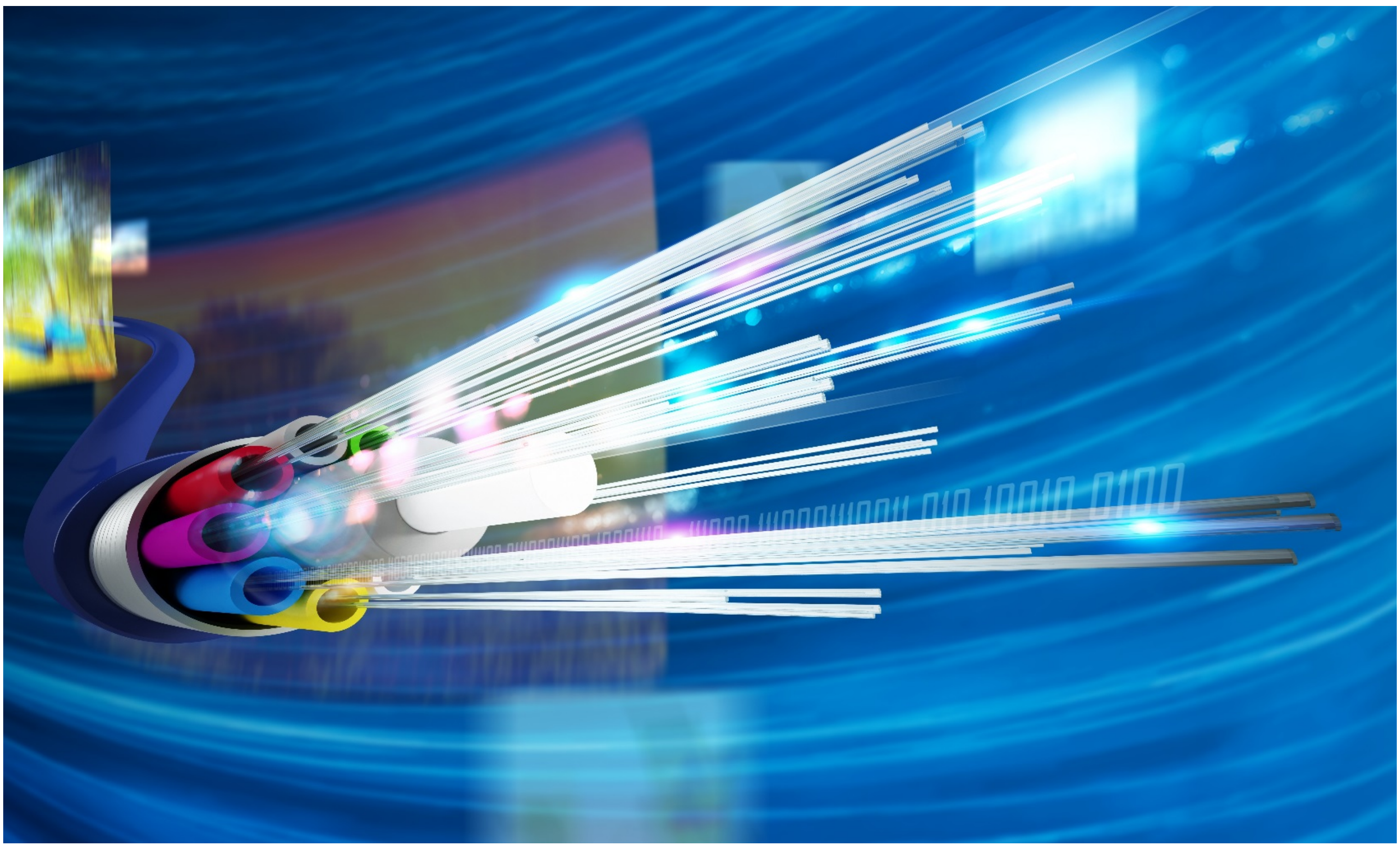
Standing Committee
for Economic and Commercial Cooperation
of the Organization of Islamic Cooperation (COMCEC)

Increasing Broadband Internet Penetration In the OIC Member Countries



COMCEC COORDINATION OFFICE
February 2017

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Table of Contents

List of Figures

List of Tables

Abbreviation

ADSL	Asymmetric Digital Subscriber Line
DWDM	Dense Wave Division Multiplexing
4G	Fourth Generation wireless technology
GSMA	Global Mobile Suppliers Association
LTE	Long Term Evolution
Mbps	Megabit per second
OTT	Over the top
3G	Third Generation wireless technology
Wi-Fi	Wireless Fidelity
WiMAX	World Wide Interoperability for Microwave Access

EXECUTIVE SUMMARY

Broadband is defined as a high capacity data transmission technology that allows a large number of messages and telecommunications traffic types (video, data, voice) to be communicated simultaneously. Ever since its introduction in the early 1990s, broadband technology has undergone a dramatic diffusion around the world, including within the countries of the Organization of Islamic Cooperation (OIC). As of the end of 2015, 14.95% of households in the OIC Member Countries are connected to broadband technology, while 29.41% of individuals have mobile broadband connectivity. In several OIC Member Countries (such as Azerbaijan, Lebanon, Malaysia, Qatar), fixed broadband household penetration has exceeded 50%, while in others (Bahrain, Saudi Arabia, and UAE) mobile broadband penetration is higher than 70%.

Conceptual framework and best practices for fostering broadband investment and adoption

Broadband is a critical infrastructure for fostering economic growth and citizen welfare. Beyond the benefits linked to GDP growth, broadband contributes to job creation and enhancement of consumer surplus. Broadband penetration has been proven to have an impact between 0.25 and 1.38 percent for every increase in 10 % of fixed broadband penetration. Beyond the contribution to GDP growth, broadband also has a positive effect on job creation. The impact on this variable can be split into two types of effects: jobs generated by the initial deployment of infrastructure and employment resulting from network effects and their spillover into other areas of the economy. As with GDP, the spill over employment effects of broadband are not uniform across sectors. The job creation impact of broadband tends to be concentrated in service industries, (e.g., financial services, education, health care, etc.) although a positive effect has also been detected in manufacturing. Broadband adoption also contributes to an increase in household income by raising the efficiency in labor markets and enhancing the population digital skills.

The economic contribution of broadband increases with penetration: research evidence indicates that the higher broadband penetration is, the stronger its effect on economic growth. This effect is labeled “critical mass” or, in economic terms, the return to economies of scale. Thus, countries and their citizens will benefit from accelerating broadband adoption.

Yet, some barriers prevent an increase in broadband penetration. The first one is driven by supply: citizens do not acquire broadband service simply because they lack service in the area where they live or work. This barrier has been called the supply gap. The second one is called the demand gap, and measures the potential users that could acquire broadband service (since operators offer it in their territory,), but do not. While the digital divide represents the sum of both supply and demand gap, the critical success factors and policy initiatives aimed at addressing each of them are different. At the highest level of analysis, the residential broadband demand gap is the result of three challenges:

- Limited affordability: certain portions of the population either cannot afford a device or purchase the subscription needed to access the Internet,
- Limited awareness of the potential of the broadband service or lack of digital literacy,
- Lack of cultural relevance or interest: the value proposition of applications, services, and content provided by the Internet does not fulfill a need of the adopting population.

Broadband service providers are also facing challenges that prevent them from investing in the development of forward-looking broadband infrastructure. The global telecommunications industry is facing the challenge of continuing to deploy network infrastructure that accommodates the exponential growth in data traffic. Annual global Internet traffic in 2016 has reached 88.7 billion gigabytes per month. Having grown at an annual rate of 30% in the past five years, it is expected to continue increasing at a compound annual growth rate of 22% through 2020. Internet traffic will grow fastest in the Middle East and Africa (27% compound annual growth rate) reaching 10.9 billion gigabytes per month in 2020. To accommodate the growing traffic, broadband service providers need to deploy fixed and mobile networks capable of delivering data flows at faster speeds. While pressured to increase capital spending for deploying ultrafast networks, broadband service providers are facing increased competition from Over The Top (OTT) platforms (such as Google, Facebook and Netflix) with the potential to capture a growing share of traditional telecommunications revenue streams. The intensity of competition among broadband service providers and between telecommunications and OTT players is putting pressure on the broadband industry revenues, which have not grown after 2011.

Governments and private broadband service providers have recognized the presence of barriers to increasing broadband penetration reviewed above. The broadband supply gap tends to be focused in rural and isolated areas. A workable business case for broadband deployment is typically predicated on the possibility of serving aggregate clusters of demand generally concentrated in population dense geographies. While this is feasible in the case of urban and suburban settings, rural geographies do not provide an attractive market, while increasing the capital required for deployment. Several approaches can be put in place to address this barrier. For example, one approach focuses on alleviating some of the constraints of the rural broadband business case. Some governments deploy publicly owned backbone networks with the objective of reaching remote locations. Since traffic backhauling represents approximately 30% of the operating costs of running a broadband network, a government-owned network represents an opportunity of cutting transit costs to subsidize rural broadband network operations. Another approach to tackling rural broadband deployment involves the introduction of innovative ways of allocating radio spectrum to reduce the costs of constructing wireless networks. Conventional spectrum management approaches, which imply high costs to acquire spectrum licenses, raise a potential hurdle to deploying broadband in rural areas. In this context, some governments have designated rural areas where a common band of spectrum is assigned on a cooperative basis on a shared basis.

On the consumer side, limited affordability is a critical adoption obstacle. Beyond the competitive stimuli, the reduction of broadband service prices can be achieved through a number of targeted public policy initiatives. These are generally implemented with the objective of achieving universal broadband adoption. The underlying rationale for these policies is that, beyond a competition model, government policies should be implemented to further price reductions of broadband. One approach relies on state-owned telecommunications operators to offer, under their public service imperative, a low-priced broadband service.

Finally, addressing the digital literacy obstacle requires the implementation of programs that build an understanding of the service offerings, and develop user confidence, explaining the benefits of use, and understanding security and privacy constraints as well. In general terms, four types of initiatives targeting digital literacy impediments exist: 1) inclusion of specific digital training programs at all levels of the formal education system; 2) targeted digital literacy interventions addressed to specific segments of the population, such as the elderly, the disadvantaged or the rural population; 3) deployment of community access centers; and 4) privacy and security training programs to build the levels of trust from consumers in order to foster adoption of broadband.

The broadband situation in the OIC Member Countries

Thirty-one percent of individuals residing in the OIC Member Countries access the Internet on a regular basis. Internet penetration has been growing at a fast pace since 2008 when the gap between these states and OECD (Organization for Economic Cooperation and Development) countries has begun to narrow down. However, as of 2015, at this point the proportion of Internet users in the OIC Member Countries (30.59%) remains half that of OECD countries (77.24%). As expected, the percentage of Internet users varies significantly across the OIC Member Countries. For example, Internet penetration in African OIC Member Countries reaches 27.90%, while in Arab OIC Member Countries, it is 39.53%, and in Asian OIC Member Countries, it is 28.05%.

Fixed broadband penetration within the OIC Member Countries has reached 14.95% of total households, compared to 78.07% in OECD countries. In addition to the significant difference between both groups of countries, it should be noted that fixed broadband among the OIC Member Countries has not been increasing at a pace comparable to Internet adoption. On the other hand, mobile broadband penetration has reached 29.41% of total population, compared to 87.17% for OECD countries. In this case, the penetration growth trends indicate a slowing down trend among OECD countries (which implies a gradual saturation) and an acceleration among the OIC Member Countries, which reveals a convergence in adoption between both groups of countries.

The fixed broadband market structure in the OIC Member Countries exhibits, in the aggregate, a moderate level of competitive intensity. Of the countries with available information, thirteen have three or more fixed broadband service providers (an indication of sustainable competition), while eleven have less than three (an indication of low competitive intensity). Moreover, based on this structure and the correspondent market shares of providers in countries where complete information is available, the Herfindhal-Hirschman Index[1] (an indicator of industry concentration) indicates that only four OIC Member Countries have a somewhat healthy competitive fixed broadband environment while the remainder is either highly concentrated or operating under monopolistic market conditions. On the other hand, the mobile broadband market structure in the OIC Member Countries exhibits, in the aggregate, a moderate level of competitive intensity. Of the countries with available information, twenty have more than three operators, seventeen have three carriers, while twelve have less than three (an indication of low competitive intensity). Based on this structure and the correspondent market shares of countries where complete information is available, the Herfindhal-Hirschman Index indicates that eight OIC Member Countries have a healthy competitive environment while thirteen exhibit moderate competitive intensity.

A compilation of research on adoption barriers among the OIC Member Countries indicates that affordability remains a preeminent variable in explaining the non-adoption of broadband, particularly in emerging countries. Approximately 9 % of non-adopters indicate in surveys that affordability is one of the reasons for not acquiring broadband, while 6% mentioned lack of digital literacy and 14% responded that they either did not need the Internet or argued that a cultural barrier prevented them from acquiring the service.

Even if enhancing broadband adoption is a dominant priority for the OIC Member Countries, the achievement of high broadband penetration will also entail some risks. Four risk areas, identified in research conducted in developed countries, need to be considered and policy initiatives need to be implemented to mitigate them. The first risk is the degradation of human relationships as a result of intense digital consumption. The second risk, particularly among adolescents, is the decline in conducting other knowledge gathering activities, such as reading caused by intense digital consumption behavior. A third risk that has been studied particularly in developing countries is cultural uprooting. An analysis of the most popular Internet sites accessed by region indicates that in MENA countries only 27 of 100 most popular sites are produced locally, while the remaining are either developed overseas or developed overseas and translated to local language (Arabic, French or English). A fourth risk related to the increase reliance on broadband relates to the economic disruption of an Internet shutdown, outage, or cyber-attack. Given the increasing dependence on broadband for the world economies, it is estimated that the economic impact of Internet disruption per day for a given country ranges from $ 3.8 million for interrupting a national app (such as Twitter or Google) to $ 15 million for an outage of the national Internet.

[1] The Herfindahl-Hirschman Index is calculated by adding the square power of the market share of all industry participants. An index of 10,000 indicates a monopolistic market structure while an index lower than 3,500 is considered to depict an industry with a healthy level of competition. An index higher than 3,500 would indicate moderate competitive intensity.

Policy prescriptions for enhancing broadband development in the OIC Member Countries

The universe of the OIC Member Countries is not homogeneous when it comes to the challenges faced regarding broadband development. Three broadband development stages have been identified: 1) advanced supply infrastructure and service adoption, 2) intermediate development of fixed broadband and 4G mobile network deployment combined with medium service penetration, and 3) limited infrastructure coverage and low service adoption. OIC Member Countries can be grouped in these three categories (see table 1).

Table 1: OIC Member Countries: State of broadband supply and demand (2015)

	Supply			Demand	
	Fixed Broadband Coverage (ADSL)	**Mobile Broadband Coverage (3G)**	**Mobile Broadband Coverage (4G)**	**Fixed Broadband Penetration (households)**	**Mobile Broadband Penetration (population)**
OIC Average	**53.33%**	**64.16%**	**46.82%**	**14.95%**	**29.41%**
Advanced	**>70 %** Azerbaijan, Bahrain, Brunei, Jordan, Kazakhstan, Lebanon, Malaysia, Maldives, Oman, Qatar, Saudi Arabia, Turkey, UAE,	**>70%:** Albania, Azerbaijan, Bahrain, Bangladesh, Brunei, Cote d'Ivoire; Egypt, Gabon, Gambia, Jordan, Kazakhstan, Kuwait, Lebanon, Malaysia, Maldives, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Suriname, Syria, Tunisia, Turkey, UAE	**>70%** Kazakhstan, Kuwait, Pakistan, Qatar, Saudi Arabia, UAE	**>70%** Azerbaijan, Bahrain, Lebanon, Qatar, Saudi Arabia, UAE	**>70%** Bahrain, Kuwait, Libya, Malaysia, Oman, Qatar, Saudi Arabia, Suriname, UAE
Intermediate	**70%-40%** Kuwait, Palestine, Suriname	**70%-40%** Afghanistan, Algeria, Benin, Cameroon, Indonesia, Iran, Iraq, Kyrgyzstan, Mozambique, Nigeria, Pakistan, Senegal, Sudan, Togo, Uganda, Turkmenistan, Uzbekistan	**70%-40%** Jordan, Malaysia, Morocco, Oman,	**70%-40%** Brunei, Kazakhstan, Malaysia, Maldives, Oman, Palestine, Suriname, Turkey	**70%-40%** Albania, Algeria, Azerbaijan, Cote d'Ivoire, Egypt, Indonesia, Kazakhstan, Lebanon, Maldives, Tunisia, Turkey
Developing	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea Bissau, Guyana, Indonesia,	**<40%** Burkina Faso, Chad, Comoros, Djibouti, Guinea, Guinea Bissau, Guyana, Libya, Mali, Niger, Mauritania, Sierra Leone, Somalia, Tajikistan, Yemen	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea Bissau, Guyana, Indonesia,	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea-Bissau, Guyana,	**<40%** Afghanistan, Bangladesh, Benin, Brunei, Burkina Faso, Cameroon, Chad, Comoros, Djibouti, Gabon, Gambia, Guinea, Guyana, Iran, Iraq, Jordan, Kyrgyzstan, Mali,

	Supply			Demand	
	Fixed Broadband Coverage (ADSL)	Mobile Broadband Coverage (3G)	Mobile Broadband Coverage (4G)	Fixed Broadband Penetration (households)	Mobile Broadband Penetration (population)
	Iran, Iraq, Kyrgyzstan, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Sierra Leone, Somalia, Syria, Sudan, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen		Iran, Iraq, Kyrgyzstan, Mali, Mauritania, Mozambique, Niger, Nigeria, Sierra Leone, Somalia, Syria, Sudan, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen	Indonesia, Iran, Iraq, Jordan, Kuwait, Kyrgyzstan, Libya, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen	Mauritania, Morocco, Mozambique, Niger, Nigeria, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tajikistan, Togo, Turkmenistan, Uganda, Uzbekistan, Yemen

Source: International Telecommunications Union; GSMA Intelligence; Regulatory authorities; Telecom Advisory Services analysis

In general terms, some OIC Member Countries in the Middle East (Bahrain, Oman, Qatar, Saudi Arabia, UAE) and Central Asia (Azerbaijan, Kazakhstan) tend to be fairly advanced in terms of supply and penetration of broadband services. On the other hand, a large group of African countries (Benin, Burkina Faso, Cameroon, Chad, Guinea, Senegal, Sierra Leone, Sudan, Togo) are still at a limited stage of broadband development both in terms of supply and demand. Finally, a number of countries in North Africa (Egypt, Tunisia, Morocco), Sub-Saharan Africa (Cote d'Ivoire), Middle East (Kuwait) and Asia (Brunei, Kyrgyzstan, Turkey, Uzbekistan) exhibit advanced service coverage of the population combined with low penetration.

Advanced OIC Member Countries exhibiting high broadband service coverage and adoption are facing the challenge of building a forward-looking world-class infrastructure that will position them in a leading position in terms of digitization. This entails deploying fiber optics in their last mile, completing their 4G wireless coverage and preparing to deploy 5G. Supply related policies for these countries need to recognize that few broadband providers (typically the incumbent telecommunications operators) are capable of tackling these challenges. Along these lines, governments need to consider policies that entail appropriate incentives to warrant next generation infrastructure deployment. They typically include a range of tax benefits and regulatory holidays.

Countries with advanced coverage but limited penetration face classical demand gap reduction challenges. First and foremost, governments have to recognize that increased service adoption is dependent on lowering the total operating cost incurred by consumers for purchasing the technology. This can be achieved through service subsidies or modification of tax regimes, like exempting low-income population from paying import duties on terminals or VAT on service. Moving to the digital literacy domain, governments need to put in place a series of training programs oriented to foster digital literacy. Up to 29% of broadband non-adopters in certain OIC Member Countries cited limited digital literacy as a reason from not acquiring service. Initiatives aimed at building digital literacy need to involve both embedding programs in the formal education system, while targeting non-formal initiatives to specific segments of the population (elderly, handicapped, rural poor, etc.).

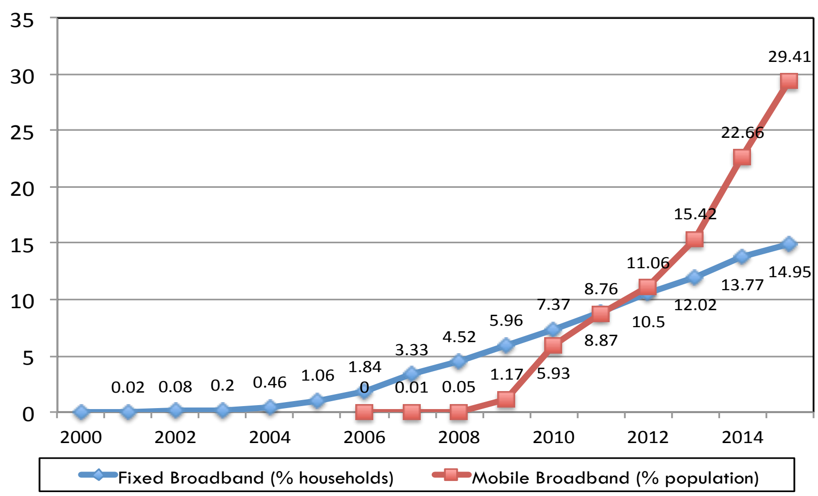
For countries that are still at the early development stages of broadband demand and supply, a combination of infrastructure deployment incentives and demand stimulation policies are required. Policy makers in these countries have to recognize that the competitive incentive will not be sufficient to generate the stimuli required to promote infrastructure investment. Assuming that governments of these countries have limited resources to inject investment in universal broadband reach, it might be necessary again to rely on incumbents and provide them with the right incentives to deploy broadband networks. Infrastructure investment stimulation policies should be put in place simultaneously with demand promotion mechanisms that drive uptake to commercialize the supply availability.

I. INTRODUCTION

Broadband is defined as a high capacity data transmission technology that allows a large number of messages and traffic types (video, data, and voice) to be communicated simultaneously. The term broadband is also used to define high-speed access to the Internet that is always on and faster than traditional dial-up connectivity. Along these lines, broadband refers to a variety of technologies that can be broadly categorized in terms of fixed (including copper-based Asymmetric Digital Subscriber Line (ADSL), cable modem, and fiber optics), fixed wireless (such as WiMAX), and mobile (which includes 3G, 4G and the upcoming 5G technologies).

Ever since its introduction in the early 1990s, broadband technology has undergone a dramatic diffusion around the world, including within the countries of the Organization of Islamic Cooperation (OIC). As of the end of 2015, 14.95% of households in the OIC Member Countries are connected to broadband technology, while 29.41% of individuals have mobile broadband connectivity. These statistics are even more impressive when considering that broadband did not start its diffusion process 2001 in the case of fixed, and 2007 for mobile (see figure1).

Figure 1: OIC Member Countries: Diffusion of fixed and mobile broadband



Source: International Telecommunications Union; Telecom Advisory Services analysis

It is in this context of massive adoption that policy-makers and researchers have been studying the whole range of social and economic effects related to broadband, as well as developing conceptual frameworks that help define policies aimed at maximizing its penetration and measuring its contribution. This report focuses precisely on defining such a framework and developing a set of recommendations to enhancing broadband penetration within the OIC Member Countries. It is organized into six chapters. Chapter II develops a conceptual framework to help the development of policy recommendations aimed at enhancing broadband penetration. It explores five key issues:

- What is broadband's contribution to social and economic development, including GDP growth, job creation, productivity, household income, and consumer surplus?
- Are there any differences in terms of economic impact between developed and developing countries?
- Are there any specificities between broadband technologies in terms of their suitability to developed or developing countries?
- What are the supply trends that are detected so far, in terms of presence of global, regional and local broadband service providers?
- What are the challenges for developing countries regarding fixed and mobile broadband penetration?

