# The Economic and Social Impact of Mobile Broadband in Egypt

A report for the GSMA

Tim Miller, Sarongrat Wongsaroj, Tim Hogg

22 September 2014

**Plum Consulting**, London
T: +44 20 7047 1919, **www.plumconsulting.co.uk**

## Table of Contents

# Executive summary

The Egyptian telecommunications industry has seen rapid growth over the past ten years, driven by the uptake of mobiles. Mobile penetration now exceeds 100%, and over half of those with mobiles use them to access the Internet in some way. As the population becomes increasingly connected, the Government would ordinarily expect to be able to see substantial benefits both in economic growth and in social and cultural terms. However, these benefits will not be realised unless the Government acts now to enable the mobile broadband industry to grow with demand. Moreover, the policies that the Government chooses to follow will have a direct impact on the size of the benefit.

In 2011, the National Broadband Plan set a target for 2015 of 22% of households to be connected to fixed broadband, while 10% of citizens (approximately 8 million) should be subscribed to mobile broadband. However, since the publication of the Plan, it is clear these targets are no longer relevant. Fixed line penetration (for all lines, not just broadband) has fallen to 8% of homes, while as of December 2013 it was estimated that 14.5 million Egyptians accessed mobile broadband, well ahead of the target; in fact, this surpasses even the target set for 2021.

Therefore, it is increasingly evident that for the Egyptian Government to fully realise the potential benefits of broadband, it must focus its policies on ensuring that mobile broadband supply is not constrained. The potential benefits are very large. This paper estimates that the productivity gain to 2030 driven by an **unconstrained** mobile broadband market is worth around EGP310bn in net present value, when compared to how the economy is set to grow with current market limitations. This growth in GDP would be able to support the creation of up to 1.2 million jobs across the economy by 2030. On top of this pure economic impact, there will be further social and cultural benefits arising from the increase in penetration, and consumer surplus will also rise significantly.

However, as mentioned above, the exact policies implemented by the Government will have a direct impact on the size of the benefit that can be realised. This study looks at a further scenario, where the Government reserves certain new spectrum for new mobile network operators, and finds that the total economic benefit (and, subsequently the total social and cultural benefits) is significantly reduced. This finding – which shows what policies must be put in place to maximise benefits – should be incorporated in a new national broadband plan.

# Challenges for operators

As the number of mobile subscribers has grown, from around 7 million in 2004 to 100 million in 2014, operators have found that they are increasingly constrained by both the capacity of their networks and the profitability of the service. This, combined with an element of regulatory uncertainty over the use of other spectrum bands, makes it difficult for operators to invest in providing their subscribers with better quality of service through sufficient bandwidth.

Further, operators are unable to significantly increase profitability through changes to the cost base, as many wholesale prices are kept at a high level by monopoly provision of core networks and international links, even if such monopolies are shifted or rebranded. If mobile operators are prevented from laying their own cables or buying wholesale at reasonable terms and conditions from multiple sources, they may be unable to access capacity where it is needed. It must also be ensured that administrative and approval difficulties at a local and national level, such as getting planning permission, do not prevent operators making the necessary investment in infrastructure. The

Government must act to ensure that the overall telecommunications market is structured to support the provision of new and innovative services to end consumers.

In general, there is a need for a lower-cost alternative to boost the network capacity, such as access to more spectrum under the existing market structure. Since operators must make long-term business plans for meeting capacity and demand, and as a result must be aware of when spectrum will be available a long time in advance, it is crucial that decisions on the award process and timing for releases of spectrum are made now.

## Recommendations

It is clear from the outcome of this study that a new national broadband plan is required, taking into account the growth on mobile (and mobile broadband) in Egypt and revising objectives, targets and policies based on international best practice and experience. There needs to be a clear, practical resource management plan to enable strong broadband growth. Trends in the industry demonstrate that the most efficient way of increasing internet connectivity across the society will be to facilitate the growth of mobile broadband. This will be best achieved by releasing more spectrum to Egyptian operators, without reserving this for new mobile network operators (including Telecom Egypt) but also without preventing any interested company from bidding if they are able to offer a competitive package to consumers.

Given this, the overall recommendations of this report are:

- The previous national broadband plan must be replaced. A new national broadband plan must be drafted, in consultation with industry and users, to overcome obstacles and set targets and policies for the markets for the next ten years. This study, and the work of the committee working on Kayan, could be used as a basis to develop this new plan.
- The regulator must make as much spectrum available as possible for mobile broadband usage, as quickly as possible, particularly in the 700 MHz and 800 MHz bands. This must be awarded through a fair and transparent process with no bands reserved for any particular use or company.
- It is also important that the steps and milestones in the release process are clearly mapped out and effectively communicated to industry stakeholders to create a predictable environment for investment, which will ensure timely use of the spectrum.
- Access to infrastructure that is necessary for mobile broadband deployment – such as fibre duct, international gateway, landing stations and tower sites – must be made simpler and more cost-effective, and be closely monitored to ensure that neither price nor availability of the mobile broadband to consumers inhibits the take-up of service.
- Penetration of mobile broadband must be encouraged as the most efficient way of promulgating e-health, e-education and other Internet services that will improve the day-to-day lives of ordinary Egyptians, including in their dealings with public authorities.
- Consumers and businesses must be given the freedom to innovate in the use of Internet services that are demanded to increase business productivity (and thus GDP). Government services must also look to improve their usage of online services to make the public sector more efficient.
- The new national broadband plan should set reasonable targets set for fixed and mobile broadband penetration and quality of user experience to reflect the increased importance of

mobile telecommunications in the economy.  These revised targets will be particularly important in any discussion over the implementation of universal service.

# 1 Introduction

Mobile broadband represents a tremendous opportunity for Egypt in increasing the productivity of its workers, providing access to education and training to its citizens, and facilitating involvement with national politics and government. The high speeds and low latency that broadband provides are needed by many services such as tele-conferences and tele-medicine. Egyptian citizens have already shown a willingness to use technology to aid communication and to build business, with mobile penetration exceeding 100% and over half of the population (52%) now using the Internet; half of those using the Internet access it over mobile devices using 2G or 3G technology. However, there is still some way to go before all members of society are able to fully benefit from the Internet, particularly given the low levels of fixed line broadband penetration and potential mobile capacity constraints in dense urban areas. Further, Egyptian operators have not yet launched LTE mobile networks, which will make mobile data connections faster, cheaper and more reliable, again increasing usage.

This report considers the ways in which mobile broadband can benefit Egypt's citizens and the country as a whole.

- Economically, mobile broadband will increase productivity across the Egyptian economy which will impact GDP growth and support the creation of new jobs.
- Socially, it will enable improvements in education, healthcare, access to public services, and access to personal finance.
- Culturally, it will encourage greater citizen participation in government projects and help protect the environment. Government agencies such as the emergency services also stand to benefit if equipped with mobile broadband.

This report quantifies the economic benefits of mobile broadband in Egypt, and gives a qualitative explanation of the social and cultural benefits.

Mobile broadband can only be effectively used in Egypt if the Government takes appropriate steps to ensure that sufficient radio spectrum is available to meet future data demand and makes the spectrum available to mobile operators on transparent, reasonable and market driven terms. Long term commitment to regulatory policies promotes stability and thus private sector investment in mobile infrastructure, whereas an inefficient allocation of spectrum will hinder the roll-out of mobile broadband in Egypt, and each delay will have a negative impact on GDP.

## 1.1 Structure of this report

This report is structured as follows.

- Section 2 provides an overview of the Egyptian telecommunications market, which gives context to the issues that are investigated in the remainder of the paper.
- Section 3 explains the methodology and results of the economic impact model and the recommendations that flow from it.

More information about the economic impact model can be found in the appendices, as well as an explanation of the substantial non-economic benefits that accompany mobile broadband.

- Appendix A gives the economic modelling methodology.

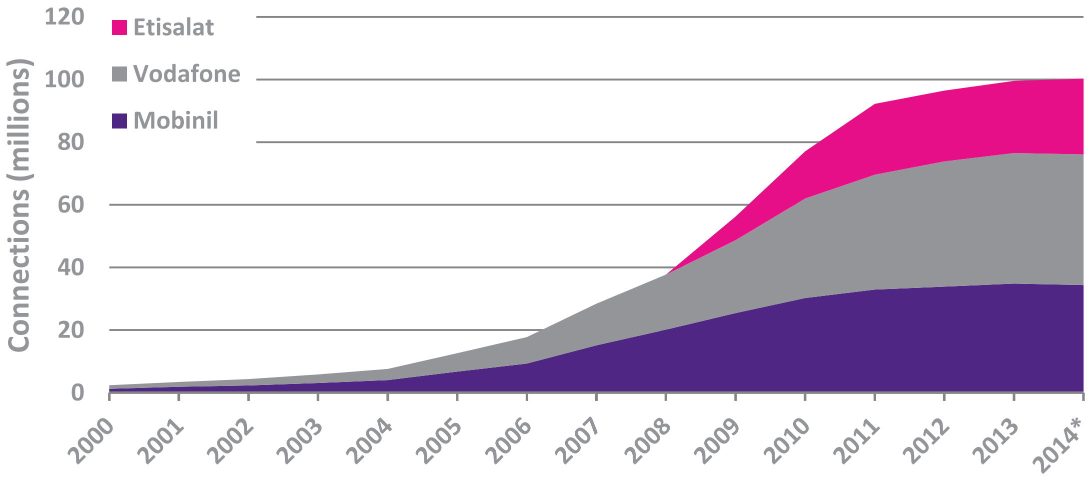
- Appendix B explains the additional social and cultural benefits.
- Appendix C details the assumptions of the economic impact model.

# 2 The Egyptian market

The Egyptian telecommunications market has long been one of the most advanced in Africa and in the Middle East, although the use of mobile communications remained limited until around 2005 and the growth of the market has not been supported by government policies to the extent of some other countries in the region. After 2005, the use of mobile grew very rapidly in Egypt, and 2014 has seen the number of mobile connections reach 100 million, representing a mobile penetration rate of 120%[1]. All three mobile operators, Vodafone, Mobinil and Etisalat, have experienced significant growth in subscribers.

With the introduction of unified telecommunications licences, Telecom Egypt will have the ability to offer mobile services. However, as it currently does not hold the rights to any mobile spectrum and has not invested in its own mobile infrastructure, its operations will require roaming on other mobile operators' networks. This may change in the future, as the Ministry of ICT (MoICT) and the National Telecommunications Regulatory Authority (NTRA) will have the ability to release further spectrum for mobile use, and it may be possible for some of this to be acquired by Telecom Egypt.

Figure 2-1: Mobile connections

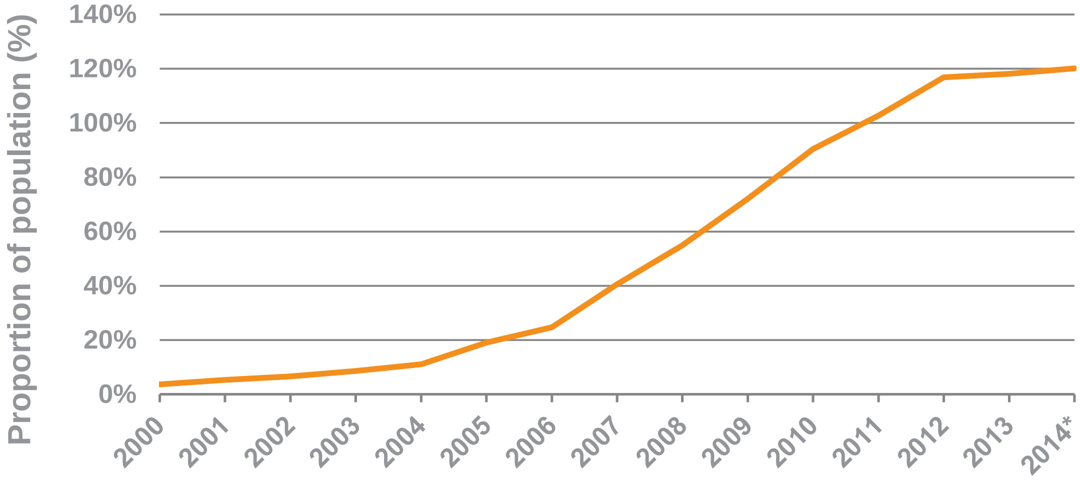



Source: Plum Consulting, Budde
*June

As can be seen, the rate of growth in connections tailed off from 2011, as the penetration rate reached 100% and the market entered a saturation point. However, the demand for spectrum is likely to continue to grow as data consumption per subscriber continues to increase. This growth reflects that seen across the Middle East and North Africa, although some countries (such as the UAE, Bahrain and Oman) have seen a more rapid increase in data use.

[1] Mobile penetration includes the number of mobiles, smartphones, tablets, and USB dongles.

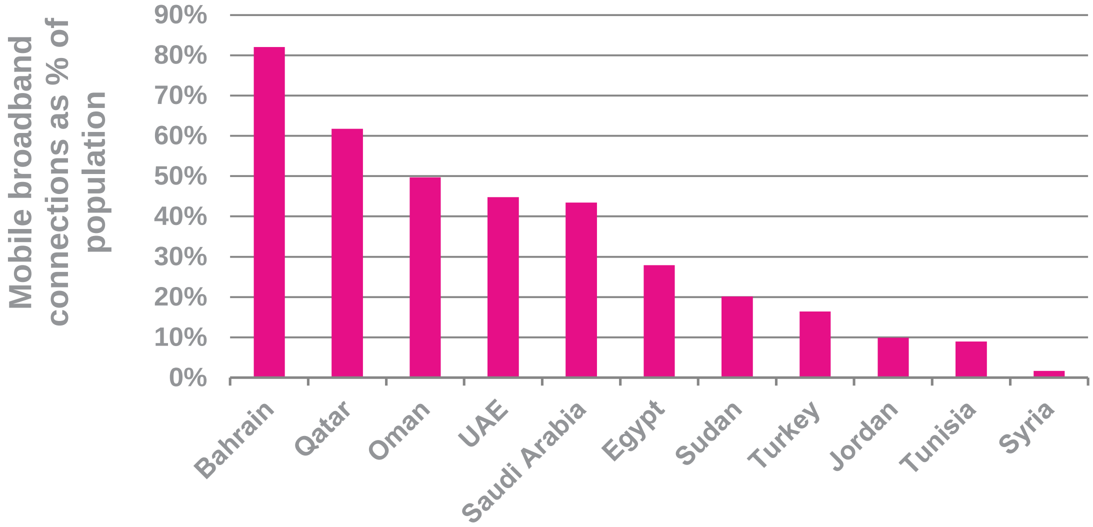
Figure 2-2: Mobile penetration




Source: Plum Consulting, Budde
*April

However, there is more that can be done; at 28% the penetration of mobile broadband in Egypt is lower than in many Middle Eastern countries. This presents the Government of Egypt with a clear opportunity for growth, which will positively impact on the whole of the country's economy.

Figure 2-3: Mobile broadband penetration (2012)[2]



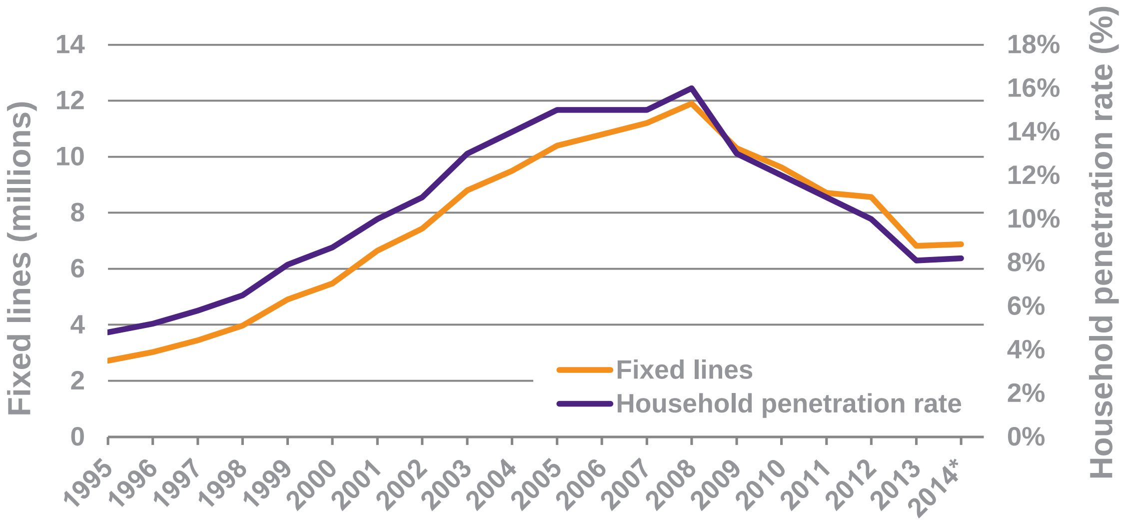

Source: Plum Consulting, ITU

The growth in mobile connections is in contrast to fixed line telephone services, over which Telecom Egypt has a monopoly, which peaked in 2008 with 11.9 million lines – a household penetration rate of 16%. The falling penetration rate of fixed lines in 2014 points to the increasing substitution of mobile for fixed lines. The number of fixed lines also provides an upper limit on the number of households

[2] Mobile broadband here refers to subscriptions (mobile, tablet, USB dongle) of at least 256 kbps.

that are able to access fixed broadband, again pointing to the importance of investment in mobile broadband.

Figure 2-4: Fixed lines connections and household penetration rate




Source: Plum Consulting, Budde
*April

Despite this falling use of fixed line connections, Telecom Egypt is currently investing in fibre-to-the-premises technology in order to provide faster Internet connections. There is some competition in this area, mainly in providing business and enterprise connections in some limited geographic regions. With the introduction of unified licences, it may be possible for existing mobile operators to offer fixed services. However, this is unlikely given the small size of the market. Instead, the MoICT is considering the formation of a new wholesale organisation, Kayan, which would be licensed to deploy fibre and sell wholesale access to any other existing operator. There is currently uncertainty around the ownership structure and governance of Kayan.

