regulations have costs and benefits. The costs stem from the fact that denying additional bandwidth to a given firm risks inefficiency, as already discussed. A company, particularly an established network already reaching a high market share, has a great number of productive opportunities for the use of additional spectrum – extra services, new applications, technology upgrades, and so forth. More bandwidth is, in generally, highly complementary with the inputs otherwise supplied by the network.

A spectrum cap seeks to ensure that bandwidth is made available to rival networks. Where licenses are auctioned,

Table 1. Estimated welfare gains from earlier Indian 3G licensing

Policy	Economic Magnitude	Multiplier	Social Gain	Annualized
Actual: 3G Auction 2010	$14.5 bil. (winning bids)	0.33 (tax efficiency)	$4.8 bil.	$0.5 bil.
Counter-factual: 3G licenses assigned 2005	10% pen rise in mobile broadband	0.75% GDP increase	$9.4 bil. (dollar GDP)	$9.4 bil.
			$26.3 bil. (PPP GDP)	$26.3 bil.
	10% pen rise in mobile voice	1% GDP increase	$12.5 bil. (dollar GDP)	$12.5 bil.
			$35.0 bil. (PPP GDP)	$35.0 bil.
	10% pen rise in mobile BB & voice	as above	$21.9 bil. (dollar GDP)	$21.9 bil.
			$61.3 bil. (PPP GDP)	$61.3 bil.

Figure 2. Mean mobile license auction prices, selected countries[42]



either in primary or secondary market, there is a risk that leading incumbents may cast high bids based on the prospect of above-competitive returns anticipated from the exercise of market power. Limiting this prospect may increase competitiveness for retail customers, resulting in lower prices, larger outputs, and enhanced economic efficiency.

But that desired outcome depends on how the cap actually works. As imposed, it may not really help energize competitive forces. Even where spectrum resources are diverted to rival (non-market leading) wireless service providers, they must effectively use the bandwidth in question. And because weaker firms are the targeted beneficiaries of the policy, this outcome is far from assured. Where spectrum caps inhibit expansion by market leaders, impose inefficient restrictions on the number two or number three players in the market, or divert resources to firms that do not optimally deploy them, they incur social costs that may easily outweigh any benefits in terms of protecting competition.

Lessons from US policy

The U.S. experience may be instructive. When 2G licenses were assigned, starting in 1994, the F.C.C. crafted rules limiting what wireless licenses an operator could hold. It allowed a firm to acquire mobile licenses allocated up to 45 MHz in a given market. The regulation was produced by a simple industry concentration ratio analysis. Basing market shares on capacity, and using the allocated bandwidth of licenses as proxies for capacity, the Commission determined that limiting firms to no more than 45 MHz would result in at least four firms competing in each market. It found the resulting levels of market concentration reasonably competitive.

While the 45 MHz cap was formally eliminated in 2003, regulators have authority over license assignments and can limit market concentration through approvals or denials of license transfers.[44] The spectrum cap has been, in that process, implicitly raised over time, without adverse effects. In 2004, there were six national networks. Two major mergers (AT&T Wireless was purchased by Cingular to form today's AT&T; Sprint acquired Nextel) were consummated, increasing industry concentration. What the mergers triggered, however, was highly beneficial: not only did mean price-per-minute continue its sharp decline, both AT&T and Sprint quickly embarked on 3G network build-outs. The acquisition of new bandwidth via merger was essential for these upgrades to be undertaken.

Hence, by 2006 the U.S. was served by three mobile broadband data networks. This was remarkable in that spectrum allocation authorities had yet to distribute 3G licenses. The key was that mobile authorizations had been generically liberalized; operators were allowed wide scope to determine technologies, services, and business models. This enabled network development even when regulators were slow to supply additional bandwidth. In effect, liberal rules on spectrum use, along with the rise of secondary markets, substituted for administrative allocation of spectrum.

But they were not a cost-free substitute. U.S. spectrum allocation lagged behind many Asian and E.U. countries. Had more abundant bandwidth been available to wireless networks, 3G upgrades might have occurred without a merger wave. More capacity would have been engineered into the systems built. The industry might have both achieved economies of scale and remained less concentrated.

Unintended consequences of Mexico's spectrum policy

When complex rules govern spectrum allocations, the effects are often perverse. The Mexican spectrum allocation rules are instructive. For years, regulators struggled with how to assign new bandwidth rights, grappling with – among other issues – spectrum cap rules. At least five years of delay ensued. Finally, progress was made when a July 2010 auction assigned 3 new 10-MHz licenses (2 x 5 MHz) authorized for 3G. These licenses covered the 9 regions of the country, including Mexico City, the largest and most economically important market.

Table 2. Mexican spectrum allocation (Jan. 2010)

Bands (MHz)	Service Type	Bandwidth	status
806-821/ 851-866	SMR	30 MHz	~22 MHz assigned
824-849/ 869-894	Cellular	50 MHz	50 MHz assigned
1850-1910/ 1930-1990	PCS	120 MHz	3 30-MHz licenses assigned; 3 10-MHz licenses auctioned July 2010
1710-1755/ 2110-2155	AWS	90 MHz	2 30-MHz national licenses & 3 10-MHz regional licenses also auctioned July 2010
	AWS	30 MHz	held back; to be assigned
TOTAL		320 MHz	~163 MHz in use

Concurrently, some 120 MHz of Advanced Wireless Services (AWS) spectrum (1.7/2.1 GHz) was allocated for use, and a separate auction was set to assign AWS licenses. This auction ended in August 2010. The AWS band was allocated thus:

- 60 MHz: two national licenses (30 MHz each)
- 30 MHz: three local licenses in each of 9 regions (10 MHz each)
- 30 MHz: held back for licenses to be issued later

Were all these allocations to be added to carriers' spectrum portfolios, the Mexican market would boast some 320 MHz for mobile services, endowing it with relatively liberal access to frequencies. Regulators struggled, however, with the issue of pronounced market concentration. Telcel, a firm affiliated through ownership with the dominant Mexican wireline operator, served 72% of Mexican wireless subscribers. See Table 3. Much effort was therefore spent on enacting spectrum caps.

Table 3. Mexican mobile market shares, Q2 2009[15]

	Subscribers	Market Share	% Prepaid	Growth YoY (%)
Telcel	58,081,000	72.24	92.08	9.89
Telefonica	15,942,500	19.83	94.25	12.95
Iusacell	3,547,000	4.41	68.42	-12.42
Nextel	2,834,900	3.53	0.0	16.38
TOTAL	80,405,400		88.22	9.47

The rule adopted determined that no carrier may own licenses allocated 80 MHz or more in any given market. This would effectively create a four-to-a-market rule. But the devil is in the details. In Mexico, much of the new bandwidth is supplied via national licenses, whereas the existing holdings have been accumulated with regional licenses (9 regions cover the country). When the national cap (80 MHz) is triggered in any single region, it becomes binding. Licenses cannot be split or traded in a secondary market, making the overlaps binding. Perversely, this limits not just Telcel's acquisitions, but also those of its chief rival, Telefonica.

In particular, Telefonica had been unable to supply 3G services in Mexico City (Region 9), the largest and most important market, given that only Telcel held 3G licenses there. While plans to issue more licenses were announced in 2005, not until the 2010 auction were assignments actually made. The lack of a 3G network seriously hampered Telefonica. Its larger rival, Telcel, controlled over 50 MHz in Mexico City, including licenses authorizing 3G services. Analysts examining revenue trends found that: "Telefonica is feeling the effects of being unable to compete with Telcel in high-speed data services."[46]

Yet when the 2010 auctions were finally held, Telefonica was effectively barred from bidding on half of the bandwidth offered in the dual (PCS/AWS) license auction. The spectrum cap barred it from acquiring either of the two 30-MHz national (AWS) licenses, owing to the fact that its licenses covering 52 MHz in one region, Monterrey, would put it over the cap (see Table 4).

The upshot was that rules designed to *constrain* Telcel instead *protected* Telcel by perversely restricting its major rival. In fact, the rules constrained not just the number two competitor, Telefonica, but even the struggling third network, Iusacell.

The result was that, of the 120 MHz of AWS spectrum allotted for new services, at best just one-half of the bandwidth will be put to productive use. One 30 MHz band was not offered for sale, presumably given the lack of demand under the rules adopted. The two nationwide licenses were unavailable for bidding by any of the three largest incumbent networks. Only one bidder (for either) materialized; Televisa-Nextel won by offering the minimum bid (just $14 million).[47] And that license may lie idle. Televisa withdrew from its partnership with Nextel in October 2010, throwing plans for a new network build-out into doubt.

"José Manuel Mercado, a senior Latin America analyst at Pyramid Research, a telecommunications consulting firm in Cambridge, Mass., said the end of the deal would slow the introduction of new services and help keep prices higher than they might be if there were more viable players in the Mexican market, where wireless broadband remains underdeveloped."[48]

Perhaps the one bright spot in the 2010 Mexican auctions was that, after years of regulatory lag, Telefonica was finally able to procure three 10 MHz (2 x 5 MHz) Mexico City 3G licenses. It immediately introduced 3G services in competition with Telcel.[49]

Table 4. Mexican mobile carriers bandwidth (MHz, Jan. 2010)

License Region (Main City)	Telcel	Telefonica	Iusacell + Unafon	Nextel
1 (Tijuana)	48.4	50	31.6	22
2 (Culiacán)	48.4	50	31.6	22
3 (Cd. Juárez)	53.4	50	31.6	22
4 (Monterrey)	53.4	52	31.6	22
5 (Mérida)	48.4	30	51.6	22
6 (Guadalajara)	53.4	30	56.6	22
7 (León)	48.4	30	51.6	22
8 (Puebla)	48.4	30	51.6	22
9 (Mexico City)	53.4	30	56.6	22

The exclusion of major networks (via spectrum caps or other policies) runs the risk that weak bidders will win auctions and then perform poorly as service providers. This undermines the push for enhanced market rivalry, of course, and sabotages the principal efficiency argument for using competitive bidding to assign licenses in the first place: such mechanisms tend to divert resources to the most efficient service providers. While policy makers should be careful to avoid monopoly outcomes with their allocations, they must – for the very same reasons – be careful to balance policy measures. Incumbent carriers that have developed large networks exhibit pronounced cost advantages – economies of scale and scope – and are, quite often, efficient users of incremental spectrum. Barring their access to bandwidth is not a free policy, and can easily backfire, raising prices for consumers and pre-empting the introduction of advanced services.

4. Conclusion

"Bringing broadband penetration levels in emerging markets to today's Western European levels could potentially add USD 300-420 billion in GDP and generate 10-14 million jobs. Mobile broadband is uniquely positioned to stimulate economic growth and welfare in areas that lack adequate fixed-line broadband infrastructures."[50]

Nowhere in the emerging digital economy is there a more straightforward lever for encouraging economic development than spectrum allocation policy. Regulators focused not on managing markets, but on streamlining the flow of spectrum to the competitive marketplace, will deliver great benefits.

This requires regulatory regimes that transfer bandwidth to productive users, increasing benefits for the public while maintaining rivalry in the marketplace. Reducing competitive pressures by measures such as delaying spectrum allocations, rigidly restricting licensee use of bandwidth, or designing auctions to inflate government revenues (rather than consumer welfare) are penny-wise, pound foolish. When bandwidth is abundant and spectrum is widely available to the marketplace, efficiencies obtain, prices fall, services expand, and new networks will be built. A successful regulatory focus that creates the incentives for the efficient deployment of mobile voice and broadband data services can generate exceptionally high social returns.

Notes

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2 Thomas W. Hazlett & Roberto E. Muñoz, *Spectrum Allocation in Latin America: An Economic Analysis*, 21 Information Economics and Policy 261 (June 2009), 262-3.

3 Thomas W. Hazlett & Roberto E. Muñoz, *A Welfare Analysis of Spectrum Allocation Policies*," 40 RAND Journal on Economics 424 (Autumn 2009), 431-32, 438.

4 As noted by economist Richard Thaler, discussing additional spectrum allocations in the U.S. Richard Thaler, *The Buried Treasure in Your T.V. Dial*, NY Times (Feb. 27, 2010).

5 Even spectrum that is unused for some period of time may in fact be efficiently deployed by a carrier rolling out services over time along an optimal investment path. This pattern is routinely observed with many resources. With spectrum, carriers plan technology upgrade cycles years into the future. A firm able to procure bandwidth rights will typically not seek to instantly deploy the full bandwidth. Instead, it will build network infrastructure to complement and improve its value. This will generally take months or years. In some cases, operators will intentionally wait to deploy, gaining option value. As new technologies or business models emerge, they then commit non-salvageable capital to create such infrastructure. These lags do not indicate anti-competitive withholding or "warehousing." New entrants without any anti-competitive opportunities are as likely to pursue a deliberate investment course as are incumbents. Nor do the deployment lags suggest that existing markets do not "need" more spectrum. Rather, it reveals how careful private owners are when creating creating or improving networks, keenly aware that faster build-outs are generally more expensive (or of poorer quality), and that improved technologies develop over time.