Having developed the conceptual framework, Chapter III examines the global trends regarding broadband development. It begins by reviewing the drivers and trends towards the expansion of presence of global broadband service providers. With this background, it presents a comparative regional view of fixed and mobile broadband adoption around the world. On this basis, fixed and mobile broadband service coverage is analyzed to understand the dimension of the supply gap (as measured by the percentage of unserved population). The statistics of broadband service coverage and penetration are compared to measure the demand gap, defined as the percentage of the population that can purchase broadband service because it is being available in their place of residence but choose not to. The analysis of supply and demand gaps provides the context for understanding the critical success factors and challenges that need to be met to accelerate the diffusion of broadband. They include initiatives such as rural broadband deployment to close the supply gap, price reduction to increase service affordability, and enhancing digital literacy. Along these, a sample of best practices aimed at increasing broadband penetration among non-OIC Member Countries are presented.

Having examined the global trends, Chapter IV turns to examine the situation of broadband in the OIC Member Countries, both in terms of supply and demand. The chapter begins by assessing service availability by fixed and mobile technology. The supply assessment also includes a review of average broadband speed as an indicator of service quality. The review of broadband supply is complemented with an analysis of market structure, which includes an assessment of competitive intensity, and industry concentration. After reviewing the supply environment, the chapter turns to analyze broadband demand within the OIC Member Countries. By relying on the concepts introduced in Chapter II, the demand assessment focuses on penetration by technology and quantification of the demand gap. This serves to understand some of the critical demand barriers (such as pricing, lack of digital literacy, cultural concerns and others) among the OIC Member Countries. The chapter finally addresses some of the potential risks related to the increased use of broadband, which reviews issues such as cultural uprooting, infringement of data privacy, cyber-attacks, and others.

In order to get a more detailed view of the situation of the OIC Member Countries, Chapter V presents three in-depth case studies of broadband in the OIC Member Countries: Cote d'Ivoire, Saudi Arabia, and Kazakhstan. These countries were selected to reflect the geographic diversity, and differing broadband development challenges within the universe of the OIC Member Countries. Along those lines, the case studies also serve to highlight specific challenges faced by countries affected by large portions of the population with low income and limited literacy, versus countries with higher levels of broadband network development that are aiming to achieve global digital leadership.

Having developed a deep understanding of broadband supply and demand dynamics, Chapter VI finally moves to the prescriptive part of the study, which is organized by groups of countries facing similar challenges. It first formulates policy recommendations to accelerate the development of advanced broadband supply in the OIC Member Countries. The focus will be on stimulating investment to the more advanced fixed and mobile broadband technologies, comprising the promotion of competition, combined with state aid whenever necessary. After presenting recommendations to address the supply gap, the chapter presents a set of initiatives to tackle the demand gap among populations and enterprises.

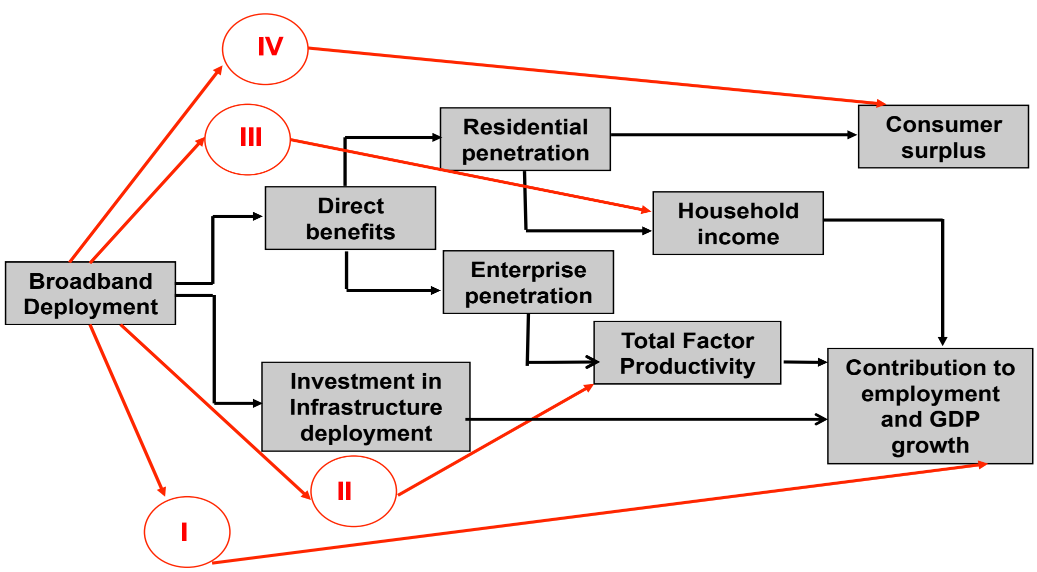
II. CONCEPTUAL FRAMEWORK REGARDING BROADBAND PENETRATION

The development of policies aimed at increasing broadband penetration require outlining a conceptual framework that measures the payback in terms of social and economic returns and identifies the barriers that prevent broadband from achieving universal adoption. The following chapter begins by reviewing the research evidence regarding broadband social and economic contribution, emphasizing the impact on economic growth and job creation (section II.1). Its purpose is to highlight why increasing broadband adoption is critical to fostering economic development. Having demonstrated broadband economic impact, evidence is presented to show the difference in economic contribution for developed and emerging countries (section II.2). The third component of broadband impact conceptual framework has to do with its technological underpinnings, reviewed in section II.3. Finally, the main challenges regarding broadband supply and demand are presented in section II.4. The purpose of the final section is to provide an understanding of the key barriers that prevent countries from achieving high broadband adoption and, therefore, harnessing its full economic potential.

II.1. Impact of broadband on economic and social development

Broadband contributes to economic growth initially through a series of effects similar to those generated by the deployment of any type of infrastructure. Beyond deployment effects, broadband, as a general purpose technology, generates externalities, ranging from GDP growth to job creation and enhancement of consumer surplus (see figure 2).

Figure 2: Social and economic contribution of broadband



Source: Katz (2012)

Figure 2 depicts four distinct social and economic contributions of broadband. Effect 1 refers to the impact on GDP and job creation resulting from investing in the deployment of broadband (also called the "construction effect"). Effect 2 depicts the impact of broadband on business productivity by reducing transaction costs and enhancing the efficiency of enterprises (sometimes referred as "spill over effect"). Effect 3 posits the increase in average household income as a result of enhancing the capacity of the population to market its skills. Effects 2 and 3 contribute in turn to GDP growth. Effect IV, which is not captured in the GDP statistics, has to do with an increase in consumer surplus, is measured as the value created to consumers when they access the Internet (for example, to use e-Government and e-Health applications, or download information and entertainment). This section will present the results of research conducted over the past twenty years in support of the argument that broadband technology has a significant impact on economic growth and job creation.

Broadband impact on GDP growth

The measurement of the economic and social contribution of broadband technology has faced three types of methodological challenges. First, since broadband has been deployed in such a short time-span, it is only very recently that researchers have gained access to sufficiently large disaggregated data sets that allow identifying quantitatively the conditions under which broadband has a social and economic effect. Second, considering that broadband is an access technology, its economic contribution only materializes with the information that it is supposed to transmit. In other words, broadband penetration does not result in an automatic impact on economic growth: content and information processing capacity are critical enablers for this contribution to materialize. The third methodological challenge has to do with the determination of the direction of causal impact: does broadband have an impact on economic growth or is it economic development that triggers an increase in broadband consumption[2].

Over time, researchers have been able to overcome these challenges providing policy makers with increasing evidence that broadband technology should be considered a general purpose technology, meaning that its adoption can affect an entire economy, potentially altering societies through its impact on pre-existing economic and social structures. Initially, due to limitations on data availability, the majority of the studies focused on the impact of fixed broadband on OECD countries (Bojnec & Ferto, 2012; Czernich et al., 2011; Koutroumpis, 2009) or particular statistics-rich developed countries – for example, the United States (Crandall, Lehr, & Litan, 2007; Shideler, Badasyan, & Taylor, 2007; Thompson and Garbacz, 2009). When more data became available for countries in the emerging world, researchers were able to begin generating evidence of broadband impact in developing countries (Kumar et al., 2016 for China, Chavula, 2013 for Africa, and Katz et al, 2012, 2013, 2014 for several developing countries in Africa, Asia, and Latin America). The first body of evidence of the positive effect of broadband focused on fixed technologies since they were the first to be adopted (see Table 2).

[2] The implication of this statement is critical since if it is economic growth that leads to broadband penetration, policy makers should not implement initiatives aimed at fostering broadband adoption; they should emphasize conventional economic development policies which would lead over time to a diffusion of broadband.

Table 2: Research results of fixed broadband Impact on GDP growth

	Country	Study	Data	Effect
High Income Economies	All countries	Qiang & Rosotto (2009)	1980-2002 for 66 high income countries	10 % broadband penetration yielded an additional 1.21 percentage points of GDP growth
	OECD	Czernich et al. (2009)	25 OECD countries between 1996 and 2007	The adoption of broadband raises per-capita GDP growth by 1.9-2.5 percentage points
		Koutroumpis (2009)	2002-2007 for 22 OECD countries	An increase in broadband penetration of 10% yields 0.25% increase in economic growth
		Bojnec & Ferto (2012)	Dynamic Panel modeling of 34 OECD countries broadband data between 1998 and 2009	Positive relationship of broadband on GDP growth
	United States	Crandall, Lehr & Litan (2007)	48 States of US for the period 2003-2005	Not statistically significant results
		Thompson & Garbacz (2009)	46 US States during the period 2001-2005	A 10% increase in broadband penetration is associated with 3.6% increase in efficiency
Low and Middle income economies	All countries	Qiang & Rosotto (2009)	1980-2002 for 120 countries (low and middle income)	10 % broadband penetration yielded an additional 1.38 in economic growth
	China	Kumar et al. (2016)	Autoregressive Distributive Lag for Chinese Internet, broadband, mobile and export data between 1977-2013	All the indicators of ICT have a positive and statistically significant elasticity coefficient ranging from 0.010 to 0.080
	Jordan	Katz & Callorda (2016)	Simultaneous equations of Jordan data between 2006 and 2014	0.73% of GDP growth for every 10 % increase of mobile penetration
	Morocco	Katz & Callorda (2016)	Simultaneous equations of Morocco data between 2006 and 2014	0.84% of GDP growth for every 10 % increase of mobile penetration
	Panama	Katz & Koutroumpis (2012)	Simultaneous equations of Tunisia data between 2000 and 2010	0.45% of GDP growth for every 10 % increase of mobile penetration
	Africa	Chavula (2013)	Cross-sectional endogenous model of fixed lines, internet and mobile lines for 49 African countries between 1990 and 2007	1% increase leads to 0.21% increase in GDP per capita
World		Choi & Yi (2009)	200 countries between 1991-2000 for Internet penetration	Internet has a positive effect on GDP growth
		Vu (2011)	102 countries internet data up to 1995	For the average country, the marginal effect of the penetration of internet users was larger than that of mobile phones, which in turn is larger than that of personal computers. The marginal effect of ICT penetration, however, lessens as the penetration increases.

Source: compiled by Telecom Advisory Services

As table 2 indicates, most studies concluded that broadband penetration has an impact on GDP growth. However, the magnitude of the contribution appeared to vary widely, from 0.25 to 1.38 percent for every increase in 10 % of fixed broadband penetration[3].

[3] Or .36% if the standard assumption that 1% increase in productivity or efficiency results in 1% increase in GDP is made.

With the launch of mobile broadband, research turned to gauging the economic effect of this technology. Thompson & Garbacz (2011) studied the effect of fixed and mobile broadband in economic growth among high-income and low-income countries and found that both technologies have a positive impact in both sets of countries. Furthermore, the authors found that mobile broadband has a considerable greater effect on low-income countries. Katz and others (Katz & Callorda, 2013, 2016a, 2016b; Katz & Koutroumpis, 2012, 2014) also studied the effect of mobile broadband on GDP growth in several countries of Latin America, Asia and Africa, identifying a positive and statistically significant relationship. Similarly, a set of studies recently completed for the GSMA showed that mobile voice and data communications had a direct economic contribution of 1.7%, and a 2.2% indirect contribution on GDP worldwide in 2014 (GSMA Intelligence, 2015). Table 3 presents the studies measuring the impact of mobile broadband on GDP growth.

Table 3: Research results of mobile broadband impact on GDP growth

	Country	Study	Data	Effect
High Income Countries	**United States**	Thompson & Garbacz (2011)	Stochastic frontier model of mobile, fixed telephony and broadband penetration for 93 countries between 1995-2003	Positive relationship on GDP growth
Low and Middle Income Countries	**Senegal**	Katz & Koutroumpis (2014)	Simultaneous equations of Senegal data between 2009 and 2013	0.22% of GDP growth for every 10 % increase of mobile broadband penetration
	Jordan	Katz & Callorda (2016a)	Simultaneous equations of Jordan data between 2011 and 2014	0.39% of GDP growth for every 10 % increase of mobile broadband penetration
	Morocco	Katz & Callorda (2016b)	Simultaneous equations of Morocco data between 2011 and 2014	0.54% of GDP growth for every 10 % increase of mobile broadband penetration
	Philippines	Katz & Koutroumpis (2012)	Simultaneous equations of Morocco data between 2000 and 2010	0.36% of GDP growth for every 10 % increase of mobile broadband penetration
	Asian countries	Ahmed & Ridzuan (2013)	Panel test of standard production function for Telecommunications investment of eight Asian countries between1975 and 2006	Positive relationship
	Ecuador	Katz & Callorda (2013)	Simultaneous equations of Ecuador data between 2008 and 2012	0.52% of GDP growth for every 10 % increase of mobile broadband penetration

Source: compiled by Telecom Advisory Services

Broadband impact on job creation

Beyond the contribution to GDP growth, broadband also has a positive effect on job creation. The impact on this variable can be split into two types of effects: jobs generated by the initial deployment of infrastructure and employment resulting from network effects and their spillover into other areas of the economy.

The construction of broadband networks has three effects on job creation. First, network deployment requires the creation of direct jobs (for example, telecommunications technicians, construction workers and equipment manufacturing operators) to install these networks. Second, direct job creation has an impact on indirect jobs (for example, metallurgical and electrical product industries that supply inputs to the industries directly involved). Finally, household spending resulting from direct and indirect jobs leads to induced employment.

There are six studies that estimate the impact of broadband network construction on employment: Crandall et al. (2003), Katz et al. (2008), Atkinson et al. (2009), Katz et al. (2009a), Liebenau et al. (2009), and Katz et al. (2010a). All of these studies estimate the number of jobs created as a result of capital investment for the deployment of broadband networks: 63 billion US$ required to deploy broadband services throughout the U.S. (Crandall et al., 2003); 13 billion CHF to build a national fiber optic network in Switzerland (Katz, 2008); 10 billion US$ (Atkinson, 2009) and 6.3 billion US$ (Katz et al., 2009a) as part of counter-cycle stimulus packages in the United States (Katz et al., 2009a); 7.5 billion US$ to complete the deployment of broadband in the United Kingdom (Liebenau et al, 2009); and 47 billion US$ to implement the National Broadband Plan in Germany (Katz et al., 2010a). All of these studies have calculated multipliers, which measure the total employment change throughout the economy resulting from the deployment of a broadband network (see table 4).

Table 4: Broadband construction impact on job creation

Country	Study	Objective	Results
United States	Crandall et al. (2003)	Estimate the employment impact of broadband deployment aimed at increasing household adoption from 60% to 95%, requiring an investment of US $ 63.6 billion	• Creation of 140,000 jobs per year over ten years • Total jobs: 1.2 million (including 546,000 for construction and 665,000 indirect)
	Atkinson et al. (2009)	Estimate the impact of a US $10 billion investment in broadband deployment	• Total jobs: 180,000 (including 64,000 direct and 116,000 indirect and induced
Switzerland	Katz et al. (2008b)	Estimate the impact of deploying a national broadband network requiring an investment of CHF 13 billion	• Total jobs: 114,000 over four years (including 83,000 direct and 31,000 indirect)
United Kingdom	Liebenau et al. (2009)	Estimate the impact of investing US $ 7.5 billion to achieve the target of the *"Digital Britain"* Plan	• Total jobs: 211,000 (including 76,500 direct and 134,500 indirect and induced)

Source: compiled by Telecom Advisory Services

Beyond job creation as a result of the construction of broadband networks, the impact of externalities on employment, referred to as "innovation" or "network effects" (Atkinson et al. 2009) have also been quantified. By studying the externalities resulting from the adoption of broadband, numerous effects have been identified:

- Introduction of new services and applications such as telemedicine, Internet information searches, electronic commerce, distance education and social networks (Atkinson et al., 2009)
- New forms of trade and financial intermediation (Atkinson et al., 2009)
- Development of new products and services (Atkinson et al., 2009)
- Improved productivity as a result of the introduction of more efficient business processes provided by broadband, and marketing of excess inventories and supply chain optimization [4] (Atkinson et al., 2009)
- Revenue growth resulting from extended market coverage (Varian et al., 2002 and Gillett et al., 2006)
- Growth of some industries within the services sector (Crandall et al., 2007)
- Impact on the composition and deployment of industrial value chains. Broadband can attract jobs from other regions as a result of the ability to process information and provide services remotely. The services most greatly impacted are outsourcing and the deployment of virtual customer care centers.

Job creation as a result of externalities has been calculated based on econometric analysis of historical data series, and has yielded important conclusions. These studies have been carried out mainly in the United States, although one was conducted in Germany and another one in Ecuador. Table 5 presents the econometric studies that were used to estimate the impact of broadband in the creation of jobs, according to the positive externalities.

Table 5: Impact of positive broadband externalities on employment

Country	Authors	Data	Effect
Germany	Katz et al. (2010a)	2000-2006 for Germany counties	A 1% increase in broadband penetration contributes to employment growth by 0.002%
United States	Gillett et al. (2006)	1998-2002 United States zip codes	Availability of broadband access increases employment growth between 1% and 0.5%
	Crandall et al. (2007)	For 48 states in the United States	For every 1% increase in broadband penetration in each state, employment would increase by an estimated 0.2 and 0.3% per year, if the economy were not at full employment.
	Thompson et al. (2009)	2000-2006 for 48 states in the United States	Job creation varied by industry
State of Kentucky (United States)	Shideler et al. (2007)	Data broken down by county in the state of Kentucky for 2003-4	A 1% increase in broadband penetration contributed between 0.14% and 5.32% to employment growth, depending on the industry.
State of California (United States)	Kolko (2010)	1999-2006 for California zip codes	The study does not find a significant relation in part because broadband service is measured based on the number of operators per zip code.
Ecuador	Katz & Callorda (2013)	Econometric model of Ecuador data between 2008 and 2012	0.56 percentage points increase in employment rate for every 10 % increase of fixed broadband penetration

Source: Compiled by Telecom Advisory Services

According to these studies, once broadband is deployed, its contribution to employment growth ranges from 0.14% to 5.32%, depending on the territory and the industrial sector. More precisely, a 1% increase in broadband penetration contributes between 0.002% and

[4] Efficient telecommunications make it possible to reach a broader market, facilitating business processes. They also result in reduced input costs as the capacity to search for lower prices increases.

0.5% to employment growth. Like the relationship between broadband and GDP growth, the contribution of broadband to employment is also conditioned by a number of special effects. Studies have particularly focused on two specific questions:

- Does the impact of broadband on employment differ according to industry sector?
- Is there a decreasing return in employment generation linked to broadband penetration?

As with GDP, the spillover employment effects of broadband are not uniform across sectors. According to Crandall et al. (2007), the job creation impact of broadband tends to be concentrated in service industries, (e.g., financial services, education, health care, etc.) although the authors also identified a positive effect in manufacturing. In another study, Shideler et al. (2007) found that, for the state of Kentucky in the United States, county employment was positively related to broadband adoption in multiple sectors, including manufacturing and certain services. The only sector where a negative relationship was found with the deployment of broadband (0.34% – 39.68%) was the lodging and food services industry. This was the result of a particularly strong capital/labor substitution process taking place, whereby productivity gains from broadband adoption yield reduced employment. Similarly, Thompson and Garbacz (2008) concluded that, for certain industries, "there may be a substitution effect between broadband and employment"[5]. It should therefore be considered that the productivity impact of broadband can cause capital-labor substitution and may result in a net reduction in employment.

This specific effect has been analyzed by Katz et al. (2010) for rural economies of the United States. In this research, it was found that, within rural counties, broadband penetration contributes to job creation in financial services, wholesale trade and health sectors. This is the result of enterprise relocation enabled by broadband, which benefits primarily urban communities in the periphery of metropolitan areas (Katz et al. 2010d). In fact, research is starting to pinpoint different employment effects by industry sector. Broadband may simultaneously cause labor creation triggered by innovation in services and a productivity effect in labor-intensive sectors. Nevertheless, while a robust explanation of the precise effects by sector and the specific drivers in each case is still missing, it is reasonable to expect that the deployment of broadband should not have a uniform impact across a national territory.

Some researchers have also found a decreasing impact of broadband on employment. While Gillett et al. (2006) observed that the magnitude of impact of broadband on employment increases over time, they also found that the positive contribution of broadband to employment tends to diminish as penetration increases. This finding may support the existence of a saturation effect. Coincidentally, Shideler et al. (2007) also found a negative statistically significant relationship between broadband saturation and employment generation. This would indicate that at a certain point of broadband deployment, the capability of the technology to have a positive contribution to job creation starts to diminish.

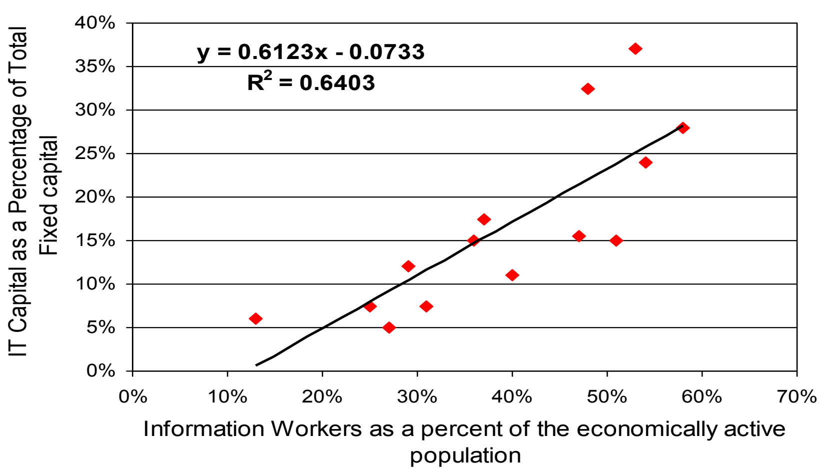
[5] This effect was also mentioned by Gillett *et al.* (2006).

In summary, a review of the research on the economic impact of broadband indicates multiple effects. Firstly and foremost, the evidence is fairly conclusive about the contribution of broadband to GDP growth. While the size of this contribution varies, discrepancies can be related to different datasets as well as model specifications. Secondly, broadband contributes to employment growth with spillover impacts on the rest of the economy. While deployment programs are, as expected, concentrated in the construction and telecommunications sectors, the impact of externalities are greater in sectors with high transaction costs (financial services, education, and health care).

Broadband impact on productivity

It is logical to assume that productivity of information workers, defined as the portion of the economically active population whose working function is to process information (administrative employees, managers, teachers, journalists) depends directly on the investment in ICT capital (and particularly broadband). The studies conducted by Prof. Raul Katz[6] have, in fact, concluded that the larger the percent of the workforce dedicated to information generation and processing, the higher the proportion of capital stocks invested in the acquisition of ICT infrastructure (see figure 3).