## 2.1 Egypt's ICT policy objectives

Mobile is widely recognised as an enabler for socio-economic growth, thereby driving broader digital inclusion. In 2011 the Ministry of Communications & Information Technology (MCIT) and the National Telecom Regulatory Authority (NTRA) launched the eMisr National Broadband Plan, setting out an ambitious vision of almost all Egyptians having access to fast broadband by 2021, so as to meet objectives on improving education, health, and other social aspects. The Plan drew relevance from the market into which it was introduced, which has changed significantly over the past three years; with the benefit of hindsight, it is clear to see that it set targets that were too difficult to achieve. Due to this, combined with political change, a new national broadband plan is needed. However, some of the high-level objectives set in out in the original Plan could still be relevant for Egypt.

In order to meet these objectives, the Plan recommended, amongst other policies, the refarming of existing mobile frequency bands and the provision of additional spectrum for wireless broadband. Key considerations such as access to harmonised spectrum at affordable costs, regulatory certainty and greater market liberalisation are essential to drive the necessary industry investment to achieve Egypt ICT policy objectives.

The Plan did not directly specify which services it wished to introduce. However, many of the services that have the ability to bring maximum benefits to consumers require high-speed and low-latency connections, which may only be provided by broadband. For example, streaming lectures from education institutions will require a robust, high-bandwidth connection, while interactive medical procedures will require both high bandwidth and low latency.

As well as these overall objectives and policies, the Plan set out specific targets on penetration and service take-up. These are set out in Figure 2-1.

**Table 2-1: eMisr National Broadband Plan targets[3]**

| Targets | Technology | 2015 | 2021 |
|---|---|---|---|
| Availability targets | Fixed | 75% households have 2 Mbps | 90% households have 25 Mbps |
| | Mobile | 98% of population have 3G coverage | 90% population have LTE coverage |
| Penetration targets | Fixed | 4.5 million (~22%) households subscribed to broadband | 9 million (~40%) households subscribed to broadband |
| | Mobile | 8 million (~10%) citizens subscribed to mobile broadband | 14 million (~15%) citizens subscribed to mobile broadband |
| National and social targets | Unspecified | 50% of communities have 25 Mbps<br>50% of 3rd level Egyptian administrative localities served with at least one public access point with 25 Mbps | 100% of communities have 25 Mbps<br>100% of 3rd level Egyptian administrative localities served with at least one public access point with 25 Mbps |

These targets relied on increasing fixed broadband connectivity, with relatively little consideration of the role of mobile broadband. This is contrary to the actual development in the Egyptian market. Since 2011 mobile services have increasingly provided a substitute to fixed broadband access, with the increase in Internet penetration being primarily driven by the uptake of 3G services. As of December 2013, mobile broadband was used by 14.5 million Egyptians[4], with a further 3.9 million using USB modem devices to wirelessly connect to the Internet[5]. The majority of Egyptian Internet users (52%) now access the Internet via a mobile device. Mobile technology is therefore the technology to be promoted.

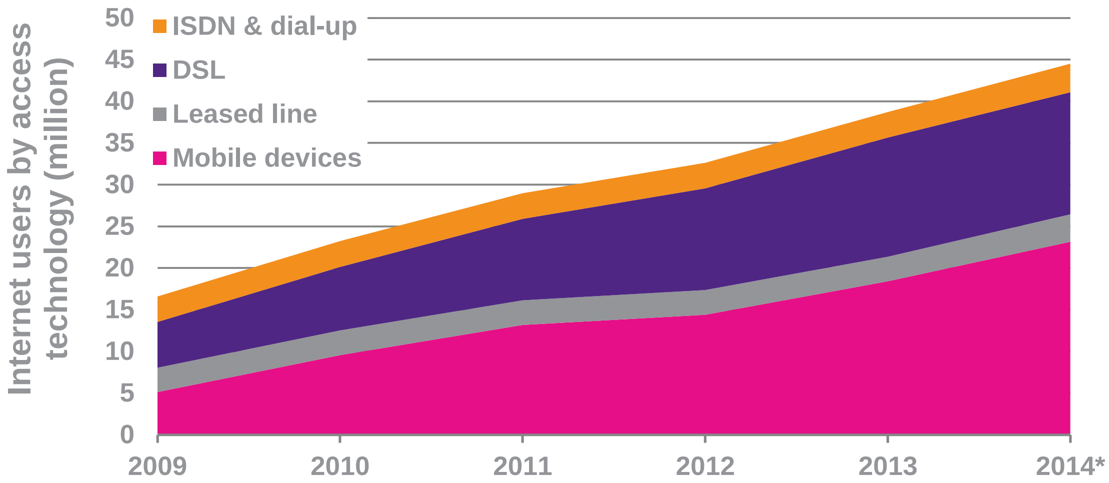
[3] NTRA, 2011: *eMISR National Broadband Plan*, available from http://www.tra.gov.eg/emisr/Presentations/Plan_En.pdf

[4] Many of these are likely to be casual users, who use the service either as a supplement to their fixed broadband connection or by virtue of the fact that they have an HSPA handset, and hence do not contribute to effective broadband penetration.

[5] Estimated by Paul Budde Communications.

Figure 2-5 shows that the evolution of different means of Internet access in the Egyptian Telecommunications market.  In 2014, mobile devices are the most popular access technology for the Internet, and continue to grow in importance.

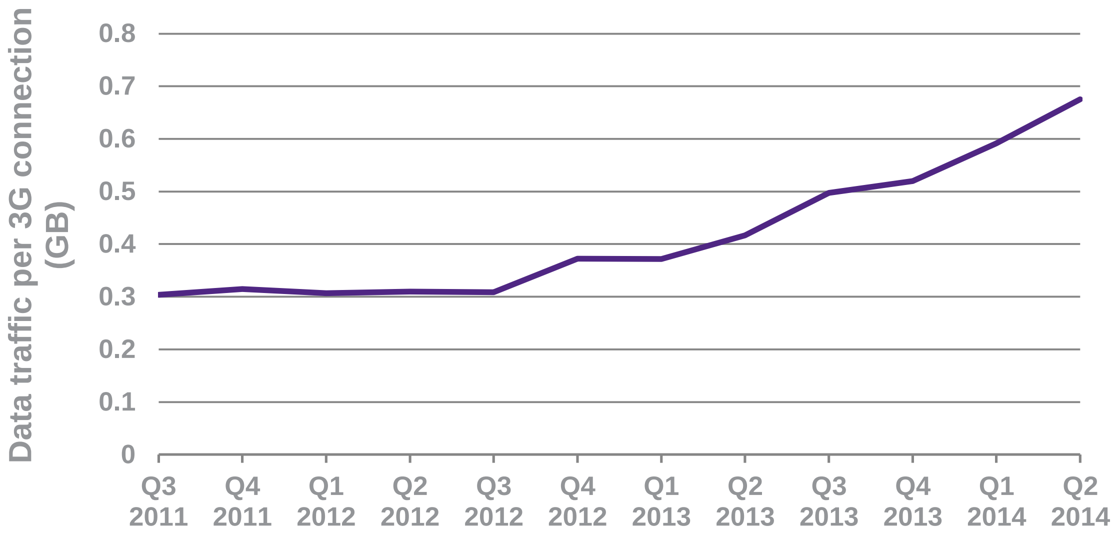
**Figure 2-5: Internet users by access technology**




Source: Plum Consulting, Budde

There is also evidence that data consumption per subscriber is increasing.  Figure 2-6 shows that the data consumption per 3G subscriber, which doubled between 2011 and 2014.  This is derived from a local operator's total data traffic per quarter and the number of 3G subscribers as reported by the GSMA Intelligence.  The economic model in this report (as described in Section 3.2) uses Cisco forecasts of data usage per user rather than this snapshot from one operator.  As in other countries, the amount of data consumed per person is expected to increase further as people spend more time online and use more online services.  This will drive the demand for mobile network capacity.  LTE service will enable more online services and greater use due to its lower latency and higher speeds.

Figure 2-6: Traffic per 3G subscriber




Source: Plum Consulting, GSMA Intelligence

Both Figure 2-5 and Figure 2-6 suggest that there is a clear demand on the part of the Egyptian population to take up mobile broadband as the primary means of connectivity to the Internet. For this reason, it does not seem logical for a new national broadband plan to continue to promote fixed broadband targets to increase overall broadband penetration. The market for fixed lines is shrinking, and these are the base access technology for ADSL broadband. Even with the current investment into fibre lines in Egypt, the quality of connection on fixed lines is unlikely to differ significantly from mobile broadband.

The Government should instead focus on mobile broadband as a primary means of delivering broadband service. This means ensuring that there will be enough coverage and capacity on mobile network to support users of high-speed mobile data and setting policies that ensure operators are able to deploy sustainable mobile broadband networks.

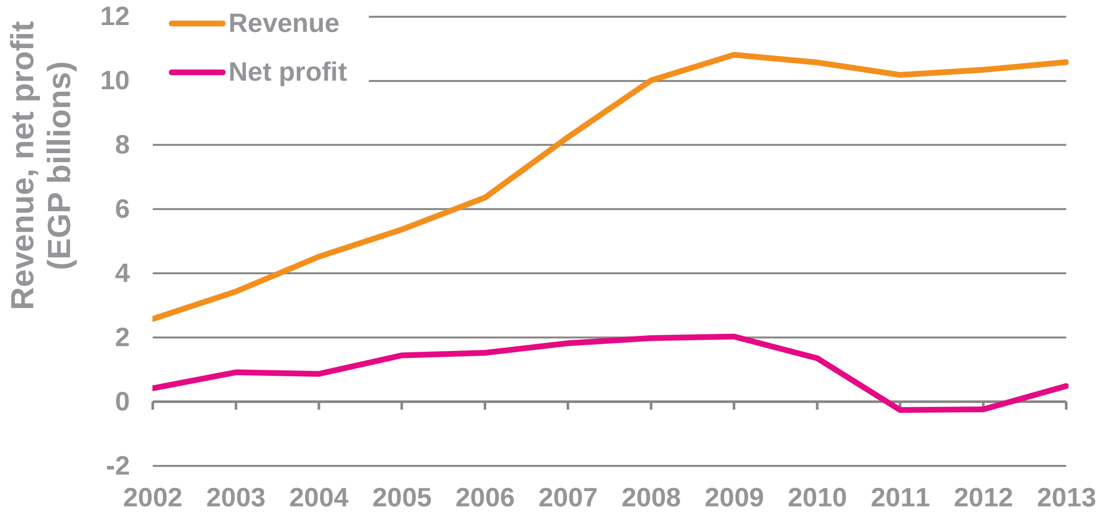
## 2.2 Challenges for operators

Mobile network operators in Egypt suffer from low profitability, high costs of core and backhaul networks combined with regulatory uncertainty over new structures for these markets, and a significant lack of spectrum.

### Profitability

Increases in mobile penetration have been accompanied by falling average monthly revenue per subscriber (ARPU); ARPU in 2013 was less than a quarter of ARPU in 2002. As a result of this, the benefits of mobile broadband are largely being felt by Egyptian consumers rather than operators, since profitability is low. For example, Figure 2-7 shows how Mobinil's net profit has not risen in line with its revenues. Low profitability prevents significant network investment.

Figure 2-7: Mobinil financial results




Source: Plum Consulting, Budde

## Fixed networks

The high cost of core and backhaul networks, and restricted access to international gateways, are significant factors in the low profitability of mobile networks. Telecom Egypt currently holds a monopoly over the wholesale fibre business; MNOs have deployed their own fixed wired network infrastructure in some cases but are not allowed to resell capacity to other users. Additionally, mobile network operators are not permitted to build fixed wireless transmission links, leaving them with few alternatives for cost-effective backhaul. The growing consumption of mobile data has led to more usage of Telecom Egypt's fibre network which has led to greater wholesale profits for Telecom Egypt in recent years[6].

There are current discussions over the introduction of a fixed wholesale operator, Kayan, who would offer core and backhaul fibre products (as well as potentially other network infrastructure) to all licensed operators. If this were appropriately regulated, with prices set at an efficiently competitive level, it may allow mobile network operators greater flexibility with pricing. However, there remain a number of questions over the potential ownership and regulation of Kayan, and without a clear decision on the future of the market the current operators will be unable to invest.

In addition, there is a danger that the Government will wish to use Kayan as the sole supplier of all core and backhaul fibre in Egypt. This would prevent mobile operators from reacting to shifting demand patterns in a timely manner and would lead to a less efficient network.

[6] GSMA Intelligence

In order to overcome fixed network challenges, it is necessary to ensure that there is sufficient facilities-based competition throughout the value chain, as suggested by Gelvanovska et al (2014)[7]. Competition should also be supplemented with liberalisation of these markets to ensure that the most economic option is available to the operators. In the case of backhaul network, it may be cheaper for mobile network operators to self-build and share the infrastructure than to purchase the capacity wholesale. However, market liberalisation of the telecommunications market also takes time to implement as shown in the case of Bahrain (see Figure 2-8), and so decisions must be made early and plans built firmly into the forward-looking national broadband policies.

**Figure 2-8: Timeline of the liberalization process of the Telecommunications Sector in Bahrain**

| | |
|---|---|
| 2002 | • Telecommunications law |
| 2003 | • Granting of a second mobile licence (Zain) |
| 2004 | • Liberalisation of the telecommunications sector |
| 2007 | • Strategic and retail market review of the telecommunications sector |
| 2008 | • Implementation of regulatory procedures resulting from the strategic review |
| 2009 | • Licensing of a third mobile company (VIVA) |
| 2011 | • Granting of access to operators to use Batelco's fixed network |

Source: World Bank, Plum Consulting

## Spectrum availability

Further, there is a high degree of uncertainty in the Egyptian mobile market at the moment due to the lack of a regulatory statement on spectrum release. It is difficult for operators to raise funds for investment if there is uncertainty over future profitability, or if it may be the case that such investment is not needed for expanded capacity.

It is expected that the very low levels of profit and investment uncertainty for mobile operators will make it increasingly more difficult for the operators to justify an extensive network build-out to support demand in future. In addition, the very low retail margin for existing operators will have an impact on the success of new entrants that may try to compete in the market, particularly if they are introduced through a mandated entry rather than a competitive auction process. Low profit margins mean that it

[7] N Gelvanovska, M Rogy and C Maria Rossotto. 2014: *Broadband Networks in the Middle East and North Africa, Accelerating High-Speed Internet Access. Directions in Development*, World Bank, available from http://elibrary.worldbank.org/doi/abs/10.1596/978-1-4648-0112-9

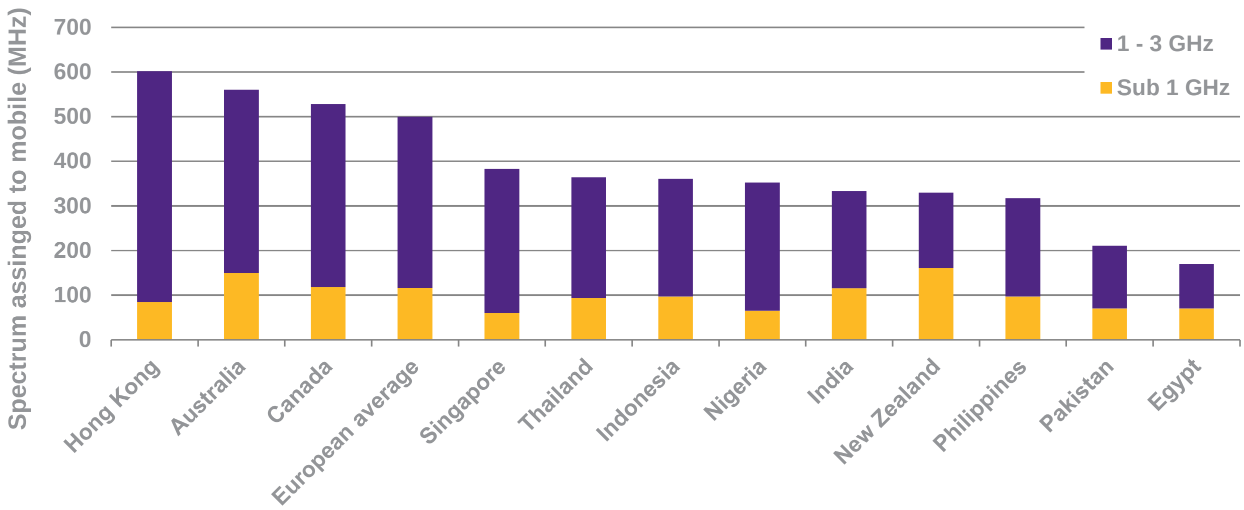
may be unviable to share returns between two separate companies, and this will especially be the case since a new entrant into the market will have little scale and efficiency and a high cost base.

In general, there is a need for a lower-cost alternative to extensive network build-out in order to boost the network capacity, such as access to more spectrum under the existing market structure. The economic modelling, set out in Section 3.2, indicates that there could be a capacity crunch in mobile networks from as early as 2019 given the current amount of spectrum in the 900 MHz, 1800 MHz and 2100 MHz already issued to operators in the market and the current level of network infrastructure. Such a shortage of capacity will seriously impact the rate of broadband growth.

Even where capacity constraints are forecast for a number of years from the present, operators must have certainty around the amount of spectrum they will have at the time, and preferably have access to the spectrum ahead of this point so that they may have fully tested and operational networks ahead of any capacity shortage.

Figure 2-9 compares availability of mobile spectrum in Egypt with other countries. Egypt clearly has less spectrum assigned to mobile operators than other comparable countries, and it has a fraction of the amount assigned in most developing, let alone developed, countries.

**Figure 2-9: Spectrum assignments to mobile operators**[8]




Source: Plum Consulting, national regulators

Therefore, to stimulate investment and growth of the industry, it is crucial that the regulator communicates clear plans for the timely release of additional harmonised spectrum for mobile use as soon as possible.

It is further important that the spectrum that is released is both free from interference, and secure from other uses. Interference from other services will prevent operators from making full use of it, and if the spectrum may be reclaimed by the Government at any point then operators will not invest due to disruption risks and uncertainty.