6 R. H. Coase, *The Federal Communications Commission*, 2 Journal of Law & Economics 1 (1959).

7 Ronald Coase, William Meckling, and Jora Minasian, *Problems in Radio Frequency Allocation*, Rand DRU-1219-RC (1995).

8 See, e.g., Federal Communications Commission, *In the Matter of Promoting More Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets: Second Report and Order*, WT Docket No. - 00-230 (Rel. Sept. 2, 2004).

9 European Commission, *Study of Options for Introducing Secondary Trading of Radio Spectrum in the European Union: Executive Summary* (May 2004).

10 Gregory L. Rosston & Thomas W. Hazlett, Statement of 37 Concerned Economists, Comment submitted to the Federal Communications Commission (Feb. 2001); http://reg-markets.org/admin/authorpdfs/redirect-safely.php?fname=../pdffiles/phpkx.pdf.

11 As mobile licenses were called in the Federal Communications Commission's Spectrum Policy Task Force Report (Nov. 2002).

12 Thomas W. Hazlett, *Optimal Abolition of F.C.C. Spectrum Allocation*, 22 Journal of Economic Perspectives 103 (W 2008).

13 Alex Besen, *To Be Virtually Mobile*, Telephony Online (March 28, 2005).

14 John Mayo & Scott Wallsten, *Enabling Efficient Wireless Communications: The Role of Secondary Markets*, 22 Information Economics and Policy 61 (March 2010).

15 Thomas W. Hazlett & Evan Leo, *The Case for Liberal Spectrum Licenses: A Technical and Economic Analysis*, 26 Berkeley Technology Law Journal (forthcoming, 2011).

16 Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?*, 41 JOURNAL OF LAW & ECONOMICS 529 (Oct. 1998).

17 Dallas W. Smythe, *Facing Facts About the Broadcasting Business*, 20 University of Chicago Law Review 96 (1952); William Melody, *Radio Spectrum Allocation: The Role of the Market*, 70 American Economic Review Papers & Proceedings 393 (May 1980).

18 Robert Crandall, *New Zealand Spectrum Policy: A Model for the United States?*, 41 Journal of Law & Economics 821 (Oct. 1998); Charles Jackson, *Coase and the New Zealand Spectrum Reforms*, Journal of Law & Economics (2010, forthcoming).

19 See Thomas W. Hazlett & Muñoz, "Spectrum Welfare" (2009), for elaboration.

20 *Where Do We Go From Here?* The F.C.C. Auctions and the Future of Radio Spectrum Management, U.S. Congressional Budget Office (April 1997); http://www.cbo.gov/doc.cfm?index=9&type=0.

21 The author advocated wireless license auctions prior to their enactment. See Thomas W. Hazlett, *Making Money Out of the Air,* N.Y. Times (Dec. 2, 1987); *Dial 'G' for Giveaway*, Barron's (June 4, 1990). He remains a champion of the policy switch.

22 Telecom Regulatory Authority of India, *Overall Spectrum Management and review of license terms and conditions*, Consultation Paper No. 6/2009 (Oct. 16, 2009), 3.

23 Ibid., 4-5.

24 This is sometimes stated as "2 x 50," referencing the fact that mobile licenses are typically allocated with paired bands (a "down" and "up" path).

25 Using data from MediaNama, One97 Communications, and the Telecommunications Regulatory Authority of India (TRAI).

26 Coleman Bazelon, *The Indian 3G and BWA Auctions*, paper for the Telecommunications Policy Research Conference (Oct. 1, 2010).

27 In addition, two broadband wireless access (BWA) licenses were auctioned per market. Each license was assigned 20 MHz (unpaired) spectrum in the 2.3 GHz band, for 40 MHz total. These assignments are also dominated, in general, by the bandwidth available elsewhere in 2.3 GHz, 2.5 GHz, and 3.5 GHz bands.

28 Robert Jensen, *The Digital Provide: Information (Technology), Market Performance, and Welfare in the South India Fisheries Sector*, 122 Quarterly Journal of Economics 879 (Aug. 2007).

29 Heena Jhingan, *Delays in 3G Spectrum Auction Irks Industry Players*, VOICE & DATA The Business of Communications (Jan. 4, 2010).

30 *Telecom: 3G Spectrum Auction*, Kotak Institutional Equities (March 15, 2010), 1-4.

31 Source: *Telecom: 3G Spectrum Auction*, Kotek Institutional Equities (March 15, 2010).

32 Kotak (2010), 16.

33 It should be noted that reduced license values do not always correlate to higher consumer welfare. Regulators can do many things to reduce profitability other than enhancing competitive forces. In particular, divvying spectrum allocated to licenses into smaller and smaller blocks, while making more competition possible, can also undermine scale efficiencies.

34 Kotak (2010), 15.

35 There existed very limited 3G service in India prior to the May 2010 auction. In 2009, 90% of carrier revenues were from voice. Of the 10% from data, 85% was from text messaging. *Indian mobile phone sales to increase 18.5% in 2010: Gartner* CBR Communications Mobility (July 30, 2010); http://mobility.cbronline.com/news/indian-mobile-phone-sales-to-increase-185-in-2010-gartner_300710.

36 It is possible that the net increase in broadband penetration would be lower than the increase in 3G penetration, given overlap between pre-existing broadband subs and new 3G subs. But India has extremely low broadband penetration, just 5.28 million subscribers (June 2009 ITU data; http://www.internetworldstats.com/asia/in.htm) in a population of over 1.1 billion. A 10% 3G penetration would encompass about 100 million subscribers.

37 Sören Buttkereit, Luis Enriquez, Ferry Grijpink, Suraj Moraje, Wim Torfs, Tanja Vaheri-Delmulle, *Mobile Broadband for the Masses: Regulatory Levers to Make It Happen*, McKinsey & Co. (Feb. 2009); www.mckinsey.com/clientservice/telecommunications/Mobile_broadband_for_the_masses.pdf, 4.

38 Joe Leahy and Andrew Parker, *Bharti Criticizes 'Inflated' India 3G Prices*, Financial Times (May 19, 2010); http://www.ft.com/cms/s/0/9a5fac1c-6353-11df-a844-00144feab49a.html.

39 Based on correlations over 1980-2006. *Spectrum as an Economic Resource*, ICT Regulation Toolkit, International Telecommunications Union website (visited July 31, 2010); http://www.ictregulationtoolkit.org/en/Section.2659.html.

40 There are annual fees paid by licensees in addition to license bids. In essence, all countries collect taxes (and most, additional fees) from operators on an ongoing basis, and auctions are not needed for the purpose.

41 Quoted in Leahy & Parker (2010).

42 Data generally from Thomas W. Hazlett, *Property Rights and Wireless License Values*, 51 Journal of Law & Economics 563 (Aug. 2008); augmented by data from KB Spectrum website (visited July 13, 2010), http://kbspectrum.com/blog/?page_id=348.

43 It might be noted that real estate prices in some major cities in developing countries exceed prices in, say, Kansas – an outcome that may reflect simple scarcity rent differentials. But that comparison does not explain the license price comparison here, in which national average values are the object of comparison.

44 "The FCC eliminated the per se limit on the aggregation of Commercial Mobile Radio Services (CMRS) spectrum effective January 1, 2003. The FCC's spectrum cap rule restricted the amount of broadband CMRS spectrum an entity could hold or have attributed to itself in a particular geographic area. The rule applied to licensed broadband Personal Communications Service (PCS), cellular, and Commercial Specialized Mobile Radio (SMR) spectrum. Instead of the bright-line rule limiting the amount of spectrum to preserve competition, the Commission opted going forward to analyze the competitive effects of transactions involving mobile telephony service providers on a case-by-case basis." F.C.C. website; http://wireless.fcc.gov/spectrum/index.htm?job=spectrum_cap (visited Oct. 19, 2010).

45 *Mexico Looks to Stimulate Mobile Market Through 3G Auctions*, Wireless Intelligence (Sept. 3, 2009); http://www.mobilebusinessbriefing.com/article/mexico-looks-to-stimulate-mobile-market-via-3g-auctions.

46 Ibid.

47 "Spectrum caps and other requirements imposed by the Federal Competition Commission meant that only the Televisa-Nextel consortium could bid for one of the two nationwide licenses. Cofetel annulled the sale of the second nationwide license." Ken Parks, *Mexico Awards National Wireless Licence to Televisa Consortium*, Total Telecom (Aug. 17, 2010); http://www.totaltele.com/view.aspx?ID=457949.

48 Elizabeth Malkin, *Negotiations Fall Apart for Telecom Deal in Mexico*, N.Y. Times (Oct. 18, 2010); http://www.nytimes.com/2010/10/19/business/19nextel.html.

49 Ken Parks, *Mexico's Megacable inks wireless deal with Telefonica*, Total Telecom (Aug. 26, 2010); http://www.totaltele.com/view.aspx?ID=458136.

50 McKinsey & Co (2009), "Mobile broadband for the masses: Regulatory levers to make it happen", February 2009, p.3.

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Rethinking mobile regulation for the data age

Overview

One of the key drivers for the mass adoption of mobile phones has been the reduction in costs for low-usage subscribers. This has been the result of efficient pricing in the two-sided mobile market – in other words, the interaction of retail charges for outgoing calls and wholesale inter-network charges for incoming calls. This pricing structure for voice calls has enabled mobile operators to cushion low income subscribers from the full cost of mobile subscription and usage. As a result, subscribers have been able to get their mobile service at low or no cost, and able to receive voice calls without having to pay.

However, the affordability for mobile voice thanks to the two-sided charging structure does not apply to mobile broadband. There is a fundamental difference between the data and voice markets: unlike voice, where mechanisms exist to divide charges between both sides of the market, at present the cost of data is recovered from one side of the market only – the data user. This adversely affects the affordability of mobile services.

We argue that until mechanisms develop to charge both sides of the mobile data market, the key challenge for regulators is how to harness the successful two-sided pricing for voice service to ensure the successful spread of mobile data services. Regulators need to abandon their current 'silo mentality', which ignores the fact that their decisions on one of either voice or data will have an impact on the other.

This rethink needs to accommodate the fact that mobile termination rates affect the incentives for mobile operators to invest in networks that will support the future growth of data services, and the much greater capacity they require, and to do so without significantly jeopardising the affordability of voice services.

This is a much tougher task in emerging markets where consumers' incomes are constrained, regulatory capability is often more fragile, and mistakes are harder to retrieve. However, finding the right set of policies to keep mobile data services affordable in the short to medium term is a key challenge. In the longer term, developments in the two-sided pricing of data services may produce different outcomes, but their contours are not yet known.

The outline of this paper is as follows. Section 1 outlines the two-sided nature of mobile markets and show that the pricing structure matters for efficient use of mobile telephony. Section 2 describes the pricing structure and highlights the growth of mobile telephony in emerging markets. Section 3 describes the pricing structure on mobile broadband and how it differs from voice pricing. It sets out the interdependency in pricing voice and data via the regulation of termination rates, and the degree to which the so-called 'waterbed effect' operates. Section 4 looks at the effects or pricing structures on the growth of mobile data services. It ends with some proposals for regulation of both services that will enable mass take-up of affordable mobile broadband.

1. The two-sided nature of mobile markets

In two-sided markets, two distinct groups of consumers who need each other rely on a platform to intermediate transactions between them.[2] A famous traditional example of the 'platform' is the village matchmaker. A more modern one is the payment platform which allows purchasers of goods with credit cards to interact with stores selling those goods.

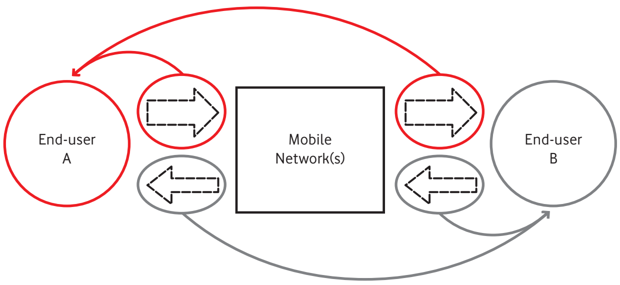
A telecommunications network is two-sided in the sense that the calling and the called party need each other to accomplish their communications (though they may alternate roles). And, as with other examples, there is a network effect – the more people there are on the platform, the more valuable the platform is to each of them.

The key pricing lesson from analysis of two-sided platforms is that who pays what is important in determining the amount of traffic. Not only should the overall level of prices be set efficiently, but the burden of cost-recovery across the two sides of the market should also be set efficiently.

Two-sided analysis in the context of the mobile market has typically focused on voice traffic, and the interaction between incoming and outgoing calls. With the network acting as the platform between the calling party and the receiving party, the relevant pricing issue was what structure of pricing to initiate calls and to receive calls was most efficient. In the context of a balanced calling pattern (in which every subscriber makes the same volume of calls as he or she receives), this structure does not matter so much. However, different subscribers initiate and receive differing volumes of calls: in particular, low-spending customers typically receive more calls than they make.

With such calling patterns, it may be more efficient to place a higher burden of the total cost of the call on the party who is best able and willing to incur the costs. This is the feature of the calling-party pays (CPP) pricing system shown in figure 1, where the full cost of the call falls on the party initiating the call – there is no charge to receive calls. To facilitate this (for calls going across networks) wholesale payments called mobile termination rates (MTRs) are charged by the terminating network to the originating network to compensate it for the costs incurred in terminating the calls.