Figure 3: Information workers an ICT investment



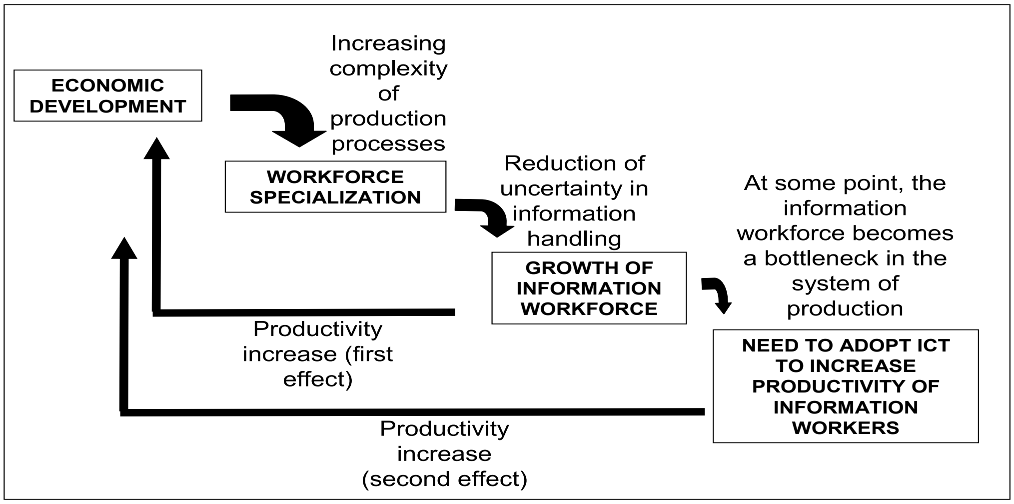
Note: Data for information workforce was derived from ILO statistics while IT Capital was sourced from Kaplan (2001)
Source: Adapted from Katz (2009b)

Figure 3 and the corresponding regression coefficient indicate the existence of a direct relationship existing between the amount of information workers and IT capital investment in a given economy: the larger the proportion of information workers in a given the economy, the more capital is invested in information technology. How can one theoretically explain the relationship between ICT and productivity? In his economics dissertation at Harvard University (1982), Charles Jonscher raised the hypothesis that if one can measure the micro-economic impact of ICT on firm productivity, then one should also be able to link the growth in

[6] Katz, 2009b

informational occupations and the adoption of technology to improve their productivity at the macroeconomic level. This causal link is conceptually depicted in figure 4.

Figure 4: Causality Model: ICT innovation and diffusion is driven by the growth of information workforce



Source: Jonscher (1982); Telecom Advisory Services analysis

According to this causality framework, economic growth logically leads to increasing complex production processes. In turn, complexity in production processes results in increasing the functional complexity within firms (e.g. more inputs to be combined, more steps to be scheduled in a timely manner, more interactions occurring with suppliers of raw materials and with buyers of the end product). The first response of economic organizations to this effect is the creation of "information workers"—laborers whose primary function is the manipulation of information for purposes of organizing the production of goods. At some point, however, information processing workers become a bottleneck in the economic system. They cannot grow forever because this process reduces the overall availability of resources in other occupations. Furthermore, when information workers become a large proportion of the workforce, the complexity of information processing becomes a bottleneck itself. In other words, there is a limit to the possibility of manually storing, transferring and processing the growing amounts of information. This is where information and communication technologies come in. Their development and adoption is aimed at increasing the productivity of information workers and addressing this bottleneck. The availability of computing and communications allows firms (and their information workers) to be more productive in their manipulation of information. Broadband is a specific component performing this important productivity enhancement.

For example, research on the impact of broadband on productivity has successfully identified positive effects. For example, Waverman et al. (2009) determined the economic effect of broadband on the GDP of 15 OECD countries for the time period of 1980 to 2007. These included 14 European and the United States. By relying on an augmented production function derived from Waverman et al. (2005), the authors specified two models: a production function and a hedonic function for ICT capital stocks. Broadband impact on the productivity of the more developed countries in the sample was found to be .0013 and was statistically significant at the 5% level[7]. In other words, Waverman estimated that for every 1% increase in broadband penetration in high and medium impact income countries, productivity grows by 0.13%. In another document, the authors commented upon the productivity effect in the countries of their sample with relatively low ICT penetration (Greece, Italy, Portugal, Spain and Belgium.). They found that broadband impact on productivity was nil, which indicated the high adoption costs, and critical mass thresholds[8]. In other words, for broadband to have an impact on productivity, the ICT eco-system has to be sufficiently developed[9].

Broadband impact on household income

In recent years, the implementation of national household surveys that now include ICT modules has allowed to research the impact of broadband based on *micro*-economic data. For example, using information from Peruvian households between 2007 and 2009, De Los Rios (2010) found that, during this time period, Internet adopters experienced significant income growth relative to those households that did not have the service. The author of this report recently conducted a study evaluating the impact of broadband on household income in Ecuador (Katz and Callorda, 2015).

To estimate the impact of broadband on poverty reduction using microdata, the authors calculated the impact of broadband deployment on average income at the country's county level. Ecuador is an appropriate case for this analysis because, while at the end of 2009 the country had a limited offering of residential broadband services, between 2009 and 2011, CNT, Ecuador's telecommunications fixed broadband provider, greatly expanded its coverage. As a result, the population in newly served townships could access fixed broadband service for the first time. This expansion led to a significant increase in broadband penetration at the provincial level in the country. Based on disaggregated data, a variable was built indicating the counties that lacked broadband access in 2009 (due to a lack of coverage) but gained service by late 2010 / early 2011 (thanks to the aforementioned extension of the state-owned telecommunications operator's network). Through this process, two groups were created: 1) a treatment group, comprised of those individuals living in cantons where broadband was introduced during the 2010-2011 period, and 2) a control group, comprised of those individuals living in cantons that already had access to residential broadband services by the fourth quarter of 2009. Using this identification strategy, and given that the treatment group and the control group are statistically equal at the baseline of the observed variables, a regression model that estimates the impact of treatment on individual income levels was built. Controls were included for the variables that, at the individual level, can affect income (age,

[7] The original regression yielded a coefficient of 0.0027 for the 2/3 more developed countries in the sample and negative effect for the lower third. A negative effect did not make sense so the authors constrained the effect for the lower third to zero. At that point the coefficient for the full sample moved to 0.0013.

[8] Waverman, 2009

[9] For example, Waverman et al. estimated that in the United States broadband penetration contributed approximately to 0.26% per annum to productivity growth, resulting in 11 additional cents per hour worked (or US $ 29 billion per year).

gender, employment status and healthcare coverage, level of formal education, and role within the family). In this section, the average impact on individual income level of broadband introduction at the canton level is estimated.

The results indicated that broadband adoption increased the average individual income by US$ 25.76, which represents a 7.48% increase in relation to the initial average income of the entire sample. Given that the introduction of broadband occurred over the course of two years - between December 2009 and December 2011 - the *annual* increase in the income level was 3.67%. This figure captured the increase in income generated directly by broadband use, the impact on the job market as a result of the labor required for network deployment and the new staff hired by companies to provide the service, as well as the spillover effect on society. The impact on income was shown to be greater among households owning a computer. As evidence, computer users witnessed an average income increase of US$ 38.36, which equates to a total 8.00% increase, or 3.92% per year. Finally, the largest impact occurs among Internet service users, who benefit from increased speed and, in the case of those users who previously used dial-up Internet service, elimination of the incremental cost of usage. Users who can now access the service directly in their homes as a result of network deployment also benefited. For this group, the increase in the income level was substantially greater than in the previous cases: their income increased by US$ 51.86, a 10.27% rise relative to their initial income, or a 5.01% increase per year.

This analysis demonstrated that the introduction of broadband services at the county level results in an increase in average household income. While the causes for this increase can vary, broadband does have an impact through four effects. First, broadband deployment requires infrastructure construction in order to provide the service, additional workers for the operator's new commercial offices, and technical personnel for the installation and maintenance of household broadband. The new demand for labor in a market with an unemployment rate that is already below 5% generates a shift in the demand curve for workers, which leads to an increase in equilibrium wages. Furthermore, the rise in wages through this channel may reflect a need for better compensation for those workers who, given the low unemployment rates, should receive better wages to meet or exceed their reservation wage. This is defined as the "construction effect".

A second explanation for the income increase is that, as seen in Katz (2012), broadband has a positive effect on worker productivity. Classic labor economics literature shows that wages in competitive markets equal marginal productivity. As a result, higher labor productivity should yield higher wages. This is labeled the "productivity effect".

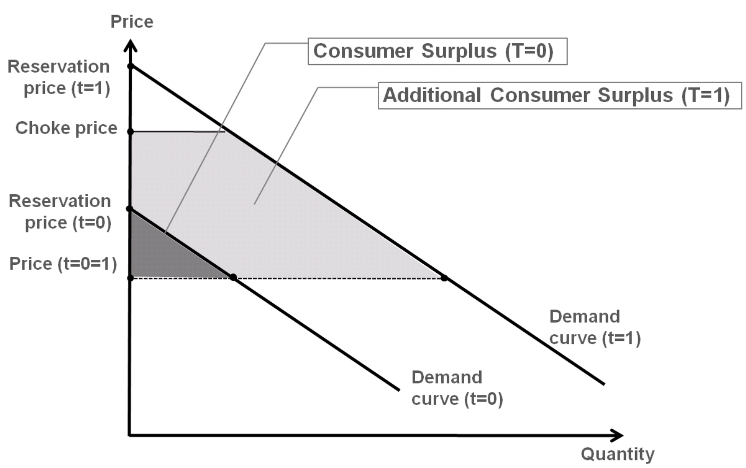
Third, research results also show that the effect of broadband deployment is greater for computer and Internet users. In this sense, the introduction of broadband at the county level allowed workers with digital literacy skills to signal their computer knowledge to potential employers and then use those skills in the workplace in return for a higher wage. This has been called the "skill signaling effect".

Finally, the introduction of broadband can also help to reduce the time otherwise required for an effective job search, allowing underemployed workers to look for full-time work using broadband services. This increase in efficiency leads to a reduction in unemployment periods and generates an increase in the migration of underemployed workers to full-time positions, which, in turn, results in higher labor income. In other words, reduced transaction costs related to finding employment can ultimately result in higher income (with less search time required, the underemployed can find full-time work).

Broadband impact on consumer surplus

There are some specific economic effects of broadband that are not necessarily captured by economic growth or employment creation. This is the case of consumer surplus, which has also been found to be affected by the positive externalities of broadband. Consumer surplus is defined as the amount that consumers benefit from purchasing a product for a price that is less than what they would be willing to pay. In other words, consumer surplus is the utility gain by consumers due to prices that are lower than their reservation prices. In figure 5 the consumer surplus is the area between the demand curve and the market price. The larger the area under the curve is, the more utility consumers derive.

Figure 5: Conceptual representation of consumer surplus



Source: adapted from Katz et al. (2008b)

Consumer surplus may change over time because of two reasons. The first one is an outward-shift of the demand curve, and the second is a price reduction. The price reduction may result from productivity gains and competition. More competition and market saturation force producers to reduce prices. These two developments are responsible for increases in consumer surplus. As indicated in figure 5, the dark grey area represents the initial consumer surplus at t=0. The shift of the demand curve at t=1 results in an additional consumer surplus (light grey area). The whole consumer surplus in period 1 is the sum of the dark and light gray areas.

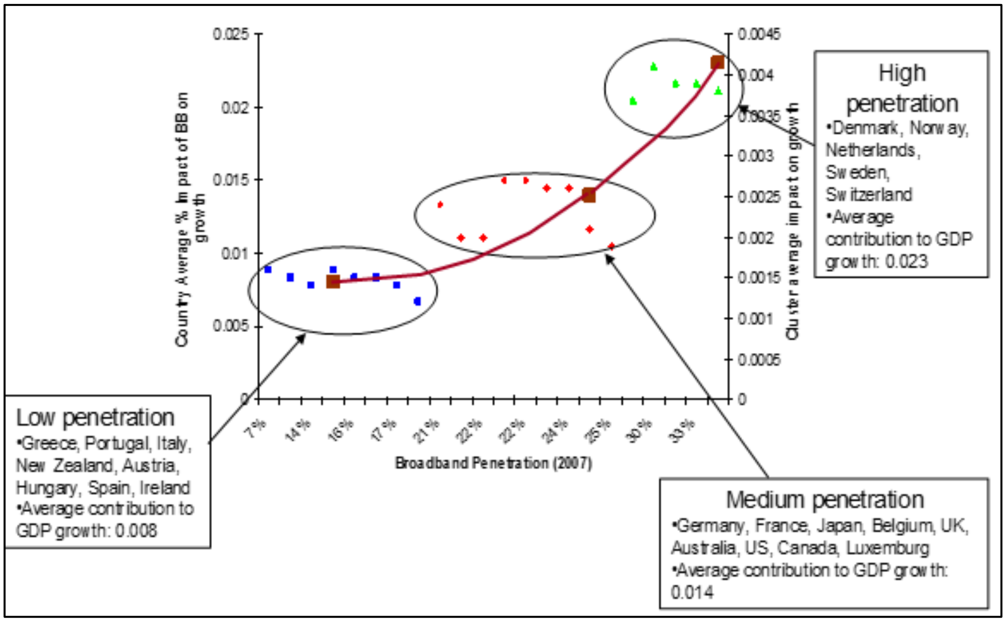
The estimation of consumer surplus resulting from broadband penetration is important, although this economic benefit is not captured by GDP. Greenstein and McDevitt (2009) estimated the consumer surplus generated by broadband adoption in the United States. In their analysis for the period between 1999 and 2006, the authors determined that in 2006 the consumer surplus generated by broadband represented US$ 7.5 billion (or 27 % of the total US$ 28.0 billion in broadband surplus). This was calculated on the basis of what users would be willing to pay to adopt broadband and substitute narrowband access. Consumer surplus can also be conceptualized in terms of the benefits that broadband represents to the end user. The variables driving willingness to pay include the rapid and efficient access to information, savings in transportation for conducting transactions, and benefits in health and entertainment.

The authors also estimated the surplus generated as a result of broadband adoption in Canada, United Kingdom, Spain, Mexico, Brazil and China (Greenstein & McDevitt, 2010). In this case, due to the data limitations, they restricted their analysis to the benefit derived from price declines, which necessarily underestimates its total impact. Nevertheless, the researchers determined that for 2009, the total Brazilian broadband surplus represented US $ 7.03 billion, of which 22 % should be considered to be consumer driven. In the case of Mexico, the total surplus is US $ 2.30 billion, and the consumer portion was 8%. In general terms, the authors concluded that the total broadband surplus is directly related to broadband penetration.

II.2. Differences between developed and developing countries with regards to broadband impact

As briefly discussed above, research on the economic and social impact of broadband determined that the technology impact is not homogeneous across countries. Koutroumpis (2009) was the first researcher to determine that the broadband contribution to GDP growth increases with penetration: the higher broadband penetration is, the stronger its effect on economic growth. This effect is labeled “critical mass” or, in economic terms, the return to economies of scale. The evidence generated by Koutroumpis on OECD datasets indicated that the impact of broadband on GDP growth increased with its penetration, when grouped in three categories of OECD countries (see figure 6).

Figure 6: OECD: Percentage of impact of broadband on GDP growth



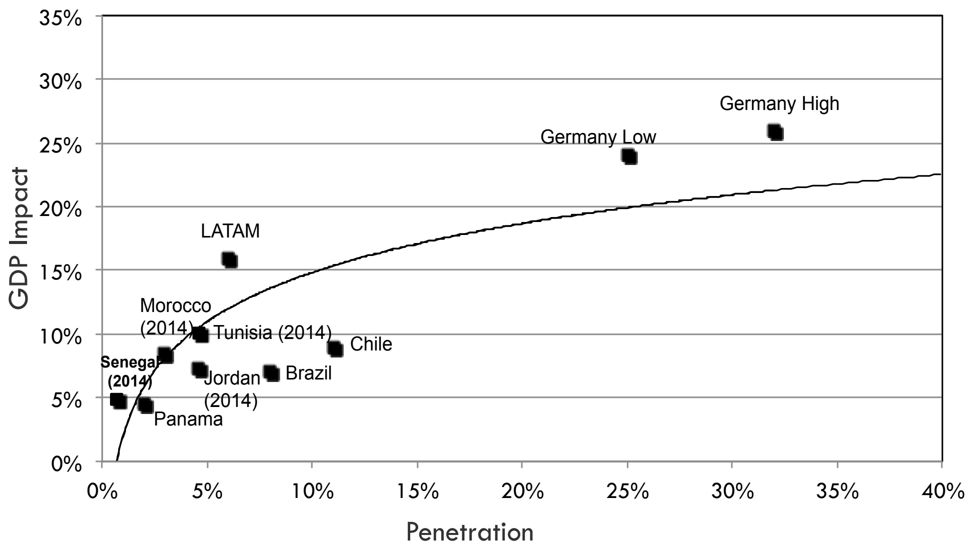
Source: adopted from Koutrompis (2009)

The "return to scale" effect was also confirmed in a later research conducted by Katz et al. (2010) for Germany. The estimate was based on a statistical analysis of the impact of broadband on economic growth of German counties (landkreisse) between 2000 and 2006. The authors determined that, on average, a 1% increase in broadband penetration contributes 0.0255% to GDP growth. This result coincides with Koutroumpis' estimate of 0.023 for high fixed broadband penetration countries. At the same time, by dividing the data set between counties with high and low broadband penetration, the authors validated the existence of a return to scale. For counties with an average fixed broadband penetration of 24.8%, the contribution to GDP growth was around 0.0238%, while for those with an average penetration of 31%, broadband contributed 0.0256% to GDP.

The return to scale effect has also been found in countries with low levels of broadband development. Katz & Callorda (2016) were able to model the impact of mobile broadband on growth of the GDP of Senegal for the period 2009-2014, replicating research conducted by Katz & Koutroumpis (2014) for 2009-2012 and 2009-2010. During each period, mobile broadband penetration increased from 0.29% of total population (2010) to 3.42% (2012), and finally 10% (2014). While in the first period, mobile broadband did not have any impact on GDP growth, in the second one, each 10% in mobile broadband penetration yielded 0.22% in GDP growth. In the third period, when mobile broadband penetration reached 10%, the impact coefficient on GDP growth increased to 0.40% for each 10% increase in broadband penetration.

The same effect, whereby the economic impact increases with penetration, can be found in the case of fixed broadband (see figure 7).

Figure 7: Fixed broadband economic impact vs. fixed broadband penetration



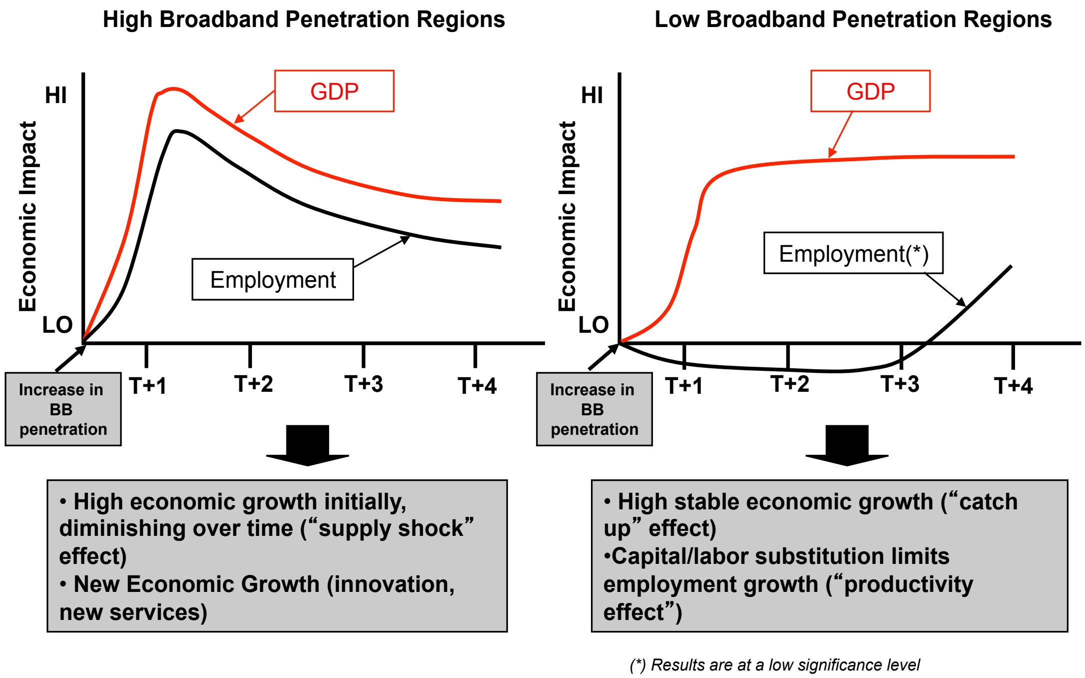
Source: Katz and Callorda (2016)

Figure 7 plots on the horizontal axis fixed broadband penetration and on the vertical axis the contribution to GDP growth as calculated for several countries relying on a similar econometric structural model based on simultaneous equations[10]. Validating the "return to scale", the figure indicates that the contribution to GDP growth increases with fixed broadband penetration. For example, the contribution coefficient to GDP growth in Germany's counties with high (32%) and low (25%) population penetration is much higher (0.26 and 0.24 respectively) than in countries with lower fixed population penetration, such as Tunisia (4.60%), with a contribution coefficient of 0.1010. The implications of these findings for emerging countries are clear. Since the magnitude of economic contribution of broadband technology increases with penetration, it is imperative that they strive to maximize overall penetration.

The impact of broadband on job creation also varies between developed and emerging regions within a single country. The research on broadband impact in Germany discussed above highlighted differential job creation impact between advanced and emerging counties. In counties with high broadband penetration, once penetration increased, the effect of job creation is significant in the short term, fading over time due to a potential saturation effect. On the other hand, in counties with low broadband penetration, the increase in broadband deployment results in a negative impact on job creation (in other words, a reduction in the number of jobs) in the short term, reaching a positive effect in the long term. A comparison of these effects is presented in figure 8.

[10] The models are compiled from different research articles from Koutroumpis (2009), Katz and Koutroumpis (2012), Katz and Callorda (2014 and 2016).

Figure 8: The regional effect of broadband on job creation according to different levels of penetration



Source: Katz (2011)

These different effects can be explained by the fact that increased broadband deployment in more advanced regions creates a "supply shock" within the context of companies who can leverage technology to generate new businesses while yielding production efficiencies. In contrast, in regions with lower broadband adoption, the increase in broadband penetration leads to an initial substitution between capital and labor, in which the productivity generated by the technology produces a decline in employment.[11] In the medium term, the increase in adoption has a positive impact, which can be explained in terms of learning in the assimilation of the technological input and the generation of innovations that create jobs. In other words, in those regions lagging behind, the effect of broadband is increased productivity in the short term and, as a result, the loss of jobs; in the medium and long term, innovation leads to job creation.

In sum, while there is a strong consensus in the positive and statistically significant effect of broadband on economic growth, when comparing findings across research, a number of caveats need to be raised. First, broadband exhibits a higher contribution to economic growth in countries that have a higher adoption of the technology (this could be labeled the "critical

[11] This effect was alluded to by Gillett et al. (2006) in indicating, "broadband can facilitate the capital-labor substitution, resulting in lower rate of employment growth." Thompson et al. (2008) also mentions “it is possible that a substitution effect between broadband and employment exists."

mass theory"[12]). Research has been successful in identifying the existence of a critical mass effect, indicating the existence of increasing economic returns to broadband penetration. Second, broadband has a stronger productivity impact in sectors with high transaction costs, such as financial services, or high labor intensity, such as tourism and lodging. Third, in less developed regions, as postulated in economic theory, broadband enables the adoption of more efficient business processes and leads to capital-labor substitution and, therefore loss of jobs (this could be labeled the "productivity shock theory"). Fourth, the impact of broadband on small and medium enterprises takes longer to materialize due to the need to restructure the firms' processes and labor organization in order to gain from adopting the technology (this is called "accumulation of intangible capital"). Finally, broadband economic impact is higher when promotion of the technology is combined with stimulus of innovative businesses that are tied to new applications. In other words, the impact of broadband is neither automatic nor homogeneous across the economic system. This emphasizes the importance of implementing public policies not only in the areas of telecommunications regulation, but also in education, economic development and planning, science and technology, and others.

II.3. Technological evolution of broadband

Ever since its introduction in the mid-1980s, broadband technology has been evolving in terms its performance and usage flexibility. The assessment of broadband technology trends needs to be organized along the five components of the broadband communications value chain (see table 6).