[8] Frequencies that have been assigned to specific operators for use – rather than just allocated for mobile use

Finally, how spectrum is distributed between existing and new market players will have significant impacts on how efficiently the spectrum can be used to serve end-users. Therefore, there is also a need to carefully consider how the spectrum is to be released. If new spectrum is disproportionately allocated to a new mobile network operator, whether it be Telecom Egypt or another new entrant, it may be several years before consumers are able to benefit from it given the time it would take to roll out a new network. The next section considers the market structure, with a particular focus on a new entrant to the market.

## 2.3 Market structures

The scarcity of suitable spectrum for mobile broadband services has driven some governments to consider new market structures that they believe could enable a more efficient use of spectrum, or a more competitive marketplace. These new market structures can take the form of new spectrum being awarded to a new entrant operator, with no additional allocations to existing operators. By reserving new spectrum for a new mobile network operator, regulators may hope to encourage more competition, lowering prices and improving quality of service.

However, these objectives may not be met if such action is taken in a market where there is already effective competition, as appears to be the case in Egypt.

First, it is clear from investigations into company financials that there is little scope for reducing prices for mobile broadband services, given the relatively low current profitability margins of mobile operators. This low profit margin is driven by competition, and it can be seen in Figure 2-1 that operators are competing with each other for subscribers. A new entrant is therefore unlikely to cause operators to reduce market prices further[9]. Indeed, studies by Ofcom in the UK have found that beyond a market size of three operators, there is a rapidly decreasing welfare benefit of introducing new competition[10].

Second, it is unlikely that a new mobile network operator will be able to offer services at a lower cost than existing operators. In the short term, certainly, unit costs for data will be higher than existing operators, with high fixed costs spread across a small subscriber base (and low level of traffic). Even after the new network operator has become more established in the industry, the fact that there are more operators each with a lower number of subscribers will mean that citizens will face higher, not lower, prices as the fixed costs of four networks (rather than three) will need to be recovered[11].

This is true even if the regulator believes that the new mobile network operator will be able to use more efficient and cheaper technology. Either all operators will be able to use this same technology, or the regulator will be setting up an unequal marketplace where different operators will have different quality of service. This latter example will prevent effective competition.

[9] Unless they are in a position to cross-subsidise from an existing business to sustain a loss; such unregulated behaviour would be disruptive on Egypt's ability to achieve mobile broadband growth.

[10] Ofcom, 2007: *Application of spectrum liberalisation and trading to the mobile sector*, Annex 10, available from http://stakeholders.ofcom.org.uk/binaries/consultations/liberalisation/annexes/lib_annex.pdf

[11] These arguments do not apply to the case where a new entrant is not operating their own network, but rather is either roaming across others' networks or acting as a virtual network operator. While there are still additional costs to be recovered in having additional brands and retailers in the market, these costs are generally small compared to the cost of running a network.

### Implications for modelling

Given the above, this study believes that reserving spectrum for a mobile network operator will not assist the Egyptian Government in achieving its objectives in relation to broadband penetration and usage. In order to investigate this, the benefits obtained if all spectrum is awarded to a new network operator are compared to those obtained by granting existing operators access to new spectrum. To do this, the possible impacts of the new entrant market model on the magnitude of the potential economic benefit for Egypt are examined. The impact of the implementation of a new entrant for future sub-1 GHz spectrum is considered with respect to demand for service and network infrastructure capacity.

This could be considered to be an extreme case, with all new spectrum reserved[12] for a new mobile network operator. However, even if the Government were to only reserve part of the spectrum for a new operator, many of these issues would still arise – particularly around the inefficiencies of additional small networks and the inability of operators to lower prices further than the current level. The potential impact of reserving only part of new spectrum for new entrants in the mobile market is discussed in Section 3.2.

## 2.4 Summary

This analysis has indicated some key areas in which recommendations in policy can be made. In particular, to enable the growth of the mobile broadband market, the Government must make secure and clean spectrum available to mobile operators as quickly as possible. Further, such awards must be made on a fair market basis.

However, before finalising policy it is important to consider the potential size of the benefits, and consider how these align with the Egyptian Government's existing policy proposals.

[12] It should be noted that this applies to cases where the spectrum is reserved, but it should not be assumed that spectrum cannot be used efficiently by new entrants. By making potential new entrants compete in auctions alongside existing operators, the regulator can be sure that spectrum awarded to new entrants will be used in an appropriate way, as the incentives on this new entrant will be correctly aligned.

# 3 Potential benefits and recommendations

Section 2 has shown that the mobile telecommunications market in Egypt is growing rapidly and is ideally placed to bring benefits to the economy and its citizens.  This section sets out where these benefits arise from and presents estimates of the size of the benefits.  Following this, this section compares the resulting analysis to those in the National Broadband Plan, and finally sets out an overall set of policy recommendations.

## 3.1 Origin of benefits

Broadband deployment and adoption affect the economy in a variety of ways.  Their effect can be direct and measurable as well as indirect and not robustly quantifiable.  The impact of improved broadband availability and usage on labour productivity will be reflected directly in a measurable uplift in GDP.

On the other hand, increased consumption of broadband also increases consumer surplus, which would require extensive data to be directly estimable, and access to broadband could also improve certain aspects of people's lives that are not captured by the national GDP.  For instance, the quality of life of many could be enhanced where broadband helps bring access of certain social services such as health and education to them.

Regulators must take account of these impacts when setting policy.  In order to maximise benefits, regulators must look to maximise the number of people able to access broadband connections. However, it is key that these connections are suitable for the types of services that consumers will want to use.  Understanding how benefits are felt is therefore key when setting out policy recommendations.

### Economic benefits

An increase in deployment of broadband and broadband service take-up can have significant impacts on the GDP through two key channels.

- The first is the direct injection of funds into the economy as operators deploy new infrastructure. This can support the creation of new jobs through increased spending and demand, and multipliers, such as the creation of and consumption broadband-based or online services, in the economy lead to further rises in GDP.
- The second is the adoption of broadband by businesses, consumers and Government.  The adoption of broadband by enterprises can enhance multifactor productivity, which contributes to GDP growth.  Better international connectivity also makes a country more attractive as a business hub, which encourages foreign direct investment, and it enables business process outsourcing, which can help exports grow. Similarly, households which use broadband will have better access to information and services which could help to improve its members' job prospect and labour productivity and increase household income.  Government can also be made much efficient through the use of online services; many public services will run at reduced cost and with better reach into the population with a greater degree of transparency.

These channels are the sources of quantifiable impact of broadband on the economy, since they can be measured by growth in GDP. However, this quantifiable impact of broadband deployment is not the only economic benefit. Consumers' welfare in the form of consumer surplus also adds to the overall benefit, where consumer surplus is defined as the difference between what consumers are willing to pay for a service and its price. The availability of broadband and other broadband-based services will necessarily lead to an increase in overall consumer surplus because of a rise in the amount of services consumed in the economy. Mobile broadband availability requires sufficient spectrum to be allocated for mobile use and the absence of constraints on infrastructure.

Following this increase in GDP, the government could expect to see an increase in employment driven by the increased demand in the economy. While some of the increase in GDP would be taken out of the economy through taxation or savings, there would be a considerable rise in spending which would require higher employment across the economy to meet the higher demand in all goods and services.

## Social and cultural benefits

Furthermore, broadband – in particular mobile broadband – can also lead to an increase in the population's social and cultural welfare. Many of the positive cultural and social changes from greater broadband adoption will not be reflected in the GDP estimates, but rather are about improving aspects of quality of life which cannot be quantified in monetary terms. These less tangible benefits arise from the use of broadband in the following six areas:

- **Education and research** – the Internet can improve education by enhancing remote communication and the delivery of teaching or training materials[13]. In addition, broadband Internet can improve the quality of education by expanding the range of synchronous and asynchronous learning opportunities through new online services and applications. For example, in 2013 Zain of Kuwait partnered with Hamdan Bin Mohammed e-University (based in the UAE) to create a mobile education Cloud Campus from which mobile subscribers were able to purchase nearly 2000 mobile education apps[14].
- **Personal finance** – mobile broadband can make it possible for banks and customers to perform complex transactions remotely, making it possible for more people to more effectively look after their personal finances and save for the future or invest. Mobile banking has taken off in Africa and the Middle East with huge growth predicted in many countries[15].
- **Healthcare** – appropriate mobile solutions can provide healthcare for more people, improve the quality of life for patients, and increase efficiency of healthcare delivery models while reduce costs for healthcare providers. For example, patients in Kenya, India and other countries are now able to verify legitimate medicines on their mobile phones[16].

[13] OECD, 2011: *The economic impact of Internet technologies*

[14] GSMA, 2013: *mEducation Toolkit*, available from http://www.gsma.com/connectedliving/wp-content/uploads/2013/12/meducation_operator_toolkit_Middle-East1.pdf

[15] Arabian Gazette, 2 July 2013: *MEA mobile banking users to quadruple by 2017*, available from http://www.arabiangazette.com/mea-mobile-banking-users-quadruple-2017-20130712/

[16] Business Call to Action, 2012: *Sproxil: Combating Counterfeit Drugs with Mobile Phones*, available from http://www.businesscalltoaction.org/wp-content/files_mf/sproxilcasestudy2.23.2012forweb17.pdf

- **Environmental impacts** – mobile broadband as a conduit for remote monitoring and wide-bandwidth communications can help government agencies protect the environment against climate change and irresponsible behaviour, and will help farmers increase water efficiency. Countries across the Middle East are recognising the potential benefits of smart irrigation systems that use mobile broadband to significantly increase water efficiency[17].
- **Involvement with government and national culture** – mobile broadband will bring benefits both to government, in terms of reduced cost and efficiency in the running of core services, and to citizens, in their interactions with government services. For example, the Gulf Cooperation Council is launching an e-Government portal in 2015 which will provide services for citizens as the travel within the GCC[18].

While some of these applications can be carried out over narrowband Internet connections, many will require the high bandwidth and low latency that comes with broadband. However, the deployment mobile broadband requires policy decisions to be made in regard to spectrum availability – the substantial social and cultural benefits are dependent on operators being given access to enough spectrum. Appendix B provides detailed examples of how broadband can generate social benefits in these areas.

While fixed broadband can provide similar services it currently has lower penetration than mobile broadband, largely because it is less accessible and provides less functionality. The best way to reach consumers with Internet services and the best way to increase usage of them is therefore to increase mobile broadband coverage and penetration. The difference in cost between mobile and fixed broadband will be more pronounced in rural areas – mobile is likely to be the only viable way of introducing broadband to much of Egypt, especially if constraints on infrastructure are removed.

## 3.2 Estimating the benefits

In this study, the focus of the quantitative impact assessment is the impact of greater take-up of business and consumers' mobile broadband on GDP. Therefore, the quantitative result of this analysis excludes the benefits from increased consumer surplus as well as social and cultural impacts of greater access to mobile broadband. This, in part, will make the numerical estimate of the positive impact of the benefit in this study a conservative estimate.

### Economic impact

The methodology used in estimating the economic impact here is based on the positive correlation between the rate of broadband penetration and the change in the rate of growth of the country's GDP. Several studies published confirm that broadband adoption has a positive contribution to GDP growth in both developed and developing countries. A summary of the findings of the most recent studies can be found in Appendix A.

[17] Agenda from *Middle East Smart Landscape Summit 2014*, http://landscapesummit.com/

[18] ITP.net, 3 September 2014: *All GCC e-Government portal to launch early 2015*, available from http://www.itp.net/599691-all-gcc-e-government-portal-to-launch-early-2015

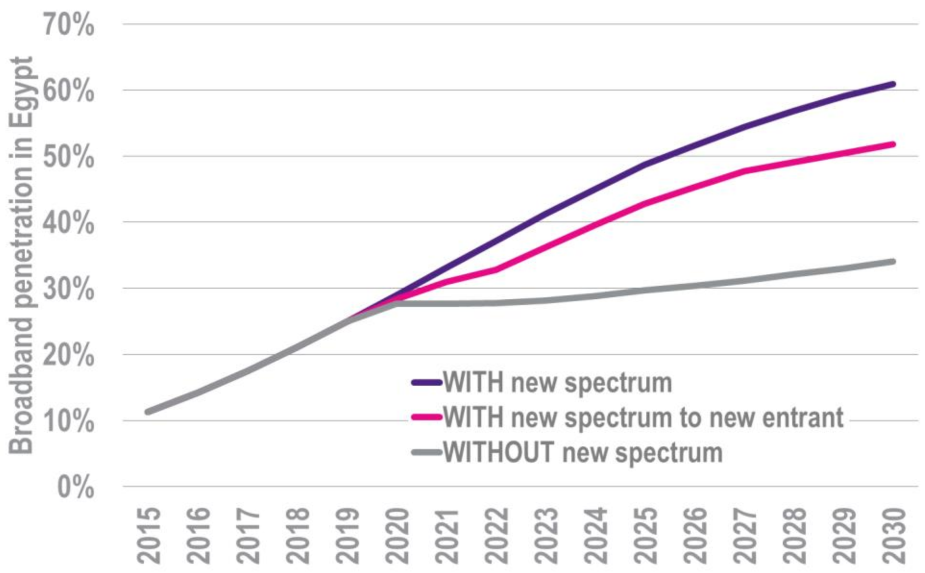
To assess the economic impact, this study examines the change in GDP between a base case and two spectrum release scenarios. The base case and the two alternate scenarios are defined in terms of spectrum availability and spectrum distribution of future spectrum.

- **The base case** – no additional spectrum in the 700 MHz, 800 MHz, 1800 MHz or 2100 MHz is released, and the existing three operators continue operating with the current amount of spectrum.
- **Scenario 1** – all new spectrum in the 700 MHz and 800 MHz as well as the remaining spectrum in the 1800 MHz[19] and 2100 MHz[20] bands are efficiently awarded through a fair and transparent market-based mechanism.
- **Scenario 2** – all new spectrum in the 700 MHz and 800 MHz as well as the remaining spectrum in the 1800 MHz and 2100 MHz bands are granted to a new mobile network operator.

The full discussion of the distinction between the base case, Scenario 1 and Scenario 2 is given in Appendix A, and detailed assumptions that form the basis for the modelling can be found in Appendix C. Scenario 2 here is taken as an extreme case to illustrate the change in impact of any movement away from the fair and open spectrum award.

The analysis shows that under current operators' spectrum holdings, network capacity will become constrained by 2020. Therefore, more spectrum is needed to support demand growth. With more spectrum, more mobile broadband users can be supported, increasing broadband penetration. The growth paths of broadband penetration for the base case, Scenario 1 and Scenario 2 are shown in Figure 3-1.

**Figure 3-1: Broadband penetration scenarios**



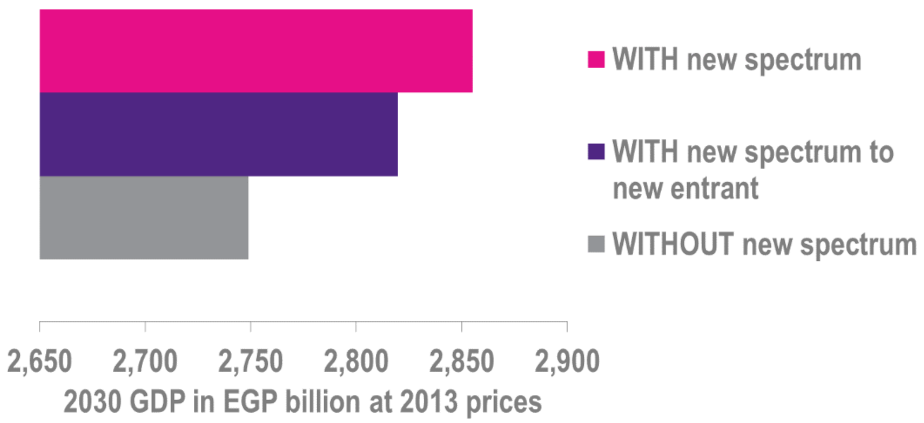

Source: Plum Consulting

[19] 2×55 MHz of the 1800 MHz band

[20] 2×25 MHz of the 2100 MHz band

The increase in broadband penetration has a positive impact on the GDP growth rate and hence the GDP in Egypt, and the faster the penetration grows, the higher the GDP growth uplift. Figure 3-2 shows Egypt's GDP in 2030 under the base case and the two spectrum release scenarios.

Figure 3-2: Egypt's GDP in 2030




Source: Plum Consulting

The estimates of the total change in GDP between 2014 and 2030 and the estimated increase in the Government's tax revenue for the same period (both expressed as NPV in 2013 constant prices) are shown in Table 3-1. The table also shows the potential impact on employment by 2030 in terms of the maximum number of jobs[21] that can be supported by the increase in GDP, after adjustments for tax and savings are made.

Table 3-1: Summary of economic benefit estimates

| Scenario | Increase in GDP (in NPV terms) | Increase in tax revenue | Additional jobs supported by 2030 |
|---|---|---|---|
| With new spectrum assigned to existing operators (**Scenario 1**) | EGP310bn | EGP47bn | Up to 1.2 million jobs |
| With all new spectrum granted to a new entrant (**Scenario 2**) | EGP206bn | EGP31bn | Up to 0.8 million jobs |

Scenario 1 and Scenario 2 as defined in this study are two extremes, and the benefit estimates for them should be interpreted as the maximum and the minimum levels of benefit achievable if the Government releases all available spectrum. When the spectrum is partly reserved for a new entrant, with the rest awarded through an open auction, there could be deployment inefficiencies if the new entrant cannot roll out its network as quickly as the incumbents due to financial or other constraints. The value of benefit estimate will lie somewhere between the benefit for Scenario 1 and the benefit for

[21] The methodology for this calculation can be found in Appendix A.

Scenario 2. The relative efficiency of such a scenario and the size of the benefit realised would depend on the three factors:

- the amount of spectrum awarded to each operator;
- the usefulness of the precise frequencies awarded; and
- the timing of the assignment.

However, any such alternative scenario would lead to an economic benefit that lies between those estimated for Scenario 1 and Scenario 2 – that is, Scenario 1 remains the maximum economic benefit that can be expected.