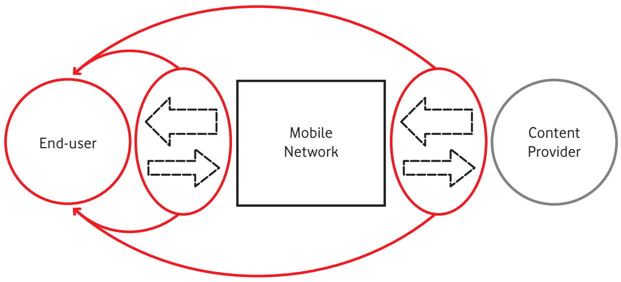
Figure 1. Voice market – calling party pays



The data market, however, is charged in a different manner (see figure 2). All the network costs of data are recovered by the end-user – both uploaded and downloaded data. When someone is sent an email, the end-user is charged to download and access it. Similarly, when the end-user sends an email she is charged. Every time a website is visited the full download and upload costs are recovered from the end-user.

Failure to adopt efficient price levels and structures for both the end-user and the content provider will prevent many emerging market end-users from being able to afford mobile data access.

Figure 2. Data Market – current charging regime



The mobile industry would, by itself, probably move to a more efficient structure of charging. This may involve sharing the cost burden between content user and a content provider that finances its content in part by selling advertising or by 'sponsored access.'[3] Or different tiers of service may be offered, exemplified by Facebook zero (0.facebook.com), which allows access free of charge to a lightweight site omitting photos but included core functionality.

However, until 'smart charging' is widespread, and adopted by content providers, it is likely that most costs will continue to be recovered from end-users. In emerging markets, with very price sensitive end-users, it is desirable to take steps to prevent the worst consequences of this inefficient pricing structure across both sides of the two-sided data market.

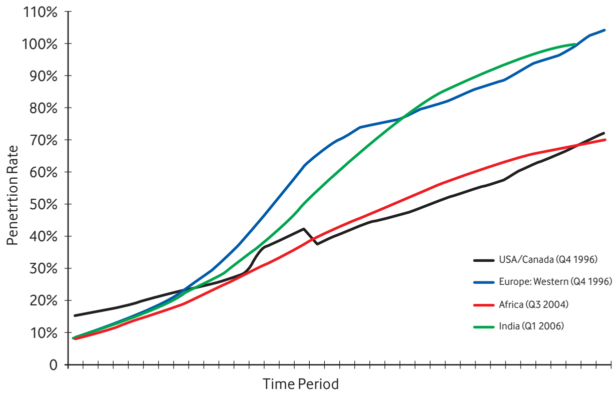
2. Pricing and mobile growth in emerging markets

Mobile voice telephony is one of the wonders of the world. In the past 20 years, take-up has grown from a few millions to five billion now. This phenomenon was not generally foreseen: McKinsey famously forecast in 1990 that the number might reach one million by 2000. But grow it did, to a level where about 80% of the world's population are connected.

Arguably one of the most significant global impacts of mobile telephony has been the way it has enabled people in developing countries to bridge the digital divide and have a personal telephone connection. This is an outcome that would be impossible relying solely upon fixed line connections. Across Africa, Latin America, the Middle East and Asia, the mobile phone enables the mass market to achieve telephony services.

This has resulted in a unique parallel growth in mobile penetration between developed and emerging markets – in other words, that growth has occurred at roughly the same rate. While the growth in the market may have begun at different times (due to different rates of market licensing and liberalisation) once growth begins, subscribers in emerging markets have embraced mobile services at the same rate as seen in developed markets.

Figure 3. Comparative growth in mobile penetration



Source: Wireless Intelligence. Western Europe and North America penetration rates are actual; Africa & India data are a mix of actual and forecast values.

Figure 3 compares the growth in the rate of mobile penetration for Western Europe, North America, Africa and India, in the period after each region/country achieved the same starting penetration rate (~8%). The pattern after those starting dates, shown in the figure, has been remarkably similar. For example, Indian penetration is predicted to reach 100% at the same speed as was seen in Western Europe; and similarly, Africa is predicted to achieve 70% penetration within the same time period as North America did. Few other products can claim such similar growth rates among countries with such varying levels of income and wealth.

A key feature of CPP is subscription-free SIM ownership, which gives subscribers the ability to remain on the network and receive calls at no expense to themselves. This is possible because the wholesale charging regime for incoming calls (mobile termination rates) allows operators to recover the costs of the termination leg (as well as the origination leg) from the caller's network.

In recent years, there has been a lot of discussion in relation to voice services concerning the linkages between the wholesale and retail charges – between the retail price of outgoing calls, whether to the same network (on-net) or another (off-net), and the wholesale charge for termination.[4] The question has been phrased in terms of what's become known as the water bed effect: if there is an increase in the price of one service provided by an operator (say, mobile termination), do competitive pressures force down the prices of other services such as outgoing calls or handsets supplied to the customer?[5]

The distribution of revenue between retail charges (recovered from an operator's own subscribers) and wholesale charges (recovered from other networks) is an important factor in the growth of mobile subscriptions. Several studies show a positive correlation between the level of wholesale payments and the level of penetration.[6]

It is worth explaining the mechanism through which this occurs. In developed country markets during the last decade, the vast majority of incoming calls to mobiles came from the fixed network (usually owned in common with one mobile network). Mobile operators could set their own termination rates, while those levied by fixed operators for calls flowing in the opposite direction were regulated to something approximating their cost. This made fixed-to-mobile calls expensive, and was *de facto* a substantial transfer of resources from fixed to mobile networks.[7]

This transfer enabled mobile operators to reduce their retail rates (either airtime or rental charges), making mobile subscription more affordable and increasing mobile penetration. But over time in the EU this transfer from fixed operators has been reduced as mobile termination rates were regulated down to a current average of around €0.05 per minute. Termination rates in the EU are likely to fall considerably further over the next few years, from roughly €0.05 to €0.02 per minute, or less.[8] One argument for the continuing regulated decrease in the level of termination charges was that the need to assist mobile subscription growth through higher wholesale revenues (and hence lower retail subscription charges) no longer applied in Europe, where mobile ownership has reached saturation level.

The situation in emerging markets is different. Typically, they have a significantly lower level of fixed line connections, with mobile networks the main supplier of connectivity. What's more, the lack of affordability is a key impediment to the uptake of mobile services.

Even so, the growth in mobile penetration has been staggering, with penetration rates in India of about 55% and in Africa of 50%. Mobiles have also been put to work to do other things than voice calls, notably mobile payments. But while the growth has been extraordinary, there remains significant potential for further growth. Growth up to now has been largely led by the richer urban population (following traditional mobile diffusion patterns), and also through ownership of multiple SIM cards. Extending mobile ownership to low income and rural areas is likely to be more problematic and will be greatly influenced by market characteristics and government policies.

Emerging market regulators are faced with an apparent dilemma: how to extend coverage to rural areas (which requires significant and costly network investment) while ensuring that the poorer rural populace can afford the services?

Thus in developing countries, coverage issues loom much larger. The business case for extending coverage is most immediately sensitive to the level and structure of likely revenues. In marginal rural areas, where more traffic flows in than out (reflecting the income disparity between city and countryside), termination revenues can tip the balance between the financial viability or otherwise of investing in network extension. It is essential that the relative willingness to pay on the part of both sides (the more wealthy urban and less wealthy rural) in the two-sided call market be reflected in the prices that prevail. The consequences for network investment of an inappropriate pattern of price regulation (in both the retail market and call termination market) can be considerable. Yet regulators can be tempted to overlook the inter-dependence of the different charges.[9]

A sample of regulated termination rates in emerging economies is given in Table 1. Many regulators are, roughly speaking, replicating the method of setting rates used in the European Union and elsewhere in the period up to the publication of the European Commission's Recommendation in 2009 (the LRIC+ method, described in section 4 below),[10] in which the burden of common costs is shared equally by all services.[11] But a few – notably including Kenya, which halved its rates in August 2010[12] – are adopting the European Commission's revised 2009 methodology (known as pure long run incremental cost or pure LRIC) which includes no common costs. The South African regulator has broadly used a costing method known as fully allocated cost (FAC), which is closer to LRIC+ than to pure LRIC, since termination charges embody a full share of common costs.[13]

Table 1. Mobile termination charges in selected emerging economies

Country	Target Rate (USD cents)	Target Year	Cost Method
South Africa	5.5	2013	FAC
India*	0.4	current	Opex-only
Brazil**	19.2	2012	Uncertain
Kenya	1.2	2013	Pure-LRIC
Botswana	4.1	2013	LRIC+
Tanzania	7.2	2012	LRIC+
Indonesia	2.9	current	LRIC+

* Following a successful appeal by operators, the Indian regulator must amend MTR to take into account capital costs. ** Based on Q1 2010 MTR of 24c, and 10% reductions in 2011 & 2012, as per Anatel Public Consultation No.37.

Thus regulators in developing counties have shown an increasing appetite both to regulate mobile termination charges, and to follow European regulators in bringing rates down to reflect a very parsimonious estimate of incremental costs. On the face of it, this is beneficial for consumers as it lowers certain charges. However, the interdependencies discussed above mean this regulatory approach has unintended consequences. Developing country regulators are not too late to recognise the likely impact of their decisions on operators' incentives to extend geographical coverage and to add new broadband services, discussed in the next section.

3. Pricing structure of mobile broadband

The calling party pays (CPP) pricing structure for mobile voice services enabled a transfer of funds from high usage customers to low usage customers via wholesale termination payments, a pattern which has helped the rapid and successful diffusion of mobile services in emerging markets.

The prevailing pattern for mobile broadband charging is different. As described above, subscribers are charged to both receive (download) data and send (upload) data. Broadband charging utilises a charging system with no corresponding wholesale termination payment – all costs are recovered from each subscriber.

For example, a mobile-to-mobile Voice-Over-IP (VOIP) client call is treated as a data stream. So that for each minute of VOIP usage, both calling and receiving subscriber are charged respectively the cost of sending and receiving voice packets over their networks. Assuming standard VoIP codecs[14] are used we can estimate the cost to make and receive a minute equivalent of voice call.[15] Using at the cheapest internet prices available in South Africa[16] by the two main operators, one minute of VoIP conversation uses data costing between ZAR0.14-0.18 (around US$0.03).

One can see that this charging pattern is likely to be attractive to people making many calls, as the cost is shared between the caller and the receiver. But the receiving party faces data charges, whereas for a traditional voice call the receiving party will incur no charge. So for subscribers who receive calls, but do not make any, the cost of communication will increase significantly.

Internet browsing is charged in the same manner, with the subscriber incurring the full cost of access to receive and to send data packets. Under current internet charging regimes there is no mechanism for wholesale charges between the mobile network and the provider of content – the full costs rests with the subscriber not the content provider.

Subscription and cost of handset are also prices which dictate the affordability of mobile services. As explained above, in most emerging markets subscription for voice services is available free of charge and in additional the cost of a basic phone for voice and SMS services is also quite low. A basic phone, such as the Vodafone 150, can be purchased unsubsidised for less than US$15.

We can compare the cost to acquire a handset and to receive say 100 minutes of calls a month. Using standard voice communication, the subscriber would have to pay less than US $15 for a handset and would incur no usage fees. On the other hand, if the communication was made through VoIP, one would need to acquire a more expensive handset to utilise 3G technology (around US$50) and would be charged to receive the 100 minutes of VoIP, which would cost around US$3.

One can see how such a fundamental change in the pricing structure could have significant impact on the affordability of mobile telephony. If data were the only service provided, such pricing would likely limit the ability of low income subscribers to afford mobile subscriptions. However, data is only one service of several – and many low income subscribers remain voice-only subscribers. The challenge in many emerging markets is how to design efficient pricing for all mobile services and still ensure diffusion of services to high cost rural subscribers and to low income, low usage subscribers everywhere.

We have already noted the academic and regulatory debate about the interaction between wholesale and retail voice charges. Less attention has been paid to the optimal pricing of mobile broadband. And even less attention has been focused on pricing between wholesale voice, retail voice and mobile broadband. The key challenge is to replicate the affordability cushion for mobile data services. The next section looks at this issue.

While the pricing mechanism may not exist within data services to allocate costs efficiently across both sides of the market, it might be possible to remove some of the data cost burden from end-users through efficient multi-product pricing. Operators offering mobile voice services have always been 'multi-product' firms, providing outgoing and incoming calls, as well as other services such as SMS messaging and handsets.

It is a feature of multi-product firms that some costs are common across some, or all, of the firm's products. That is particularly the case for mobile networks where all of the services use the vast majority of network assets – originating voice, terminating voice, SMS, broadband, etc. For example, towers (a significant cost component of a mobile network) support equipment which can be used to provide either voice or broadband or SMS. There is no concept in mobile engineering of a voice tower or a broadband tower.

A recent regulatory cost model estimates that around 43% of total network costs are common – that is, cannot be causally attributed to any one service, and thus do not fall within the pure LRIC of any service. The percentage reflecting common costs is higher with stricter definitions of incremental cost. Such a large component of common costs could enable operators (and regulators) to create an affordability cushion for data services, if common costs were allocated appropriately.