Table 6: Broadband communications value chain

Value Chain Link	Function	Alternative Technologies
International Connectivity	Connections to the rest of the world and Internet "cloud"	Satellite Fiber optics (submarine cable and long-haul terrestrial) Microwave
Domestic backbone	Traffic carried between fixed points of interconnection and to the routing switch	Fiber optics Microwave links
Switching/routing	Intelligence in the network that ensures that communications traffic is routed correctly	Optical switching
Last mile distribution	Access to the customer premise or individual terminal	Fixed wireline (ADSL (copper), Cable modem, Fiber optics) Fixed wireless (WiMax, Satellite) Mobile (3G, 4G, 5G)
Distribution within customer premise	Modem Router Link to terminal	Ethernet Wi-Fi
Terminal		Smartphone PC Tablet TVs

Source: Telecom Advisory Services

Each component of the broadband value chain can be supported by a number of technologies. Some, like satellites and fiber optics, are suited for particular environments, and should be

[12] According to this, the economic impact of broadband increases exponentially with penetration of the technology as a result of network effects.

considered substitutes. Others, such as mobile wireless 3G, 4G and 5G, represent generations of what is essentially a same approach to broadband communications, each of them implying better performance and spectrum resource utilization. The following sections review each group of technologies by value chain stage.

International connectivity

The suitability of technologies to support international connectivity varies in terms of a country's geography. In general terms, microwave links can be more suited for connectivity between neighboring countries, although their capital requirements and technological limitations (in terms of overall bandwidth) restrict their applicability. Microwave technology can provide long haul transmission using a chain of repeater transmitters, each transmitting over a distance of up to 50 kilometers. The principal drawback of microwave links is their capacity constraint. The ever growing Internet traffic cannot be easily handled by microwave links, which has an impact on the quality of service. In addition, since a microwave network is supported by repeating sites, the impact on maintenance economics of operating such a technology can be fairly high.

Two technologies are mostly relied upon for broadband international connectivity: fiber optics and satellites. In fact, fiber optic submarine cables and communications satellites provide the vast majority of broadband international links (although some terrestrial networks are still based on microwave technology).

For countries bordering on a coast line, submarine fiber optic cables provide the most cost-effective option as a cable installation can combine several strands, each capable of transmitting at a rate of several gigabits per second. The capital expenditures required to deploy fiber optics imply that they are relied first and foremost for long haul high capacity transmission. However, once installed, fiber optic cables provide great opportunities to scale up and increase overall transmission capacity simply by activating additional strands of cable pairs. Carriers using fiber optic cables can transmit vast amounts of broadband traffic, not only because single strands have wideband capacity and fast transmission speeds, but also because many pairs of cable can be bundled together. Furthermore, the technology of DWDM (Dense Wave Division Multiplexing) makes it possible for multiple laser beam transmissions to take place via a single cable strand using different, non-interfering frequencies.

When operators cannot economically justify the cost of installing cables, most long haul carriage of broadband traffic takes place via satellites. In addition, satellites are particularly applicable for countries that are located far from submarine coastal landing sites. Satellites receive a signal from a landlocked location and relay it to other locations within their footprint. On the other hand, satellites have significant economic disadvantages compared to fiber optic cables. Satellites can offer only about 500-750 MHz in bandwidth while a few fiber optic cable pairs can transmit the total capacity of all available communications satellites. Furthermore, satellites have a usable life of about ten years and cannot be easily repaired should a malfunction occur.

Fixed wireline last mile distribution

This stage of the broadband value chain provides connectivity from the network to the consumer, be it a PC installed in residence, a laptop, tablet or a smartphone being operated by an individual. There are three types of technologies supporting last mile distribution: fixed wireline, fixed wireless, and mobile wireless.

Three types of technologies support fixed wireline broadband access: digital subscriber line (provisioned by a telecommunications company), cable modem (supplied by a cable TV operator), and fiber optics (again operated by a telephone company). Telephone companies provide broadband ADSL service by expanding the bandwidth available from already installed copper wires used to provide the telephone service. With this service, telecommunications companies can offer broadband service typically at transmission speeds of about 1.5 Mbps. This performance is dependent upon the distance separating the residence from an operator switching center[13]. The need for subscribers to be located no farther than 5 kilometers from a switching center reduces the market size of potential subscribers, restricting it to geographies with high population density.

ADSL service offers slow broadband service as compared to what cable television operators' offer. Cable television operators can also retrofit their existing networks to provide broadband service. By partitioning a television channel, cable operators can designate the frequencies represented by this channel as available only for uploading and downloading data. Given that the cable television network operates with amplifiers located throughout its network, cable modem service can be offered anywhere the company offers video service. Additionally cable modem service can operate at download speeds well in excess of what ADSL can provide. Additionally, cable operators can further increase service speeds (to up to 120 Mbps) by adding more bandwidth in 6 MHz increments, a process known as cable bonding. This procedure is achieved through standards such as DOCSIS 3.0.

Finally, telecommunications companies can opt to migrate their access network to fiber optics, providing service at vastly increased access speeds (in many cases reaching 200 Mbps). More importantly, fiber optics represent a critical technology to accommodate future internet traffic growth. The increase in traffic is driven first by an exponential growth in Internet access devices. For example, while as of 2016, mobile broadband connections in the Middle East and North Africa region represent 44% of the total, this number will reach 62% by 2020[14]. Similarly, smartphone adoption is expected to increase from 39% to 65% within the same timeframe. The growth in Internet access devices is compounded by an increase in traffic per device. For example, the average Internet user in Saudi Arabia will generate 30.2 gigabytes of Internet traffic per month in 2020, a compound annual growth rate of 18% from 13.4 gigabytes per month in 2015. As a result in this country alone, Internet traffic will grow 3.5

[13] DSL subscribers located relatively close to a telecommunications company switching facility can receive somewhat higher bit transmission speeds, but subscribers located more than 5 kilometers typically cannot receive any DSL service. Because operators rely on unamplified copper wire as the medium for service, signals weaken as the distance increases between the subscriber and the operator switching office.

[14] GSMA (2016). *The mobile economy: Middle East and North Africa 2016*. London.

times between 2015 and 2020[15]. The costs of installing fiber in the last mile are considerably high (US$ 2,000 in urban areas, $4,000 in suburban areas, and $12,000 in rural areas per home connected). This puts pressure on operators to market additional services in order to generate enough revenue to render the deployment business case profitable.

Fixed wireless last mile distribution

Since many countries lack ubiquitous access to new or transitional broadband wireline technologies, fixed wireless options can provide a solution for serving many localities. Four fixed wireless technologies exist: WiMax, Wi-Fi, Super Wi-Fi, and direct satellites.

WiMax (World Wide Interoperability for Microwave Access) refers to a microwave technology, typically operating at 2.5-3.5 GHz frequencies, that can provide last mile broadband service at speeds of up to 30-40 Mbps. WiMax provides the ability to extend wireless type access over a larger footprint. However, as WiMax network demand grows and as users move further away from a transmitter, actual achieved speeds decline. Operational WiMax networks typically deliver broadband speeds ranging between 1 and 15 Mbps.

In its basic application, Wi-Fi (Wireless Fidelity) can provide access to a wired or wireless broadband service to multiple users within a small distance from a wireless router[16]. This technology offers an extension of an existing broadband service, such as ADSL, cable modem, or fiber optics. Wi-Fi service typically requires the installation of a wireless router operating on unlicensed microwave spectrum at low transmission power. Tablets, smartphones and PCs equipped to transmit and receive Wi-Fi frequencies can communicate with the Wi-Fi router serving as an interface for downloading and receiving traffic from the Internet. Wi-Fi has been also applied as a last mile distribution fixed wireless technology. For example, Wireless Internet Service Providers (WISPs) rely primarily on unlicensed spectrum to offer broadband accessibility in rural areas of the United States. While some WISPs utilize licensed spectrum, the majority relies on UNII and ISM bands or lightly licensed spectrum in the 3.65 GHz band: 26MHz of unlicensed spectrum just above 900MHz, 50MHz in 2.4GHz and 100MHz in 5.8GHz. While WISPs initially utilized the 802.11b platform, they have mostly migrated to 802.11n, which allows them to deliver 10 Mbps service or higher to 200 customers from a single four sector base station.

Super Wi-Fi is an enhancement of Wi-Fi technology which operates in the frequency bands between 54 MHz and 698 MHz to deliver broadband within up to 10 miles with high penetration at 20 Mbps download and 6Mbps upload speeds. It can extend the range of Wi-Fi and provide broadband in rural areas. Super Wi-Fi relies on empty channels of spectrum (known as white spaces) and uses Dynamic Spectrum Access that optimizes access to available unused bands[17].

[15] CISCO (2016). *Visual Networking Index*.
[16] In essence Wi-Fi constitutes an "access to access" service in the sense that it only provides a wireless and mobile option within a closed and limited area, e.g., a home or coffee shop.
[17] Users will predominantly use Super Wi-Fi networks to access smart, radio-enabled devices that report their location to an Internet database. The database will dictate the TV white spaces channels and appropriate power level based on in its

Mobile wireless last mile distribution

Beyond fixed wireless, mobile wireless technologies have the potential to offer faster, cheaper and more widespread installation of broadband services. Using microwave frequencies for backhauling traffic and an antenna that transmits a 360-degree signal, wireless carriers can cover a diameter of 100 kilometers, depending on the radio frequency and the topology of the terrain. Wireless network operators do not have to install ducts, conduits and wires to serve each and every subscriber. Instead the omnidirectional signal from a single tower can deliver voice and data traffic to any user within the transmission contour and also any user can communicate with the tower using a smartphone.

Since the mid-1980s, wireless telecommunications has evolved in four distinct generations. In the first generation, in the mid to late 1980s, cellular radio used analog transmission to provide wireless telephony only. The second generation (launched in the early 1990s) introduced digital transmission technologies and the first spectrum efficiency techniques. In the third generation (adopted initially in early 2000s) cellular networks acquired the first ability to handle data traffic. In this third generation, wireless operators retrofitted their networks to handle data traffic commingled with voice calls. However, broadband speeds under 3G networks are fairly slow: these networks can handle the real time "streaming" of music and the distribution of web pages, but not the streaming of full motion video and other bandwidth intensive applications, such as some forms of video gaming. 4G service offers dedicated high speed data service at bit transmission speeds exceeding what terrestrial ADSL offers and rivaling that of cable modem services, becoming an alternative to many fixed wireline service. The proliferation of handsets, including tablets and lightweight computers, coupled with ever increasing content and software options has stimulated increasing demand for wireless spectrum. Recent evidence of deployment indicates that 4G Long Term Evolution ("LTE") has overtaken WiMax as the preferred option for extremely high-speed wireless broadband service.

5G technology is generally defined as providing throughput that will be 10-100x faster than 4G, which could mean real-world speeds of about 4Gbps or more. Most of the speed increases are due to how the carriers will be adding more wireless channels, using millimeter wave technology (which means the signal has to travel shorter distances), installing small cells that dramatically increase the coverage map, and increasing capacity in the wired backhaul locations. The speed boosts, low latency, and backwards compatibility with existing networks will provide a framework for new network architectures, like Cloud RAN (radio access network) where localized nano-data centers will occur supporting server-based networking functions like Industrial IoT gateways, video caching and transcoding at the edge for UltraHD video, and newer mesh-like topologies supported with more distributed heterogeneous networks ("HetNets"). In short, 5G will lead to a dramatic increase in cell sites (which due to the higher frequency a lot of them will have significantly shorter range) and demand for

current location. The database has a list of all protected TV stations and frequencies across the country, so the devices can avoid interference with TV broadcasts and wireless signals. This technology is truly dynamic – as different TV channels become available, Super Wi-Fi devices can opportunistically switch from one group of channels to another.

backhaul[18].

II.4. Main challenges regarding fixed and mobile broadband penetration

There are two types of barriers preventing an increase in broadband penetration. The first one is driven by supply: citizens do not acquire broadband service simply because they lack service in the area where they live or work. This barrier has been called the supply gap. The second one is called the demand gap. While the supply gap measures the portion of the population of a given country that cannot access broadband because of lack of service, the demand gap focuses on the potential users that could buy broadband service (since operators offer it in their territory, either through fixed or wireless networks), but do not. While the digital divide represents the sum of both supply and demand gap, the critical success factors and policy initiatives aimed at addressing each of them are different.

Four success factors are critical for increasing broadband service penetration. In order to reduce the supply gap, the key factor is how to define the right mechanisms that would stimulate the deployment of networks in regions that are still uncovered. The economics of broadband networks (more specifically, the capital required for deployment and the costs of operating the technology) are constrained in low-density regions, particularly when inhabited by underprivileged population. With a low (or even negative) return on investment, private sector broadband service providers have no economic incentive to deploy the technology in rural and isolated areas. Under these conditions, governments are responsible for intervening to address this supply failure. The remedies and approaches that have proven to be useful in this domain will be addressed in Chapter III.

At the highest level of analysis, the residential broadband demand gap is the result of three challenges[19]:

- Limited affordability: certain portions of the population either cannot afford a device or purchase the subscription needed to access the Internet
- Limited awareness of the potential of the broadband service or lack of digital literacy
- Lack of cultural relevance or interest: the value proposition of applications, services, and content provided by the Internet does not fulfill a need of the adopting population

Each of these three obstacles are driven by one or a combination of at least five structural variables:

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[18] 5G wireless technology has been defined according to eight requirements (GSMA, 2015):

- 1-10 Gbps connections to end points in the field (*i.e.* not theoretical maximum)
- 1 millisecond end-to-end round trip delay (latency)
- 1000x bandwidth per unit area
- 10-100x number of connected devices
- (Perception of) 99.999% availability
- (Perception of) 100% coverage
- 90% reduction in network energy usage
- Up to ten year battery life for low power, machine-type devices

[19] Other barriers, such lack of trust in the Internet, might also exist.

- **Income levels**: disadvantaged socio-demographic groups, measured by income, have limited capacity to afford the acquisition of broadband. However, affordability has been found to be correlated with limited awareness and lack of cultural relevance of content. Research indicates that lack of cultural relevance, as a barrier in developed countries, is prevalent in very circumscribed socio-demographic categories. For example, in the United Kingdom, the non-broadband households that cite lack of relevance to explain non-adoption of broadband tend to belong to lower income demographics with people over 65 years old. In a study conducted in Spain (ONTSI, 2012), lack of relevance of Internet content was found to be inversely proportional to income levels.

- **Education levels**: the education attained by potential users influences the degree of digital literacy and is related to interest in accessing the Internet. Beyond the direct relationship between income and broadband adoption, the influence of education is quite relevant. Particularly, in households above the sixth income decile (where affordability represents less of a barrier), education becomes a determining factor. The higher the educational achievement of the head of household, the higher broadband adoption is. The study of the education variable reveals the complex interrelationship it has with the affordability factor. At lower income levels, the affordability variable is stronger than the educational one in predicting adoption. On the other hand, at income levels higher than the sixth decile, demand is less elastic to income, and educational achievement becomes preeminent.

- **Age**: similarly, the age variable is inversely related to digital literacy and content relevance. Studies conducted in the developed world have all pointed out the existence of a generation gap linked to limited digital literacy. In the United Kingdom and the United States, the average age of a non-adopting household is over 65 years old (OFCOM, 2012). Research in the emerging world suggests the existence of a threshold of 30 years old, after which Internet use tends to decline significantly. The difference between the 30-year threshold for Internet usage and persisting broadband penetration at the 35 to 44 age bracket is explained by the presence of children in the household. Children tend to act as change agents in a household, stimulating Internet usage and sustaining broadband adoption. This indirect influence cancels some of the generational gap identified in numerous studies.

- **Ethnicity**: as a result of linguistic and/or cultural structural factors, ethnic group belonging can impact the level of interest in accessing the Internet. Along these lines, the lack of content in local languages could represent a major barrier for adoption.

- **Gender**: differences in education or insertion in the labor market between male and female population can have an impact on broadband adoption, For example, a gender gap was detected in some countries (see Universidad Alberto Hurtado, 2009 for Chile;

INEI, 2012 for Peru; and Rectoria de Telecomunicaciones, 2011 for Costa Rica). However, research by Hilbert (2011) has indicated that the gender gap disappears when control variables such as income and education are included in the analysis.

In addition, non-adoption of broadband could be explained by concerns regarding data privacy. While this factor has been found to explain approximately 10% of non users of electronic commerce among Internet subscribers, it could be hypothesized that privacy concerns also prevents some users from outright broadband usage. For example, survey data compiled by the International Telecommunications Union indicate that 0.20% of Bahraini non adopters, 5.20% of Iranian non Internet users, 6.20% of Brazilian non-users, and 1.30% of Egyptian non adopters mention privacy and/or security concerns as an Internet adoption barrier.

Finally, research has found that a small portion of non-broadband users justify their lack of adoption on religious grounds. Data in support of this assertion is not available, except that approximately 1% of non-adopters in the survey data compiled by the International Telecommunications Union mention a cultural barrier as reason for non-adoption. Religious reasons could potentially be blended under this barrier.

This section presented the conceptual framework required for defining policies aimed at developing broadband networks and services. First, the evidence of social and economic benefits derived from broadband development was reviewed. Second, following the demonstration of broadband economic impact, evidence was presented to show the difference in broadband's social and economic contribution for developed and emerging countries. Third, maximizing the social and economic contribution of broadband is contingent upon selecting the right technologies and platforms. Finally, the main challenges regarding broadband demand were presented. These four components will serve as a framework to assess broadband's global trends as well as the current situation in the OIC Member Countries.

III. BROADBAND GLOBAL TRENDS

The following section presents information on global trends regarding broadband supply and demand. It first reviews industry trends at a global level and then highlights the gaps in penetration. It also identifies three best practices as approaches that would allow tackling some of the principal broadband adoption barriers.

III.1. Global broadband industry trends

The global telecommunications industry is facing the challenge of continuing to deploy network infrastructure that accommodates the exponential growth in data traffic. The need to continue building high-capacity networks is putting pressure on capital investment at a times when revenues are stagnating due to demand saturation and competition from Over The Top platforms. In this context, industry consolidation and the structuring of multinational carriers that stake dominant market positions in key geographies has become a critical imperative.

Exponential broadband traffic growth

Annual global Internet traffic in 2016 has reached 88.7 billion gigabytes per month. Having grown at an annual rate of 30% in the past five years, it is expected to continue increasing at a compound annual growth rate of 22% through 2020, therefore reaching 194 billion gigabytes[20]. This growth is a result of both the increase in data access devices and usage per device, primarily video traffic. For example, by 2020 there will be 3.4 Internet connected devices per capita up from 2.2 in 2015.

Drivers of traffic growth are numerous ranging from the increase in machine to machine devices (which in 2020 will amount to 46% of total installed base), to the introduction of ultra-high definition video streaming (which requires twice the bit rate of high definition), to the increased use of online gaming and social networking, and the migration of video watching to video streaming from conventional television.

In this context of exponential traffic growth, Internet traffic will grow fastest in the Middle East and Africa (27% compound annual growth rate) reaching 10.9 billion gigabytes per month in 2020. The growth rate in Central and Eastern Europe will be similar resulting in 17 billion gigabytes per month in 2020, while growth in North America and Europe will be between 19% and 20%.

Deployment of high-capacity networks

To accommodate the growing traffic, broadband service providers need to deploy fixed and mobile networks capable of delivering data flows at faster speeds. While high-capacity broadband networks represent 38% of all subscriptions on a worldwide scale, the choice of technology tends to vary by region. For example, some European countries (France, Spain, and

[20] CISCO (2016). *Visual Networking Index.*

Portugal) have chosen to deploy fiber to the household, while others (Germany, United Kingdom, Belgium) tend to rely on hybrid networks combining fiber to the node and legacy copper networks. These networks can adopt VDSL vectoring technology capable of delivering speeds of up to 1 Gbps. On the other hand, cable TV operators have been deploying DOCSIS 3.1 architectures capable of delivering up to 1 Gbps of download speed.

In the case of mobile technology, 4G/LTE is the technology of choice. The global user base of subscribers that have already adopted 4G has reached 1.453 billion by 2Q2016, connecting approximately 1 in 5 mobile users worldwide (19.5%)[21]. LTE subscribers are forecast to reach 3.3 billion by 2018[22]. In terms of future migration, some operators are already trialing 5G technology, which will be able to deliver download speeds of up 10 Gbps. Commercial deployment of 5G is expected to begin by 2020 in developed countries.

Competition from Over The Top platforms

While pressured to increase capital spending for deploying high-capacity networks, broadband service providers are facing increased competition from Over The Top platforms with potential for capturing a growing share of traditional telecommunications operators' revenue streams. For example, Skype (owned by Microsoft) already represents, at 214 billion annual minutes, the largest international telecommunications carrier[23]. Similarly, WhatsApp (owned by Facebook) is expected to continue capturing a share of mobile voice networks. A 10% reduction in the volume of voice calls in Western Europe is expected between 2016 and 2021, largely driven by substitution to WhatsApp[24].

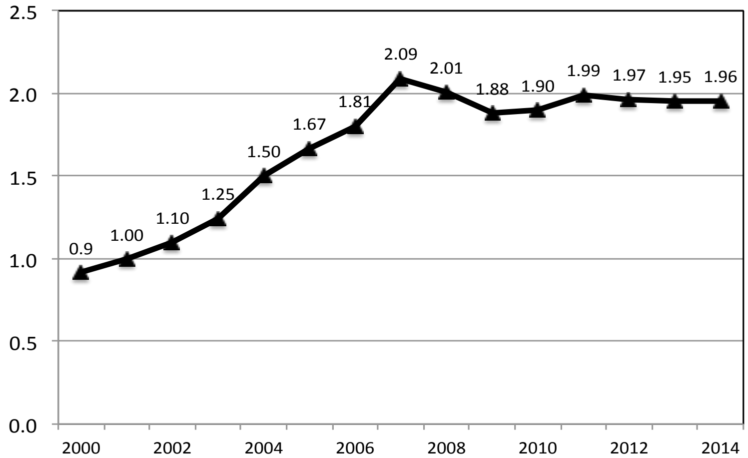
The net effect of OTT players is an erosion of price realization, whereby operators need to cut prices in order to match the offerings of "asset light" competitors, whose business model is not predicated on selling telco minutes but monetizing advertising revenues.

Revenue stagnation

The intensity of competition among broadband service providers and between telecommunications and OTT players is putting pressure on the telecommunications industry revenues. An estimation of total telecommunications industry revenues between 2000 and 2014 indicates a stagnation after 2011 (see figure 9).

[21] Global Mobile Suppliers Association (2016). *Evolution to LTE report. October 26*.
[22] IDATE. *Digiworld Yearbook 2016*. Montpelier.
[23] Telegeography (2014). *Skype traffic continues to thrive*. January 15.
[24] Analysys Mason (2016). Top ten predictions for 2017. December 21.

Figure 9: Total telecommunications industry revenues (in trillion US$) (2010-2014)



Source: International Telecommunications Union; Telecom Advisory Services analysis

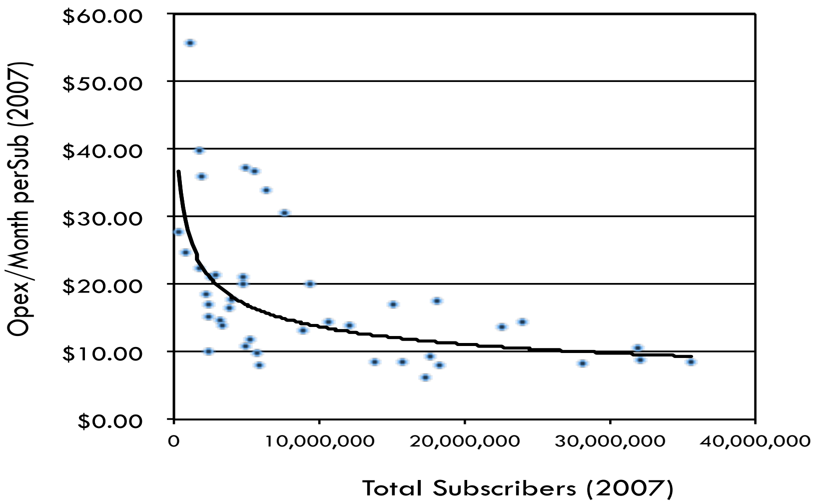
Revenue stagnation is affecting operator's margins. To compensate, operators are capitalizing on the mobile Internet momentum and betting on convergence with video distribution. In addition, consolidation within countries and across borders represents a lever to generate a return to economies of scale.