It should be noted that the levels of benefit derived here are predicated on the absence of hindrances to effective investment planning and immediate spectrum use discussed in Section 2.2. This means that it is assumed that:

- the spectrum to be released is both free from interference, and secure from other uses;
- the spectrum release process is well mapped out and well communicated to industry stakeholders;
- the distribution of spectrum is done through a fair and transparent process and spectrum is assigned in line with individual needs as expressed through a market-based mechanism.

In addition, there will also need to be good access to fixed facilities that operators need to enhance their core and backhaul networks in line with radio access network capacity. This means ready access to fibre ducts at reasonable prices on a wholesale basis or otherwise relative freedom to self-build. This also extends to access to sites for base station to expand the radio access network.

If these conditions are not satisfied, there could be delay in deployment of new technologies. This will have the effect of slowing down growth in the mobile broadband market and lower the potential GDP gains.

### Consumer surplus

The economic benefit quantified in this report does not include the effect of greater mobile broadband availability on consumer surplus. Consumers will capture much of the benefit of additional mobile broadband, and so consumer surplus will increase as the supply of mobile broadband increases. There will also be new mobile broadband-based online services such as telemedicine, m-education and m-health, which improve accessibility of traditional services. Such services are of huge functional benefit and encourage new users to adopt mobile broadband. These new users will contribute to increasing the total consumer surplus, raising it further. Furthermore, the availability of such new online services will also generate additional consumer surplus as they are consumed.

### Social and cultural impact

On top of the direct effect on GDP and the increase in consumer surplus, improved broadband availability and accessibility also yield social and cultural benefits, as described in Section 3.1 and Appendix B. These social impacts are not estimated in the quantitative analysis because they cannot be quantified or only have very long term benefits. This does not mean, however, that they are insignificant.  The long term benefits of e-health and e-education to Egypt – better health outcomes and a more productive workforce – will be extensive.  The benefits of mobile broadband on personal finance and the environment will be substantial.  Egyptian culture too will be enriched by greater social inclusion.

### Total impacts

The aggregate, both tangible and intangible, benefit of mobile broadband will, therefore, be bigger than the direct GDP impact summarised in Table 3-1.  Both consumer surplus and social and cultural benefits will increase as the adoption of mobile broadband increases, meaning that again higher benefits will be felt under Scenario 1 than under Scenario 2, both of which will have greater benefit than the base case.

## 3.3 Recommendations for broadband growth

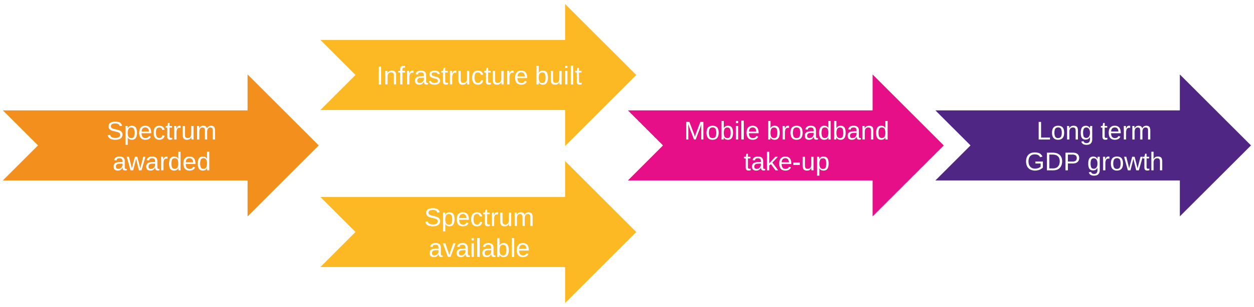
Through the National Broadband Plan and other initiatives the Egyptian Government and the NTRA have pursued the objective of greater broadband use in Egypt, which will lead to significant economic and social benefits.  The benefit mobile broadband is maximised when mobile penetration is highest.  However, there are significant issues that may reduce the benefits attained from mobile broadband.  In particular, without an in increase in the amount of spectrum available for operators, networks are likely to quickly become capacity constrained.

Assigning all new spectrum through a fair and equal award process is the best way to ensure an efficient outcome.  Established players are more likely to be able to use the spectrum quickly given that they already have a core network, a portfolio of sites and can leverage their existing customer base.  If a new entrant is able to bring other efficiencies or new services to the market and compete with established operators, an open award process will not preclude them.  Fair and open award processes serve to ensure that only efficient users of spectrum are granted holdings.

Regardless of which operators are granted spectrum, operators will still need to be able to plan their investment ahead to move quickly on deployment, and this requires clear information from the Government about the release of the spectrum.  Once spectrum is awarded, operators must be given security that it will not be retaken by the Government as insecure property rights undermine investments and disrupt services.

As discovered by this report, spectrum constraints will be hit in 2020.  Spectrum needs to be available well before then in order to ensure that the additional capacity will be ready when the current capacity constraints are hit.  Figure 3-3 outlines how there must be certainty over spectrum assignments long before mobile broadband services are actually launched, given the extensive work that is required before capacity is available.  A combination of spectrum releases and regulatory certainty over liberalisation is needed to promote mobile broadband.

Figure 3-3: Mobile broadband roadmap




Source: Plum Consulting

As well as spectrum supply, there are three main non-spectrum constraints on network rollout that could become a barrier to capacity expansion:

- access to backhaul and core fibre,
- availability of international connectivity, and
- availability of sites on which to locate base stations.

If the backhaul and core fibre network does not keep up with data demand on the radio access network then it will become a bottleneck; similarly if prices for core and backhaul networks are kept high due to monopoly provision, they will prevent mobile operators from providing services at a welfare-maximising price. It is therefore crucial that the Kayan, if implemented, is closely regulated. Access to and price of international gateways can represent a similar constraint, particularly as an increasing amount of traffic is carried over the Internet. It is also important for mobile operators to be able to build new base stations, a process often held back by administrative and approval difficulties in getting planning permission.

The result of the quantitative analysis in this report assumes that these non-spectrum constraints do not become a hindrance to the ability of mobile operators to expand their network capacity. In the event that there are such constraints, the benefit derivable from spectrum release will be smaller: other types of network constraint will limit the growth of the mobile broadband market. The Government must ensure that its current plans for Kayan and other fixed network regulatory developments do not impede the potential growth of mobile broadband.

### 3.3.1 The National Broadband Plan targets and policies

As discussed in Section 2.1, the eMisr National Broadband Plan set targets for both mobile and fixed broadband penetration in 2011, but it is now clear that trends in the telecommunications industry have made these targets unrealistic; mobile broadband is the most cost efficient technology for Egypt. In order to maximise benefits, it appears that the Government should focus on expanding mobile broadband penetration.

> *"...it is crucial that national broadband policies should be well formulated according to the stage of broadband market development of each individual country with emphasis on those areas that are the most relevant for that stage. This enables the government to introduce adequate and, just as*

*importantly, timely regulatory and policy measures which may effectively contribute to further market development while taking into account the specific situation of each country."*

Gelvanovska et al (2014)

There are a number of potential issues that need to be overcome for mobile broadband to be widely adopted.

## Spectrum availability

Spectrum availability is a key constraint that requires decisive policy action. The National Broadband Plan recognised this need for additional spectrum, and identified policies to provide more spectrum for mobile.

- Firstly, allowing operators access to the full balance of identified spectrum in the 900, 1800, and 2100 MHz bands. A substantial amount of internationally identified spectrum, in bands that have developed broad international ecosystems and economies of scale, is not currently available to mobile operators in Egypt.
- Secondly, allowing the refarming of existing spectrum holdings. Technology neutrality will give operators flexibility to respond to consumer demand by converting their existing holdings from 2G or 3G to 4G (LTE) services. Policies that support refarming are an important part of maximising spectral efficiency.
- Thirdly, the Plan supports making use of the digital dividend for mobile. As highlighted in this report, the 700 MHz and 800 MHz bands will be crucial in providing extra capacity for mobile broadband. Releasing these bands for mobile should be a priority.
- Fourthly, the Plan states that additional spectrum will be needed for mobile. It estimates that between 2×25 MHz and 2×75 MHz is needed by 2015, and that by 2012 between 2×150 MHz and 2×500 MHz will be needed to meet demand. It does not, however, make specific recommendations towards meeting this goal.
- Lastly, the Plan encourages innovative spectrum access models. While new techniques like cognitive radio may eventually play a role in increasing spectral efficiency going forward, the technology and effective means to mitigate interference are not yet in place. New models of spectrum access are unlikely to be developed in time to avoid the spectrum capacity constraints in Egypt.

Each of these policy recommendations is consistent with this report's findings, but it must be noted that the Plan did not state how new spectrum is to be awarded. Maximum benefit will be achieved if additional spectrum is awarded in a fair and open auction, with no spectrum reserved for new entrants.

Indeed, the most important factor in making optimum use of available spectrum is the nature of the assignment process to mobile operators. Award procedures should be transparent, no more complex than necessary, fair and efficient. Transparent, simple spectrum awards build confidence in regulation and ensure the timely release of spectrum. Fair procedures that do not discriminate amongst bidders result in efficient outcomes. In a competitive auction the bidder that bids the most should make the most efficient use of the spectrum; discriminating against efficient bidders in favour of less efficient bidders will reduce the impact of mobile broadband on the Egyptian economy.

As discussed in this report, the award of spectrum to a new mobile network operator would reduce the benefit of mobile broadband in Egypt. This report demonstrates that discriminating in favour of Telecom Egypt or any other firm in a spectrum award would reduce the welfare of Egyptian consumers. This is not to say that Telecom Egypt should be excluded from any auction, however; if Telecom Egypt were able to run a competitive network after paying a market price for spectrum, then this would itself be an efficient outcome.

## Access to infrastructure

Outside of spectrum awards, both the Egyptian Government and mobile operators identify national backbone infrastructure availability and affordability as crucial for the rollout of mobile broadband.

> *"The promotion of competition in broadband should be encouraged across all segments of the broadband infrastructure (access, backbone, and international connectivity). A bottleneck at the backbone or international level will translate into obstacles at the access level. Conversely, competition at the backbone and international connectivity levels can greatly stimulate broadband penetration."*
>
> Gelvanovska et al (2014)

In order to introduce competition into the core network, the Plan set out four directives for the NTRA to pursue.

- Maximise open access on the existing Telecom Egypt core network. The Plan also raised the possibility of functional separation between the retail and wholesale arms of Telecom Egypt.
- Mobile operators should be allowed to collaborate and form a single purpose vehicle which would build and expand the core network.
- Grant mobile operators the rights to build core network.
- Allow core network providers to share infrastructure with different utilities such as electricity, water or gas.

The liberalisation of the fixed network would be beneficial for mobile operators and, by extension, their customers (as the competitive nature of the market will mean cost savings are passed on to end users). The ability of mobile operators to lay their own core and backhaul networks will firstly force Telecom Egypt to reduce prices to an efficient level, as it will need to compete within the buy-or-build decision process. Secondly, it will enable operators to respond to changes in demand demographics more quickly, increasing capacity where it is needed. If operators are able to sell wholesale capacity on their fixed networks to other operators, it will make the industry as a whole more efficient. This liberalisation is therefore crucial in allowing mobile operators to maximise economic and social benefits.

A similar constraint on mobile broadband is international landing station access and pricing. The best way to improve Egypt's access to the international Internet is to increase competition in global gateways and submarine cables. While the Plan recognised the benefits of competition in international connectivity, it did not make any policy suggestions to further it. It is crucial that such policies are put in place.

Further, the National Broadband Plan identified that a further obstacle to mobile network rollout is the lengthy process of gaining approval for base stations sites from competent authorities. A fast approval process will reduce the cost of network investment and speed up mobile broadband rollout.

## 3.4 Overall recommendations

Both the National Broadband Plan and this study agree that in order to maximise the benefit of Internet access, it is necessary to increase the penetration of Internet across the population. It is clear from recent trends in the Egyptian telecommunications market that the most efficient way of doing this is through facilitating the growth of mobile broadband. This will be best achieved by releasing more spectrum to Egyptian operators, without reserving this for new entrants but also without preventing such entrants from bidding if they are able to offer a competitive package to consumers.

Therefore, the overall recommendations of this report are:

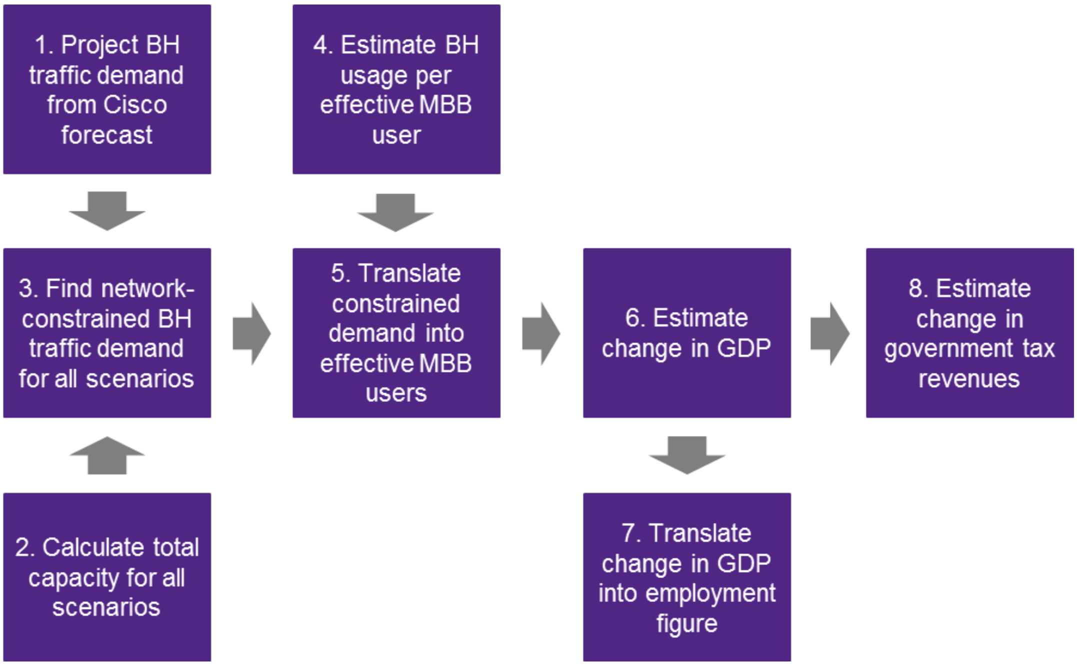
- A new national broadband plan must be drafted, in consultation with industry and users, to set targets and policies for the markets for the long term. This study, and the work of the committee working on Kayan, should be used as a basis to develop this plan.
- The regulator must make as much spectrum available as possible, as quickly as possible, particularly in the 700 MHz and 800 MHz bands. This must be awarded through a fair and transparent process with no bands reserved for any particular use.
- It is also important that the steps and milestones in the release process are clearly mapped out and effectively communicated to industry stakeholders to create a predictable environment for investment, which will ensure timely use of the spectrum.
- Access to infrastructure that is necessary for mobile broadband deployment – such as fibre duct, international gateway, landing stations and tower sites – must be closely monitored to ensure that neither price nor availability of the mobile broadband to consumers inhibits the take-up of service. As recommended by the Gelvanovska et al (2014), competition in across all levels of infrastructure should be promoted through the removal of regulatory barriers to entry.
- Penetration of mobile broadband must be encouraged as the most efficient way of promulgating e-health, e-education and other Internet services that will improve the lives of ordinary Egyptians.
- Consumers and businesses must be given the freedom to innovate in the use of Internet services that are demanded by consumers and increase business productivity (and thus GDP). Government services must also look to improve their usage of online services to make governance more efficient and to stimulate demand and adoption of mobile broadband.
- The new national broadband plan should set reasonable targets for fixed and mobile broadband penetration and quality of user experience to reflect the increased importance of mobile telecommunications in the economy. These revised targets will be particularly important in any discussion over the implementation of universal service.

# Appendix A: Economic impact

The structure of the model used to estimate the economic benefits of spectrum release is shown in Figure A-1. The modelling process is repeated for all scenarios described in Section 3.2 to derive the incremental GDP, tax and employment associated with the release of additional spectrum in the 700 MHz and 800 MHz bands, and with different methods of spectrum allocation and industry structure.

This appendix discusses each step shown below, and describes the data used. Appendix C gives a detailed list of all data and assumptions used in the model. Data has been obtained from public sources and also from confidential discussions with operators. Where data was not available from operators, assumptions have been made based on Plum's experience in other similar countries, and these assumptions have been distributed to operators for validation.

Figure A-1: Structure of the economic model




## Step 1: Project busy hour traffic from Cisco forecast

The model uses Cisco's forecasts to underpin the traffic forecasts[22]. When extracting this information, traffic forecasts for Saudi Arabia and South Africa have been excluded from the total for MEA for the following reasons:

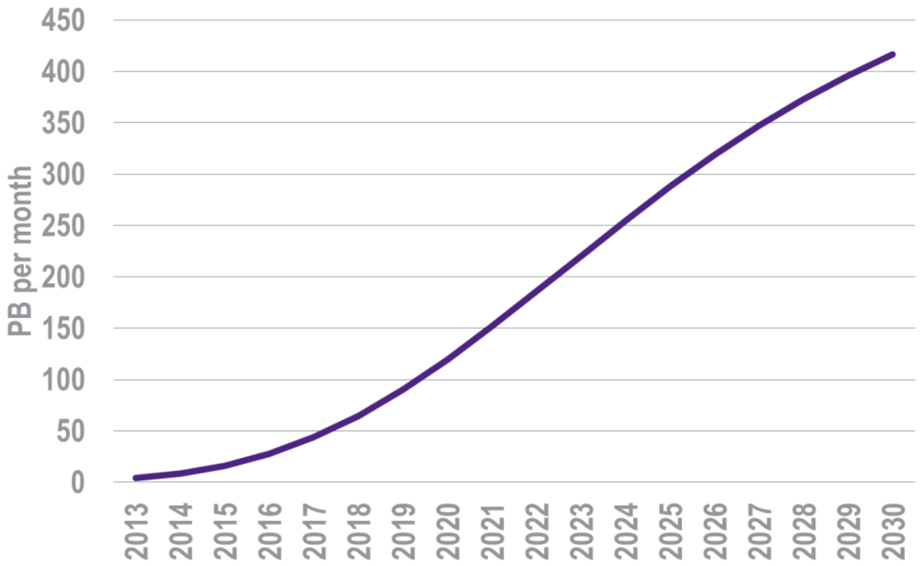
- Country-level numbers for the two countries are available in the VNI tool.