The component of common costs in contemporary 3G networks is large. This is because the 'coverage network', which creates the conditions in which services can be provided over an extended geographical area, currently accounts for a high proportion of total network costs. The frequencies used for 3G networks normally require a large number of base stations to provide coverage, and these are quite likely to have excess capacity. As they fill up with more data traffic, though, the weight of the coverage network will diminish. This is important because the coverage network counts as a cost which is common to all services. This effect can be seen in Ofcom's recent calculation of voice termination costs on two alternative bases, pure LRIC, which excludes common costs, and LRIC+, which includes them.[17] The cost per minute for voice termination is 1 US cent for pure LRIC and 2 cents for LRIC+. Over time the gap will narrow as the pure LRIC cost rises.

These considerations leave much leeway over the allocation of costs within a mobile network, whether for the purposes of business planning or regulation. Absent regulation, multi-product firms subject to any degree of competitive pressure would probably set prices for individual services somewhere between short run incremental costs and stand-alone costs. In a mobile network, this is a significant range of possibilities. If competition were strong, the firms would 'distribute' common costs so that the impact of charging above marginal costs would have the smallest impact on volume sold.

Such pricing would maximise the firm's revenue – or put another way, would minimise the loss due to the need to charge above marginal cost to recover common costs.

The introduction and growth of mobile broadband raises new 'waterbed' possibilities between voice charges (that is, both termination charges and retail rates) and the prices for data. And it also introduces the possibility of pricing data at an affordable level. So how will the price of mobile broadband react when revenue for voice services declines; and what levels of the three sets of charges will best promote penetration and usage?

In addition, there is a question as to how the effect on demand of a change in voice charges is split between data and other non-voice services (such as SMS). When data services are in their infancy, it may be that the 'transfer' of even a small proportion of common costs could have a large effect on data prices. These questions are likely to have significant impact on affordability of mobile subscriptions in developing markets.

Yet the curious thing about some recent regulatory decisions, such as the European Commission's Recommendation and the recent decision by the Kenyan regulator,[18] is that they do not mention mobile broadband at all.[19] As far as these decisions are concerned, voice might as well be the only service provided. This is clearly unsatisfactory.

4. Pricing unregulated mobile services

Around the world, mobile services are subject to either direct or indirect behavioural and structural regulation. Wholesale mobile termination is the most widely and heavily regulated price. In many emerging markets, the structure and/or level of outgoing call prices are also subject to differing levels of regulatory controls, via rules on discriminatory pricing, rules as to the level of on-net price discounts, rules regarding notification and/or approval of tariff changes, and rules regarding the licensing regime, which affect the number of networks, licence areas, coverage obligations, MVNO access, and carrier pre-selection.

Here we focus on the interaction of these controls, and in particular on the impact on the price of mobile broadband services of the level of cost recovery permitted, directly or indirectly, through voice services. This is an issue not yet fully developed by regulators.

It is useful to start by considering as a benchmark how voice and data services would be priced in relation to one another in a fully competitive market, where the operator incurs common costs. An operator breaking even in such a situation is likely to choose mark-ups over marginal/incremental costs that are inversely proportional to the sensitivity of demand for the service to its price. This is because lowering charges for price-sensitive services has a large positive effect on revenue. A lower mark-up over marginal cost for a price sensitive product has a smaller distorting effect on the allocation of resources, so it is also improves social welfare. Such pricing is known as 'Ramsey pricing', when revenues are calibrated just to cover costs.

So far, in the early days of their supply, data services have probably been charged at something roughly equivalent to marginal cost. If mobile networks have excess capacity, as many 3G networks did prior to the current boom in data subscriptions, the marginal or incremental costs of the new service were probably low. As long as prices cover incremental costs, then the service is not, on standard economic definitions, being cross-subsidised. However, as the network fills up with data, and more investment is required, these prices will be unsustainable. They may cease when new network investment is required.[20]

Mobile broadband, as a new service, is likely to be more price sensitive than mobile voice. For this reason, operators will want to price their mobile broadband competitively. Operators may be willing to persist in doing so in combination with low termination rates and outgoing call prices in the early, 'land grab', phase of recruiting customers, but this is not a sustainable long term proposition. Over that longer term, the trade off between voice and data price will become more acute. There are indications that the 'land grab' phase of mobile pricing is already coming to an end in some emerging markets. In any case eventually some operators will exit and prices will restore the remainder to a break-even position.

We can use a thought experiment to show the role common cost allocation plays in the pricing of regulated mobile services (and hence indirectly in the pricing of unregulated services too) through publicly available LRIC cost models. Ideally we would prefer to use a LRIC model which has been calibrated to suit emerging markets, but such models are not public. So for now we use the recent public cost model prepared to enable the Dutch regulator (OPTA) to set mobile termination rates.[21] This is typical of the models used by regulators in many markets to determine the cost of services – in the Dutch example it was used to set prices of mobile termination rates. The same methodology can apply to the regulation of other services such as SMS termination.

In our thought experiment, the costs being discussed are efficiently incurred annual costs that the regulator has accepted can be fully recovered over the lifetime of the network. Taking account of depreciation, this means that the annual network costs allocated in each year must be fully recovered across the various services provided in that particular year.

In the model, common costs make up 43% of total costs – in other words, 43% of total efficient costs are not directly attributable to any one service. Under the LRIC+ allocation method (see above), common costs are allocated as an (almost) equal percentage mark-up over the incremental cost, as shown in table 2.[22]

Table 2. Percentage of common costs in total cost allocation[23]

	2010	2011	2012
Subscriber	24%	24%	24%
Voice	43%	44%	44%
SMS	24%	25%	25%
Data	44%	44%	43%

It is important to be clear about the nature of the thought experiment here. We are not saying that prices for data or voice services in 2010 or 2012 are or will be equal to incremental cost plus the regulator's allocation of common costs. Instead, we are calculating what effect a switch in common cost allocation would have on 'cost-based' prices.[24] This might not be a good guide to actual business decisions, but it indicates the menu of choices facing an operator when it comes to set voice and data prices when there is a strong water-bed effect.

To demonstrate the impact of common cost allocation decisions on the unit costs allocated to data, we first show in table 3 the effect of allocating all network common costs to data. The costs of non-data services (subscriber, voice and SMS) all fall, and we see that the cost allocated to data increases by 138% in 2010 and 105% in 2012. That is, allocating all common costs to data would more than double the cost per megabyte.

Table 3. The effect of allocating 100% of common costs to data

	2010	2011	2012
Subscriber	-24%	-24%	-24%
Voice	-43%	-44%	-44%
SMS	-24%	-25%	-25%
Data	138%	117%	105%

The next thought experiment is to allocate no common costs to voice, so that all voice services are set to their incremental cost (pure LRIC). As can be seen in the table 4, the cost allocated for subscription and SMS more than doubles in 2010 through to 2012. The cost allocated to data increases by 113% in 2010 and by 90% in 2012, when the effect will be slightly muted by higher data volumes.

Table 4. The effect of allocating no common costs to voice

	2010	2011	2012
Subscriber	133%	118%	108%
Voice	-43%	-44%	-44%
SMS	133%	118%	108%
Data	113%	99%	90%

These calculations clearly demonstrate the possible consequences of the "waterbed" effect. So the key question for a regulator when reducing (or indirectly influencing) voice prices is whether the shifting of costs to other services will improve social welfare.

An important caveat to the above results is that the distribution of costs reflects the actual and projected levels of data usage in the Dutch market. This is much higher than the level of usage currently seen in most emerging markets, whose mobile data markets are immature. Halving the data usage in the original Dutch model has a significant impact on the cost allocated to data.

In the original model, the LRIC+ cost of data ranged from €0.063–0.077. Halving data volumes increases the per MB cost to €0.10–0.12. If, on top of this, all common costs are allocated to data, as Table 5 shows, those allocated costs can rise fourfold in the first year, falling to threefold when data volumes rise.

Table 5. Allocating 100% of common costs to data, at 50% of the previous volume

	2010	2011	2012
Subscriber	-24%	-24%	-24%
Voice	-43%	-44%	-44%
SMS	-24%	-25%	-25%
Data	420%	360%	322%

Our exploration of the impact of reallocating common costs across voice and data services within our break-even world is not intended to be a forecast of what will happen in response to regulatory interventions. But in conjunction with the previous analysis it does show that the universe of possibilities includes some which are adverse in two ways: first by reducing the affordability of voice to poor subscribers; and secondly by loading costs by default onto data services.

5. Conclusions

The spread of mobile voice services to reach to the mass population in emerging markets has been one of the greatest developmental success stories. This success can be put down to liberal licensing and regulatory regimes, allowing new entry and efficient pricing through competition.

One of the key drivers for the mobile phone moving beyond a service for the rich elite has been the affordability cushion created through the interaction of retail charges for outgoing calls and wholesale inter-network charges for incoming calls. This pricing structure for voice has enabled mobile operators to cushion low income subscribers from the full cost of mobile subscription and usage. As a result, subscribers have mobile service at little or no cost, and have the ability to receive voice calls without charge.

This chapter has argued that regulators must think carefully how to price mobile services to ensure the new data services are affordable, especially in emerging countries. Affordability is particularly important in these countries, where the penetration of data services is low, and there will need to be considerable investment in networks to extend coverage to lower income and rural consumers. The interdependence between voice and mobile broadband services is of greater importance to emerging economies precisely because they will have to rely almost entirely on wireless to accomplish their broadband transition.

The interdependence derives from a medium or long term 'adding up' constraint on mobile operators' revenues. To stay in business or justify new investment, they have to recover their common network and other costs within their overall revenues. If a network cannot recover any of those common costs on their regulated services, such as mobile termination charges or (to the extent that they are regulated) retail voice prices, then they will have to charge more for other services, notably mobile broadband.

This constraint does not operate on a year-to-year basis but takes account of competitive pressures in the market place and of the point in the diffusion cycle of the different services. But, in the medium run, there will be such an effect.

Perhaps more important for affordability is that, unlike voice services, mobile broadband users are charged to both send and receive data such as when a VOIP call is charged under RPP charging. This is in contrast to the CPP charging of traditional voice services which has encouraged the widespread penetration of mobile voice services.

There is no hard and fast rule which will tell regulators what to do in these circumstances. They will have to assess supply and competitive conditions in their own voice market and in their fledgling broadband market, and take account of how central a priority relative affordability of voice and data services is in their case.

The key point, though, is that regulating services within a "silo" mentality is likely to dent the affordability cushion for low usage low income subscribers as markets move into a data-focused world. Such an outcome is unlikely to improve welfare, especially in emerging markets where mobile networks will be the primary network through which broadband will be delivered to consumers.

Notes

1 The authors are grateful to the editors, and to Luke van Hooft for help with the cost calculations and other matters.

2 See, for example, OECD, Two-sided markets, DAF/COMP(2009)20, December 2009, available at www.oecd.org/dataoecd/38/61/44445730.pdf

3 This prospect is part of the 'net neutrality' debate, which we do not consider here.

4 For simplicity, in this account we abstract from charges for other services such as roaming and the provision of handsets.

5 In theory, the waterbed effect can be anything from zero to a complete offset – it depends on the degree of competition in the mobile market. Genakos and Valletti have examined the question empirically, on the basis of charges levied by European operators gathered from a variety of data sources. They concluded that, on average, a 10% decrease in termination charges causes callers' bills for outgoing calls to rise by 5%, so the waterbed effect is 'strong but not full'. This common sense conclusion is consistent with the mobile sector in Europe exhibiting a degree of rivalry among operators, but falling short of perfect competition. It also explains why operators are concerned about the impact of reductions in termination charges on their profits.

6 See P Alexander, A Candeub & B Cunningham, 'Network growth: theory and evidence from the mobile industry' Information Economics and Policy, 2010, pp 91-102.

7 According to O Bomsel, M Cave, G Le Blanc and K-H Neumann , *How mobile termination charges shape the dynamics of the telecom sector*, 2003, this transfer amounted to €19bn in France, Germany and the UK over the period 1998 to 2003. Some of it may have been recycled to Governments in spectrum licence fees paid in the 3G auctions in 2000/1.

8 Commission Recommendation on the Regulatory Treatment of Fixed and Mobile Termination in the European Union, 2009.

9 The clearest example is that of India, where the termination costs recoverable in charges not only fail to recover common costs, but exclude all capital costs too. See judgement of the Indian Telecom Disputes Settlement & Appellate Tribunal, [*Vodafone Essar & Ors v, TRAI & Ors*, Appeal No.4 of 2009, 29th September 2010] which criticised decision of TRAI to lower MTR without consideration of impact on rural investment and ability to achieve National Telecoms Policy.

10 See fn 6 above.

11 Common costs are costs which cannot be attributed on a causal basis to any particular service. They include overheads such a shared office costs in all businesses. In the mobile sector, a s explained below, they are often taken to include a basic 'coverage network' which provides a minimum level of service over the operator's area of service.

12 Communications Commission of Kenya, *Interconnection Determination No 2*, August 2010.

13 ICASA, Statement by ICASA Councillor Thabo Makhakhe on the release of final call termination regulations, 29 October 2010.

14 Standard VOIP codec is around 8kbps (G.729 or SVOPC).

15 Equal to one channel for one minute = 1 erlang. We have to allow for caller to make and receive the conversation. We assume this requires two simultaneous data flows – one sent and one received.