Furthering consolidation of global broadband players

The global broadband market is served by global, regional, and local operators. Some countries are served by local operators and subsidiaries of global players. Other countries are served only by global service providers. For example, Cote d'Ivoire (a country studied in detail in Chapter V) is almost exclusively served by global players: Orange and MTN (in fixed and mobile segments), Moov (a subsidiary of Etisalat) in mobile, Yoomee in fixed segment and two minor local fixed broadband players.

The geographic focus of global players is driven by the need to leverage economies of scale and knowledge of specific market conditions. The broadband industry exhibits strong economies of scale, indicating that there is a strong economic benefit to be obtained by operators with larger customer bases (see figure 10).

Figure 10: Economies of scale in the wireless industry

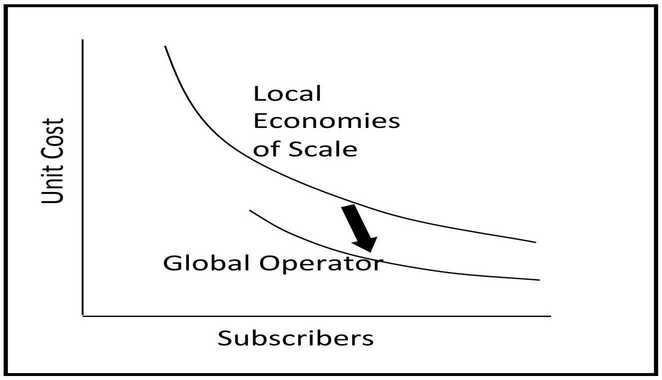


Source: Bank of America Merrill Lynch; Telecom Advisory Services analysis

Large mobile broadband operators enjoy significant cost-per-subscriber advantage over operators half their size. These economies of scale are driven primarily by the large fixed component of local radio network deployment and infrastructure costs. Furthermore, aggregate macro-scale in mobile services could be related to the fact that they are a single product industry, which is governed by volume. In addition, it is also possible that economies of multi-plant operation (multiple call centers, regional customer service, maintenance and logistics) are also at work. In addition to operating expenditures, capital expenditures are also affected by economies of scale. In fact, capital expenditures per wireless minute of use decrease with size of the subscriber base. Scale effects of capital spending are also coming into play with infrastructure upgrades (3G and 4G). For an industry that is capital intensive as wireless, the extent of capex scale effects underlines the unsustainability of multiple (more than three) redundant networks.

A broadband operator with presence in multiple countries can generate cost reductions by consolidating functions such as billing, network engineering, product development, and achieving better terms in purchasing equipment and terminals. When this occurs, the global operator can "jump" a scale curve and benefit from lower unit costs (see figure 11).

Figure 11: Difference in scale economies between local and global operator



Source: Telecom Advisory Services

When this occurs, the global operator achieves a cost advantage vis-à-vis the local player, which can be leveraged to gain more price flexibility. Beyond economies of scale, global players achieve learning curve benefits by focusing on a single region. In general terms, regions tend to share similar demographics, and certain aspects of regulatory frameworks. The first factor allows a global carrier to replicate market strategies with minimal customization costs (e.g. similar products, similar distribution channels). The second aspect – common regulatory frameworks – facilitates the development and implementation of approaches to deal with local laws and government policies.

The advantage of global players vis-à-vis local players is more noticeable in mobile than in fixed broadband. Fixed broadband is more influenced by "local" factors (e.g. cost of operations and maintenance labor, topographic characteristics) than mobile broadband. Nevertheless, fixed broadband technology is still affected by certain economies of scale and learning curve factors. On the scale side, the possibility of obtaining better prices for the acquisition of equipment still favors the global player. On the learning curve side, global fixed broadband players still command an advantage when it comes to the opportunity of sharing product development expertise and best practices. Examples of these benefits will be provided when analyzing the strategies of global players active in the OIC Member Countries (presented in chapter IV).

The advantage of regional focus has been a key driver of gradual concentration of global players on specific regions of the world. Global operators are deployed across countries through country-focused operations, but following a regional focus. For example, Orange is focused on Europe, Africa and the Middle East, MTN is focused on Africa, while Telefonica is focused on Europe and Latina America (see table 7).

Table 7: Global presence of MNC broadband providers

	Africa	Asia	Europe	L. America
Orange	Guinea-Bissau, Botswana, Cameroon, Central African Republic, Cote d'Ivoire, Egypt, Guinea, Equatorial Guinea, Kenya, Mauritius, Senegal, Mali, Niger, Tunisia, Madagascar	Jordan, Iraq	France	
MTN	Ghana, Cameroon, Uganda, Cote d'Ivoire, Sudan, Nigeria, Rwanda, Zambia, South Sudan, Botswana, Swaziland, Benin, Congo, Liberia, Guinea, Guinea-Bissau	Syria, Iran, Yemen, Afghanistan, Cyprus		
Telefonica			Spain, UK, Germany	Argentina, Chile, Uruguay, Peru, Colombia, Venezuela, Mexico, Brazil, Ecuador, Costa Rica, El Salvador, Nicaragua
Etisalat	Morocco, Mauritania, Burkina Faso, Gabon, Cote d'Ivoire, Egypt, Nigeria, Niger, Benin, Central African Republic, Mali	Afghanistan, Pakistan, Sri Lanka, UAE, Saudi Arabia		
Vodafone	Egypt	Qatar, Turkey	Albania, United Kingdom, Spain, Italy, Germany	
Airtel	Burkina Faso, Chad, Gabon, Niger, Nigeria, Sierra Leone, Uganda	Bangladesh		
Zain		Kuwait, Saudi Arabia, Jordan, Sudan, South Sudan, Iraq, Lebanon, Bahrain, Morocco,		

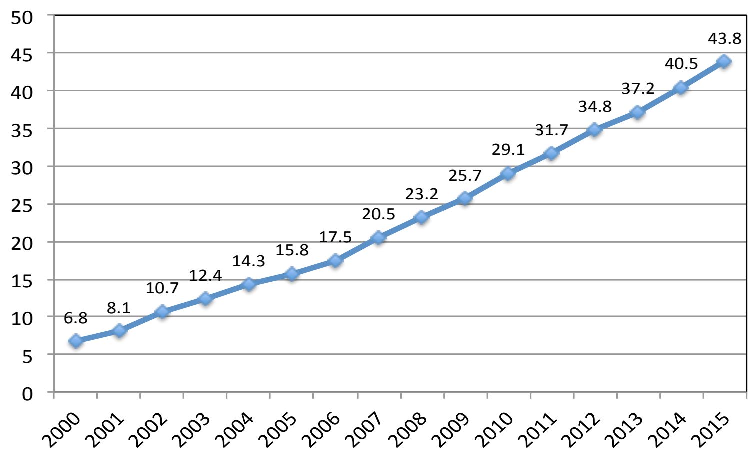
Source: Compiled by Telecom Advisory Services

III.2. Global trends regarding broadband development

Global Broadband Adoption

Forty-four percent of the world's population already accesses the Internet with regularity. Considering that in the year 2000, Internet penetration reached only 7% of the population, the diffusion of the Internet represents a revolution in terms of changes in modes of communication and access to information. The rate of growth in Internet adoption does not indicate a slow-down in the near future (see figure 12).

Figure 12: Worldwide Internet adoption (as percent of world population) (2000-2015)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Having said that, a comparison of adoption across regions indicates a lag of emerging countries vis-à-vis the developed world. As an example, as of the end of 2015, Internet penetration among OECD countries is 77.24%, while it remains at 30.59% within the OIC Member Countries. A more granular view of Internet adoption across continents provides a better view of advanced and laggard Internet adopting countries (see table 8).

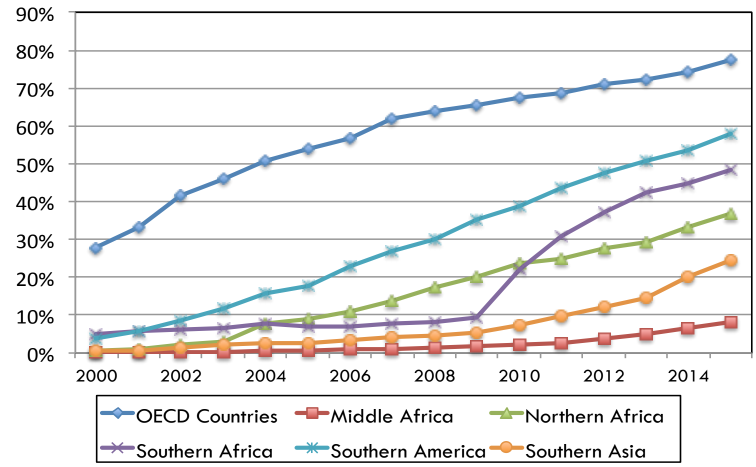
Table 8: Worldwide internet adoption (as percent of population) (2015)

Region	Internet Adoption (%)
Northern Europe	90.90
Western Europe	86.83
Australasia	85.13
OECD	77.24
Northern America	75.94
Southern Europe	70.13
Eastern Europe	67.32
Southern America	57.77
Eastern Asia	54.71
Western Asia	50.35
Central America	50.13
Southern Africa	48.26
Polynesia	47.33
Central Asia	43.98
World	43.84
Micronesia	42.11
Caribbean	39.17
Northern Africa	37.00
South-Eastern Asia	34.17
Western Africa	31.09
Southern Asia	24.53
Eastern Africa	15.57
Melanesia	13.79
Middle Africa	8.34

Sources: International Telecommunications Union; Telecom Advisory Services analysis

As table 8 indicates, Internet use in emerging regions lags the developed world average (OECD) between 20 (South America) and 69 percentage points (Middle Africa). It is important to note, however, that at least for some regions in the emerging world (such as South America, Southern and Northern Africa), the gap with developed countries is gradually narrowing down (see figure 13).

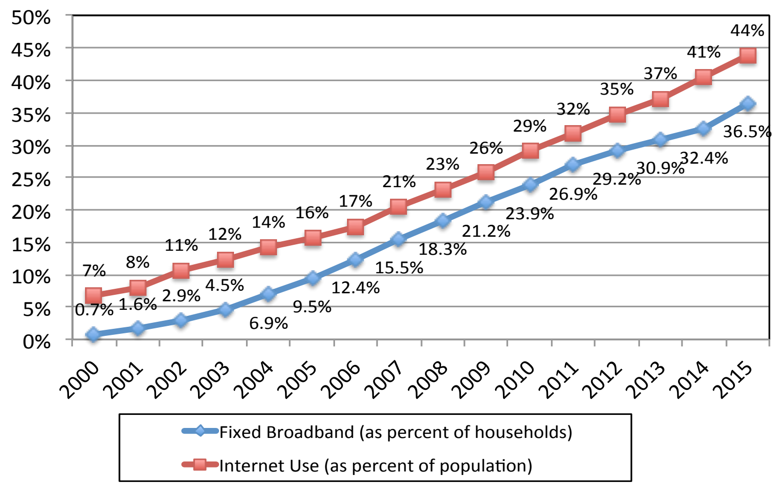
Figure 13: Selected Regions: Internet penetration (as percent of population) (2000-2015)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

In the context of growing Internet use, broadband has become a pervasive platform for providing access. On a worldwide scale, 36% of households already adopted fixed broadband technology by the end of 2015. A comparison between the adoption of Internet usage and fixed broadband penetration among households indicates that fixed access follows use of the Internet (see figure 14).

Figure 14: Worldwide internet adoption (percent of population) vs. fixed broadband adoption (percent of households) (2000-2015)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Despite the growth in fixed broadband adoption on a worldwide scale, the gap highlighted above between the developed and the emerging world remains pervasive. However, when comparing the gap between developed and emerging regions in terms of Internet usage and fixed broadband penetration, the gap is much larger in the latter. Fixed broadband adoption in the developing world lags the developed world average (OECD) between 35 (Central America) and 78 percentage points (Middle Africa) (see table 9).

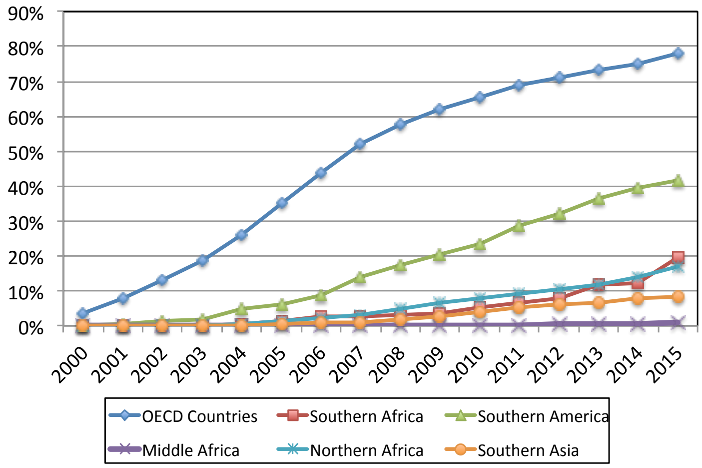
Table 9: Worldwide fixed broadband adoption (as percent of population) (2015)

Region	Internet Adoption (%)
Western Europe	89.1
Northern Europe	86.2
Northern America	84.4
OECD Countries	78.1
Australasia	75.2
Southern Europe	69.5
Eastern Asia	67.8
Eastern Europe	51.8
Western Asia	48.2
Central America	43.1
Southern America	41.8
Polynesia	41.2
World	36.5%
Central Asia	22.9
Southern Africa	19.6
South-Eastern Asia	17.3
Northern Africa	17.2
Caribbean	15.9
Micronesia	9.7
Southern Asia	8.4
Melanesia	4.2
Eastern Africa	2.2
Western Africa	0.9
Middle Africa	0.7

Sources: International Telecommunications Union; Telecom Advisory Services analysis

Furthermore, an analysis of fixed broadband penetration growth trend clearly indicates that, with the exception of South America, the gap between OECD countries and the emerging world continues to grow (see figure 15).

Figure 15: Selected Regions: fixed broadband penetration (as percent of households) (2000-2015)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

On the other hand, the adoption of mobile broadband in the emerging world has been accelerating, while its penetration in the developed countries is reaching a saturation point. The prorated adoption of mobile broadband among OECD countries has reached 87%, while the statistic in South America and Southern Africa is 67% and 58% (see table 10).

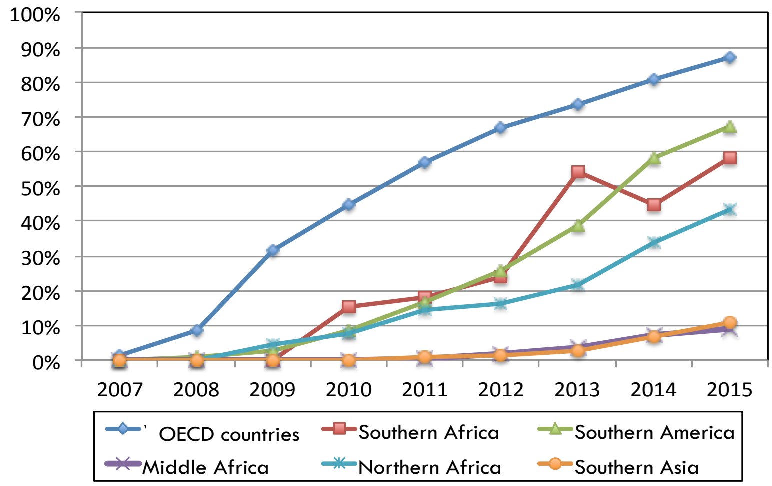
Table 10: Worldwide Mobile Broadband adoption (as % of population) (2015)

Region	Internet Adoption (%)
Western Europe	74.75
Northern Europe	95.69
Northern America	103.93
OECD Countries	87.17
Australasia	113.04
Southern Europe	72.80
Eastern Asia	62.96
Eastern Europe	58.54
Western Asia	46.39
Central America	43.09
Southern America	67.37
Polynesia	18.41
World	44.14
Central Asia	33.20
Southern Africa	58.19
South-Eastern Asia	46.87
Northern Africa	43.13
Caribbean	19.78
Micronesia	0.27
Southern Asia	10.82
Melanesia	11.15
Eastern Africa	12.54
Western Africa	23.22
Middle Africa	8.92

Sources: International Telecommunications Union; Telecom Advisory Services analysis

Furthermore, the growth in penetration for both regions continues to increase at a fast pace, while that of the OECD countries is slowing down, which indicates that some regions of the developing world are catching up with the developed countries. This is not the case with the whole emerging world. While the adoption of mobile broadband in Middle Africa and Southern Asia is increasing, the rate of growth is significantly low. These trends indicate a process whereby some regions of the emerging world are converging with advanced countries, while others seem to be diverging. In other words, when it comes to broadband adoption, the developing world does not represent a homogeneous profile (see figure 16).

Figure 16: Selected Regions: Mobile broadband penetration (percent of population) (2007-2015)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Another trend worth pointing out is that the acceleration in adoption of mobile broadband is a confirmation of its suitability to fill the demand gap in many parts of the developing world. For regions such as Middle Africa, as of 2015, fixed broadband penetration is 0.74% of households while mobile broadband has reached close to 9% of the population. Similarly, in Southern Asia, fixed broadband penetration has reached 8% of households while mobile broadband penetration represents 11% of the population. This indicates that mobile broadband is capturing a large portion of the accessibility demand. However, it is important to mention that a large portion of the mobile broadband adopting population is supported by 3G technology, which as described above, is a particularly slow technology.

Broadband supply gap

The best statistic to measure the supply gap is broadband service coverage, which is the percent of the population that could purchase broadband service because it is being offered in the place where they live, work or study; the uncovered population is the metric sizing the supply gap. Statistics on fixed broadband coverage are typically sparse. However, some data can be gathered, particularly in more developed regions of the world (see table 11).

Table 11: Regional fixed broadband coverage (as percent of population) (2015)

Regions	Coverage (%)
Australasia	92.16
Central America	92.11
Eastern Asia	98.00
Eastern Europe	90.38
Northern America	95.75
Northern Europe	98.81
Southern America	91.10
Southern Europe	97.87
Western Asia	100.00
Western Europe	98.70
OECD Countries	96.27

Sources: International Telecommunications Union; Telecom Advisory Services analysis

Table 11 depicts a clear trend: developed regions (Western, Southern and Northern Europe, Eastern Asia) exhibit a higher coverage of fixed broadband networks while other regions have a more reduced service footprint (Australasia, Central America, Eastern Europe, and South America). A more granular view by country provides a sense of the relevance of the supply gap in explaining broadband penetration (see table 12).

Table 12: Fixed broadband coverage (as percent of population) (2015)

	Country	Coverage (%)
1.	Cyprus	100.00
2.	Israel	100.00
3.	Luxembourg	100.00
4.	Malta	100.00
5.	Netherlands	100.00
6.	United Kingdom	100.00
7.	Uruguay	100.00
8.	Belgium	99.90
9.	France	99.70
10.	Portugal	99.70
11.	Greece	99.60
12.	Austria	99.10
13.	Denmark	99.10
14.	Sweden	99.00
15.	Chile	98.66
16.	Italy	98.60
17.	Czech Republic	98.50
18.	Japan	98.00
19.	Switzerland	98.00
20.	Germany	97.50
21.	Lithuania	97.10
22.	Finland	96.70
23.	Spain	96.50
24.	Ireland	96.30
25.	Colombia	96.00
26.	United States	96.00
27.	Argentina	95.98
28.	Costa Rica	94.86
29.	Hungary	94.40
30.	Norway	94.40
31.	Canada	93.50

	Country	Coverage (%)
32.	Latvia	93.10
33.	New Zealand	93.00
34.	Bulgaria	92.50
35.	Australia	92.00
36.	Iceland	92.00
37.	Mexico	92.00
38.	Romania	90.00
39.	Slovenia	88.70
40.	Poland	87.60
41.	Estonia	87.30
42.	Ecuador	87.00
43.	Slovakia	85.30
44.	Bolivia	41.37

	Coverage > 95%		Coverage 95%-90%		Coverage <90%

Source: International telecommunications Union; Telecom Advisory Services analysis

As table 12 indicates, there are six countries with a fixed broadband supply gap of more than 10%, and eleven countries with supply gap ranging between 5% and 10%. As expected, data in this table is biased towards countries with extensive coverage. Therefore, it is reasonable to assume that a large portion of the countries that do not report fixed broadband coverage exhibit a supply gap in excess of 10%. Moving now to mobile broadband coverage, it is important to differentiate between technologies. As explained in chapter II, 2G technology is not suited for mobile broadband, while 3G has significant service quality deficiencies. Table 13 presents mobile broadband coverage, both for 3G and 4G.

Table 13: Mobile broadband (3G) Coverage (by region) (as percent of population) (2015)

Regions	3G Coverage (%)	4G Coverage (%)
North America	99.81	99.24
OECD Countries	97.76	89.98
Western Europe	98.43	89.49
Eastern Europe	86.14	62.69
Latin America	87.65	55.57
Africa	88.86	47.86
Asia-Pacific	63.65	36.95

	Coverage > 90%		Coverage 90%-80%		Coverage <80%

Sources: International Telecommunications Union; Telecom Advisory Services analysis

The limitations in 4G coverage are fairly apparent in table 13. With the exception of developed regions (North America and Western Europe, or the community of OECD states) the rest of the world has serious coverage limitations. Considering that mobile broadband is more suited to address Internet connectivity in the emerging world, the supply gap in 4G represents a critical barrier to be overcome.

Broadband demand gap

As mentioned above, the demand gap is defined as the difference between either households or individuals that could gain access to broadband but do not acquire the service. This is not a statistic that is typically being tracked by either regulators or made public by operators. Considering the data on coverage and adoption presented above, the demand gap for fixed and mobile broadband can be estimated for specific regions and countries. The fixed broadband demand gap calculation extrapolates the population covered (statistic presented in table 12) to households covered and calculates the difference of this metric with households connected (see table 14).

Table 14: Fixed broadband demand gap (2015)

Country	Households Covered (%)	Households Connected (%)	Demand Gap (%)
Malta	100.00	116.83 (*)	0
Switzerland	98.00	106.51 (*)	0
Canada	93.50	95.73 (*)	0
France	99.70	100.37 (*)	0
Iceland	92.00	92.24	0
Ireland	96.30	93.51	2.79
Netherlands	100.00	97.05	2.95
Luxembourg	100.00	96.26	3.74
Norway	94.40	89.83	4.57
Israel	100.00	94.47	5.53
Denmark	99.10	93.34	5.76
Cyprus	100.00	93.89	6.11
Greece	99.60	92.62	6.98
Slovenia	88.70	81.10	7.60
New Zealand	93.00	84.20	8.80
Belgium	99.90	90.51	9.39
United Kingdom	100.00	90.26	9.74
United States	96.00	83.20	12.80
Portugal	99.70	85.98	13.72
Spain	96.50	82.46	14.04
Estonia	87.30	72.24	15.06
Japan	98.00	82.13	15.87
Australia	92.00	73.44	18.56
Germany	97.50	78.86	18.64
Sweden	99.00	75.62	23.38
Hungary	94.40	70.47	23.93
Finland	96.70	69.84	26.86
Czech Republic	98.50	69.71	28.79
Romania	90.00	60.21	29.79
Austria	99.10	67.64	31.46
Lithuania	97.10	64.48	32.62
Slovakia	85.30	52.30	33.00
Poland	87.60	54.25	33.35
Bolivia	41.37	7.16	34.21
Uruguay	100.00	65.66	34.34
Bulgaria	92.50	58.15	34.35
Italy	98.60	61.74	36.86
Argentina	95.98	58.69	37.29
Latvia	93.10	54.09	39.01
Mexico	92.00	52.54	39.46
Chile	98.66	57.51	41.15
Ecuador	87.00	45.18	41.82
Colombia	96.00	42.63	53.37
Costa Rica	94.86	40.43	54.43

Demand gap <10% | Demand gap between 10% and 20% | Demand gap >20%

(*) A higher number of connections than coverage could indicate two lines per household in some cases
Sources: International Telecommunications Union; Telecom Advisory Services analysis

The fixed broadband demand gap estimates in table 14 require some interpretation. First, the countries where the fixed broadband demand gap is lower than 10% indicates a supply/demand equilibrium, where fixed broadband service coverage is matched by household penetration. Not surprisingly, most of these countries are the developed ones (Australia, Belgium, Canada, Denmark, France, Greece, Iceland, Ireland, Israel, Luxembourg, Malta, Netherlands, New Zealand, Norway, Slovenia, Switzerland, United Kingdom)[25]. Second, there are some advanced countries where the fixed broadband demand gap ranges between 10% and 20% (Estonia, Germany, Japan, Portugal, Spain, United States). In this case, the gap can be explained primarily by fixed-mobile substitution. The early and aggressive deployment of 4G mobile broadband technology has resulted in wireless capturing a portion of the fixed demand. This also the case for some of advanced countries where the fixed broadband demand gap exceeds 20% (Austria, Czech Republic, Finland, Italy, Sweden). Finally, there are some emerging countries with a consistent imbalance between supply and demand, where the demand gap reaches 30% and higher (Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, Mexico, Romania). Reasons for this gap are multi-fold, ranging from limited affordability to lack of local content. This point will be reiterated at the end of this section, after analyzing the mobile broadband demand gap.