[22] Cisco VNI 2014, available from http://ciscovni.com/vni_forecast/index.htm

- These countries are likely to have usage that are different from the rest of developing MEA due to their more advanced mobile markets[23] – for example, 4G service has already been launched in both countries.

The regional forecasts are extrapolated beyond 2018 using a Gompertz curve. This provides the model with a trend line for traffic growth, which is then adjusted using Egypt's population as a percentage of the total regional population to derive Egypt's total mobile data usage forecasts. In effect, Egypt's future per-capita mobile data usage is assumed to be well represented by the projected consumption level for the region[24]. Figure A-2 shows the resulting traffic forecast projections for Egypt.

**Figure A-2: Traffic forecasts for Egypt**




Source: Cisco VNI 2014, Plum Consulting

These projected values for Egypt are taken to be the unconstrained mobile traffic forecasts in Egypt. The forecast assumes that there is no supply-side factor such as a lack of network capacity or high service price to constrain the demand. This means that the projections are taken to be the maximum demand for mobile data in Egypt.

[23] While other advanced markets such as Qatar and the UAE will be included in the trend analysis, their contributions to the regional projections are likely to be insignificant due to their relatively small populations. In addition, separate forecasts from Cisco are not available for these countries, so it is not possible to exclude them.

[24] This appears to be the case at least for 2013. A cross-check has been carried out comparing the starting value (2013) of the derived Egypt's forecast against a market's total for the year that has been estimated from the network data traffic for Vodafone reported by the GSMA Intelligence. This finds these two estimates to be comparable – 4.0PB per month against 3.8PB per month.

Egypt's unconstrained total monthly mobile traffic forecast is then converted into the busy-hour (BH) traffic demand in gigabits per second under the assumption that usage during the busy hour makes up 10% of total daily traffic. Further, it is assumed that 90% of the traffic is transmitted in the downlink.[25]

## Step 2: Calculate total downlink capacity for all scenarios

The total downlink capacity available on networks depends on the number of base stations in urban areas and the amount of available spectrum over the forecast period. GSMA Intelligence reports the number of base stations for Mobinil between 2009 and 2011. The model uses a linear extrapolation to derive an estimate of the site count for the operator in 2014[26]. Vodafone and Etisalat's site counts are then estimated based on their subscriber market shares compared to Mobinil. Finally the site counts are forecast, with assumptions made around the split between urban and rural site numbers.

The amount of spectrum to which each operator has access in the 900 MHz, 1800 MHz and 2100 MHz bands has been supplied by the GSMA. This, and the amount that is expected to be released in the 700 MHz and 800 MHz bands, is used to determine total spectrum portfolios for each operator during the forecast period. A view has also been taken on the pace of 900 MHz and 1800 MHz spectrum refarming to derive the total downlink spectrum available for each operator to 2030.

The detailed modelling assumptions for these and other network parameters are listed in Appendix C. Under different scenarios, spectrum holdings are varied considerably, whether in terms of which spectrum is available to mobile operators or the timing of its release.

## Step 3: Find network-constrained busy hour traffic for all scenarios

Available capacity for effective mobile broadband users from Step 2 is compared with the total unconstrained demand from Step 1. The lower of the two numbers is taken as "realised" traffic for each scenario.

## Step 4: Estimate busy hour usage per effective mobile broadband user

The range of monthly usage for an effective mobile broadband subscriber in 2013 and 2018 is estimated using information available from Cisco VNI 2014. These data provide the average monthly mobile data traffic volume per connection for smartphones, laptops and tablets in MEA, and also give the proportions of total mobile data traffic that the data from the different device groups represent along with the percentages of total device connections that each device type constitutes.

From this information, the model estimates that usage for an effective mobile broadband subscriber in MEA was between 0.5GB and 1.9GB per month in 2013. In 2018, this usage will be in the range 2.1GB to 4.5GB per month. The lower end of the range is calculated by assuming that 100% of smartphone connections are effective mobile broadband users, while the upper end of the range is calculated by assuming that only laptop and tablet connections constitute mobile broadband users.

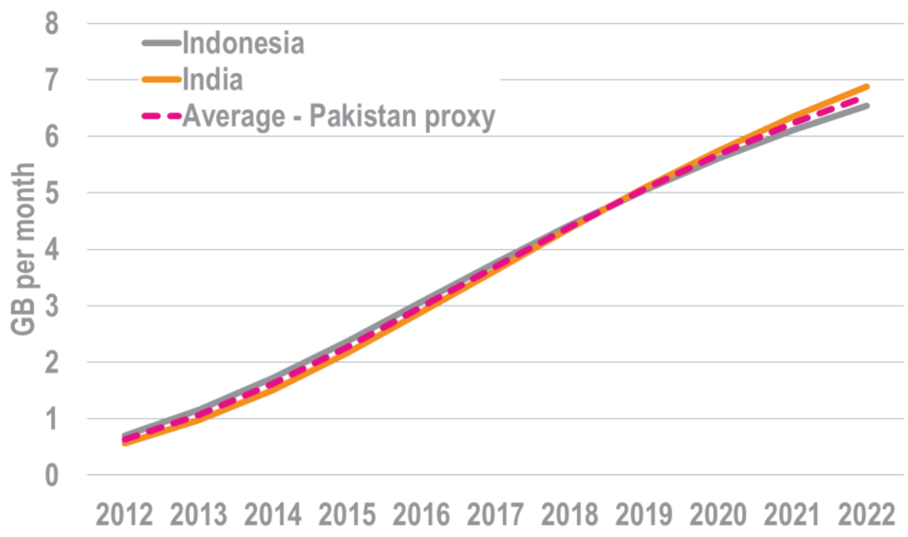
[25] Plum, 2011: *Economic study of the benefits from use of 1452- 1492 MHz for a supplemental mobile downlink for enhanced multimedia and broadband services*, available from http://www.plumconsulting.co.uk/pdfs/Plum_June2011_Benefits_of_1.4GHz_spectrum_for_multimedia_services.pdf

[26] Operators have confirmed that these numbers are in line with their actual network sizes.

Implicit in the calculation of the upper bound is that all smartphone connections are casual users of data, so that they do not contribute to an increase in broadband penetration or economic growth.

These estimated ranges bracket the projected values that have been used in a previous socio-economic study for Pakistan[27] shown in Figure A-3[28]. For this reason, these projections have been used as estimates of usage per effective mobile broadband subscriber in Egypt in this model. The values used are tabulated in Appendix C.

**Figure A-3: Usage per effective MBB subscriber**




Source: Plum Consulting

Finally, the model computes the busy-hour usage per effective mobile broadband user by assuming the same set of parameters that are used to translate total traffic demand to busy-hour traffic demand in Step 1.

## Step 5: Translate constrained demand into number of effective mobile broadband users in Egypt

The constrained busy hour traffic forecast from Step 3, which represents 10% of the total data traffic, is divided by the busy hour usage per effective broadband user from Step 4 to give the number of effective mobile broadband users in each scenario.

As a check on whether the forecasts are plausible, the model considers whether affordability could limit the potential total number of users on a ten year view. An operator has informed this study that 100% of the population in urban areas could afford to become effective mobile broadband subscribers.

[27] Plum, 2013: *The Economic Impact of 3G Mobile in Pakistan*, available from http://www.plumconsulting.co.uk/pdfs/Plum_Aug2013_Pakistan_3G.pdf

[28] The usage per effective mobile broadband user in this earlier study was derived from large developing Asian countries including Indonesia and India.

For the forecasts to be reasonable, the number of subscribers projected must fall below this affordability constraint.

## Step 6: Estimate change in GDP

Step 5 provides a take-up curve showing the number of effective mobile broadband users over time. There is one for each scenario. From this curve and publicly available population forecasts, the mobile broadband penetration is calculated (see Figure 3-1), and its year-on-year change derived. This is then multiplied by an estimate value for the percentage change in GDP growth arising from a 10 percentage point increase in broadband penetration to give a GDP growth stimulus from the growth in broadband penetration. This gives the estimate of the GDP that could be expected under each scenario.

Steps 1 to 5 are repeated for the base case and each alternate scenario. Differences in results are computed to derive the change in GDP relative to the base case. The base case and alternate scenarios are defined in Appendix A.2.

## Step 7: Translate change in GDP into employment figure

Increase in output arising from a change in labour productivity due to greater enterprise broadband adoption is assumed to be passed onto workers through wage rises. The creation of new businesses as a result of increased household broadband penetration also contributes to the rise in GDP. This means that the higher GDP translates to higher income for the general working population, which in turn will lead to a higher demand for goods and services across the economy.

The model does not assume that all increases in GDP lead to higher demand. Instead, tax revenues are removed (as it is considered that government demand is exogenous), and the remaining increase in GDP is adjusted by a factor to allow for savings in the economy[29]. The remaining GDP uplift forms the basis for estimating the extent of additional job creation.

The impact of increased GDP on employment is estimated by multiplying the ratio of jobs to GDP in Egypt by the remaining GDP uplift (after the above adjustments) in 2013. This makes the number of additional jobs computed an upper bound for two reasons.

- The first is that analysis does not take into account the productivity increase: the job-to-GDP ratio is the same 2013 figure used. This is because there is no robust way of forecasting the change in productivity and hence change in the job-to-GDP ratio between 2013 and a future time period.
- Secondly, not all of the increase in GDP will be used to create employment. Some of it will be spent on raw materials, or on other investment that may not flow back into the economy immediately.

[29] The savings proportion is estimated at 21%, which as the average of the historical gross savings percentages by the World Bank in between 2005 and 2012. This represents the difference between disposable income and consumption, and is assumed to be the average savings ratio across individuals and businesses in this report.

### Step 8: Estimate change in government tax revenues

An increase in GDP implies an expansion in industry output. This means a higher revenue for firms as well as more pay for employees, which translates to a higher tax take for the Government in the form of corporate and income taxes. Increased consumption due to higher income also generates further tax.

In this analysis, the average of the historical governmental tax intakes as a percentage of total GDP between 2005 and 2013 is used as a proxy for future tax-to-GDP ratio for the modelling period. The impact on governmental tax revenues here is calculated by applying the national tax to GDP ratio to the GDP growth stimulus from mobile broadband. Data from the African Development Bank's African Statistical Yearbook 2014 has been used to estimate the tax-to-GDP ratio. Potential governmental revenue generated from the assignment of spectrum rights such as receipts from auction is not considered in this estimation.

## A.1 The base case

As mentioned in Section 3.2.1, the benefit in GDP terms that accrues to each scenario is represented by the change in GDP from the base case. In this base case, it is assumed that no new spectrum becomes available in the future. Operators' access to spectrum is limited to just the 900 MHz, 1800 MHz and 2100 MHz bands – that is, the spectrum bands that have already been licensed. In addition, the total amount of spectrum available to the operators in these bands also remains constant. Only three operators are assumed to be present in the market in this base case given the intense competition in the market as indicated by the low profit margin.

## A.2 Modelled scenarios

Two spectrum release scenarios are examined in this study. In the first, the new spectrum in the 700 MHz and 800 MHz bands as well as the remaining spectrum in the 1800 MHz and 2100 MHz bands are assumed to be awarded through a fair auction, thus allowing both existing and potential new players to gain access to them. In the second scenario, the new bands will be issued directly to a new entrant.

It should be noted that these are considered to be two extremes of regulation, and it is possible that the Egyptian Government will decide to settle somewhere between the two scenarios – with, for example, only a proportion of spectrum reserved for a new entrant. The implications of such scenarios are discussed below.

In Scenario 1, new spectrum in the 700 MHz and 800 MHz bands is assumed to be made available from 2016 and 2020 respectively, and the rest of the unreleased 1800 MHz and 2100 MHz spectrum is made available in 2018. Therefore, existing operators will be able to supplement their spectrum holdings in the 900 MHz, 1800 MHz and 2100 MHz bands with new bandwidths from the 700 MHz, 800 MHz, 1800 MHz and 2100 MHz bands. As with the base case and for the same reason, only three operators are assumed to be operate in the market throughout the modelling period.

In Scenario 2, it is assumed that there will be no auction. The existing three operators currently in the market will not have the opportunity to gain direct access to the spectrum. Therefore, the amount of spectrum that is assumed for each operator in each band is the same as the amount assumed in the base case.

These assumptions lead to further crucial differences between the scenarios. Whereas the same number of operators is assumed under Scenario 1 as in the base case, there is an additional operator (in the form of a new entrant) in Scenario 2. Therefore, in total there will be four mobile network operators in Scenario 2; this has significant impacts in terms of network dimensioning. Another key difference between Scenario 1 and Scenario 2 is the timing of the service launch. In Scenario 1, it is assumed that the existing operators will be ready to use new 700 MHz and 800 MHz spectrum as well as the remaining 1800 MHz and 2100 MHz spectrum as soon as it is released, as it can be rolled out onto existing network infrastructure. On the other hand, the launch of new mobile broadband service will be delayed by two years when the new entrant is given exclusive rights to the spectrum. This assumed delay reflects the difficulty faced by the new entrant in securing funding for the infrastructure and hence a cautious approach to investment, and also time taken to actually build and deploy the network.

The limited network rollout is also likely to lead to a lower quality of service, a less extensive coverage network and in the medium term a slower adoption of new technologies. At the same time, the existing operators will suffer from capacity constrained networks, leading to lower quality of service through dropped connections and blocked access. This general lower quality will have the effect of lowering the unconstrained demand in Scenario 2. In the model, it is assumed that the unconstrained demand for mobile broadband data is determined by the extrapolated Cisco forecasts shown in Figure A-2 for both the base case and Scenario 1. However, in Scenario 2, the unconstrained demand is assumed to begin falling from the point at which the networks become capacity-constrained. After 2022, the unconstrained demand in Scenario 2 is assumed to be 85% of the unconstrained demand in the base case. Table A-1 compares the key assumptions that are made in the base case and Scenarios 1 and 2.

**Table A-1: Differences in assumptions across base case, Scenario 1 and Scenario 2**

| Assumption | Value assumed for the scenario | | |
|---|---|---|---|
| | Base case | Scenario 1 | Scenario 2 |
| Number of operators | 3 | 3 | 4 |
| 700 MHz spectrum release date | N/A | 2016 | 2016 |

| Assumption | Value assumed for the scenario | | |
|---|---|---|---|
| 700 MHz MBB service deployment date | N/A | 2016 | 2018 |
| 800 MHz spectrum release date | N/A | 2020 | 2020 |
| 800 MHz MBB spectrum deployment date | N/A | 2020 | 2022 |
| Additional combined spectrum released in the 700 MHz and 80 MHz bands | 0 MHz | 2×45 MHz | 2×45 MHz |
| Additional combined spectrum released in the 1800 MHz and 2100 MHz bands | 0 MHz | 2×80 MHz | 2×80 MHz |
| Unconstrained demand as a % of demand derived from Cisco VNI forecasts | 100% | 100% | 85% from 2023 |

Other assumptions are uniform across the scenarios and can be found in Appendix C.

Scenario 1 and Scenario 2 here represent two extreme cases; where there is no spectrum reserved for a new entrant and where all the spectrum is reserved for a new entrant. Clearly, there are a multitude of potential scenarios that lie between these two points. Any award where spectrum is reserved for a new entrant will be inefficient, and the more that is reserved for the new entrant, the more the inefficiency will increase – moving the outcome closer to that of Scenario 2.

This is not to say that new entrants should be barred from entering an auction – the auction should be fair to any firm to enter, and if a new entrant will make efficient use of the spectrum then they will win it at auction anyway. It is the reservation of spectrum that causes inefficiency because it can artificially move the auction result away from the optimal outcome.

## A.3 Literature review of GDP impact

The economic impact estimation methodology in this study is based on the positive relationship between the rate of broadband penetration and the change in the rate of growth of the country's GDP. A growing number of economic studies confirm this relationship. Their results are used here as the basis for the assumed impact[30]. Almost all of these studies are for high income countries and some rely on data for the period from the mid-1990s and 2000s when broadband speeds were much lower than they are today. This is likely to mean that any estimates derived in this study will be conservative. Further, the capabilities and applications offered by access to the Internet which will be better in 2015 in Egypt than, say, 10 years ago, and this will lead to additional productivity benefits.

The following table summarises some of the study results – particularly those that are more recent. These results range from 0.025% to 1.2%. Kenny and Kenny (2010) have criticised some of the higher estimates, partly because the underlying studies include time periods in which there was no broadband service. This study has therefore used an estimate towards the low end of 0.5%.

[30] There are no such studies which look exclusively at mobile broadband. One reason for this is the relatively short time period over which such services have been available and used. Even studies of fixed broadband effects are hampered by lack of a long time series and so tend to use cross sectional data as well as time series.

**Table A-2: Estimates of impact of change in broadband penetration on GDP growth**

| Authors | Impact of 10 percentage point change in broadband take up on GDP growth rate |
|---|---|
| Czernich et al (2009) | 0.9 to 1.5 percentage points |
| Grimes et al (2009) | 1.0 percentage point |
| Katz et al (2010) | 0.025 percentage points (for high speed broadband) |
| Koutroumpis (2009) | 0.25 percentage points |
| McKinsey (2009) | 0.5 percentage points |
| Micus (2008) | 0.7 percentage points |
| OECD (2011) | 1.09 percentage points |
| Qiang et al (2009) | 1.2-1.4 percentage points (higher end of range is for low or middle income countries) |
| ITU (2012) | 2.4-2.8 percentage points (based on change of 0.18-0.21 percent for a 10-percent annual change in penetration for the Middle East) |

One factor none of the studies addresses explicitly is the time period over which the effect persists – in some cases the analysis suggests they persist indefinitely while in most studies this issue is not directly addressed. This study has assumed a 5 year impact, again to be conservative.