16 MTN is the Internet Low Package, which for a free of ZAR15 provides 10MB usage. Vodacom is the MyMeg8, which for ZAR9.25 provides 8MB of data.

17 Ofcom, Wholesale Mobile Call Termination Review, April 1 2010.

18 Communications Commission of Kenya, *Interconnection Determination No.2 of 2010.* August 2010.

19 Except, in the case of the Commission's Recommendation, to say that common costs should be attributed to it before they are attributed to mobile termination There is only one reference to investment as well,

20 To the extent that operators are spending to acquire customers for the long term, they may sell data service at below cost. But lower voice termination charges reduce both the value of additional customers and the funding to acquire them.

21 OPTA, Voice terminating regulation, 7 July 2010, available at http://www.opta.nl/nl/actueel/alle-publicaties/publicatie/?id=3224

22 The actual model provides for the following mark-ups in 2012: 2G network elements 48.9%; 3G network elements 52,7%; shared network elements 32.2%. The common cost mark up for a specific service reflects the mixture of network usage of the above broad network categories.

23 Percentages shown are below the mark-up percentages as these are percentage of total value – not percentage mark up over incremental costs. So that a 32.3% mark-up results in 24% of total costs to be common.

24 Because these are not forecast prices, quantity adjustments are not made.

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Building next generation broadband networks in emerging markets

1. Overview

This paper assesses the economic viability of fibre and wireless next generation broadband networks in the light of the very different economic drivers between developed and emerging markets.

Next generation broadband networks (NGN) refer to a new network structure which is in effect based on Internet Protocol (IP). These NGN networks are capable of providing fast, always on, broadband services and being easy to reconfigure to meet changing consumer demand.

In some OECD countries there are live plans to deploy NGNs with fibre providing the last-mile access. This entails overlaying and ultimately replacing the existing copper fixed last-mile access networks with fibre.

In emerging markets, the debate on NGN investment has been influenced by the World Bank's recommendation to invest in wide-scale fibre backbone networks.[1] One example is the Kenyan National Fibre-Optic Backbone network. However, such investments (while still largely beneficial and to be encouraged) do not address the critical issue which is how end-users can have economical access to the speed and capacity of the fibre backbone network.

This paper looks at the economics of fibre and wireless access networks. Fibre and wireless access architectures require the same fibre backbone transmission and modern IP core networks. The key difference is the technology through which end-users are connected – either a fibre connection to their home or through wireless technology.

In order to enable meaningful comparisons between the existing OECD-focused cost models and business cases and the commercial environment in emerging markets, we use the concepts of income density and cost per km^2. NGN investment will occur up to the point at which the marginal cost of covering the next unit of area (cost per km^2) equals the achievable marginal revenue from customers in that area (a proportion of income density). The paper goes on to estimate the economics of fibre and wireless access networks across three Indian States (Maharashtra; Karnataka; and Rajasthan).

The results show that:

- NGN deployment through fibre access lines would likely be limited to the largest cities only. We find that fibre roll-out would be economically viable in only 3% of districts in Maharashtra, Karnataka and Rajasthan.
- Wireless broadband access networks enable a much more extensive broadband coverage. We find it is economically viable to provide wireless broadband coverage to 98% of districts in the three states.
- The higher data throughput enabled by fibre is only needed for very high demand applications such as on-demand high definition IPTV. Almost all consumer and business services can be provided through wireless access. Whether the benefits of higher throughput to consumers and businesses warrants the massive incremental investment needed to deliver fibre access networks is a critical question.
- Actual deployment is likely to be a hybrid wireless-fixed access network. This would comprise a fibre optic backbone network and fibre optic access links deployed to economically significant urban areas such as business districts and institutions, hospitals, and large businesses. Mass-market deployment of fibre (i.e. to every household) will not be viable and access is most likely to occur through wide-scale wireless.

The paper is structured as follows:

- Section 2 identifies the drivers of NGN fibre investment, looking at three parts of the network, the core, the backbone and the access networks;
- Section 3 identifies the cost drivers of the fibre access network;
- Section 4 analyses the variations in cost drivers between OECD markets and emerging markets;
- Section 5 highlights the different economic fundamentals in emerging markets as opposed to OECD markets;
- Section 6 assesses the viability of NGN fibre investment in emerging markets;
- Section 7 assesses the deployment of wireless access broadband networks in emerging markets; and
- Section 8 concludes.

2. Identifying the drivers of NGN fibre investment

Most policy discussions about NGNs in OECD and emerging markets assume the need for fibre investment to provide next generation broadband services. But little consideration has been given to the actual architecture of the networks, still less the cost drivers of this investment. This section summarises the architecture options and examines the cost drivers of fibre investment.

The architecture for a next-generation network can be divided into three broad categories: the *core* network; the *backbone* or concentration network; and the *access* network.

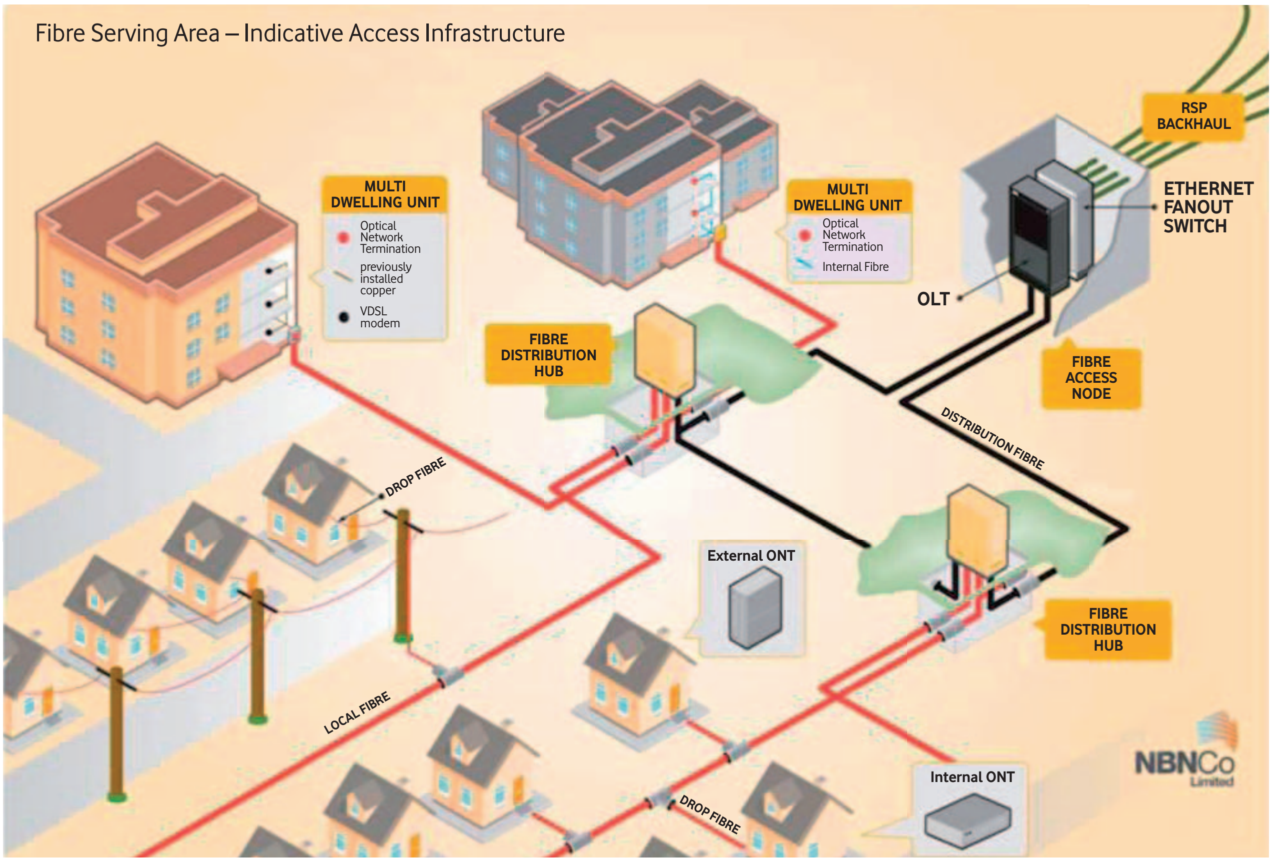
The technology options for the core and backbone/ concentration networks are relatively generic. They consist of an IP core with high capacity optic-fibre backbone links to a central office (or an equivalent aggregation node / exchange). The core and backbone networks are the same across both fibre and wireless NGN options.

The difference between fibre and wireless networks centres on the access network.

There are two commonly discussed options to connect end-users to the central office/exchange: Fibre to the Cabinet (FTTC); and Fibre to the Home (FTTH).[2] This paper focuses on FTTH technologies, as this is the architecture most often referred to in discussions of NGN access networks.[3] However, the conclusions of this paper equally apply to FTTC.[4] A simple diagram of a FTTH network is shown in figure 2.1. This figure depicts the access network architecture of the planned Australian FTTH network – showing the fibre connection between end-user premises and the central office (fibre access node).

In its 2010 report[5], the consulting firm WIK modelled the costs of a greenfield deployment of fibre access networks. Most fibre investment in emerging markets will be greenfield as they do not have an existing copper network.[6]

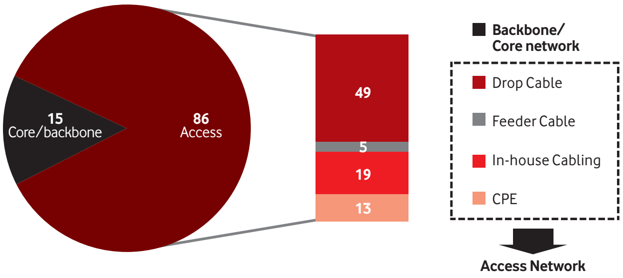
Figure 2.1. Fibre (GPON) access network architecture



Source: NBNCo, Corporate Plan 2011-13, December 2010.

For all the FTTH technologies modelled, approximately 85% of total cost of deploying a NGN fibre network lies in the access network: that is, connecting central offices to end-user locations (the network shown in figure 2.1).[7] The most expensive element (49% of the total) is the cost of deploying the physical fibre link from the end-user premise to the final distribution point (the 'drop cable'). The next element was the cost of installing in-house cabling which involves replicating any existing copper based in-house cabling in existing premises or installing new cabling in new build premises.

Figure 2.2. Proportion of cost per network element (GPON)



Source: WIK (2010)

Some costs were not included in the model, most significantly the devices, such as a wireless modem or a computer device (PC or laptop), a smartphone or tablet. For many consumers this cost may define what type of service will be accessible, especially in emerging markets where access to PCs will be limited by affordability.

Many broadband policies in emerging markets – such as the World Bank's Central African Backbone Program; and West Africa Regional Communications Infrastructure Program – focus on the deployment of fibre backbone networks and much has also been made of the growth in international connectivity through building of additional under-sea cable fibre optic.

However, the more important question to consider is how to deliver affordable broadband to the mass market. The affordability of broadband will be determined by the costs incurred in deploying NGN broadband infrastructure. Research has shown that the majority of the cost of investment relate to deploying the access network. Consequently, the cost drivers and a comparison of different access technology options need to be fully understood to ensure the best technology is deployed.

3. Cost drivers of NGN fibre access network

The WIK model consistently found that the access network (i.e., the cost of connecting premises to the central exchange) accounted for around 85% the total cost of a fibre NGN (including backbone and core costs):

> *"The main cost of these NGN/NGA architectures is borne by the access network, especially by the civil engineering cost of digging trenches etc."*[8]

The main costs for the access network within Europe concern deployment of the drop cable from the central office to each premises. The drivers of these costs are:

- Distance between the final distribution point and customer premises, expressed as household density (i.e. number of households/businesses per km²)
- Labour costs
- Trenches or aerial cabling

Based on average European data, WIK constructed a composite 'Euroland' country and divided it into 8 areas of different population density known as clusters or geotypes. The features of each geotype modelled are shown in table 3.1 below.

Table 3.1. Geotype characteristics

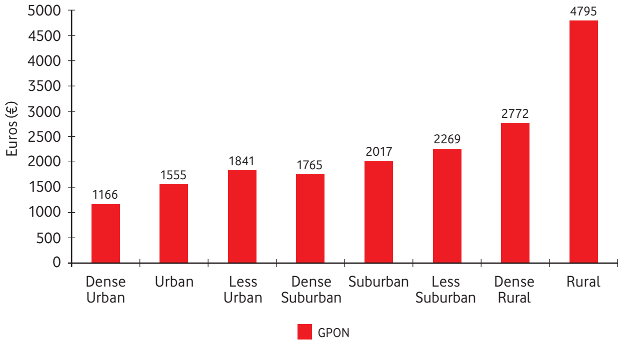
Cluster Type	Households per km²	Average trench length per household (metres)
Dense Urban	4,000	2.4
Urban	1,600	5.4
Less Urban	800	7.8
Dense Suburban	470	10.2
Suburban	280	13.1
Less Suburban	150	17.4
Dense Rural	60	28.6
Rural	< 60	55.1

Source: WIK (2010), table 3-1.

To highlight the impact of different cost drivers on the level of investment required, a constant ARPU per subscriber is assumed.