The mobile broadband demand gap is calculated by subtracting the percent of population that are broadband subscribers from the percent of the population covered by 3G networks. In this case, the estimates are calculated by region of the world because data is available for most countries (see table 15).

Table 15: Mobile broadband demand gap (2015)

Country	Population Covered (3G) (%)	Connections Penetration (%)	Demand Gap (%)
Australasia	98.80	113.04 (*)	0
Northern America	99.80	103.93 (*)	0
Eastern Asia	61.95	62.96 (*)	0
Northern Europe	99.06	95.69	3.37
OECD Countries	97.78	87.17	10.61
Micronesia	15.34	0.27	15.07
Eastern Europe	76.92	58.54	18.38
Central Asia	54.86	33.20	21.66
Western Europe	97.64	74.75	22.89
Middle Africa	32.06	8.92	23.14
Southern America	91.28	67.37	23.91
Southern Europe	97.67	72.80	24.87
South-Eastern Asia	72.64	46.87	25.77
Northern Africa	72.56	43.13	29.43
Polynesia	48.56	18.41	30.15
Caribbean	54.02	19.78	34.24
Melanesia	46.57	11.15	35.42
Southern Africa	94.75	58.19	36.56
Western Asia	85.55	46.39	39.16
Western Africa	64.68	23.22	41.46

[25] Uruguay is a particular emerging market case. A strong public program has recently completed an FTTH deployment, as a result of which fixed broadband is being offered on a subsidized basis (e.g. low speed service is being connected for free).

Country	Population Covered (3G) (%)	Connections Penetration (%)	Demand Gap (%)
Central America	87.96	43.09	44.87
Southern Asia	57.53	10.82	46.71
Eastern Africa	62.22	12.54	49.68

Demand gap <10%	Demand gap between 10% and 20%	Demand gap >20%

(*) A higher number of connections than coverage could indicate two lines per individual in some cases
Sources: International Telecommunications Union; Telecom Advisory Services analysis

As expected, in the case of mobile broadband, the prorated demand gap for developed regions (OECD countries) is fairly small. This is explained by the reduced gap in Australasia, East Asia, North America, and Northern Europe. On the other hand, most of the emerging world exhibits a mobile broadband demand gap averaging 33%, meaning that a third of the population served by mobile broadband networks does not acquire the service.

The reduction of the demand gap requires targeting the reasons for non-adoption, even after broadband networks have been deployed. As mentioned in chapter II, the residential broadband demand gap is the result of three obstacles:

- Limited affordability: certain portions of the population either cannot acquire a device or purchase the subscription needed to access the Internet
- Lack of digital literacy
- Lack of relevance or interest: the value proposition of applications, services, and content does not fulfill a need of the adopting population

A compilation of research on adoption barriers indicates that affordability remains a preeminent variable in explaining the non-adoption of broadband, particularly in emerging countries. In the developed world, approximately 20% of non-adopters have responded in surveys that affordability is one of the principal reasons for not acquiring broadband. In the developing world, affordability has been cited by an average of 30% (see table 16).

Table 16: Percentage of households mentioning affordability as a reason for not purchasing broadband

Country	Percentage	Source
Costa Rica	60	MINAET (2011)
Mexico	43	INEGI (2015)
Colombia	40	MITIC (2010)
Brazil	37	CGI (2015)
Australia	26	AGIMO (2009)
United States	24	NTIA (2011)
Portugal	20	ITU (2013)
Argentina	18	INDEC (2015)
United Kingdom	16	OFCOM (2011)
Puerto Rico	16	PRBT (2012)
Hungary	15	ITU (2013)
Chile	13	Subtel (2015)
Estonia	13	ITU (2013)
Spain	11	ITU (2013)
France	8	ITU (2013)

Source: Compiled by Telecom Advisory Services

As the data in table 16 suggests, the lower the level of disposable income, the higher the importance of the affordability barrier becomes. The economic barrier remains a key factor in limiting broadband adoption. However, it would seem that in developed countries with higher household incomes, the economic barrier takes second seat to either low digital literacy or cultural inadequacy.

Digital literacy is the ability to navigate, evaluate, and create information effectively and critically using a range of digital technologies. Digital literacy encompasses all devices, such as computer hardware, software, the Internet, and cellphones. Research around digital literacy is concerned not just with being literate at using a computer, but also with wider aspects associated with learning how to find, use, summarize, evaluate, create, and communicate information effectively while using digital technologies. Digital literacy does not replace traditional forms of literacy; it builds upon the foundation of traditional forms of literacy. Again, research studies on broadband adoption barriers reveal that digital literacy is a critical variable explaining non-adoption (see table 17).

Table 17: Percentage of households mentioning digital literacy as a reason for not purchasing broadband

Country	Percentage	Year
Nicaragua	58	2015
Chile	47	2015
Colombia	46	2015
Brazil	41	2015
Guatemala	38	2015
Mexico	33	2015
South Africa	20	2014
Argentina	19	2015
Switzerland	9	2014
Russia	5	2014
Singapore	4	2014

Source: Compiled by Telecom Advisory Services

Data from table 17 indicates that digital literacy represents an important barrier to broadband adoption in emerging countries.

Finally, since broadband is a platform used to access Internet content, applications, and services, the relevance of such content offers an incentive to purchase a subscription. Conversely, the lack of cultural relevance could serve as a barrier to adoption. Cultural relevance could be conceptualized either in terms of content suited to the interests of the adopting population or in terms of language used for interacting with applications/services or consuming content. As prices for broadband service decline, the cultural relevance factor gains in importance. In other words, from a policy standpoint, once the economic obstacles are tackled and affordability becomes less of an explanatory factor of non-adoption, the lack of relevance or interest variable gains weight. Studies indicate that, while being less important than affordability and digital literacy, cultural relevance remains a barrier to broadband adoption (see table 18).

Table 18: Percentage of households mentioning cultural relevance or lack of need as a reason for not purchasing broadband

Country	Lack of need (%)	No cultural relevance (%)	Year
Brazil	47.00	5.80	2015
Mauritius	- - -	1.60	2015
South Africa	- - -	0.20	2015
Argentina	- - -	72.00	2015
Chile	36.10	- - -	2015
Colombia	49.00	- - -	2015
Guatemala	57.00	- - -	2015
Korea	1.30	- - -	2014
Mexico	51.00	- - -	2015
Nicaragua	31.00	- - -	2015
Panama	27.00	- - -	2015
Russia	20.50	- - -	2014
Singapore	5.80	- - -	2014
South Africa	18.60	- - -	2014
Switzerland	14.40	- - -	2014

Source: Compiled by Telecom Advisory Services

The lack of cultural relevance or "lack of need" barrier presents some complexity in terms of its understanding. Two interpretation options are open. One option is that the consumer has evaluated the offerings in terms of applications, services and content and has not found them relevant to his or her needs. Under this premise, policy initiatives should be oriented towards increasing the perceived value of broadband by expanding the range and utility of offerings (these are called "demand pull" policies). The second option is that the consumer does not have enough information to make a decision of adopting broadband.

In at least one study conducted in a developed country, the linguistic factor contributed to the lack of relevance. That was identified in the United States among the Hispanic population that had recently immigrated to the country. It is important to consider, however, that, as in the United States, the linguistic barrier is strongly correlated with economic and educational factors. Therefore, it is still difficult to tease out the socio-demographic variables in order to isolate the linguistic factors. The language barrier has been identified in the emerging world as well. For example, in Peru, only 8% of those individuals whose first language was not Spanish are Internet users. That percentage increased to 40% amongst native Spanish-speakers.

Having reviewed the supply and demand barriers to increasing broadband penetration, it is relevant to move to review some of the approaches taken to address them.

III.3. Main policy, regulatory approaches and implementation for increasing broadband penetration

Governments and private broadband service providers have recognized the presence of barriers to increasing broadband penetration reviewed above. The following section presents the underpinnings of regulatory and public policy initiatives to tackle the broadband penetration gap. Additionally, some best practices developed in the course of program implementation will be presented and selected efforts implemented in developed countries will be analyzed.

Achieving rural deployment of mobile broadband

The broadband supply gap tends to be focused in rural and isolated areas. In general terms, a workable business case for broadband deployment is typically predicated on the possibility of serving aggregate clusters of demand generally concentrated in population dense geographies. While this is feasible in the case of urban and suburban settings, rural geographies do not provide an attractive market, since they imply increasing the capital required for deployment to yield a lower return. These factors act as a deterrent to broadband deployment from privately owned carriers. In this context, four policy approaches are being followed to address the rural supply gap.

The more conventional way is to allocate universal funds (collected as contributions provided from private operators) to fund projects targeted to the unserved population. Responsibility for deployment is typically assigned to private operators selected through public bids that receive the public funds to support the deployment. The subsidy can be complemented with additional incentives such as reduced taxes or elimination of permits.

In a different approach, if a publicly owned carrier is operating within the country, the government might enforce an initiative to deploy broadband in rural geographies even if conventional economic analysis renders this unattractive. This is conducted under the assumption that government-owned broadband service providers need to operate under "public service guidelines" rather than the profit imperative.

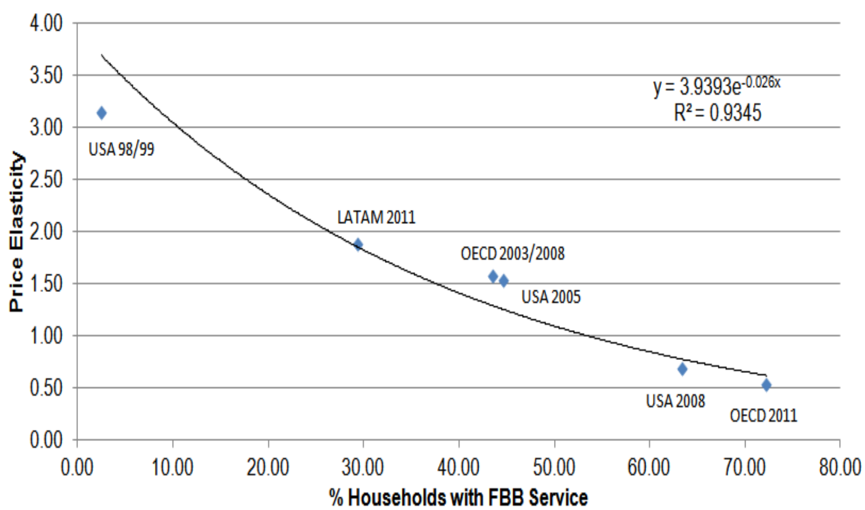
Another approach to promote network deployment in rural areas focuses on alleviating some of the constraints of the rural broadband business case. For example, several governments deploy publicly owned backbone networks with the objective of reaching remote locations. Since traffic backhauling represents approximately 30% of the operating costs of running a broadband network, a government-owned network represents an opportunity of cutting transit costs to subsidize rural broadband network operations. However, while these networks have reached geographies previously unserved by privately held transport facilities with the ability to significantly reducing backhaul costs, the "last mile" access barrier remains. The construction of fixed broadband networks, even after a national backbone network has reached the rural area is not financially feasible. In this context, wireless broadband, due to its more advantaged deployment economics could be a potential answer to this problem.

A fourth approach to tackling rural broadband deployment involves the introduction of innovative ways of allocating radio spectrum to reduce the costs of constructing wireless networks. Conventional spectrum management approaches, which imply high costs to acquire spectrum licenses might raise a potential hurdle to deploying broadband in rural areas. In this context, some governments have designated rural areas where a common band of spectrum is assigned to a cooperative on a shared basis. This concept is an alternative to nationwide spectrum rights in that small and medium size firms wishing to specialize in providing services in particular geographical areas can do so without having to resort to paying large amounts of money, typical of spectrum auctions. As expected, this approach requires some coordination to prevent interference. Allocation of licences follows a 'first-come, first-served' procedure. Licensees must pay license administration fees and annual charges; the latter include management charges and a resource rental. This approach imposes a requirement to implement services within two years of allocation. When more than one operator is interested in being licensed for a particular area, an arbitration processes is put in place to decide who gets to use the spectrum. Arbitration has been designed to encourage sharing[26].

Achieving broadband affordability

Research indicates that limited affordability is a critical adoption obstacle when fixed broadband penetration is low, which is the stage at which most emerging countries are. As a general principle, telecommunications services have negative elasticities: higher prices imply lower demand (see figure 17).

Figure 17: Correlation between fixed broadband penetration and price elasticity



Source: Estimates based on research literature

While the elasticity data in figure 17 is presented in absolute values, the price elasticity coefficient is always negative indicating the indirect relationship between price and demand.

[26] New Zealand has adopted this unique approach to managing the radio spectrum. The 1989 Radio Communications Act created the Radio Spectrum Manager, a legal entity that allows private firms to manage portions of the spectrum. In New Zealand, the Crown is the spectrum manager overseeing most of the spectrum, and in particular the Ministry of Business, Innovation and Employment is the Manager of the frequency band 2575-2620 MHz (with 5 MHz required for a guard band at the lower boundary reducing the effective bandwidth available for services to 40 MHz), which is operated as a Managed Spectrum Park. In September 2009 80 licences were awarded. The park concept seeks to encourage "a flexible, cooperative, low cost and self-managed approach to allocation and use" (MBIE, 2010) of the spectrum in the designated frequency band. It intends to allow access to a number of users in a common band of spectrum on a shared basis; also, as the Crown is the manager of the band it also seeks that the shared spectrum, if any, is also self-managed. Other objectives include encouraging efficiency and innovation in the use of spectrum. The Managed Parks are According to the MBIE the MSP is "intended for local and regional services" (MBIE, 2010) with licensees and services requiring".Currently a number of wireless broadband providers exploit the 2575-2620 MHz band after having successfully applied to be MSP licensees. Some of the names include Gisborne Net, a telecommunications provider for the eastern areas of New Zealand's North Island, mainly around the city of Gisborne, TeamTalk and NetSmarts Ltd. These companies use the band to provide wireless broadband to rural communities; each licensee incurs a cost of about NZD $300 annually per licence.

Thus, the relationship between both variables indicates that a change in the price level would have a positive impact in the level of penetration of fixed broadband. By relying on the estimates depicted in figure 17, the effect of a price reduction between 5% and 25% was estimated for different regions of the world (see table 19).

Table 19: Impact on penetration level (percentage of households) of fixed broadband (FBB) of a price reduction

Region	2015 Household Penetration	5% Price Reduction	10% Price Reduction	15% Price Reduction	20% Price Reduction	25% Price Reduction
Australasia	75.16	77.26	79.35	81.45	83.55	85.65
Central Asia	22.87	25.36	27.84	30.33	32.81	35.30
Eastern Asia	67.80	70.09	72.38	74.67	76.96	79.26
South Asia	8.39	9.72	11.05	12.38	13.70	15.03
South-Eastern Asia	17.35	19.53	21.70	23.88	26.06	28.23
Northern Africa	17.16	19.32	21.49	23.65	25.81	27.98
Eastern Africa	2.22	2.63	3.05	3.46	3.87	4.28
Midde Africa	0.74	0.88	1.03	1.17	1.31	1.45
Southern Africa	19.61	21.93	24.25	26.57	28.89	31.21
North America	84.44	86.29	88.14	89.99	91.85	93.70
South America	41.77	44.55	47.32	50.10	52.88	55.66
Eastern Europe	51.82	54.47	57.13	59.78	62.43	65.09
Northern Europe	86.24	88.04	89.85	91.65	93.46	95.26
Southern Europe	69.48	71.73	73.98	76.22	78.47	80.72
Western Europe	89.11	90.84	92.57	94.30	96.03	97.76

Source: Estimates by Telecom Advisory Services based on ITU 2015 data

As indicated in table 19, the price elasticity is higher for the regions with lower levels of penetration. As a result, in regions like Middle Africa or South Asia, a 25% price decline could yield an approximate doubling of current penetration levels. The increase in fixed broadband penetration is substantial in other emerging countries as well.

Broadband pricing needs to be decomposed among its different elements because they affect broadband initial adoption and usage in different manners. Initial adoption is constrained by device acquisition, its corresponding tax burden, service activation cost, and expected recurring costs derived from subscription retail fees and taxes.

Device retail prices and their corresponding taxes vary between fixed and mobile broadband. Fixed broadband requires the acquisition of a personal computer, while mobile broadband could be supported through either a personal computer or a smartphone. Retail acquisition prices of this type of equipment are driven by supply and demand conditions, in particular manufacturing economies of scale and component costs. While device retail pricing is typically out the realm of policy control, taxation is not. Final price of devices is affected by a set of different taxes, which vary by country and year. Taxes can, in some cases, add a significant burden to the retail price.

As an example of initiatives aimed at lowering broadband prices, in September 2011, Comcast, the cable TV operator in the United States launched its "Internet Essentials" plan to offer broadband to as many as 2.5 million low-income families for a monthly rate of US$ 9.99. The plan came as part of the approval process in its acquisition of the media and entertainment company, NBC Universal. Beyond the 1.5 Mbps Internet connection, eligible customers also qualified for $150 refurbished computers, which would come with software donated by Microsoft. Comcast also offered digital literacy training to these users free of charge. To qualify for the plan, households must: a) not yet have a broadband connection and b) have a child enrolled in a school lunch program. The US$ 9.99 monthly rate lasts for two years, at which point customers have the option to renew at a higher – but still discounted – price. Because the US$ 9.99 covers the companies' overhead costs, providers would likely not experience a significant loss in earnings nor does the government need to provide supplemental funding.

In late 2011, the United States Federal Communications Commission (FCC) announced that most of the country's major cable companies partnered to join the initiative. These companies included Time Warner, Cox, and Charter, though AT&T and Verizon chose not to participate. The low prices attract new subscribers who previously could not afford the cost of an Internet connection. In addition, Morgan Stanley is working with the cable companies to develop a microcredit program while partnering employment and education companies will offer specialized content to make Internet access more attractive to these users.

The FCC said that it supported the partnership as a means to increase the country's broadband penetration, particularly amongst the otherwise underserved segment of the population, and praised its potential to guarantee digital literacy among the country's students. It hopes that by increasing Internet access and digital literacy, high school graduates will be more hirable, as even entry-level jobs typically require basic ICT skills, which also help employees in the online job search.

Tackling digital literacy

Addressing this obstacle requires the implementation of programs that build an understanding of the service offerings, and develop user confidence, explaining the benefits of use, and understanding security and privacy constraints as well. In general terms, four types of initiatives targeting digital literacy impediments exist:

- Digital literacy through education programs entail the inclusion of specific programs at all levels of the formal education system, requiring also the implementation of training programs for teachers,
- Targeted digital literacy interventions comprise the implementation of programs addressed to specific segments of the population, such as the elderly, the disadvantaged or the rural population,
- Deployment of community access centers allows supplying non-adopting population with devices and access points to the Internet; in addition, the access centers can become points of delivery of training programs and user support,
- The privacy and security training programs allow building the levels of trust from consumers in order to foster adoption of broadband.

While digital literacy embedded in formal education processes are conducted in school institutions, closely linked to curricula, targeted programs entail group-specific training in the use of computers and broadband typically delivered through a range of public access centers. This section reviews the major categories of targeted programs.

III.4. Best Practices of non-OIC developing countries for increasing broadband penetration

The purpose of this section is to provide an example of best practices implemented by non-OIC developing countries to promote broadband deployment and stimulate adoption. The examples aim to illustrate approaches followed to address three barriers of adoption: 1) access in rural and isolated areas, 2) improving broadband affordability both in terms of service and device acquisition, and 3) development of digital literacy.

Providing broadband access in rural and isolated areas in Brazil

As part of the Brazilian Ministry of Culture's larger program, Cultura Viva, the *Pontos de Cultura* initiative is a socio-digital inclusion program that develops public digital spaces throughout the country to encourage citizens to create digital culture. By providing citizens with free, open-source software and broadband access at these telecenters, the initiative promotes technology as a tool to spur the spread and creation of digital culture, thereby affirming Brazil's cultural identity.

Digital community centers represent the most common approach to providing public access to broadband in rural and isolated areas. The deployment of community centers combines a top-down and bottom-up governance framework, whereby a public policy initiative triggers the involvement of communities in the management of each unit. The sum of grass-root community organizations dedicated to managing each center is coordinated by a steering committee, who works with each center to develop plans for extending broadband service, and providing technology awareness and training programs. In some cases, the steering committee works with a dedicated staff that acts as a resource. In that sense, the central dedicated staff becomes an enabler of the community-based effort rather than an implementer.

By virtue of their decentralized governance framework, centers become independent from contributions of the national government, with all funding support being provided by either local governments or the private sector. This structure appears to be also scalable across regions of a given country. Digital Community Centers have become highly suited to tackle technology and economic development programs within rural contexts.

In Brazil, individual communities take charge of their center's financial matters, managing it autonomously, although they all have access to a network over which they can work together to share ideas and problem solve. The centers have the potential to generate income for these communities, which can customize the services of the centers to fit the needs of their residents. Once the Ministry of Culture deems it an official "Ponto de Cultura", the center receives a digital multimedia kit, which guarantees users broadband access so that they can share their work. It also includes a multimedia studio complete with professional-grade audio, video, software development, text, and imaging technology. Equipe Cultura Digital and local grassroots organizations offer training on how to use these tools and also on the benefits of broadband in transmitting their ideas.

As part of the program, the Cultura Digital Equipe (digital culture team) hosts workshops that focus on educating the community on how to use new technology to best suit their needs. The pontos de cultura receive a monthly stipend of €1000 for the first two years, at which point they should sustain themselves. The GESAC Program of the Ministry of Communications provides this funding as part of the aforementioned media kit.

While the centers are run autonomously and funding lasts for two years, the *pontos* must continually report their progress to the Ministry of Culture to ensure that they stay on track and align with the Ministry's overall mission of promoting digital culture. There are currently 22,500 *pontos de cultura* throughout the country[27].

In a slightly different model from the one presented above, privately owned local area network (LAN) houses not only promote broadband access, but also foster a community of online gamers who can connect and compete with each other. Many centers now offer digital training and other services as well, but in the least, they promote the social aspect of high-speed Internet use and increase the demand for such services. LAN houses typically consist of a network of connected computers where users can congregate to play the games, though many have expanded to offer additional services.

In some instances, they serve as the only point of access for many citizens, while in others they supplement household broadband access, serving a more social function. Most LAN houses charge users an hourly fee and the popularity of the houses keeps the prices down as owners compete with each other to attract more customers and drive business. They have been credited with driving digital inclusion, particularly important in countries with little public investment in broadband access and low penetration rates. Throughout Brazil, citizens can access the Internet at Local Area Network (LAN) Houses, which took the country by storm in 1998. Each "house" consists of a network of assembled computers. Previously found exclusively in wealthy communities, the LAN houses are now most popular in poor, rural regions without easily accessible computers and broadband. While the houses were originally designed to support multi-player video gaming, many users report that they use the LAN Houses to stay informed and conduct job searches or work on school projects.