Table A-3: Summary of GDP impact studies

| Authors | Summary |
|---|---|
| Corrado, May 2010: *Communications capital, Metcalfe's law and US productivity growth*, The Conference Board, New York | Uses a growth accounting framework to examine the role of communication network externalities in US productivity performance and to measure the link between ICT services and ICT capital assets. Finds that over the period 2000-2007, communication network effects could have contributed 0.47 percentage points to aggregate US non-farm business sector productivity. This is about 30% of multi-factor productivity growth over the period. |
| R Katz, S Vaterlaus, P Zenhäusern & S Suter, 2010: *The Impact of Broadband on Jobs and the German Economy*, Intereconomics: Review of European Economic Policy, volume 45, issue 1, page 2 | Use input-output analysis to assess the impact on jobs and GDP in Germany of investment in high speed broadband – 50 Mbps (75% households by 2014) and 100 Mbps (50% households by 2020). Impact of 10% increase in high speed broadband penetration on GDP is 0.025%. |
| OECD, May 2011: *The Economic Impact of Internet Technologies*, Working Party on the Information Economy, DSTI/ICCP/IE(2011)/REV1 | Reviews studies undertaken by others and undertakes own estimates of the correlations between broadband penetration and GDP growth and IPV4 Internet addresses per capita and GDP growth. The former impact is twice the latter. Argues IPV4 Internet addresses per capita is potentially a better measure of Internet development. |
| N Czernich, O Falck, T Kretschmer, L Woessmann, December 2009: *Broadband Infrastructure and Economic Growth*, CESIFO working paper no 2861[31] | Based on annual data for a panel of OECD countries and using an instrumental-variable approach, one study finds that the introduction and diffusion of broadband had an important impact on growth in GDP per capita. After a country has introduced broadband, GDP per capita is 2.7 to 3.9 percent higher on average than before its introduction, controlling for country and year fixed effects. In terms of subsequent diffusion, an increase in the broadband penetration rate by 10 percentage points raises annual growth in per-capita GDP by 0.9 to 1.5 percentage points. |
| Lehr, Osorio, Gillett and Sirbu. September 2005: *Measuring broadband's economic impact*. Paper presented to the 33rd Annual Telecommunications Policy Research Conference[32] | A US study examined geographic areas according to their broadband availability and/or use of broadband to determine whether there were observable deviations from secular trends in a number of economic indicators between 1998 and 2002. The study concluded that broadband access does enhance economic growth and performance, with communities in which broadband became available experiencing more rapid growth in employment, the number of businesses overall and the number of businesses in IT-intensive sectors. Lehr et al also observed an increase in market rates for rental housing (a proxy for property values) in areas with broadband availability |

[31] Available from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1516232&http://scholar.google.co.uk/scholar?hl=en&q=economic+impact+of+high+speed+broadband&btnG=Search&as_sdt=0%2C5&as_ylo=&as_vis=0

[32] Available from http://repository.cmu.edu/tepper/457/

| Authors | Summary |
|---|---|
| J Kolko, January 2010: *Does Broadband Boost Local Economic Development?* Public Policy Institute of California.[33] | Another US study of geographic data finds a positive relationship between broadband expansion and economic growth. This relationship is stronger in industries that rely more on information technology and in areas with lower population densities. However, the study finds that although the evidence leans in the direction of a causal relationship, the data and methods do not definitively indicate that broadband caused this economic growth. It also finds that the economic benefits to residents in an area appear to be limited. Broadband expansion is also associated with population growth and that both the average wage and the employment rate—the share of working-age adults that is employed—are unaffected by broadband expansion. |
| P Koutroumpis, October 2009: *The Economic Impact of Broadband on Growth: A simultaneous approach*, Telecommunications Policy volume 33, Issue 9, pages 471-4[34] | A study of the impact of broadband penetration on economic growth in EU countries in the period of 2004-2006 finds that significant causal positive link especially when a critical mass of infrastructure is present. The study estimates the critical mass for household broadband as 20% of households, as this provides broadband access for close to 50% of the population. |
| Micus, 2008: *The Impact of Broadband on Growth and Productivity*.[35] | A study for the EU found that process improvement, increased specialization in knowledge-intensive activities and broadband-based development of innovative markets resulted in a growth of the European Gross Value Added (GVA) of € 82.4 bn per year (+0.71%) in 2006. The impact of broadband on national economies depends on the level of broadband development: in the most advanced European countries, broadband-related GVA growth reaches 0.89%, whereas in the countries with less-developed broadband, this growth is limited to 0.47%. |
| C Zhen-Wei Qiang and C Mario Rossotto, 2009: *Economic impact of broadband*, Information and Communications for Development.[36] | A World Bank study summarising the economic literature on economic growth and productivity and develops an econometric model to test the impact of broadband on GDP. The econometric study finds that increasing broadband penetration by 10% increases per capita GDP growth by 1.21% in high income countries and 1.38% in low and middle income countries. |
| Boston Consulting Group, October 2010: *The Connected Kingdom – How the Internet is transforming the UK economy*. | Study estimates that Internet contributed £100b or 7.2% of GDP in the UK economy in 2009 and forecast contribution to grow to 10% by 2015. The study also claimed that benefits additional to GDP include consumer benefits of £63b and commercial activities not in GDP of £363b. |
| R and C Kenny, November 2010: *Superfast; Is it really worth a subsidy?* | Study review many of the studies claiming significant economic benefits of broadband and finds that these studies have significant flaws that result in overstatement of the benefits. For example, Qiang World Bank study covers period back to 1980 well before broadband was available and produces implausible estimate of impact on growth. |

[33] Available from http://www.ppic.org/content/pubs/report/R_110JKR.pdf

[34] Available from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VCC-4WYCT8V1&_user=10&_coverDate=10%2F31%2F2009&_rdoc=1&_fmt=high&_orig=gateway&_origin=gateway&_sort=d&_docanchor=&view=c&_searchStrId

[35] Available from http://ec.europa.eu/information_society/eeurope/i2010/docs/benchmarking/broadband_impact_2008.pdf

[36] Available from http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf

| Authors | Summary |
|---|---|
| H Singer and J West, March 2010: *Economic effects of broadband infrastructure deployment and tax incentives for broadband deployment*[37] | A US study for FTTH council on economic benefits of (1) universal access to current generation broadband capability at 3 Mbps downstream and 768 Kbps upstream; and (2) 80% of homes passed with competitive next generation broadband capability at 50 Mbps downstream and 20 Mbps upstream delivered at peak periods. They estimate the economic impact of the proposed investment in current generation between 2011-15 as $38b in output and an increase in annual employment of 40,000. The impact of the next generation investment is $198.4b and the increase in annual employment is 250,000. |
| ITU, April 2012: *Impact of broadband on the economy*[38] | An ITU report that uses input-output analysis, micro-economic estimates and econometric modelling to evaluate the impact of broadband on GDP across the world. The econometric analysis finds that increasing broadband penetration by 10% increases per capita GDP growth by between 0.185% and 0.207% in Middle Eastern countries. |

[37] Available from http://www.ftthcouncil.org/node/858

[38] Available from http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf

# Appendix B: Social and cultural impacts

Mobile broadband brings wider benefits to individuals, communities and nations outside of the pure economic benefits outlined already in this report. Many of the cultural and social benefits from using broadband will not be reflected in the economic estimates given in Section 3 because they are about improving aspects of quality of life which are not captured by GDP measures. This section discusses these less tangible benefits in qualitative terms, giving examples of the benefits that may be delivered by broadband services in Egypt. In the eMisr National Broadband Plan the Egyptian Government targeted growth in the use of e-education, e-health and e-civic participation.

The best way to achieve take-up of Internet services such as these is to increase the number of mobile broadband subscribers. While fixed broadband can provide similar services it currently has lower penetration than mobile broadband, largely because it is less affordable and provides less functionality; the best way to reach consumers with Internet services and the best way to increase usage of them is therefore to increase mobile broadband coverage and penetration. The difference in cost between mobile and fixed broadband will be more pronounced in rural areas – mobile is likely to be the only viable way of introducing broadband to much of Egypt.

In general, there are six main categorises of benefit.

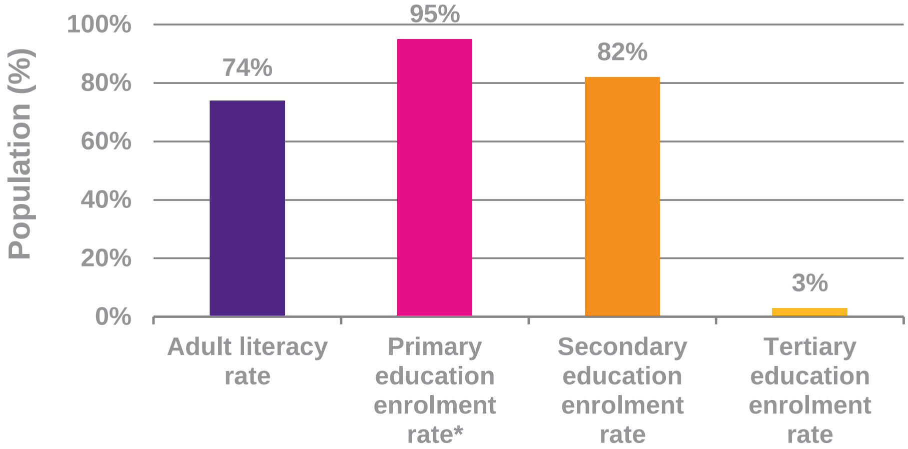
- Education and research.
- Healthcare.
- Environmental impacts.
- Personal finance.
- Involvement with government and national culture.

These will be examined in turn in the remainder of this section.

## B.1 Education and research

As shown in Figure B-1, Egypt has high rates of enrolment in both primary and secondary education. Despite this, a quarter of adult are not yet literate and tertiary education is available to only a few. Mobile broadband has the potential to revolutionise education in Egypt.

**Figure B-1: Literacy and enrolment[39] in Egypt (2012)**




Source: Plum Consulting, UNESCO
*2011 data

There are two main educational benefits which broadband access can help deliver to primary and secondary education level students. First, the Internet can improve education by enhancing remote communication and the delivery of teaching or training materials[40]. This could help ease common problems of the lack of teachers and resources, and enable students in rural areas to access online learning materials via mobile phones or laptops outside the classroom, thus helping the Ministry of Communications and Information Technology with *ICT for Education*[41].

Second, broadband Internet can improve the quality of education by expanding the range of synchronous and asynchronous learning opportunities through online services and applications. These include email, discussion boards, live webcasts, podcasts, wikis, blogs, and customised course management platforms such as Blackboard, WebCT, Moodle and Sakai. For example, tutor.ng is a Nigerian service that provides lesson plans and teaching material for teachers[42].

In South Africa the social network Mxit hosts popular services providing educational content to mobile phones; in 2012 Mxit reported that it had five million subscribers to educational services[43]. These services take the form of apps which provide revision tools, quizzes, multimedia teaching and other study materials for both students and teachers via mobile Internet[44]. The content is mainly focussed on Maths and the Sciences, but provides material on a range of other subjects such as accounting. The multimedia resource makes the learning experience more interactive, and students can learn faster and more effectively. Schools also benefit from lower spending on visual teaching aids. The National Broadband Plan gives more examples of ICT revolutionising Egyptian education.

Benefits are not restricted to primary and secondary education. Many international universities have made classes available online to the public for free, either directly of via services such as iTunes U or YouTube Education Channels. An increase in Internet availability means tertiary education will

[39] Net enrolment rate, both sexes

[40] OECD, 2011: *The economic impact of Internet technologies*

[41] Available from http://www.mcit.gov.eg/Project_Updates/335/ICT_Infrastructure/ICT_For_Learning

[42] The website is located at http://tutor.ng/

[43] Gadget, 25 October 2012: *Mxit education takes off*, available from http://www.gadget.co.za/pebble.asp?relid=5294

[44] For examples of apps see New Media Lab, 5 July 2013: *Mxit it up in the classroom*, available from http://nml.ru.ac.za/blog/christina/2013/05/07/mxit-classroom.html

become more accessible and affordable and help Egypt close the gap with the rest of the world in the provision of tertiary education.

**Table B-1: Potential benefits of mobile broadband for education**

| Key applications | Potential benefits of mobile broadband |
|---|---|
| Telepresence and e-education | Creates a virtual experience over a converged network, delivering real time face-to-face interactions, using advanced visual, audio, and collaboration technologies |
| Interactivity and personalisation | Brings lessons beyond school-based structures enabling teachers to provide individual coaching based on specific needs of individual students |
| e-learning and open source platforms | Use of open source e-learning platforms reduces costs of providing education and training |
| Crowdsourcing and information resources | Online reference databases which pool user-generated information to create collective knowledge resources. For example Wikipedia, online dictionary, encyclopaedia, translation services |

As well as education, the Internet can also enhance academic and scientific research. For example, the Internet can improve communication, and exchange of expertise, between researchers and research centres, as well as facilitate 'virtual laboratories' and 'webinars' meaning that Egyptian academics no longer need to travel to overseas universities to take part in leading research and to collaborate with eminent academia. There is also the potential for large-scale collaborative projects involving specialist researchers and ordinary citizens (for example, the SETI@home project which uses participants' computers to analyse radio telescope data for evidence of extra-terrestrial intelligence[45]).

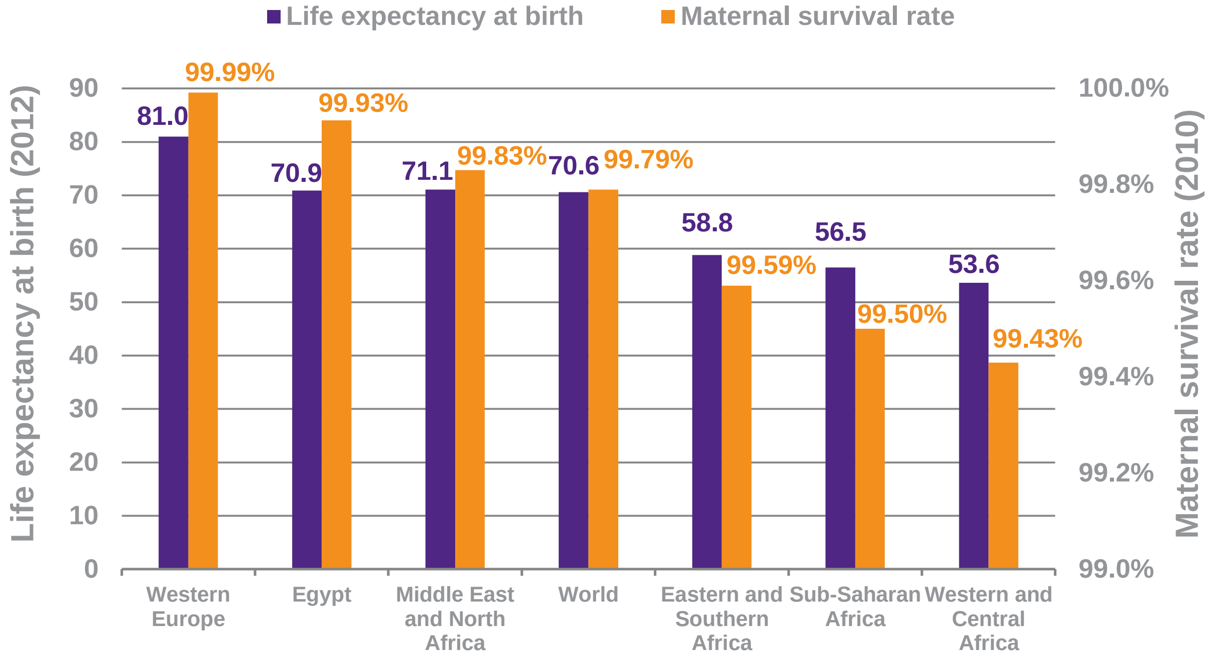
The Internet not only allows academics to access the latest research through online journal portals such as JStore but online translation services such as Google Translate mean that language is no longer a barrier in academic research. Additionally, access to the Internet (particularly through mobile broadband) will also help firms learn new skills, techniques and technologies; there will be greater flow of knowledge and ideas into the economy.

## B.2 Healthcare

As Figure B-2 shows, Egypt has good healthcare outcomes compared to Africa, the Middle East and world averages. Egypt can use mobile broadband to build upon this and improve healthcare outcomes further.

[45] http://setiathome.berkeley.edu/

Figure B-2: Life expectancy and maternal survival rate[46] in Egypt



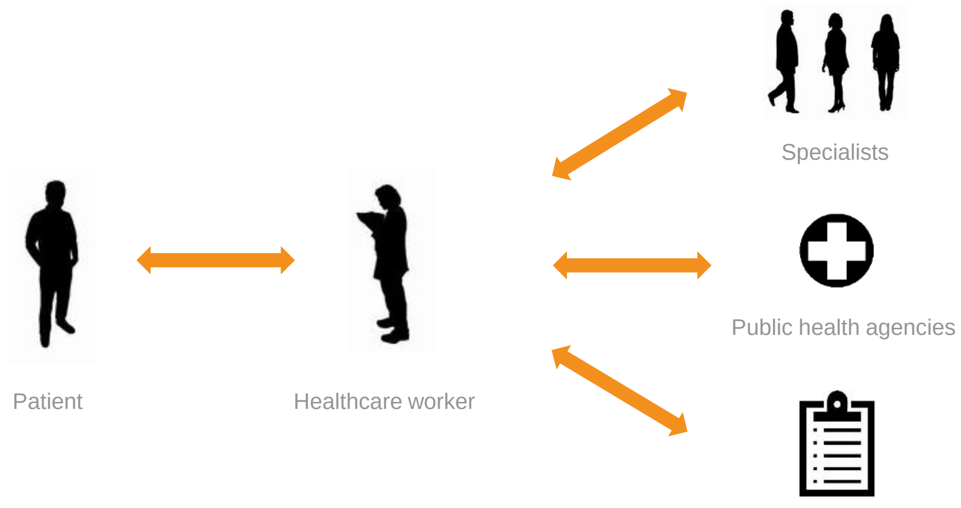

Source: Plum Consulting, UNICEF

While broadband alone cannot substitute for doctors, nurses and healthcare workers, the potential benefits of Internet applications in healthcare are large. Appropriate mobile solutions can not only provide healthcare for more people, but also improve the quality of life for patients, increase efficiency of healthcare delivery models and reduce costs for healthcare providers. It has been estimated that the use of telemedicine delivered by broadband could achieve costs savings of between 10% and 20%[47]. Through the easy transfer of information, records and applications, mobile broadband will help make healthcare workers more mobile and less tied to their desks.