The higher investment needed to cover sparsely populated areas – reflected the greater distance between central office and end-users – is illustrated in Figure 3.1 below. Investment per subscriber is around four times higher in rural areas than in dense urban areas. The modelling shows that over 50% of the cost of total fibre network investment falls in the last two rural geotypes (household density less than 150 per km²). Therefore it is clear that, irrespective of the type of fibre technology in the access network, the vast majority of costs are incurred to connect households in the most sparsely populated areas.

Figure 3.1 Investment per subscriber different geotype



Source: WIK (2010)

Labour represents the main component of these costs. In emerging markets this will differ significantly from the European benchmark. In addition access technologies that require greater labour inputs, such as trenching, will inevitably cost more than less labour-intensive architecture, such as aerial cabling. WIK assumes the cost of the drop cable via trenches to be €100 per metre in the dense urban geotype, decreasing to €60 per metre in the two least dense rural geotypes. Aerial cabling, which is used more extensively in the suburban and rural areas is budgeted at just €15 per metre.[9] The assumed share of aerial cabling varies from zero for the urban geotypes up to 60% for the rural geotypes.[10]

While these data may be generally appropriate for Europe, we must be careful about simple extrapolation to emerging markets.

4. Cost drivers for emerging markets

The cost of the fibre access network is driven largely by the civil works required to deploy physical cable links from the central office to end-user premises. This will vary according to:

- Household density;
- Labour costs and productivity; and
- Scope for aerial cabling.

The most important drivers are distance and household density. In the densest urban geotype (where fibre deployment is economically viable) the average length of fibre needed per dwelling is around 2.4 metres, whereas in the rural geotype (non-viable deployment) this extends to 55 metres. This variation has a dramatic impact.

Table 4.1 below compares dwelling density between Johannesburg, Nairobi, Delhi and London.

Table 4.1 Household density selected cities

	London	Jo'burg	Nairobi	Delhi
Households per km^2	1,918	612	1,415	1,722

Source: ONS, Kenya Census 2009, India Census 2001, South Africa Census 2001, CIA Worldbook.

As you can see the city densities are similar but it is in the less urban areas where fibre deployment becomes challenging. Table 4.2 illustrates that the overall household density for South Africa, Kenya and India are significantly lower than in the UK.

Table 4.2. Household density selected countries

	UK	South Africa	Kenya	India
Households per km^2	107.5	11.4	15.1	58.4

Source: ONS, Kenya Census 2009, India Census 2001, South Africa Census 2001, CIA Worldbook.

Lower labour costs and associated planning and civil costs may offset the impact of these differences in density. A comparison of minimum wage rates between selected OECD and selected emerging markets demonstrates that cost of deploying trenching may also be lower. For example, the UK wage rate is around US$1,500 whereas the wage rate in Kenya is US$205; US$390 in South Africa; and US$121 in India.[11]

The average of the selected countries show that the minimum wage rate in Africa is around 16% of the average of the selected OECD countries; the Asian average is around 9% of the OECD average.

Labour productivity, however, may in turn offset a large proportion of the wage differential. For example, using the labour productivity data collected by the International Labour Organisation (ILO)[12], the minimum wage rates above can be adjusted to reflect the differences in productivity.[13] Although this is a crude adjustment, it does indicate that the productivity adjusted wage rate in Africa is approximately 136% of the selected OECD countries, while the Asian average is approximately 57% of the OECD average.[14]

The cost of deploying fibre in the access network can be significantly lower if deployment can be achieved via aerial cabling (i.e. on electricity poles). The availability of electricity poles will play a key part in the cost savings due to overhead cabling. If there are no existing electricity poles on which to hang fibre, the cost advantage will not be attainable. Table 4.3 below shows the percentage of households with electricity per licence area category in India, where A circles reflect the most urbanised areas and C circles are the least urbanised areas. In addition, the security costs required to prevent damage and theft must be incorporated into the evaluation.

Table 4.3. India – electricity availability per licence area category

	Percentage of households with electricity		
	Total	Rural	Urban
Delhi	93 %	86 %	93 %
A Circles*	76 %	67 %	91 %
B Circles**	51 %	40 %	85 %
C Circles	26 %	18 %	74 %

* Includes Mumbai and Chennai Metro Circles, reported in their respective States of Maharashtra and Tamil Nadu.
** Includes Kolkata Metro Circle, reported in West Bengal.

Source: India Census 2001, State-Wise Housing Profile, Source of Lighting.

The assumption in the WIK model of extensive use of aerial cabling in European rural areas (60% of all cables) helped reduce the cost of deployment. However, as table 4.3 shows, such a high percentage would not be achievable in rural areas of B and C circles in India due to the lack of infrastructure.

The cost to deploy fibre access cabling is likely to differ substantially from European costs but the overall impact is far from clear. Household densities (the key cost driver) in emerging markets are significantly lower than in Europe especially in rural areas.

Therefore, it is far from clear that it will be less expensive to deploy fibre access networks in emerging markets. Indeed the cost may even be higher. Further work must be undertaken in this area.

5. Emerging markets have different commercial fundamentals than OECD markets

Most NGN business cases have been developed for OECD countries.

While the key driver of the costs of network deployment is household density, the key driver of the value of deployment is income per household. To facilitate comparison between towns in emerging and developed markets we have combined these concepts to calculate income density (income per km^2).

Comparative income densities in high and low income suburbs of cities such as Johannesburg are interesting to reflect on. The difference in the average area per dwelling can be seen below when comparing a satellite view of Diepkloof (low income) on the left and Parkview (high income) on the right. In a 200m^2 area, Parkview has approximately 32 dwellings while Diepkloof has 91.

Diepkloof

Parkview

Source: Google Earth

Income per household is difficult to obtain for this level of granularity, but a 2007 study found that the average household income for Diepkloof was ZAR1,500 per month.[15] Assuming household density of 455 per km^2, the income density for Diepkloof is shown in table 5.1 below.

Table 5.1. Income density

Annual income density (per km^2)	Parkview	Diepkloof
Household density	160	455
Income density (ZAR million)	222.2	8.2
Income density (USD million)	30.8	1.1

In comparison, Parkview is one of the most expensive suburbs in Johannesburg. If all the residents of Parkview have household income within the top 5% of Johannesburg income (an extreme assumption), we estimate annual household income[16] as ZAR 1.4 million ($185,000). Income density for Parkview is shown below.

In the OECD, the above-average income suburbs are more densely populated than those where incomes are below average. For example, Greater London has substantially higher household income than Parkview and Diepkloof, and also has much higher household density.

Kensington, London

Source: Google Earth

Table 5.2. Income density London

Greater London annual income per km^2	
Household density	1,918
Average household income	£ 19,038
Income density (GBP million)	36.5
Income density (USD million)	58.8

Source: Office National Statistics, Census & NUTS1 regions GDHI per head indices.

Therefore, even for the most prosperous urban areas of emerging markets, the income density (and therefore revenue potential) is dramatically lower than for urban areas in OECD countries.

The concept of income density and cost per km^2 is used to identify the extent of economic deployment in districts within the Indian states of Maharashtra, Karnataka and Rajasthan in section 6 below.

6. Assessing the economic viability of NGN investment in emerging markets

Many governments have stated a clear preference for fibre to be the access network of choice in next-generation broadband networks. However this policy choice has often been made without much data on the economic reality of deploying fibre to households. The cost of which is largely unknown.

The economic viability of NGN investments depends on the interaction between the cost to connect a particular premise, and the achievable revenue from it. Denser household concentrations reduce the distance (and cost) to provide a fibre connection. The majority of the investment in a fibre NGN network is required for rural connections and this conclusion is likely to apply even more so to emerging markets, as the key cost drivers are less favourable.

On the revenue side, the key driver is revenue per dwelling and achievable market share (or take-up). Given the high fixed cost nature of rolling out a fibre access network, a high take-up is needed to make the investment economically viable.[17]

Revenue assumptions in existing studies use ARPU assumptions from OECD market analyses and as a result are unrealistic for mass adoption in emerging markets.[18] However, by converting the ARPU and take-up assumptions into equivalent minimum revenue per km^2 requirement for economically viable deployment, we can compare existing European cost studies to emerging market figures. This conversion is shown in Table 6.1 below.

Table 6.1. Minimum monthly revenue per km^2

Cluster type	Households per km^2	Critical market share	Minimum month revenue ($'000s) per km^2
Dense Urban	4,000	26%	$62.7
Urban	1,600	38%	$36.7
Less Urban	800	48%	$23.2
Dense Suburban	470	47%	$13.3
Suburban	280	60%	$10.1
Less Suburban	150	69%	**$6.2**
Dense Rural	60	98%	$3.5
Rural	60	100%	$3.6

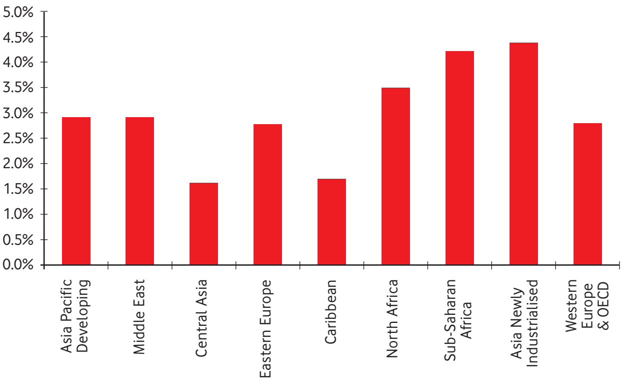
Minimum monthly revenue per km^2 = households per km^2 * ARPU * critical market share. ARPU assumed at €44.25 for all cluster types. Source WIK (2010).

Table 6.1 shows the minimum monthly revenue per km^2 for each cluster type. The minimum revenue is equivalent to the marginal cost of providing fibre access – if this level of revenue cannot be obtained then it will not be commercially viable to deploy fibre links. As noted above, the key cost driver of fibre deployment is household density. Consequently, each cluster type (representing different levels of household density) has a unique marginal cost. For example, dense urban clusters (household density greater than 4,000) have a marginal cost per km^2 of US$62,700 – equivalent to a cost per household of US$15 per month. Less suburban clusters have a marginal cost per km^2 of US$6,200 – equivalent to a cost per household of US$42 per month.

Assuming a maximum take-up rate of 70%[19], the minimum revenue per km^2 required for commercial viability is US$ 6,200. This applies to areas with a household density less than 280 household per km^2. Similarly, in an urban geotype of 4,000 households per km^2, the marginal cost of deployment is US$62,700 per km^2.

The extent of commercial roll-out will be determined by the interaction between the marginal cost identified above and the achievable marginal revenue per household. In most countries, the demand for telephone services has been estimated at somewhere between 2-5 per cent of income (figure 6.1).[20] Assuming that households would spend a maximum of 5% of total household income on broadband access, we can establish likely revenue per km^2. Fibre will not be economic in areas where telecommunications spend (calculated as 5% of income density) is greater than or equal to marginal cost of deployment (minimum revenue per km^2).

Figure 6.1. Total telecom revenues as % of GDP – 2007



Source: ITU-infoDev ICT Regulation Toolkit – UAS Module based on ITU World Telecommunication / ICT Indicators.

Using the approach outlined above, it may be economically viable to deploy a fibre access network in Greater London and Parkview in Johannesburg, as the marginal cost of deployment[21] is less than 1% of total monthly income in either case. However, in Diepkloof (with significantly lower income density) the likely revenue, on the assumption of a 5% of total income spend, falls well short of the deployment costs. Therefore, fibre would not be commercially deployed there.

Table 6.2. Commercial deployment in selected suburbs

Area	Cluster type	Monthly income per km^2 ($'000s)	Marginal cost as percentage of income
Greater London	Less Urban	$4,900	0.5%
Diepkloof (Johannesburg)	Suburban	$95	10.6%
Parkview (Johannesburg)	Less Suburban	$2,571	0.2%

This analysis can be extended to the Indian states of Maharashtra, Karnataka and Rajasthan. Maharashtra and Karnataka both have major urban centres and a mixture of less urban and rural areas. Rajasthan is a more rural state. The results are shown in table 6.3 below.

Table 6.3 breaks each state into district level, calculates the income density of each district and calculates the percentage of total income that is required to be spent on broadband access if the marginal cost is to be achieved. The relevant percentage is calculated for 2009-10 and estimated for 2019-20 (the current growth rate is assumed to continue for next ten years).

The analysis shows that a fibre access network is commercially viable in only two districts in Maharashtra (Mumbai and Thane); one district in Karnataka (Bangalore) and not even one district in Rajasthan.

These results raise a serious question about the possibility of using a fibre access network as the technology to deploy broadband services to the mass market in India or many other emerging markets.

However, fibre is not the only possible technology solution for deploying broadband internet. The next section looks at the commercial drivers for the wireless alternative.