The LAN Houses reduce the country's digital divide, offering affordable ICT and broadband access regardless of location or socio-economic status. They have led to increased sociability and promote e-governance and e-education. Many also offer computer training courses and

[27] Bria, Francesca, and Oriana Persica. "Synergies between Pontos De Cultura and Ecosystems." *Digital Ecosystems*. By Matilde Ferraro. N.p.: n.p., n.d. 4.5.1-.5.8. Web. <http://www.digital-ecosystems.org/book/pdf/4.6.pdf>.
"Ministério Da Cultura." *Study Tour Brazil*. N.p., n.d. Web. <http://studytourbrazil.wordpress.com/rio-de-janeiro-2/ministerio-da-cultura/>.
Pontos De Cultura." *Cultural Exchange Brazil*. Dutch Culture, n.d. Web. <http://www.culturalexchange-br.nl/organisations/pontos-de-cultura>.

help with resume creation and job searches. While owners choose their own pricing strategies, LAN houses typically charge between US$ 0.40 and US$ 1.50 per hour. Some neighborhoods have more than 100 LAN houses, many of which stand side by side.

The LAN houses came in part as a result of the federal government's Computers for All development project, which created credit lines allowing low-income families to purchase computers in small monthly installments. In some instances, citizens would purchase a computer and charge people to use it. As they accrued profits, they would purchase more computers and broadband access. By 2008, the country held more than 90,000 LAN houses, accounting for half of all Internet access in Brazil and 79% of all Internet access amongst the two poorest classes. For many of these citizens, the LAN houses were their only means of accessing the Internet. By 2010, an estimated 35 million citizens utilized LAN houses, a number slightly below previous years due to increased mobile phone penetration. This trend continued, as noted in a 2013 survey released by the Brazilian Internet Steering Committee. That said, LAN houses still offered access to 68% of the population in the lowest income brackets. The committee concluded that the access points remain critical for digital inclusion[28].

Achieving broadband affordability in Uruguay and China

Beyond the competitive stimuli, the reduction of broadband service prices can be achieved through a number of targeted public policy initiatives. These initiatives are generally implemented with the objective of achieving universal broadband adoption. The underlying rationale for these policies is that, beyond a competition model, government policies should be implemented to further price reductions of broadband in order to make it accessible to segments of the population affected by limited affordability.

One approach relies on state-owned telecommunications operators to offer, under their public service imperative, a low-priced broadband service. Obviously, this option is only viable in those countries that have not completely privatized their telecommunications industry. Under this option, a state-owned broadband provider assumes responsibility, as a public service entity, for providing a low-price broadband service. The advantage of this option is that, in addition to fulfilling the objective of tackling the economic barrier, the offering can act as an incentive for other private operators to launch their own more affordable service.

In May 2011, government-owned telco Antel in Uruguay launched its "Servicio Universal Hogares" – or "Internet for All" - plan, aiming to bring Internet access to every home in Uruguay. For a one-time payment of US$30 – the cost of a modem - all fixed line phone customers qualified for free ADSL service. The package offered a basic connection of 256 Kbps and targeted the low-income segment to which the price of broadband represented a barrier to

[28] Sources: Góes, Paula. "Brazil: Socio-digital Inclusion through the LAN House Revolution." *Global Voices*. N.p., 28 Sept. 2009. Web. <http://globalvoicesonline.org/2009/09/28/brazil-socio-digital-inclusion-through-the-lan-house-revolution/>.
Lemos, Ronaldo, and Paula Martini. "LAN Houses: A New Wave of Digital Inclusion in Brazil." *Information Technologies & International Development* 6 (2010): 31-35. Web. <http://itidjournal.org/itid/article/viewFile/619/259>. "Brazil." *Freedom House*. N.p., 2013. Web. <http://www.freedomhouse.org/report/freedom-net/2013/brazil#.UwgAOM0jtFA>.

connectivity. At the time, homes and businesses with basic Internet connections paid approximately US$ 150 monthly. Similarly, the Uruguayan government also planned to reach schools and educational institutions with Fiber-to-the-Home (FTTH) technology.

In June 2011, Antel announced plans to connect more than 80,000 Uruguayan households with FTTH by the end of the year. This project initially targeted higher-income, urban areas but incorporated plans to reach the lower socioeconomic groups. The rollout incorporated US$100 million investment and a partnership with the Chinese technology firm ZTE. Described as “the most ambitious broadband effort in Latin America,” the FTTH project as well as the opening of the Bicentenario submarine cable in early 2012 increased broadband access, speed, and service quality.

The December 2011 launch of its commercial LTE services allowed the telco to offer broadband connections to those regions not yet impacted by the FTTH rollout as well as those customers who could not afford the connectivity costs of fixed Internet. Antel offered customers two package plans from which to choose. By signing a 2-year contract, customers could pay US$ 90 per month for 30 GB. For US$ 76 per month plus an additional $6 in modem rental fees, customers could access 15GB through a 15-day auto-renew contract[29].

In time, the *Universal Hogares* plan expanded, bringing customers faster speeds for lower prices. As of February 2014, the telco offers the following extensions beyond the fixed wireless plan that comes with 1GB per month at no charge (see table 20).

Table 20: Uruguay: “Social” broadband plans

Price (US$)	Performance (Mbyte)	Details
2.20	256	30 calendar days from date of purchase
4.50	512	30 calendar days from date of purchase
9.00	1024	60 calendar days from date of purchase

Sources: Budde, Paul. "Uruguay - Telecoms, Mobile, Broadband and Forecasts."

Beyond service pricing, broadband economic adoption obstacles are linked to device prices. Three types of programs have been implemented to overcome the personal computer ownership barrier. The first one focuses on the provision of subsidies to reduce the acquisition price of devices. The target in this case could be households at the lower end of the socio-demographic pyramid, primary school to university students, and SMEs (especially micro-enterprises). The second program typically targets students in primary education, with governments distributing “One Computer per Child.” In this case, public school students

[29] Sources: Budde, Paul. "Uruguay - Telecoms, Mobile, Broadband and Forecasts." *Market Research*. N.p., 25 Nov. 2012. Web. <http://www.marketresearch.com/Paul-Budde-Communication-Pty-Ltd-v1533/Uruguay-Telecoms-Mobile-Broadband-Forecasts-7256999/>.
"Broadband Internet Access Worldwide." *Encyclopedia*. NationMaster, 2006. Web. <http://www.nationmaster.com/encyclopedia/Broadband-Internet-access-worldwide>.
Prescott, Roberta. "Uruguay's Antel Eyes Mobile Broadband Opportunities with LTE." *RCR Wireless News Americas*. N.p., 20 Apr. 2012. Web. <http://www.rcrwireless.com/americas/20120420/carriers/uruguays-antel-eyes-mobile-broadband-opportunities-when-launching-lte/>.
"Universal Hogares Rural." *Antel*. N.p., n.d. Web. 27 Feb. 2014. <https://www.antel.com.uy/antel/personas-y-hogares/internet/planes/internet-rural/universal-hogares->.

receive computers free of charge. The third type of initiative entails a reduction of the access price by eliminating or decreasing taxes paid at time of purchasing. Levies affected by this measure could range from sales tax, import duties, and even sector-specific levies.

In 2009, more than half of China's population lived in the rural parts of the country, where the average per capita annual income was US$ 700 (25% the average income of urban residents), broadband penetration rates were lower than in the urban areas, and the personal computer market was nearly untapped. Further, PC shipments decreased globally and spending fell.

To stimulate rural spending, the Chinese government launched a subsidy program offering a 13% rebate to rural residents buying select products to help PC manufacturers increase their sales to the country's under-developed regions, particularly after national computer demand fell. The rural computer subsidy came as part of a larger US$ 586 billion subsidy program to increase demand for home electronics, known as the Home Appliance Subsidy Program.

The government identified 14 vendors that could participate in the program and sell low-priced PCs in rural China, making computers more affordable while also spurring industry competition. These manufacturers created special products for the program with two-thirds of the computer models priced under US$ 500. The products also met regional specific demands. The PCs, for instance, kept potential variations in power supply voltage – a frequent problem in rural areas – in mind. Further, many of them came with special software for farmers, like inventory management programs. Vendors also ensured physical proximity to their customers, as citizens in rural areas did not have the means or the desire to drive for hours to buy a computer.

Hewlett-Packard sponsored variety shows and film screenings and offered product demonstrations in small towns. It also sent buses equipped with its products to elementary schools to advertise and to train students on how to use the technology. Competitor Lenovo began marketing its computers as luxury wedding gifts, employing the slogan, "Buy a Lenovo PC, Be a Happy Bride," and delivering them in large, conspicuous boxes. The company also has a flashy showroom with a section of the store devoted to products designed specifically for rural use.

Nearly 60% of all rural residents – or 200 million households - qualified for a subsidy. Initial estimates expected the program to generate the sales of 800,000 computers. The program ended in early 2012 and was dubbed a success. Combined, the subsidies covering all electronic goods for farmers and rural residents generated a 53% increase in sales[30].

[30] Sources: Chao, Loretta. "PC Makers Cultivate Buyers in Rural China." *Tech Journal*. Wall Street Journal, 24 Sept. 2009. Web. <http://online.wsj.com/article/SB125366214543432237.html>.
Lemon, Sumner, and Owen Fletcher. "China Offers Computer Subsidy for Farmers." *Desktops*. PCWorld, 5 Mar. 2009. Web. <http://www.pcworld.com/article/160750/article.html>.
He, Helen, and Simon Ye. "Rural China PC Program Will Increase PC Shipments in 2009 | 909330." Gartner, 10 Mar. 2009. Web. <http://www.gartner.com/id=909330>.
"China Launched A Massive Subsidy Program To Get People To Buy Appliances." *Business Insider*. N.p., 18 Jan. 2012. Web. <http://www.businessinsider.com/chinas-successful-appliance-subsidies-at-an-end-2012-1>.

Tackling digital literacy in the Philippines

While secondary schools do address basic digital literacy skills, they tend to provide students with a more advanced knowledge than they would gain during their primary school years. Viewing digital literacy as a life skill can explain its application in a student's life well beyond the classroom. As the global economy shifts from the manufacturing of goods to the provision of services, workers and countries require more high-level skills to stay competitive. Particularly in instances where students move directly from secondary or vocational school to the workforce, the exposure they have to ICT training via the education system has the potential to shape the trajectory of their future careers and the strength of the national economy. Employers increasingly require digital competence, and workers with this type of training also tend to acquire other on-the-job skills more easily. Further, the ICT industry tends to offer higher paying, lucrative jobs, and adding financial incentive to the benefits of obtaining advanced digital literacy.

By incorporating digital literacy training into the secondary school system, policy makers can effectively bridge the digital divide, thus creating more equal workforce opportunity amongst the population. Further, employees comfortable with using the technology at work are more likely to see its value within the household.

Given that most countries now require secondary school attendance, this environment seems to serve as the ideal setting in which to introduce citizens to basic and advanced ICT training. Training cannot come to fruition, however, without the necessary technology. In addition to developing effective and applicable lesson plans, educators and policy makers must also consider the provision of personal computers coupled with broadband connectivity. To this end, an increasing number of government initiatives have focused on distributing laptops to secondary students and faculty members. Some governments, such as North Carolina in the United States, require students to pass an ICT competence exam in the seventh or eighth grade to receive a high school diploma.

As is the case with primary school digital literacy programs, educators should have some form of measurement or standardization in place to promote the efficacy of such initiatives. Successful examples have included testing, certification programs, and partnerships with international organizations. As in the case of primary school programs, successful initiatives are also based on public and private partnerships. Gearing up Internet Literacy and Access for Students, or GILAS for short, provides public secondary schools in the Philippines with computer labs, complete with Internet connections, software, basic hardware, and Internet training. The initiative, which began in 2005, is a partnership between 26 corporations and non-profit institutions that recognize the limitations of the government's education budget. Amongst other goals, the project aims to deliver Internet access and computer equipment for schools, training for teachers and administrators, and the formulation of lesson plans.

By providing Internet access to schools, sponsors of the project see it as a means of bridging the digital divide among public high school students. Only a small number of Filipino students attend college, largely due to the prohibitive costs of higher education in the country. Beyond a college education, many employers see Internet literacy as a hiring requisite, though this skill is typically reserved for wealthier students whose families can afford household computers and Internet connections. Without computer access or the ability to afford a college education, many students have few opportunities awaiting them at graduation. By increasing computer access and digital literacy within the school system, the GILAS project aims to produce a more qualified and highly skilled workforce.

To support the initiative, GILAS matched donations from local and foreign companies, local governments, and legislators. Per the most recently released annual report, the public sector 2009 contribution added up to approximately US$ 500,860 in addition to the private sector's US$ 598,470 contribution. Overseas Filipino expatriates also made donations, mainly through the Ayala Foundation USA, which totaled US$ 175,980. In total, donations that year equaled US$ 1.3 million.

In 2010, the country's Department of Education initiated its DepEd Internet Connectivity Project (DICP) with the intention of connecting all public high schools to the Internet while providing relevant monitoring through an annual allocation of US$ 1,200 per school. The initiative complemented the GILAS program and leaders of both projects worked together to reach their shared goal. DICP focused more on financing schools' Internet connections while GILAS looked more at the initial investment in the provision of ICT tools and training.

Within four years of its 2005 inception, the GILAS program connected 39% of the Philippines' public high schools. As a result, more than 2 million students accessed the Internet and 11,621 teachers received training. By late 2012, the program had reached 3,349 schools[31].

III.5. Critical success factors for increasing broadband penetration[32]

In the prior sections, three barriers were reviewed as being the dominant obstacles in achieving broadband penetration: limited affordability, access in rural areas, and digital literacy. In addition, policy approaches were discussed and best practices were presented as examples on how to tackle these barriers. This section turns now to elaborate on the critical success factors necessary to implement said approaches[33].

[31] Sources: GILAS: Gearing up Internet Literacy and Access for Students, n.d. Web. <http://www.gilas.org/>.
2009 Annual Report: On the Way to Sustainability. Rep. GILAS: Gearing up Internet Literacy and Access for Students, 2010. Web. <http://www.gilas.org/attachments/AR_2009.pdf>.
"DICP." *DepEd Division of Malaybalay City*. N.p., n.d. Web. <http://www.depedmalaybalay.net/programs/ict/deped-internet-connectivity-project-dicp>.

[32] This section is based on Katz, R. and Berry, T. (2014). *Driving demand of broadband networks and services*. London: Springer.

[33] To reiterate, critical success factors are the essential areas of activity that must be performed well in order to achieve the mission, objectives or goals for a particular project.

Achieving broadband affordability

As discussed above, pricing of broadband service and devices is one of the critical barriers to achieving high penetration. As it has been considerably researched, the development of competition is one of the major tools for affecting a reduction in telecommunications service pricing. The theoretical basis of competition is the notion that, in the telecommunications market, multiple operators can compete among each other and generate sufficient benefits for consumers in terms of price-reductions, while guaranteeing an appropriate rate of innovation. The following features characterize a telecommunications competition model:

- Existence of multiple operators serving the same market based on their own network,
- Existence of multidimensional competitive dynamics (prices, services and user service quality) among industry players,
- Reduction of retail prices for consumers, and intense competition in product differentiation (dynamic efficiencies), resulting in additional consumer surplus,
- Competitive stimulation for each operator to increase the level of investment in its own network,
- Absence of tacit collusion between operators due to the high rate of innovation and competition based on product differentiation.

While the theoretical principles for sustainable competition in broadband are well established, their implementation is not straight-forward. Along these lines, it is important to emphasize that in order to determine the existence of an adequate level of competition capable of yielding low broadband prices, the regulators need to have access to expertise in market analysis capable to establishing whether the number of players in the market are sufficient to warrant enough consumer benefits or whether additional remedies are required to stimulate competitive intensity.

Beyond the competitive stimuli, the reduction of broadband service prices can be achieved through a number of targeted public policy initiatives. The first reviewed above with example of Uruguay relies on a state-owned operator to offer a low-priced service. A slightly modified approach to achieve this is for the government to offer a subsidy on the cost of broadband access. This could be done in the form of a plain voucher or a tax refund for qualifying segments of the population (e.g. students). In previous experiences, the critical success factors in this approach are two:

- Establish upfront who is supposed to determine what constitutes an "affordable" offer? The public service provider or the regulator,
- Ensure that whoever will define the "social" offer has the right economic expertise.

The second option to improving broadband affordability entails conducting a negotiation between the government and private operators aimed at agreeing that they will offer a low-priced broadband service targeted for disadvantaged segments of the population. In this case, government policy makers negotiate with private broadband providers the offering of a low-priced plan. This can be achieved in the context of the formulation of a national broadband plan. Alternatively, it could be achieved as part of an agreement between the government regulator and a private incumbent operator as a condition for allowing the latter to pursue a particular initiative. Under this option, the critical success factor is the determination of *quid por quo* conditions. In other words, what will the government offer in exchange for gaining an agreement from the broadband operators (e.g. Tax reduction? Regulatory holidays on fiber investment? Authorization to complete an acquisition?)

The third option is also an agreement between the government and private sector broadband providers to offer low-priced services, but in this case limited to public institutions (such as schools, libraries, or health clinics). Policies and programs that promote reduced-price broadband for public administration facilities can bridge the ever-widening digital divide while also allowing these facilities to have a wider reach when providing their services. Critical success factors under this approach are similar to the ones mentioned above.

The fourth option comprises offering free Internet access through Wi-Fi services located in public areas, such as squares, libraries, and transportation hubs. The provision of free Wi-Fi Internet access is being conceived as one of the building blocks needed to build a city's international competitiveness. There are several features and options of a free Wi-Fi program:

- Coverage of public spaces: squares and parks, public transportation, including metros, public libraries,
- Type of service: amount of time provided for free access (1hr. limit while commuting, open unlimited access),
- Type of service provider: under contract with telecommunications operators or other broadband player, offered by the city administration,
- Quality of service: basic video streaming quality,
- Business model: free provision based on a singular event, then moving to a pre-paid offering, potentially including customized interactive digital advertising.

Providing broadband access in rural and isolated areas

The approach for providing broadband access through digital community centers, such as the example of Brazil presented above, have been very useful to determine a number of critical success factors:

- Establish a permanent channel of communication between the community and the managers of the digital center, involving the community directly and encouraging to take ownership of the activities of the center,
- Community involvement could entail nominating local technology champions, who assemble community support, lead technology needs assessment and planning efforts, and work to introduce technology initiatives to meet community needs,
- Make sure that qualified personnel design the training activities and train the users,
- Construct digital community centers as a technology and entrepreneurship hubs within communities; as such, the centers provide free broadband access to the public, and, at the same time, a variety of fee-based business and technology services to local non-profits and businesses,

- Among the entrepreneurship services that the digital centers can provide are employee training, modern office space, technology expertise and business consulting,
- Put in place a full technical service team that ensures that all equipment is always working properly,
- In terms of advertising and promotional activities, the center should post monthly newsletters on its website, addressing issues for small businesses, such as fundraising opportunities, or dealing with foreign worker authorization permits, and
- Consider outsourcing some of the center functions to facilitate its sustainability.

Complementing these activities, it is important to conduct periodic monitoring:

- Ensure that centers issue annual or semi-annual reports informing about activities being held, courses, results, topics taught, number of participants, etc.,
- Conduct internal evaluations of access centers every six months, measuring and comparing indicators such as number of visits per month, number of users per month, indicating gender, age, email accounts, blogs, and websites being created.

If the digital access centers are set up based on a public and private partnership, it is important to set up an overseeing structure, such as a Management Board that meets regularly to discuss and manage progress of the program. The Board should comprise a senior executive from each of the partner's organizations, plus a representative from the community. Additionally, the community should have a coordinator from each center, all of whom meet regularly to discuss issues faced in running their centers.

Tackling digital literacy

Targeted digital literacy programs are of a wide variety, potentially addressing a number of objectives, not all necessarily consistent. In designing such programs, policy makers need to consider what are the goals of the program, since these goals will frame the methods of intervention. Among the goals to be considered in designing a digital literacy program, the following issues need to be considered:

- What is the overall objective of the program? Digital literacy, conceived as a skill, represents the means to achieve a varying set of goals, such as improvement of quality of life, develop citizenship and promote democratic participation, or social inclusion. By outlining the ultimate objective, policy makers will help framing the program.

  As expected, digital literacy programs could have more than one objective, partly driven by the population being targeted. For example, if targeting the rural poor, the purpose of the digital literacy program could include providing access to broadband, improving quality of life to prevent rural exodus to cities, and promoting social inclusion. As Hilding-Hamann et al. (2009) mention in their report to the European Commission, that differences in program objectives could "reflect different policy domains" (e.g. education, economic development, social welfare). Program objectives could also be driven by the potentially different constituencies sponsoring the program.

- What is the target group? Targeted digital literacy programs take different shapes according to the population they will address. As an example, the type of content to be emphasized in program delivery will change significantly if the program aims to target the elderly (email for social inclusion and fostering of social and family ties) versus adults (applications to build employability skills). It is often the case that even needs within a single targeted group might be of different types. For example, some digital literacy programs that target the elderly have focused on helping users working with devices, while others have focused on basic operations and routines of operating systems.

- Usability versus accessibility? Some digital literacy programs emphasize training and skills transmission, while others complement this with infrastructure for public broadband access. This represents a critical policy choice since access does not necessarily equate to the capability to use broadband in a productive and beneficial manner. In fact, if the primary objective is usability, experience indicates that tailored courses, complemented with intense coaching, are the more appropriate approach.

  As expected, if the target of the digital literacy program is the rural poor, accessibility will be a dominant objective. A combination of both objectives –use and access- can be provided by community access centers, which will be reviewed later. Nevertheless, best practices indicate that accessibility and usability are not that easy to combine in digital literacy programs. As such, the two objectives are frequently addressed sequentially, first providing access, followed by training.

- Formal versus informal delivery mode? Formal digital literacy training entails structured programs based on established curricula, learning tools, and certification. Informal training is not delivered in specific training environments, lacking a structured pedagogical process. While it might not be intuitively appropriate for targeted programs, the emergence of new Internet platforms might lead to the adoption of informal approaches.

- Scale of implementation? This question addresses whether programs will be focused on a particular region, or deployed on a national scale. In Hilding-Hamann et al. (2009) view, "national programs are rooted in centralized policies at the national level and (…) seen as strategically linked to government objectives", such as building an information society. In general terms, local programs, while having a more limited impact across targeted populations, tend to experience a large sustainability success rate due to more limited funding requirements. Nevertheless, Hilding-Hamann et al. (2009) did not find a relation between size of the program and sustainability.

  Sustainability is a primary concern of targeted digital literacy programs. In their review of 464 programs, Hilding-Hamann et al. (2009) estimated that 22% of them had been discontinued. Furthermore, they found that program sustainability is generally linked to the number of stakeholders ("more than half of the (ongoing) initiatives have been delivered by three or more implementers").

- Device focus: Until now, the great majority of digital literacy programs have focused on personal computers connected to broadband technology. However, with the growing importance of wireless broadband and smartphones, the need to make decisions on what kind of device the digital literacy program focuses on will become very important.