[46] The inverse of the maternal mortality rate

[47] Boston Consulting Group, 2011, cited in ITU-UNESCO, 2011, *Broadband: a platform for progress*

Figure B-3: Healthcare uses for mobile broadband




Source: Plum Consulting

Mobile broadband will allow patients to more efficiently access and distribute their medical health records which may cut bureaucracy and treatment times, thus helping the Ministry of Communications and Information Technology with *ICT for Health*[48].

Tele-consultations in which healthcare workers talk to patients remotely increase efficiency and can give rural patients access to good healthcare. Such consultations may use VoIP which provide video services – vital for good patient care. Recent developments in healthcare applications may allow healthcare workers to monitor patient blood pressure, pulse and weight, potentially remotely[49].

Counterfeit drugs are a common problem in developing markets, so the ability to verify legitimate medicine via a mobile phone will be a very helpful for the population of Egypt. This is already starting to be done in some countries, including Kenya and India, using SMS, but the advent of broadband would increase take up and ease of use[50].

[48] Available from http://www.mcit.gov.eg/ICT_Infrastructure/ICT_for_Health

[49] Reuters, 12 August 2014: *Exclusive: Apple prepares Healthkit rollout amid tangled regulatory web* http://www.reuters.com/article/2014/08/12/us-apple-healthcare-exclusive-idUSKBN0GC09K20140812

See also the Apple iOS 8 Preview at https://www.apple.com/eg/ios/ios8/health/

[50] Business Call to Action, 2012: *Sproxil: Combating Counterfeit Drugs with Mobile Phones*, available from http://www.businesscalltoaction.org/wp-content/files_mf/sproxilcasestudy2.23.2012forweb17.pdf

**Table B-2: Potential benefits of mobile broadband for healthcare**

| Key applications | Potential benefits of mobile broadband |
|---|---|
| Education and awareness | Websites and social networking to support public health and behavioural change<br>Information sharing among health workers |
| Data collection and health record access | Mobile applications to collect or access real-time patient data and records<br>Efficient communication of medical records between health workers and locations |
| Monitoring and medication compliance | Maintain care giver appointments or ensure medication regime adherence via one-way or two-way communications<br>Long distance monitoring of vital signs via mobile health monitoring applications |
| Disease or epidemic outbreak | Send and receive data on disease incidence, provide warnings during outbreaks and public health emergencies |
| Health and administrative systems | Accessible cloud-based drug inventory management, up-to-minute stock checking, verification of drugs to help combat counterfeit drugs<br>Guidance applications for healthcare workers aid diagnosis |
| Analysis, diagnosis and consultation | Phone as point-of-care device with mobile phone-based diagnosis<br>Tele-consultations cut patient trips to hospital, reducing disease transmission<br>Local health workers can send pictures/case notes to specialists for tele-diagnosis |

Tele-medicine is already being used in Egypt[51]. For example, the *Women HealthCare Mobile UnitProject* which uses mobile vans equipped with radiology units to screen women for breast cancer. The vans send mammogram images back to the national radiology centre of excellence for analysis using ADSL or satellite links[52]. Mobile broadband has the potential to lower the cost of such projects.

Another example is that of the Siwa Teleconsultation initiative; a one year trial connecting Siwa hospital with the El Shatby Hospital in Alexandria from 2009 to 2010[53]. Under the scheme doctors in Siwa used video conferencing to consult experts at the El Shatby Hospital about complex paediatric cases. This meant that children in the (relatively) isolated city of Siwa were able to benefit from expert healthcare that would otherwise have been unavailable to them. Mobile broadband will allow this type of thing to occur throughout Egypt rather than just at isolated sites. The National Broadband Plan gives more examples of how ICT is used in Egyptian healthcare.

Where broadband is common public health agencies are increasingly turning to social media as an efficient way of reaching the population. Social media, such as Facebook, is an important driver of mobile broadband take-up and as such is a highly effective way of communicating important public health messages. For example, in the USA the '*One and Only Campaign'* educates the public about safe injection practices through easily 'shared' pictures and an accessible website.[54] By targeting

[51] Hussein and Khalifa, 2012: *Telemedicine in Egypt: SWOT analysis and future trends*, available from http://www.who.int/goe/policies/countries/egy_support_tele.pdf

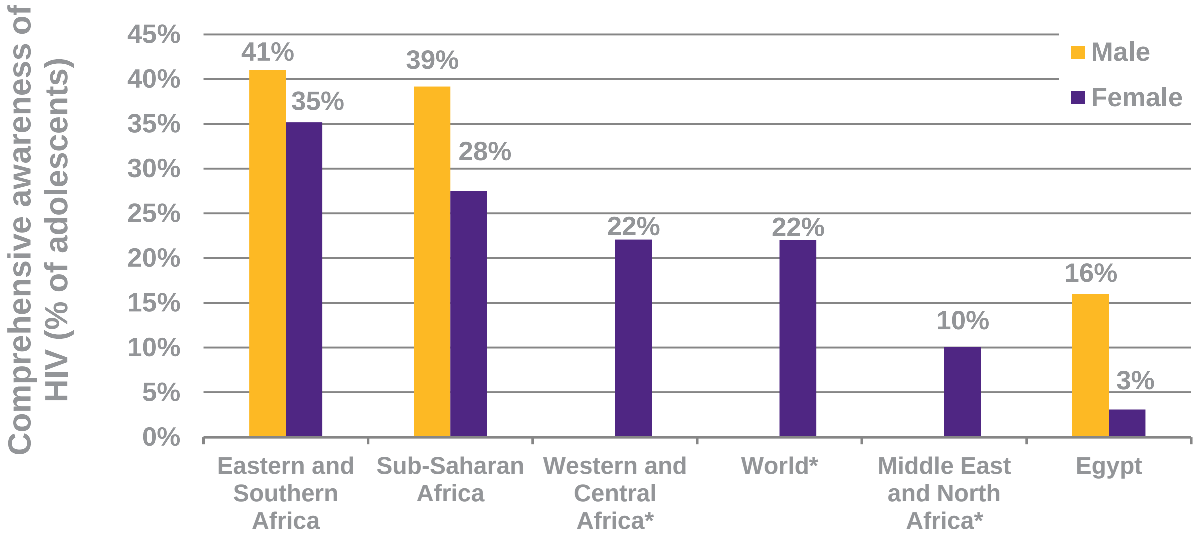
[52] See http://www.mcit.gov.eg/Publication/Publication_Summary/126 for further details.

[53] eHealth, December 2009: *Saving Children Through Tele- Consultation in Remote Egypt : Sherif El Tokali, Poverty Reduction, MDGs & Private Sector Team Leader, UNDP- Egypt; Ada Fishta, ICT Specialist, UNDP- Egypt; Alexandra Gil, UN University Volunteer Khaled Shams, World Health Organization, Eastern Mediterranean Regional Office*, available from http://ehealth.eletsonline.com/2009/12/11353/

[54] The website is at http://www.oneandonlycampaign.org/safe_injection_practices

social media the campaign has been able to reach and educate the population within a short timescale. The nature of communication through social media is that it can be very quick to get a message out; making it a valuable tool for public health crisis management. For example, social media could be used to improve HIV awareness amongst Egyptian adolescents.

Figure B-4: Comprehensive awareness[55] of HIV amongst Egyptian adolescents (2008 – 2012)




Source: Plum Consulting, UNICEF
*Data for men unavailable

Such management in the face of an epidemic is only as good as the lines of communication to those healthcare workers on the front line. Mobile broadband enables workers to have access to up-to-date information on the move and also helps public health agencies collect data from healthcare workers on the spread of disease. Tele-consultations will also cut the risk of infectious diseases spreading.

## B.3 Environmental impacts

Mobile broadband will help government agencies protect the environment against climate change and irresponsible behaviour, and will help farmers increase their efficiency. Smart irrigation systems using broadband use real time information on rainfall, ground moisture and temperature to alter the amount of water provided to crops on a localised basis; raising water efficiency significantly[56].

Also, through mobile broadband government agencies will be able to accurately monitor changes in climate, such as rising sea levels, and thus be better prepared to deal with such potential threats. Overall, mobile broadband will aid the collection of environmental data and the development of

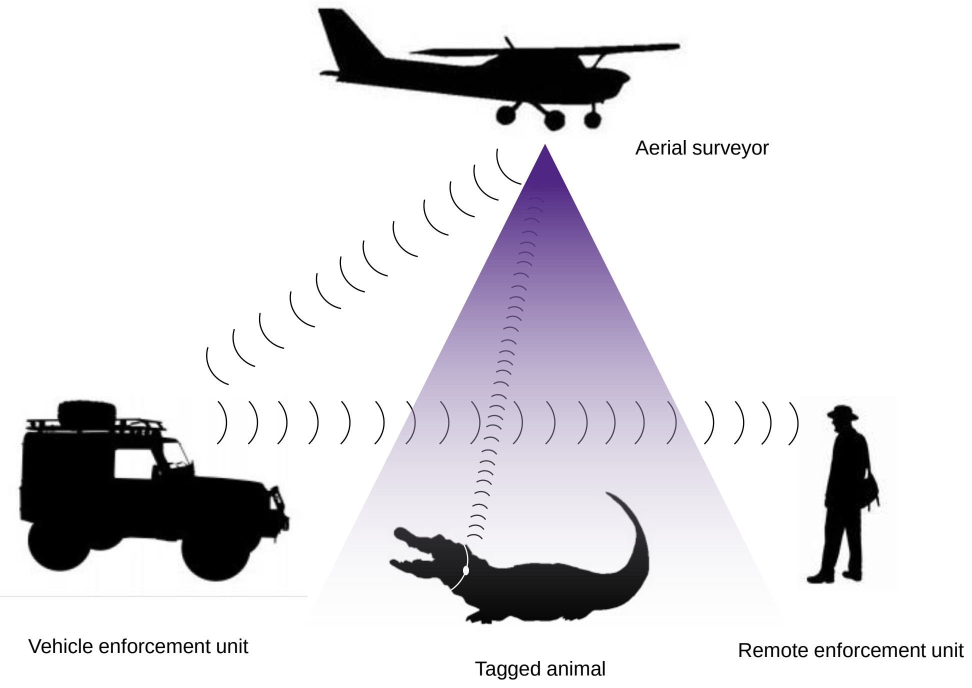
[55] Defined by UNICEF as: “the percentage of young men and women (15-24 years) who correctly identify the two major ways of preventing the sexual transmission of HIV (using condoms and limiting sex to one faithful, uninfected partner), who reject the two most common local misconceptions about HIV transmission, and who know that a healthy-looking person can have HIV”.

[56] Brendon Herron, 2009: *An Australian smart electric grid – Critical infrastructure for addressing global warming.* . Telecommunications Journal Of Australia volume 59, no 1, available at http://www.swinburne.edu.au/lib/ir/onlinejournals/tja/tja_vol59_no1_2009.pdf

environment-friendly agriculture and industry. The National Broadband Plan detailed how ICT can be used to counter climate change.

Mobile broadband can also help government agencies in the fights against poaching. For example, rangers have started using unmanned drones to observe and protect national parks from poaching. Similar technology can also be used to assist in the fight against other criminal activities, such as weapons trafficking.

**Figure B-5: The role of mobile broadband against poaching**



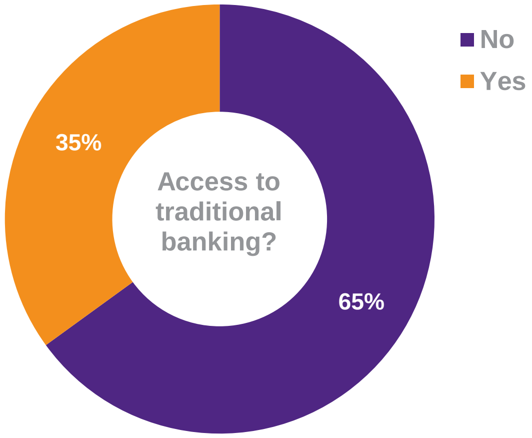

Source: Plum Consulting

## B.4 Personal finance

It is easy to underestimate the positive impact that control of personal finance can have upon individuals, families and communities. The ability to store money safely, save for the future and invest in SMEs has the potential to liberate people from cycles of poverty. At present only 35% of the Egyptian population have access to traditional banking.

There are two levels of control over personal finance that mobile broadband brings. Firstly, the cost to an individual of running a bank account or other financial service is much lower when they are able to do so without travelling to a bank branch for every transaction. This will be of most benefit to rural populations. Many African countries are already starting to realise the benefits of mobile on personal finance, with services such as M-Pesa enabling people to conduct financial transactions on their phone. These existing services use SMS messaging rather than mobile broadband and as such the services that they offer are limited, although some firms are already using this to pay their employees. One of the greatest benefits of mobile finance is security; money becomes less vulnerable to burglary. The economic and social value of this to the population of Egypt will be substantial.

**Figure B-6: Proportion of the Egyptian population who have access to traditional banking**




Source: Plum Consulting, Budde

The second level of control over personal finance that mobile broadband brings not only allows people to transfer money, but gives them bank accounts which enables them to plan for the future. Mobile banking over broadband will enable people to save money; for investments, for adversity or for retirement. Saving for investment will provide a boost to SMEs, which may lack access to capital markets. Saving for hard times will help communities become self-sufficient and thus cope with famine, drought or disease. Saving for retirement will reduce the burden on future generations.[57]

Mobile banking over broadband will give savers the opportunity to search for the best returns on investment, and will give borrowers, including SMEs, the opportunity to finds the cheapest capital, thus providing significant competition in the financial services industry. This could have a substantial impact in Egypt, where only 9% of the population have a credit card[58]. Mobile banking will also enable people to transfer money between countries with lower transaction costs opening the possibility of international investment.

**Table B-3: Potential benefits of mobile broadband for personal finance**

| Benefits of mobile finance | Benefits |
|---|---|
| Benefits of mobile banking over SMS | • Security<br>• Transfers |
| Additional benefits of mobile banking over broadband | • Saving for retirement<br>• Saving for adversity<br>• Saving for investment<br>• Access to capital markets<br>• More consumer choice<br>• International transfers |

[57] This will have the indirect effect of reducing the fertility rate.

[58] Budde, 2014: *Egypt – Mobile Market – Insights, Statistics and Forecast*

## B.5 Government

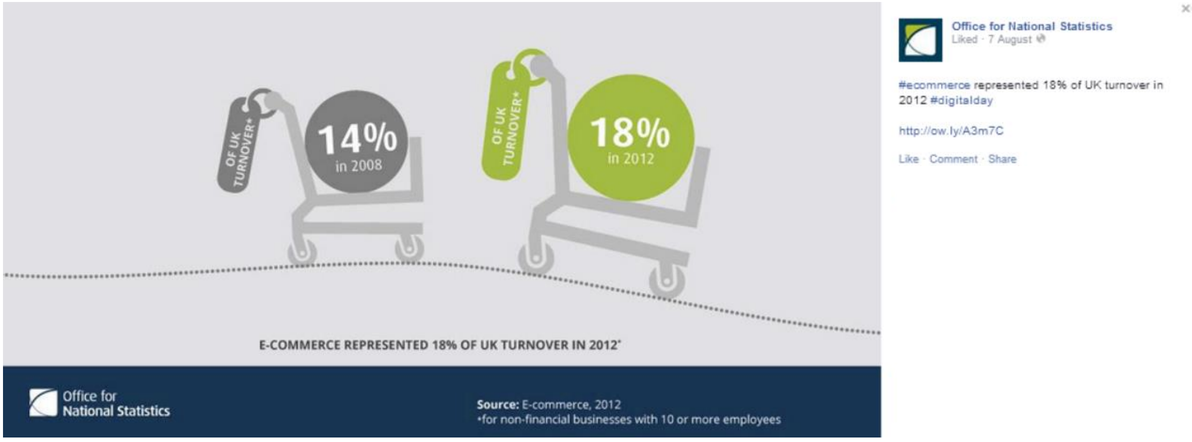
Mobile broadband will bring benefits both to Government, in the running of core services, and to citizens, in their interactions with government services. Government services such as the emergency services will be better equipped:

- Emergency services will be able to use the Internet for navigation (Google Maps, for example).
- Police will be able to check criminal records on the move.
- Paramedics will be able to send pictures and videos of patients to the hospital for expert advice and to prepare the hospital for the arrival of the patient.
- The public will be able to send the emergency services photos and real-time videos of emergencies meaning that the emergency services can better talk the public through what they should do, and be able to send the most appropriate help.
- Police will be able to verify counterfeit goods on location.
- Cameras on emergency service vehicles and persons will give command centres better information about emergency situations.

It is not just the emergency services who would benefit from having mobile broadband. Many other government officials would benefit from having access to the Internet on the go; for example building inspectors would be able to access architectural plans on their mobile phones while visiting construction sites.

Widespread adoption of mobile broadband in the general population will mean that certain government services can move online. For example, paying taxes online prevents corruption, cuts bureaucracy and eases the detection of fraud. Mobile broadband can also be harnessed to widen the availability of government information and broaden e-civic engagement, in accordance with the National Broadband Plan. Many governments publish documents, policies and statistics online in a format which is easily viewed from mobile phones. In the UK, the Office for National Statistics (ONS) now publishes statistics on social media to encourage participation, with the data presented in a way that makes it easy to understand and view from a mobile phone. The ONS even holds question and answer sessions on social media for those who wish to understand more about where the data comes from and what it means.