Table 6.3. Assessing commercial deployment in selected states of India

Broadband cost as percentage of monthly district income (US$ per km²)											
Maharashtra	Cluster Type	2009-10	2019-20	Karnataka	Cluster Type	2009-10	2019-20	Rajasthan	Cluster Type	2009-10	2019-20
Mumbai	Dense Urban	**1%**	**1%**	Bangalore	Dense Suburban	**2%**	**1%**	Jaipur	Dense Rural	12%	**5%**
Thane	Less Suburban	**4%**	**2%**	D.Kannada	Dense Rural	13%	**5%**	Banswara	Less Suburban	15%	6%
Pune	Dense Rural	7%	**3%**	Bangalore Rural	Dense Rural	14%	**5%**	Alwar	Dense Rural	21%	9%
Nagpur	Dense Rural	11%	**5%**	Dharwad	Dense Rural	18%	7%	Kota	Dense Rural	24%	10%
Kolhapur	Dense Rural	11%	**5%**	Mysore	Dense Rural	21%	8%	Bharatpur	Dense Rural	26%	11%
Nashik	Dense Rural	16%	7%	Udupi	Dense Rural	22%	8%	Ajmer	Dense Rural	27%	11%
Raigad	Dense Rural	16%	7%	Bellary	Rural	25%	9%	Dausa	Dense Rural	29%	12%
Aurangabad	Dense Rural	20%	9%	Kolar	Dense Rural	26%	10%	Rajsamand	Dense Rural	34%	14%
Sangli	Dense Rural	20%	9%	Davanagere	Dense Rural	30%	11%	Jhunjhunu	Dense Rural	34%	14%
Jalgaon	Dense Rural	21%	9%	Belgaum	Dense Rural	31%	12%	Bhilwara	Rural	35%	15%
Bhandara	Dense Rural	22%	10%	Ramanagara	Dense Rural	31%	12%	Sikar	Dense Rural	36%	15%
Satara	Rural	23%	10%	Mandya	Dense Rural	35%	13%	Dholpur	Dense Rural	38%	16%
Solapur	Rural	24%	10%	Bagalkot	Rural	37%	14%	Swaimadhopur	Dense Rural	41%	17%
Ahmednagar	Rural	25%	11%	Kodagu	Rural	37%	14%	Dungarpur	Dense Rural	43%	18%
Akola	Dense Rural	25%	11%	Haveri	Dense Rural	38%	14%	Udaipur	Rural	43%	18%
Ratnagiri	Rural	31%	14%	Gulbarga	Dense Rural	38%	14%	Sriganganagar	Rural	43%	18%
Gondia	Rural	31%	14%	Shimoga	Rural	42%	16%	Sirohi	Rural	46%	20%
Parbhani	Rural	32%	14%	Tumkur	Rural	43%	16%	Karoli	Rural	48%	20%
Latur	Dense Rural	34%	15%	Hassan	Rural	44%	16%	Bundi	Rural	50%	21%
Wardha	Rural	35%	15%	Chikballapur	Rural	44%	17%	Hanumangarh	Rural	52%	22%
Chandrapur	Rural	36%	16%	Gadag	Rural	45%	17%	Jhalawar	Rural	52%	22%
Nanded	Dense Rural	36%	16%	Bidar	Rural	45%	17%	Cittoragarh	Rural	54%	23%
Nandurbar	Rural	36%	16%	Raichur	Rural	46%	17%	Pali	Rural	56%	24%
Sindhudurg	Rural	37%	16%	Chitradurga	Rural	53%	20%	Baran	Rural	59%	25%
Amravati	Rural	39%	17%	Chikmagalur	Rural	55%	21%	Jodhpur	Rural	64%	27%
Dhule	Rural	39%	17%	Bijapur	Rural	60%	23%	Tonk	Rural	64%	27%
Buldhana	Rural	41%	18%	Chamarajanagar	Rural	67%	25%	Nagaur	Rural	74%	31%
Jalna	Rural	42%	18%	Koppal	Rural	67%	25%	Jalore	Rural	80%	34%
Beed	Rural	42%	18%	U.Kannada	Rural	70%	26%	Bikaner	Rural	127%	54%
Yavatmal	Rural	43%	19%					Churu	Rural	131%	56%
Hingoli	Rural	45%	20%					Barmer	Rural	170%	72%
Osmanabad	Rural	50%	22%					Jaisalmer	Rural	573%	243%
Washim	Rural	61%	27%					Pratapgarh		na	na
Gadchiroli	Rural	177%	77%								

Source: Net District Domestic Product (NDDP), State Economic Censuses for Maharashtra, Karnataka and Rajasthan. NDDP extrapolated to 2019-20 assuming Statewise GDP growth rate.

7. Assessing the economic deployment of wireless access broadband networks in emerging markets

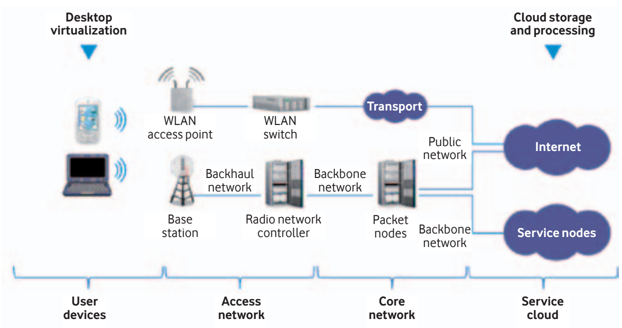
The minimum revenue required to deploy a fibre access network would comprise an unrealistically high proportion of total income in almost all the districts of the Indian states investigated, and some suburbs of Johannesburg in South Africa. It is reasonable to conclude that outside of the most densely populated cities (like Mumbai, Delhi or Bangalore) a fully commercial deployment of fibre is unlikely to occur.

Wireless access is a viable alternative, however. In most emerging markets current internet access (including broadband) is already mostly provided through mobiles rather than through PCs. For example, IDC estimates that in 2010 there were 4.4 mobile internet users per 100 people in the Middle East and Africa region compared to 3.3 PC-based internet users. Similarly, in India there are estimated to be 5.6 mobile internet users compared to 3.4 PC-based users.[22]

The cost of service and coverage analysis underpins the reasons why mobile telephony is far ahead of fixed telephony in emerging markets are likely to continue to drive the trend shown above, and to carry over into NGN broadband access.

The technical architecture of a wireless access is set out in Figure 7.1.

Figure 7.1. Architecture of wireless internet



The core network and the backbone/backbone network are the same in both a wireless network and fibre NGN architecture. The fundamental difference between wireless and fibre architecture is the access network and the connected user devices.

- The *access network* provides the last leg of connectivity between the core of the Internet and the user devices. For a cellular radio based network, it consists of a multiplicity of base stations, with each typically connected radio network controller.[23] The base stations provide radio connectivity using licensed spectrum and communicate with the user devices. The access network is usually the most capital intensive part of a cellular network. For more localized premises, such as a campus or individual buildings, wireless access can also be provided using a wireless local area network (WLAN). WLAN utilizes unlicensed spectrum at 2.4 GHz or 5 GHz. With a more extensive WLAN, a WLAN switch may have to be used to provide resource management. Connectivity to the core of the Internet can be achieved by direct connection to the public network.
- *User devices* refer to a variety of devices including smartphone, laptop computer, tablet computers, personal computers and the like.

Wireless broadband can provide cost-effective coverage

While the technology used to deliver wireless access is fundamentally different from that used to deliver fibre access, the cost drivers are similar, the most significant being household density. This enables us to compare the relative costs to deliver broadband access (at a given speed) across the different access technologies. We use the same approach as used in section 6.

We can extend the concepts of income density and minimum revenue per km^2 to directly compare the cost of providing fibre and wireless coverage. Minimum revenue in this context equals the cost to cover each square kilometre. The key driver of the cost per km^2 is the *coverage area* of a cell site and the *cost of the site*. The main driver of the site area is the spectrum range over which the mobile signals are carried. The specific area per cell will be determined by local geographic factors.

The *coverage area* per site is sourced from a recent study for the GSMA focusing on the coverage benefits of deploying 3G in 900MHz and represent average values.[24] The estimated average site area is extrapolated to the range of wireless broadband-relevant spectrum ranges using relative density estimates. The relevant figures for the calculation of the wireless cost per km^2 is shown in Appendix A.

The *cost of each cell site* will differ with technology and for each market. For example, sites in many emerging markets are often more expensive in rural areas due to difficulty in building and the extensive use of diesel and the need for security. Sites in many urban areas can also be quite expensive due to land values and scarcity of appropriate site locations. The relative cost of an urban and rural site will vary in each specific country. We therefore use cost assumptions in the recent Kenyan cost model produced by Analysys Mason. They assumed a cost per base station of US$ 87,800 and US$ 91,000 for rural base stations.

Bringing the coverage area data (see Appendix A) and the site cost together gives the cost comparisons shown in Table 7.1.

Table 7.1. Comparing wireless and fibre coverage costs

Wireless Coverage Cost per km^2				
	Dense Urban	Urban	Suburban	Rural
450 MHz	$14,900	$6,000	$1,300	$100
800-900 MHz	$42,600	$17,000	$ 3,700	$300
1.8 GHz	$68,000	$21,000	$ 5,100	$600
2.1 GHz	$79,800	$24,600	$ 6,000	$700
2.5-2.6 GHz	$102,000	$31,600	$ 7,700	$800
3.5-3.6 GHz	$165,700	$51,100	$ 12,400	$1,400
Fibre Cost per km^2	$62,700	$36,700	$10,100	$6,200

Source: Cost per site; Analysys Mason, Kenyan LRIC Cost Model 2010. Urban fibre cost is average of urban and less urban. Suburban fibre cost is average of dense suburban, suburban and less suburban. Rural fibre cost represents the lowest cost per km^2 for the viable maximum market take-up of 70%.

The highlighted cells in the table indicate the spectrum ranges and the geotypes where it is cheaper to provide wireless coverage rather than the deploy fibre (assuming the marginal cost of fibre discussed above). The cost of wireless coverage depends upon the spectrum range over which it is deployed – for example, rural coverage for wireless broadband utilising the UHF spectrum at 450 MHz is around 8% the cost of using 3.6 GHz spectrum.

The above data also shows that wireless coverage is also cheaper than deploying fibre in all geotypes for spectrum below 900 MHz. Wireless is lower cost than fibre in *urban and suburban* geotypes for 2.6GHz and below. Providing wireless broadband coverage, over all possible spectrum ranges, is cheaper than deploying fibre for *rural* geotypes – and is approximately 95% cheaper per km^2 than fibre using 800-900 MHz spectrum.

The use of wireless technologies to provide broadband coverage to the majority of the population would be significantly more cost-effective than deploying fibre.

The implications of this for broadband coverage in the three Indian states looked at above (Maharashtra, Karnataka, and Rajasthan) are set out below. As we saw, it was commercially viable to deploy fibre access network in 2009-10 to only two districts in Maharashtra, one district in Karnataka, and no districts in Rajasthan. However, it is commercially viable to deploy wireless broadband coverage using 800-900 MHz spectrum to all but one district in Maharashtra, all districts in Karnataka, and all but one district in Rajasthan.

Table 7.2. Assessing commercial deployment in selected states of India

Wireless broadband cost as percentage of monthly district income (US$ per km^2)					
Maharashtra	2009-10	Karnataka	2009-10	Rajasthan	2009-10
Pune	0.4%	Bangalore	1%	Jaipur	0.2%
Nagpur	1%	D.Kannada	1%	Alwar	0.4%
Kolhapur	1%	Bangalore Rural	1%	Kota	0.5%
Nashik	1%	Dharwad	1%	Bharatpur	1%
Raigad	1%	Mysore	1%	Ajmer	1%
Aurangabad	1%	Udupi	1%	Dausa	1%
Sangli	1%	Bellary	1%	Rajsamand	1%
Jalgaon	1%	Kolar	1%	Jhunjhunu	1%
Mumbai	1%	Davanagere	1%	Bhilwara	1%
Bhandara	1%	Belgaum	1%	Sikar	1%
Satara	1%	Ramanagara	1%	Dholpur	1%
Solapur	1%	Mandya	2%	Swaimadhopur	1%
Ahmednagar	1%	Bagalkot	2%	Dungarpur	1%
Akola	1%	Kodagu	2%	Udaipur	1%
Ratnagiri	1%	Haveri	2%	Sriganganagar	1%
Gondia	2%	Gulbarga	2%	Sirohi	1%
Parbhani	2%	Shimoga	2%	Karoli	1%
Latur	2%	Tumkur	2%	Bundi	1%
Wardha	2%	Hassan	2%	Hanumangarh	1%
Chandrapur	2%	Chikballapur	2%	Jhalawar	1%
Nanded	2%	Gadag	2%	Cittoragarh	1%
Nandurbar	2%	Bidar	2%	Pali	1%
Sindhudurg	2%	Raichur	2%	Baran	1%
Amravati	2%	Chitradurga	3%	Jodhpur	1%
Dhule	2%	Chikmagalur	3%	Tonk	1%
Buldhana	2%	Bijapur	3%	Nagaur	1%
Jalna	2%	Chamarajanagar	3%	Jalore	2%
Beed	2%	Koppal	3%	Bikaner	3%
Yavatmal	2%	U.Kannada	3%	Churu	3%
Hingoli	2%			Barmer	3%
Osmanabad	2%			Banswara	4%
Thane	2%			Jaisalmer	12%
Washim	3%			Pratapgarh	na
Gadchiroli	8%				

Source: Net District Domestic Product (NDDP), State Economic Censuses for Maharashtra, Karnataka and Rajasthan.

Wireless broadband will support the majority of internet applications

Wireless coverage is cheaper than providing fibre connections in all geotypes using 900 MHz spectrum and below. However, this does not imply that wireless will replace fibre connections where it is commercially viable to roll-out fibre.

The cost drivers of fibre and wireless are different – fibre is expensive to provide coverage but enables high capacity once connected; whereas wireless is relatively cheap to provider coverage but is capacity-limited and requires further investment to increase capacity. The fundamental advantage of wireless is that it is much cheaper to provide connectivity. In areas where fibre is deployed, we would expect wireless to exist as a complement to the fibre network – to be used where mobility is needed.

The early diffusion of broadband services appears to be driven by numerous applications most of which are equally well supported on both fibre and wireless networks. The basic productivity-enhancing applications such as e-mail, e-banking, m-government, and vast majority of web-browsing, are allowed by the throughput provided by wireless technologies (see table 7.3). Thus when viewed from the perspective of end users, and their ability to pay, the differential quality of services between fibre and wireless, which undoubtedly exists for bandwidth intensive video services (such as multi-channel on-demand HDTV), is unlikely to be of sufficient value to underwrite the early stage commercial deployment of fibre access networks.

Wireless access networks will provide bandwidth of appropriate levels at a much lower cost for the vast majority of mass market broadband usage. Specialised bandwidth demands (such as hospitals, schools and large businesses) will still require dedicated P2P fibre connections to fully ensure the benefits of productivity, eHealth and eEducation solutions. But the mass consumer market would not be better served by a network which is more expensive as it delivers speeds required for few consumer services (other than on-demand HD IPTV). Indeed, in emerging markets, where cost will be the key driver in determining the level of broadband penetration, it would appear that wireless broadband would be a much more viable option for ensuring mass consumer penetration.

The key conclusion is that a wireless access network can be a cost effective way to deploy high speed broadband to wide area populations. FTTH can support higher speeds and this will be required for key users and is economic to provide in the densest areas, but wireless will be more cost effective for most emerging market geotypes and provide bandwidth of sufficient performance to enable acceptable current technology video conferencing; provide a good, responsive web-browsing experience; and support email services.

NGN Deployment in New Zealand

Real world deployments are likely to feature a mixture of technologies in the access network. The key factors determining which technology is likely to be deployed are the use to the end-user, speed of deployment, cost of deployment and willingness (or ability) of the end-user to pay for broadband service.

As an example of how the mix might work in practice, Vodafone New Zealand and Telecom NZ have recently won a tender to provide next generation broadband to rural New Zealand. The investment plan: focuses first on bringing fibre to schools and hospitals where the case for productivity and social gains is strongest; uses a mixture of wired and wireless technology to maximize value for money and population coverage; and is future-proof with a clear path to both fixed and wireless upgrades as demand develops.

It will bring 100 Mbps fibre connections to approximately 730 rural schools and hospitals. It will then use this deployment as a backbone to provide 5Mbps fixed wireless broadband[25] to more than 80% of the homes in the relevant area, with some 57% of fixed broadband covered homes also having access to a fixed DSL service. This part of the plan involves laying approximately 3,100 kms of fibre – and re-using 6-7,000 kms of fibre already laid by Telecom NZ – to connect, schools, hospitals, businesses and fixed wireless broadband delivery points.

By concentrating first on these key hubs, Vodafone's roll-out plan allows fibre benefits to be delivered quickly to the population: 510 schools (79% of students) are expected to be connected in the first year with a further 125 to be connected in year 2.

To improve coverage to 80% of the population the parties will build 154 new open access cell sites. This will also significantly improve rural cellular coverage for mobile voice, SMS and data. It is expected that the plan will provide mobile coverage to over 4500 km of rural roads and surrounding areas that are currently un-served. As mentioned above, 57% of the relevant homes will also have access to xDSL services at rates above 5Mbps, half of these with speeds above 10Mbps; and of those, 34% should achieve speeds of 50Mbps or better.

The network will be designed so as to be easily upgraded to full FTTH architecture when demand conditions are sufficient. While the fixed wireless broadband solution will, initially, be provided over 3G HSPA+ with a maximum data rate of up to 28.8 Mbps there are plans to upgrade this to LTE in 2013/14 which should deliver speeds of up to 100Mbs.[26]

Table 7.3 Broadband applications using different technologies

	Fibre	2G		3G**		LTE***
	FTTH	GPRS	EDGE	HSDPA	HSPA+	
Max throughput*	100 Mbps	0.08 Mbps	0.23 Mbps	2 Mbps	56 Mbps	100 Mbps
E-mail	✓	✓	✓	✓	✓	✓
Basic Internet	✓	×	✓	✓	✓	✓
e-Govt	✓	×	✓	✓	✓	✓
Basic e-health	✓	×	✓	✓	✓	✓
e-banking	✓	×	✓	✓	✓	✓
Music download	✓	×	×	✓	✓	✓
Video download	✓	×	×	✓	✓	✓
Tele-working	✓	×	×	×	✓	✓
Advanced e-health	✓	×	×	×	✓	✓
Online gaming	✓	×	×	×	×	✓
High Definition IPTV	✓	×	×	×	×	✓
On-demand multi-channel IPTV	✓	×	×	×	×	×

* Theoretical maximum downlink speed.
** Downlink speed of typical HSDPA network deployed currently. HSPA+ theoretical maximum.
*** 20MHz carrier.

8. Conclusions

Most empirical studies and published commercial plans for the deployment of next-generation fibre networks in OECD countries show that the vast majority of the total costs of a fibre network (85%) lie in the access network – the cost to connect end-user premises to the central office.

This paper applies the findings of these studies to the very different contexts of emerging markets. Many planned and actual investments in emerging markets (such as Kenyan national fibre-optic network, and the proposed Indian NGN) focus on deploying backbone fibre from central offices back to the core network. While important and beneficial, this focus ignores the key investment question of how to connect end-users to the network (last-mile access investment).

In conclusion, this paper finds that the commercial deployment of fibre access networks is likely to be more challenging in emerging markets. This is due to the combination of higher cost of network deployment due largely to lower dwelling densities; and lower achievable revenue per user.

Using the concepts of income density and network cost per km^2 this paper demonstrates that fibre deployment in three Indian states is likely to be extremely limited – FTTH roll-out would be commercially viable in just 3% of the districts assessed. On the other hand, it is commercially viable to provide wireless broadband coverage to 98% of districts.

In most emerging markets the diffusion of broadband to the mass market will only be possible through wireless access networks. NGN wireless networks will provide a cost-effective alternative for bandwidth of sufficient performance to watch good quality standard definition streamed video such as YouTube most of the time, enable acceptable current technology video conferencing, to provide a good, responsive web-browsing experience and support email services. While fibre access would enable greater throughput up to 100 Mbps using current technologies, much of this throughput is only needed for very high demand applications such on-demand HD IPTV – almost all current consumer and business services can be provided through wireless access.

This paper finds that fibre access investment will likely be limited to specific areas that are commercially viable, such as business districts, institutions, hospitals, and large business. But mass-market deployment of fibre (i.e. fibre to every household) will not be commercially viable.

Appendix A

The coverage areas used below are sourced from an Ovum study for the GSMA focusing on the coverage benefits of allowing 3G to be deployed in 900MHz as well as 2.1 GHz. Ovum calculated the following site areas to represent average values.

Table A.1. Coverage area

Coverage area (km²)				
	Dense Urban	Urban	Suburban	Rural
900MHz	2.06	5.15	23.47	304.87
2100MHz	1.1	3.57	14.65	139.06

Source: Ovum, Market Study for UMTS 900: *A Report to GSMA*. February 2007. See page 21 for cell radius and area.

Mobile broadband can be provided over a range of spectrum – ranging from the digital dividend UHF spectrum (400MHz) up to 3.6 GHz. We extrapolate the relevant site areas above to a range of wireless broadband-relevant spectrum ranges using relative density estimates. The table below shows the estimated coverage area for different spectrum bands.

Table A.2. Coverage area for MBB-relevant spectrum

Coverage area (km²)				
	Dense Urban	Urban	Suburban	Rural
450 MHz	5.89	14.71	67.06	871.06
800-900 MHz	2.06	5.15	23.47	304.87
1.8 GHz	1.29	4.19	17.19	163.16
2.1 GHz	1.1	3.57	14.65	139.06
2.5-2.6 GHz	0.86	2.78	11.41	108.29
3.5-3.6 GHz	0.53	1.72	7.06	66.99

Source: Vodafone Group; Booz & Company.

Notes

1 For example, see Williams, M (2010) *Broadband for Africa: Developing backbone communications networks*. http://siteresources.worldbank.org/extinformationandcommunicationandtechnologies/Resources/Broadband_for_Africa.pdf

2 Fibre to the Building / Premises (FTTB/P) may be understood as a variation on FTTH as fibre is deployed to a point within the dwelling with active equipment which then utilises the existing copper in-house wiring. FTTH deployments can then be divided into (i) Point-to-point (P2P) architectures or (ii) Point to Multi-point Passive Optical Networks (PON). Of these, GPON is the most common standard in Europe while EPON is deployed principally in Japan and South Korea. A third option called wave-division multiplexing PON (WDM PON) is a future technology currently in development.

3 FTTC can be a first step on the road to FTTH. Analysys Mason concludes that 42% of the total rollout costs of FTTC are accounted for by the fibre to the cabinet which can all be reused for FTTH. However, given the very large proportion of costs accounted for by the drop and in-house segments, this only represents 9% of the total FTTH rollout cost. See Analysys Analysys Mason (2008), *The costs of deploying fibre-based next-generation broadband infrastructure*, at 1.4.2. Available at http://www.broadbanduk.org/component/option,com_docman/task,doc_view/gid,1036/Itemid,63/

4 81% of the costs of a FTTC network lie in the access network. See Analysys Mason (2008), *The costs of deploying fibre-based next-generation broadband infrastructure*.

5 WIK-Consult (2010), *Architectures and competitive models in fibre networks*, December. Available at: http://www.vodafone.com/content/dam/vodafone/about/public_policy/position_papers/vodafone_report_final_wkconsult.pdf

6 Different fibre technologies modelled are P2P, GPON, P2P GPON, and WDM-PON. The modelling showed that the cost of network does not vary significantly between the different access technologies – at around 7-10% – holding all other variables constant. For a detailed explanation of each of these technologies, see section 2.2 of WIK-Consult (2010).

7 The study is based on a hypothetical country of approximately 22m households. Based on geo-data of several EU member states, this hypothetical country is split into eight areas according to population density, from dense urban to rural area. Available at http://www.vodafone.com/content/index/about/about_us/policy/news/fibre_competition.html

8 WIK-Consult (2010) p.98.

9 WIK-Consult (2008) Economics of next generation access, A Report for ECTA, at 2.1.2. Available at http://www.ectaportal.com/en/REPORTS/WIK-Study/WIK-NGA-Study-2008/

10 Dense Urban: 0%; Urban: 0%; Less Urban: 10%; Dense Suburban: 20%; Suburban: 30%; Less Suburban: 40%; Dense Rural: 60%; Rural: 60%. Source: WIK (2010), Table 3-2, p.97.

11 ILO, Global Wage Report 2010/11.

12 ILO, Global Wage Report 2010/11.

13 Total labour cost = per unit cost * number of units employed.

14 ILO, Global Wage Report 2010/11. Productivity adjustments are a more complex issue than the simple process used in this paper. It is beyond the scope of this paper to address this issue: more precise data, such as labour productivity of construction industry across countries, could be used. Alternatively, multi-factor productivity adjustments could also be considered. This issue warrants further study.

15 Mncube, Dumisani Wilfred (2007), Household survey on energy consumption patterns in Johannesburg townships: a case study of Diepkloof, Soweto, Chapter 4. Data for zones 1 and 2.

16 South Africa Census 2001, Household Income for Johannesburg. Average income of the top 5% of households adjusted to 2010 prices.

17 WIK shows that for a greenfield FTTH network GPON architecture could be delivered to 64.4% of the population in its hypothetical average European country on a commercially viable basis, if 70% of passed premises take up services. The recently released Commercial Plan of the Australian NBNCo also assumes that 70% of passed premises will choose to sign up to its FTTH GPON network.

18 The WIK modelling assumes that each household has an ARPU of €44.25 per month (US$ 58.50), while the NBNCo assumes an ARPU of AUD 23.55 per month (US$ 23.94) in FY2013, increasing to AUD 52.20 (US$ 53.07) in FY2020.

19 This is consistent with the European modelling and the commercial plan of the Australian NBNCo. It must be noted, however, that such a rate of take-up would appear optimistic for emerging markets. Lowering the assumed required take-up increases significantly the minimum monthly revenue per km² required to make deployment economically viable.

20 http://www.ictregulationtoolkit.org/en/Section.3337.html

21 Assuming a marginal cost of deployment equivalent to the relevant cluster type.

22 IDC, Digital Marketplace Model and Forecast

23 This is the architecture for 2G and 3G. In LTE radio network controllers are no longer required as separate elements

24 Ovum, *Market Study for UMTS 900: A Report to GSMA*. February 2007. See page 21 for cell radius and area.

25 The fixed wireless service will also support 3 higher service levels with dedicated throughput for business and priority users.

26 Utilises a 20 MHz carrier at 700 MHz.

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75%

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