**Table B-4: Office for National Statistics uses social media**




Source: Plum Consulting, Facebook

In 2014 the Delhi police force launched a new campaign to end corruption by creating a hotline for people to alert them to corrupt police practices. This new hotline took the form of a *WhatsApp* number; an over-the-top messaging service that uses mobile broadband to send messages, pictures and calls. The new service was very popular; within a week of launching it had received 3,700 messages, 622 calls, 2 videos and 3 audio messages[59].

## B.6 Other benefits

Mobile broadband enables consumers to access e-commerce; the buying and selling of goods, as well as the paying of bills and taxes, over the Internet. This brings:

- New distribution channels for existing products and services (such as digital music, video or software).
- More efficient search mechanisms for locating information and better availability of assessment of consumer goods, which could lead to lower prices.
- New ways of addressing consumers' needs online, often at very minimal cost (such as email, mobile marketing).
- Better communication between consumers about firms and products.

Broadband also makes the process of searching for employment much more efficient, using search engines and networking opportunities such as LinkedIn. More flexible working patterns, such as working from home, will bring further benefit to Egypt's population. Better information on weather and prices will lower business risk for those working in agriculture. Mobile broadband will especially benefit the disabled, thus helping the Ministry of Communications and Information Technology achieve the goals of the National Initiative of ICTs for People with Disabilities[60].

[59] BBC, 13 August 2014: *Five police investigated after Delhi launches WhatsApp anti-bribery campaign*, available from http://www.bbc.co.uk/news/world-asia-india-28768823

[60] Details can be found at http://www.mcit.gov.eg/Digital_Citizenship/ICTs_for_People_with_Disabilities

# Appendix C: Modelling assumptions

This appendix sets out some of the data and assumptions that have been used in the model. Information sources are listed alongside the values. Where operators have provided data which is confidential, an indicative range is supplied.

## C.1 Demographic assumptions

| Parameter | Value used | Source |
|---|---|---|
| Population (million) | | The UN (World Urbanization Prospects: 2014 Revision) |
| 2013 | 82 | |
| 2015 | 85 | |
| 2020 | 91 | |
| 2025 | 97 | |
| 2030 | 103 | |
| Urban population percentage | | Plum's projection based the UN's World Urbanization Prospects numbers for 2015, 2020, 2025 and 2030 |
| 2013 | 43% | |
| 2015 | 43% | |
| 2020 | 44% | |
| 2025 | 45% | |
| 2030 | 47% | |
| Average number of people per household | | Estimated based on UN-Habitat statistics |
| 2013 – 2023 | 4 | |
| 2024 – 2030 | 3.5 | |
| Maximum % of urban population that can afford mobile broadband service | 100% | Estimate assuming that there is little to no affordability constraint for the urban population – that is, the market is competitive and prices are sufficiently low when there is no supply constraint |

## C.2 Market and traffic demand assumptions

| Parameter | Value used | Source |
|---|---|---|
| Number of operators (Base Case) | 3 | GSMA Intelligence |
| Mobile population coverage (2013-2025) | | Estimate based on industry experience, validated by operators |
| Urban | 100% | |
| Rural | 92% – 94% | |
| Blended | 92% – 94% | |

| Parameter | Value used | Source |
|---|---|---|
| Country's monthly mobile data usage volume<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>4 PB<br>16 PB<br>120 PB<br>288 PB<br>417 PB | Estimated based on pro-rating Plum's Gompertz-curve projection of Cisco VNI 2014 forecasts for MEA excluding South Africa and Saudi Arabia using relative population from the UN |
| Monthly data usage volume per effective mobile broadband subscriber<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>1.2 GB<br>2.4 GB<br>5.6 GB<br>7.2 GB<br>8.3 GB | Estimates based on previous socioeconomic studies, and Cisco VNI's reported usage for tablets, smartphones and computers in 2013 for MEA |
| Number of fixed broadband subscriptions (million)<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>2.6<br>3.6<br>6.1<br>8.9<br>12.0 | Estimated based on a straight-line extrapolation of the UN's statistics for fixed wireless broadband lines in The State of Broadband reports (2012[61] and 2013[62]) |

## C.3 Network assumptions

| Parameter | Value used | Source |
|---|---|---|
| % of traffic from occasional users<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>15%<br>11%<br>5%<br>0%<br>0% | Estimates based on previous studies |
| % traffic in busy hour | 10% | Plum study for Qualcomm[63] |
| % traffic in downlink | 90% | Plum study for Qualcomm |
| % utilisation of capacity for reasonable quality of service for end user | 60% | Plum study for Qualcomm |
| Sectors per BTS | 3 | Estimates based on previous studies |

[61] www.broadbandcommission.org/Documents/bb-annualreport2012.pdf

[62] www.broadbandcommission.org/Documents/bb-annualreport2012.pdf

[63] http://www.plumconsulting.co.uk/pdfs/Plum_Aug2013_Pakistan_3G.pdf

| Parameter | Value used | Source |
|---|---|---|
| Spectrum efficiency (bps/Hz)<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>0.45<br>0.65<br>1.10<br>1.35<br>1.60 | Estimate based on discussion with equipment vendors as used in Plum's study for Qualcomm on LSA in 2.3 GHz band[64] |
| Year on year change in spectrum efficiency (bps/Hz) | 0.05 – 0.10 | Estimate based on discussion with equipment vendors |
| Number of sites per operator at end of 2013 | 4,000 – 8,000 | Estimate based on data from a previous study for Qualcomm on benefits of L-band in MENA[65], validated by operators |
| Growth rate of site count<br>Urban areas<br>Rural areas | <br>1% – 10%<br>2% | Estimate based on data from a previous study for Qualcomm on benefits of L-band in MENA |
| Ratio of urban site count to rural site count | 45:55 | Estimate based on data from a previous study for Qualcomm on benefits of L-band in MENA |
| % of rural sites that are mobile-broadband ready[66]<br>2013<br>2015<br>2020<br>2025<br>2030 | <br>0%<br>20%<br>50%<br>50%<br>50% | Estimate based on previous modelling |

[64] http://www.plumconsulting.co.uk/pdfs/Plum_Dec2013_Economic_benefits_of_LSA_2.3_GHz_in_Europe.pdf

[65] http://www.plumconsulting.co.uk/pdfs/Plum_Oct2012_The_economic_benefits_from_deploying_1.4_GHz_spectrum_in_the_MENA_region.pdf

[66] This is defined as a site that has a backhaul link capable of high-speed data transmission.

## C.4 Economic assumptions for GDP growth model

| Parameter | Value used | Source |
|---|---|---|
| Boost to GDP growth rate per additional 10pp broadband penetration | 0.5 percentage points | Plum study for GSMA[67] |
| Duration of for which the growth rate boost persists | 3 years | Plum study for GSMA |
| Discount rate | 5% | Estimated based on World Bank's reported real interest rate for the country between 2004 and 2013 |
| GDP at 2013 constant prices (EGP billion) | | IMF World Economic Outlook database April 2014 edition |
| 2013 | 1,753 | |
| 2016 | 1,915 | |
| 2019 | 2,124 | |
| 15-year base-line GDP yearly growth rate[68] | 2.0% | Plum's estimate based on IMF's near-term projection |
| Tax as a percentage of GDP for the modelling period | 15% | Estimated based on averages calculated using information on GDP and tax available from African Statistical Yearbook 2014[69] |

## C.5 Spectrum assumptions

It is assumed that, in future, all new GSM900 and GSM1800 devices will be UMTS-compatible (given the current trend) and LTE1800 handsets will be cheap enough that operators can gradually refarm their 900 MHz and 1800 MHz spectrum for use with mobile broadband from 2014, the latter of which is assumed to be deployed in urban areas only. The assumptions below are made based on the total quantum of spectrum available to operators that Plum is aware of.

### C.5.1 Total downlink MBB spectrum available if the 700 MHz, 800 MHz and 2600 MHz spectrum and the remaining 1800 MHz and 2100 MHz is not released

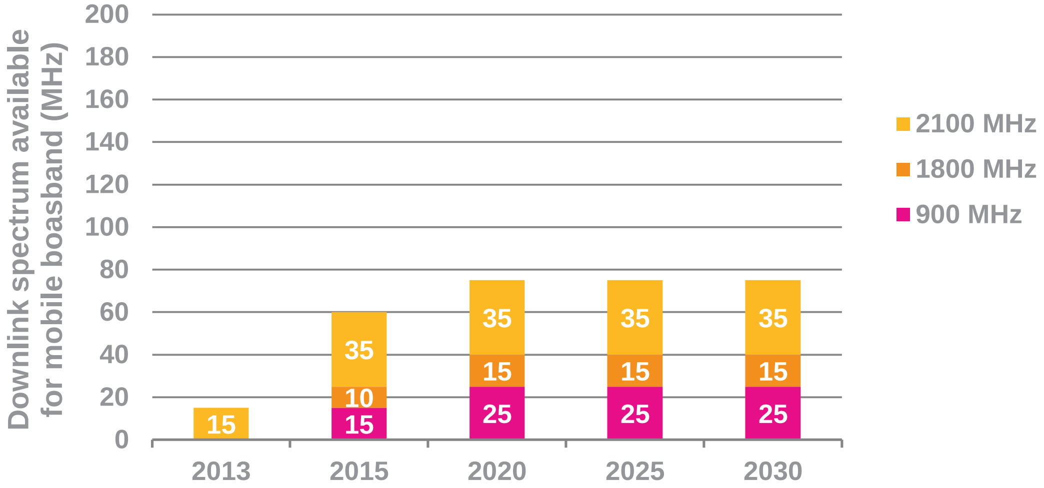
The bandwidth in each row of the tables below refers to the total bandwidth in each spectrum band that is available **for mobile broadband services**. It is assumed that the 900 MHz and 1800 MHz bands will be re-farmed gradually from 2G services from 2014 and 2018 respectively and that the rest of the 1800 MHz and 2100 MHz will be released in 2018.

[67] http://www.plumconsulting.co.uk/pdfs/Plum_Aug2013_Pakistan_3G.pdf

[68] The rate at which GDP is expected to grow in the absence of contribution from broadband

[69] http://www.afdb.org/en/documents/publications/african-statistical-yearbook/

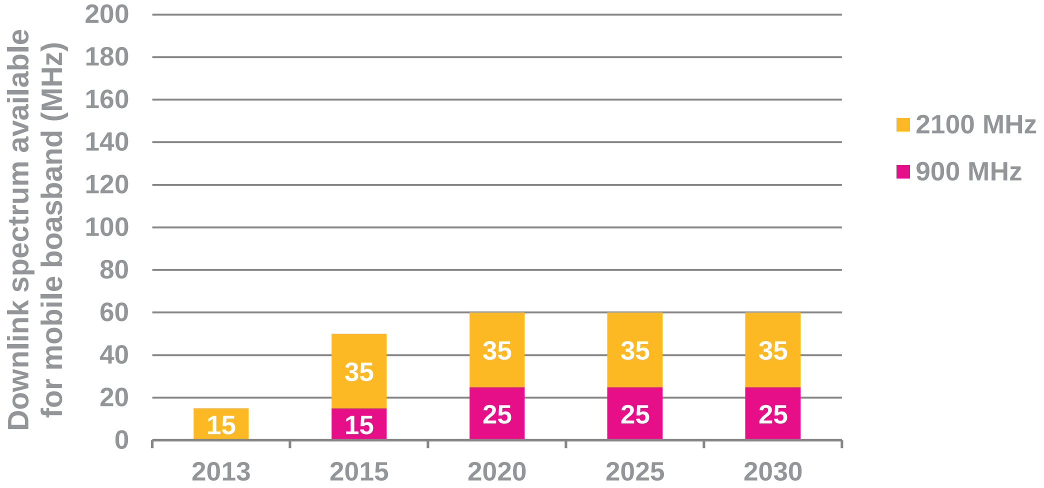
**Figure C-1: Spectrum in urban areas with no further award**




Source: Plum Consulting

| Band | 2013 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| 700 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 800 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 900 MHz | 0 MHz | 15 MHz | 25 MHz | 25 MHz | 25 MHz |
| 1800 MHz | 0 MHz | 10 MHz | 15 MHz | 15 MHz | 15 MHz |
| 2100 MHz | 15 MHz | 35 MHz | 35 MHz | 35 MHz | 35 MHz |
| 2600 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| **Total** | **15 MHz** | **60 MHz** | **75 MHz** | **75 MHz** | **75 MHz** |

**Figure C-2: Spectrum in rural areas with no further award**

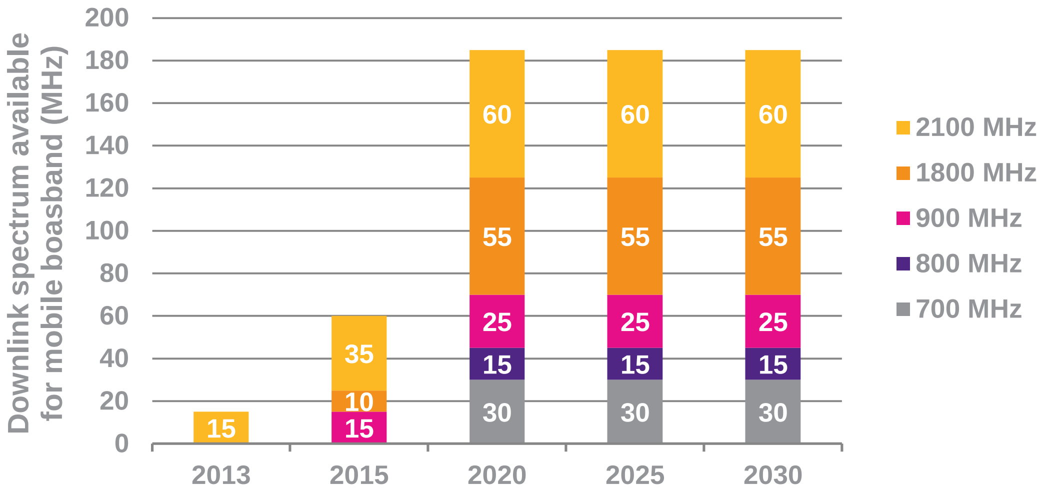



Source: Plum Consulting

| Band | 2013 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| 700 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 800 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 900 MHz | 0 MHz | 15 MHz | 25 MHz | 25 MHz | 25 MHz |
| 1800 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 2100 MHz | 15 MHz | 35 MHz | 35 MHz | 35 MHz | 35 MHz |
| 2600 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| **Total** | **15 MHz** | **50 MHz** | **60 MHz** | **60 MHz** | **60 MHz** |

### C.5.2 Total downlink MBB spectrum available if the 700 MHz, 800 MHz and 2600 MHz spectrum and the remaining 1800 MHz and 2100 MHz is released

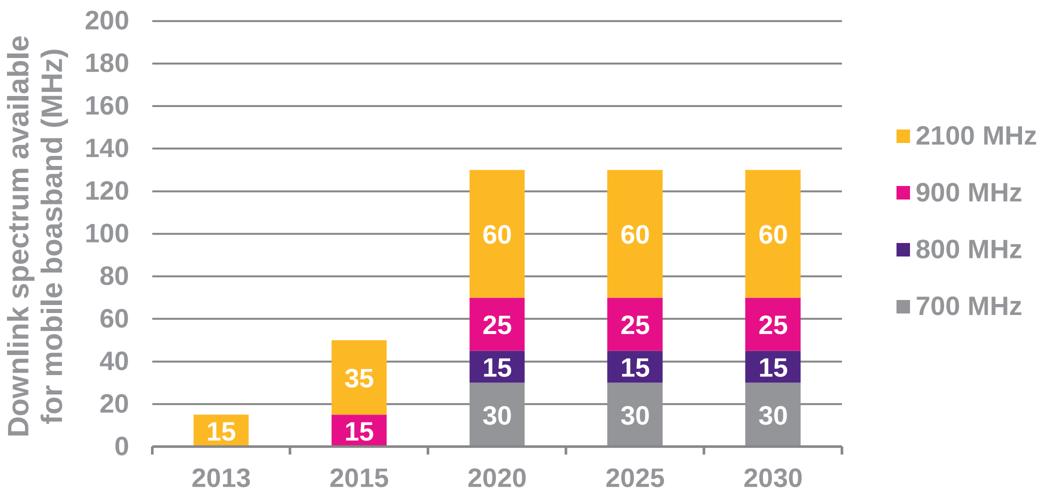
Figure C-3: Spectrum in urban areas with further awards




Source: Plum Consulting

| Band | 2013 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| 700 MHz | 0 MHz | 0 MHz[70] | 30 MHz | 30 MHz | 30 MHz |
| 800 MHz | 0 MHz | 0 MHz | 15 MHz | 15 MHz | 15 MHz |
| 900 MHz | 0 MHz | 15 MHz | 25 MHz | 25 MHz | 25 MHz |
| 1800 MHz | 0 MHz | 10 MHz | 55 MHz | 55 MHz | 55 MHz |
| 2100 MHz | 15 MHz | 35 MHz | 60 MHz | 60 MHz | 60 MHz |
| 2600 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| **Total** | **15 MHz** | **60 MHz** | **185 MHz** | **185 MHz** | **185 MHz** |

**Figure C-4: Spectrum in rural areas with further awards**




Source: Plum Consulting

| Band | 2013 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| 700 MHz | 0 MHz | 0 MHz[71] | 30 MHz | 30 MHz | 30 MHz |
| 800 MHz | 0 MHz | 0 MHz | 15 MHz | 15 MHz | 15 MHz |
| 900 MHz | 0 MHz | 15 MHz | 25 MHz | 25 MHz | 25 MHz |
| 1800 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| 2100 MHz | 15 MHz | 35 MHz | 60 MHz | 60 MHz | 60 MHz |
| 2600 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz | 0 MHz |
| **Total** | **15 MHz** | **50 MHz** | **130 MHz** | **130 MHz** | **130 MHz** |

[70] Assumed to be available from 2016

[71] Assumed to be available from 2016