Generational differences represent another major barrier to broadband adoption. Typical age cohort where adoption starts declining dramatically in emerging countries is 40 years old (when controlling for income). In that sense, digital literacy programs conceived as extension of either universities or secondary schools have proven to be very valuable in bridging the generational gap. The overall long-term goal of these programs is to improve social inclusion of the elderly population. The primary content delivered in this type of programs are standard computer courses, in some cases tailored specifically to the needs of the elderly (e.g. email to communicate with the family, photo sharing, use financial applications, purchasing tickets online, etc.). However, in addition, digital literacy courses for the elderly give seniors an opportunity to meet people and develop a social network. Among the best practices in the deployment of digital literacy for the elderly, the following have been highlighted:

- Carefully determine needs of targeted population given the different requirements that have been observed across the segment,
- Create a website supporting the program, which would include self-study course modules for use on an ad-hoc fashion in community centers,
- Self-study programs should comprise online courses, complemented with traditional printed materials,
- Include an entertainment section (media, music) in the website to enhance attractiveness,
- Strive to coordinate the program with cultural organizations that are part of the user community (for example, they can act as advertising vehicles for digital literacy programs),
- Equip program with self-contained units that could be used via touch screens and a simple menu system,
- If program is offered at a community center, ensure continuous presence of host instructors that can answer inquiries, take registrations, and be responsible for all technical logistics,
- Make sure that instructors stay after classes to act as tutors for the seniors that stay in the center working on the computers,
- Provide an environment where users can share their experiences in dealing with technical issues with peers, which constitutes an important retention mechanism,
- Digital literacy programs for the elderly attain better results when they are delivered in an environment that provides the opportunity to meet other people and break their social isolation,
- It is sometimes useful to involve students of upper secondary schools in the role of volunteer "digital facilitators" to teach internet browsing and e-mail use to the elders;

the one-to-one relationship between the young tutor and the trainee (a concept called "intergenerational learning") improves the learning experience,
- Focus on teaching material that is immediately transferable and applicable to the senior everyday life.

As Hilding-Hamann et al. (2009) concluded in their extensive review of digital literacy programs, a large portion of these programs are targeted to the unemployed, with the objective of increasing their employability. In this context, these programs tend to provide a certification to provide a proof of skill. On the other hand, digital literacy programs focused on adults with a low education level represent an opportunity to provide a second chance instruction, thereby enhancing their personal development. Some of the best practices captured in the assessment of adult digital literacy programs include the following:

- Consider delivering courses in mobile settings (e.g. trucks equipped with computers, servers, and mobile broadband) to make it easier for people to participate in different geographies, thus enlarging the reach of the program; the mobile unit and instructors can arrive in one town, install the equipment in a library, a city hall or any community center, offer the five day courses, and then move on to the next location,
- Allow participants to borrow equipment and take it home to continue practicing after the training sessions (although this could face some logistical difficulties),
- The formal course should last approximately five days and be delivered to groups not larger than 12 individuals, so each of them gets proper attention,
- After completion of the formal course, users can enroll in a web-based program; and
- Waive enrollment fee for unemployed adults, but consider charging for others.

Given the modern day economic shift away from low-skilled manufacturing jobs to high-skilled services jobs, lack of workplace opportunity is particularly heightened as a result of the digital divide. Additionally, economic, educational, and geographic disparities tend to impact ICT exposure, further exacerbating this cycle. Thus, successful digital literacy programs many times target the disadvantaged groups that are less likely to have prior knowledge of computers or the Internet and face more hurdles as a result (the unemployed, older citizens, welfare recipients, and rural population).

Training can be provided in a variety of ways, so long as it is offered in an easily accessible, affordable manner to encourage participation. Many training sessions, for example, are offered at local community access centers or schools, where citizens already feel comfortable, while others are offered online. Sessions can cover a variety of topics, but tend to focus on the development of ICT skills with "real world" application, including, but not limited to e-mail, internet inquiry, job search, and CV creation. Many programs also offer certification options, providing participants with tangible evidence of their acquired skillset. Further, as training programs become more popular, they create more economic opportunity through the demand for citizens to serve as trainers or project managers.

Digital divide based on gender differences has been studied in the emerging world with a varying set of evidence about its level of importance. Most of the digital literacy programs targeted to women have as primary objectives, reduce the digital divide, promote social inclusion and improve the employability profile of women. According to Hilding-Hamann et al. (2009), the following best practices in this kind of programs have been identified:

- All instructors should be females with experience in teaching computer skills; students appreciate the notion of "women teaching women", addressing not only a skills gap but providing a remedy to unequal opportunities in the workplace,
- Additionally, the instructors could be unemployed women with prior computer experience; as a result, the program could also become a vehicle for reintegrating unemployed women in the workforce,
- Include a mentoring process in the program, which is based on younger peers or attendees to prior sessions,
- Advertise programs in order to promote enrollment at places such as nurseries, schools, playgrounds, and markets,
- Alternatively, kindergartens and schools could become places for recruiting program participants,
- Provide flexibility in course delivery to allow for occasional absences,
- Structure lessons as "learner-centric" rather than "curriculum-centric", building the program around what attendees say they want to learn (e.g. use online search of job opportunities),
- Consider partnering in delivery of the program with associations or non-governmental organizations focused on advancing women welfare and/or enhancing the social inclusion of women by means of technology,
- If focusing on women belonging to a specific ethnic group, tailor the material to be delivered in suitable language, and customize it to the cultural idiosyncrasies of the targeted group, and
- In some cases, it could be very productive to involve the whole family in learning ICT skills in order to motivate mothers to participate.

This chapter presented information on global trends regarding broadband supply and demand. It illustrated the concepts of supply and demand gap by reviewing industry trends at a global level and then highlighting the gaps in broadband adoption. It also identified three best practices in non-OIC developing countries (Brazil, Philippines, and Uruguay) as approaches that would allow tackling some of the principal broadband adoption barriers faced by the OIC Member Countries.

IV. CURRENT SITUATION OF BROADBAND PENETRATION IN THE OIC MEMBER COUNTRIES

Having analyzed worldwide broadband trends, the report will now turn to analyzing the current situation of broadband in the OIC Member Countries. This analysis will address relevant topics in the supply and demand areas with the purpose of defining policy and regulatory recommendations.

IV.1. Broadband Supply in the OIC Member Countries

Availability of fixed and mobile broadband infrastructure

The statistics on fixed broadband coverage among the OIC Member Countries are not available in an up-to-date international database. However, the responses to a survey submitted to country regulators and case study interviews conducted in the context of this study, yield the following coverage metrics (see table 21).

Table 21: Selected OIC Member Countries: Fixed broadband coverage (percent of population) (2016)

Country	Fixed Broadband Coverage (%)
Turkey	98
Jordan	85
Saudi Arabia	80
Kazakhstan	70
Suriname	60
Cote d'Ivoire	20
Benin	5

Source: Study survey and interviews

While difficult to draw any conclusion for this limited data set, it would appear that fixed broadband coverage has reached a high level in Asian OIC Member Countries, while African states still exhibit low coverage of the population.

This situation differs significantly from coverage of mobile broadband. In this case, mobile broadband operators in African OIC Member Countries could serve at the end of 2015 58% of the population. That being said, the OIC Arab states mobile broadband operators were already covering 74% of the population. Of note, despite their impressive growth in mobile broadband coverage, OIC Member Countries still lag OECD countries by 33 % points (see table 22).

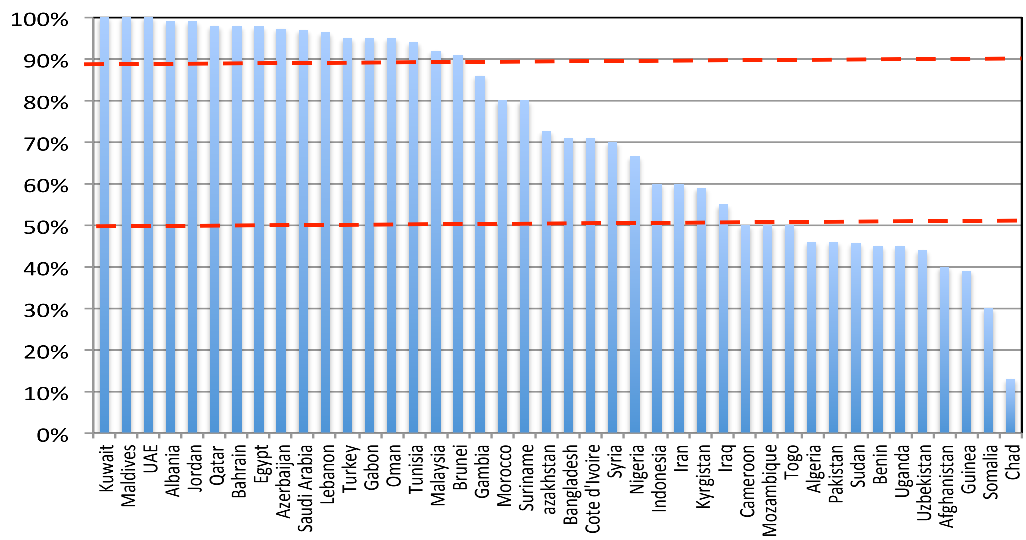
Table 22: OIC Member Countries: mobile broadband coverage (3G) (percent of population) (2015) (%)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
OECD	5.93	45.02	64.40	79.52	82.82	91.63	93.20	95.24	97.78
Asian OIC	0.61	1.23	3.40	4.89	6.85	13.29	22.31	43.17	62.69
Arab OIC	0.08	6.94	24.50	41.55	51.86	55.17	58.06	65.85	74.30
African OIC	0.00	0.00	2.18	5.59	7.00	10.28	17.92	32.43	57.71
Total OIC	0.35	2.24	7.87	13.47	16.55	21.75	29.14	45.82	64.16

Source: Regulatory Agencies; International Telecommunications Union; Telecom Advisory Services analysis

As table 22 indicates, Arab OIC Member Countries have increased their mobile broadband service coverage faster than the other regions. A country perspective provides a perspective of the wide disparity still existing across the OIC Member Countries (see figure 18).

Figure 18: OIC Member Countries: Mobile broadband coverage (3G) (percent of population) (2015)



Source: Regulatory Agencies; International Telecommunications Union; Telecom Advisory Services analysis

According to the data presented in figure 18, there are 16 OIC Member Countries that have reached a mobile broadband coverage in excess of 90%, while 12 have coverage between 90% and 50%, and less than 50% of the population is covered by the service in the remaining 13 countries. These statistics are very important since they shed a light on the critical problem facing each of the OIC Member Countries when it comes to broadband penetration. For those countries that have coverage in excess of 90% of the population, the critical challenge is how to close the demand gap. For countries with coverage less than 50%, they need to address the supply side before they focus on stimulating demand.

In the case of 4G coverage, while statistics are not comprehensive for all OIC Member Countries, crowdsourcing sites[34] like Open Signal provide a view of service coverage and download speed for selected carriers and countries (see table 23).

[34] Crowdsourcing sites like Open Signal rely on input of smartphone users to compile coverage and download speed statistics for wireless carriers around the world.

Table 23: OIC Member Countries: Mobile broadband coverage and download speed (4G) (2016)

Country	Operator	Population Coverage (%)	Average download speed (Mbps)
Jordan	Zain	68	8
Kazakhstan	Altel	83	8
Kuwait	Zain	89	8
	Viva	85	7
	Ooredoo	82	6
Malaysia	Maxis	69	12
	DiGi	54	12
	Celcom	51	11
	U Mobile	43	14
Morocco	IAM	67	15
	INWI	62	14
	Meditel	40	18
Oman	Omantel	58	20
Pakistan	Warid	70	4
	Zang	68	7
Qatar	Ooredoo	81	10
Saudi Arabia	Zain	71	3
	STC	69	5
	Mobily	52	4
UAE	Etisalat	80	27
	du	75	17

Sources: Open Signal; Telecom Advisory Services analysis

As indicated in table 23, 4G deployment appears to be fairly advanced among the countries with available data. On the other hand, as will be reported in the Cote d'Ivoire case study in section V.1, 4G coverage in Sub-Saharan OIC Member Countries is still at its infancy.

Moving now to the type of technology, table 24 presents a breakdown of fixed broadband lines in terms of ADSL, fiber optics lines (provisioned by a telecommunications carrier), cable modem accesses (supplied by a cable TV operator), and other technology platforms (primarily fixed wireless through WiMax platforms).

Table 24: OIC Member Countries: Breakdown of fixed broadband lines

	Lines per 100 population	Total Lines	Share ADSL (%)	Share Cable modem (%)	Share Fiber Optics (%)	Other Fixed (*)(%)
Lebanon	22.76	1,150,205	57.96	0.00	0.00	42.04
Azerbaijan	19.76	1,899,456	85.69	1.06	6.86	6.40
Bahrain	18.61	253,041	58.81	0.00	0.58	40.61
Kazakhstan	13.05	2,188,543	51.29	2.23	39.98	6.50
UAE	12.81	1,226,830	11.21	0.02	88.34	0.43
Turkey	12.39	9,504,594	76.68	5.48	16.44	1.40
Saudi Arabia	12.01	3,590,719	49.99	0.00	32.39	17.62
Iran (I.R.)	10.86	8,633,861	83.90	0.00	0.00	16.10
Qatar	10.06	236,465	25.82	0.00	73.86	0.32
Suriname	9.48	51,994	0.00	0.00	92.14	7.86
Malaysia	8.95	2,743,280	49.61	2.42	31.31	16.66
Brunei Darussalam	7.99	34,240	0.00	0.00	37.18	62.82
Albania	7.6	242,870	63.99	23.60	6.20	6.21
Guyana	6.65	53,687	99.94	0.00	0.01	0.05

	Lines per 100 population	Total Lines	Share ADSL (%)	Share Cable modem (%)	Share Fiber Optics (%)	Other Fixed (*)(%)
Maldives	6.47	23,175	72.96	20.84	2.30	3.89
Palestine (**)	6.03	274,500	100.00	0.00	0.00	0.00
Oman	5.61	233,234	70.11	0.00%	0.00	29.89
Algeria	5.57	2,263,284	94.93	0.00%	0.01	5.05
Egypt	4.52	3,826,410	98.72	0.00%	0.00	1.28
Tunisia	4.34	487,923	96.84	0.00%	0.41	2.75
Jordan	4.16	320,205	60.66	0.00%	2.54	36.80
Kyrgyzstan	3.71	211,521	39.85	30.12%	29.62	0.40
Uzbekistan	3.57	1,060,645	38.75	0.00%	8.03	53.22
Morocco	3.38	1,147,533	98.87	0.00%	0.19	0.94
Syria	3.14	700,000	73.91	0.00%	0.00	26.09
Bangladesh	2.41	3,865,911	0.57	0.10%	67.89	31.44
Djibouti	2.33	20,962	21.64	0.00%	0.00	78.36
Yemen	1.55	395,000	100.00	0.00%	0.00	0.00
Kuwait	1.37	49,093	100.00	0.00%	0.00	0.00
Indonesia	1.09	2,785,000	96.77	1.08%	0.00	2.15
Libya	0.97	61,000	0.00	0.00%	0.00	100.00
Pakistan	0.95	1,793,199	72.69	2.08%	0.74	24.49
Togo	0.92	65,971	76.34	0.00%	0.00	23.66
Somalia	0.74	82,000	0.00	0.00%	0.00	100.00
Benin	0.67	73,263	10.21	0.00%	0.00	89.79
Senegal	0.67	100,611	100.00	0.00%	0.00	0.00
Gabon	0.63	11,082	91.56	0.00%	0.00	8.44
Côte d'Ivoire	0.52	109,707	45.38	0.00%	0.27	54.35
Uganda	0.32	128,452	50.27	0.00%	0.00	49.73
Comoros	0.26	2,000	94.65	0.00%	0.00	5.35
Mauritania	0.24	9,638	96.22	0.00%	0.00	3.78
Gambia	0.18	3,573	13.23	0.00%	2.70	84.07
Chad	0.08	11,337	0.00	0.00%	0.00	100.00
Mozambique	0.08	21,697	87.81	0.00%	12.19	0.00
Cameroon	0.07	16,000	100.00	0.00%	0.00	0.00
Sudan	0.07	27,683	41.61	0.00%	9.56	48.83
Tajikistan	0.07	6,000	0.00	100.00%	0.00	0.00
Guinea-Bissau	0.06	1,051	0.00	0.00%	0.00	100.00
Niger	0.06	11,000	0.00	100.00%	0.00	0.00
Turkmenistan	0.06	3,000	0.00	0.00%	0.00	100.00
Burkina Faso	0.04	7,210	91.95	0.00%	0.00	8.05
Mali	0.02	3,499	100.00	0.00%	0.00	0.00
Guinea	0.01	1,000	0.00	0.00%	0.00	100.00
Nigeria	0.01	15,688	100.00	0.00%	0.00	0.00
Afghanistan	0	0	20.00	62.00%	0.00	18.00
Iraq	n/a	n/a	n/a	n/a	n/a	n/a

(*) Other fixed broadband subscriptions refers to Internet subscriptions using other fixed (wired)-broadband technologies to access the Internet (other than DSL; cable modem; and fiber) at downstream speeds equal to or greater than 256 kbps. This includes technologies such as Ethernet LAN and broadband-over-powerline (BPL) communications.
Source: Regulatory Agencies; International Telecommunications Union; Telecom Advisory Services analysis

As presented in Table 24, ADSL is the prevalent fixed broadband technology across the OIC Member Countries. Of all 52 million fixed broadband lines, 68% are supported by ADSL technology, only 2% by cable modem, 17% through fiber optics, and 13% by other fixed broadband technology (primarily WiMax). Considering that cable modem (in its latest generations) and fiber optics are the technologies that can provide fast speed broadband, it is apparent that the OIC Member Countries still have very limited access to the latest generation of technology. Of the 9.6 million cable modem and fiber optics lines, 2.6 million are in Bangladesh, 2.1 million in Turkey, 1.1 million in the United Arab Emirates, 1.1 million in Saudi Arabia, 900,000 in Malaysia, and 900,000 in Kazakhstan. This limited deployment has an impact on the speed at which broadband subscribers can access the Internet. According to the table 25 the average fixed broadband download speed across the OIC Member Countries is 3.4 Mbps.

Table 25: OIC Member Countries and OECD: Average fixed broadband speed (in Mbps) (2015)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
OECD	3,680	3,978	4,125	4,231	5,230	6,126	8,656	9,974	11,669
Asian OIC	754	837	873	827	1,038	1,384	1,902	2,363	3,556
Arab OIC	1,005	1,008	1,232	1,299	1,291	1,529	1,766	2,267	3,149
African OIC	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Total OIC	822	884	972	958	1,108	1,425	1,864	2,336	3,442

Source: Akamai; Telecom Advisory Services analysis

As table 25 indicates, the average download speed has not improved significantly in the last nine years, when it was 1.005 Mbps. In the meantime, the average download speed across OECD countries has increased from 3.680 Mbps to 11.669 Mbps. As research has indicated, broadband speed has a direct economic impact. In the emerging world, upgrading from 0.5 to 4 Mbps increases household income by US$ 46 per month (Bohlin, 2014). Similarly, doubling of broadband speed increases GDP by 0.3%. These effects emphasize the need to accelerate deployment of fast fixed broadband across the OIC Member Countries. This challenge will be discussed further in chapter V.

The statistics for mobile broadband speeds point out to a similar lag by the OIC Member Countries, although the deployment of 4G/LTE is expected to increase the share of faster mobile broadband connectivity. As of the end of 2016, 41 OIC Member Countries have at least one operator with an active LTE network. Of these, Kuwait, Malaysia, Saudi Arabia and the United Arab Emirates have begun to reflect a growing 4G share of the total mobile broadband subscriptions (see table 26).

Table 26: OIC Member Countries: Breakdown of mobile broadband subscribers

	Subscriptions per 100 pop.	Total Subscribers (2015)	Share 3G (*) (%)	Share 4G (*)(%)	Year Launched (first operator)
Kuwait	139.31	4,992,033	81.30 (2015)	18.70 (2015)	2011
Bahrain	131.78	1,791,892	- - -	- - -	2012
Saudi Arabia	111.67	33,387,589	94.84 (2015)	5.16 (2015)	2011
UAE	91.99	8,810,000	94.84 (2015)	5.16 (2015)	2011
Malaysia	89.94	27,567,668	94.40 (2015)	5.60 (2015)	2013
Qatar	80.03	1,881,144	98.00 (2015)	2.0 (2015)	2013
Oman	78.26	3,253,949	- - -	- - -	2013
Suriname	75.85	416,004	- - -	- - -	2015
Maldives	63.64	227,820	100	0	
Tunisia	62.63	7,036,966	99.19 (2015)	0.81 (2015)	2015
Azerbaijan	60.92	5,856,215	100	0	2016
Kazakhstan	59.97	10,057,237	98.47 (2015)	1.53 (2015)	2012
Lebanon	53.43	2,916,231	100	0	
Turkey	50.94	39,067,554	100	0	2016
Egypt	50.66	42,913,302	100	0	2018
Indonesia	42.05	107,518,000	99.87 (2015)	0.13 (2015)	2013
Albania	40.58	1,297,281	- - -	- - -	2015
Côte d'Ivoire	40.39	8,602,170	- - -	- - -	2014

	Subscriptions per 100 pop.	Total Subscribers (2015)	Share 3G (*) (%)	Share 4G (*)(%)	Year Launched (first operator)
Algeria	40.11	16,298,082	- - -	- - -	2014
Morocco	39.28	13,337,087	94.10	5.90	2015
Jordan	35.58	2,736,017	- - -	- - -	2015
Gabon	33.12	579,997	- - -	- - -	2014
Kyrgyzstan	30.98	1,768,305	- - -	- - -	2011
Sudan	29.41	11,649,027	100	0	2016
Uzbekistan	28.69	8,523,779	- - -	- - -	2010
Senegal	26.42	3,953,818	99.68 (2015)	0.32 (2015)	2015
Mauritania	23.1	942,386	100	0	
Nigeria	20.95	38,448,990	98.70 (2015)	1.30 (2015)	2015
Iran (I.R.)	20.02	15,913,352	- - -	- - -	2014
Mali	18.84	3,063,186	100	0	
Uganda	18.31	7,349,540	99.31 (2015)	0.69 (2015)	2012
Burkina Faso	15.44	2,766,018	100	Licence	
Guinea	13.93	1,719,446	- - -	- - -	2015
Bangladesh	13.45	21,575,313	99.78 (2015)	0.22 (2015)	2015
Pakistan	13.02	24,496,354	99.85 (2015)	0.15 (2015)	2014
Tajikistan	12.08	1,040,000	- - -	- - -	2012
Syria	10.38	2,311,107	100	0	
Gambia	10.02	197,402	- - -	- - -	2015
Mozambique	9.37	2,541,315	100	0	
Togo	6.02	431,661	100	0	
Afghanistan	5.97	1,910,178	- - -	- - -	2015
Yemen	5.85	1,494,000	100	0	
Djibouti	5.56	50,000	- - -	- - -	
Brunei Darussalam	4.48	19,199	- - -	- - -	2013
Cameroon	4.27	1,000,000	- - -	- - -	2015
Benin	4.24	461,027	- - -	- - -	2015
Iraq	3.55	1,271,100	- - -	- - -	2013
Niger	1.84	354,000	100	0	
Chad	1.38	187,206	- - -	- - -	2014
Guyana	0.23	1,820	100	0	
Guinea-Bissau	0	0	- - -	- - -	2015
Palestine	0	0	100	0	
Comoros	n/a	n/a	100	0	2016
Libya	n/a	n/a	100	0	2018
Somalia	n/a	n/a	100	0	2016
Turkmenistan	n/a	n/a	- - -	- - -	2013

(*) When indicated as (2015) the 4G share refers to December 2015.

Sources: GSMA Intelligence; Ovum. Telecoms, media and Entertainment Outlook 2015; Global Mobile Suppliers Association. Evolution to LTE Report. October 26, 2016; Telecom Advisory Services analysis

The increased adoption of 4G is having an impact on average mobile broadband speeds. Recent data for two years indicates that while average download speed of mobile broadband in OECD countries has jumped from 6.08 Mbps to 9.22 Mbps in just one year, data for the OIC Member Countries by the end of 2015 was still under that of the OECD in 2014 (see table 27).

Table 27: OIC Member Countries and OECD: Average mobile broadband speed (in Mbps) (2015)

	2014	2015
OECD	6.08	9.22
Asian OIC	2.06	4.17
Arab OIC	3.87	3.57
African OIC	N/D	N/D
Total OIC	2.44	4.03

Note: Data for African OIC Member Countries has not been compiled so far.
Source: Akamai; Telecom Advisory Services analysis

Broadband market structure

The fixed broadband market structure in the OIC Member Countries exhibits, in the aggregate, a moderate level of competitive intensity. Of the countries with available information, thirteen have three or more fixed broadband service providers (an indication of sustainable competition), while eleven have less than three (an indication of low competitive intensity) (see table 28).

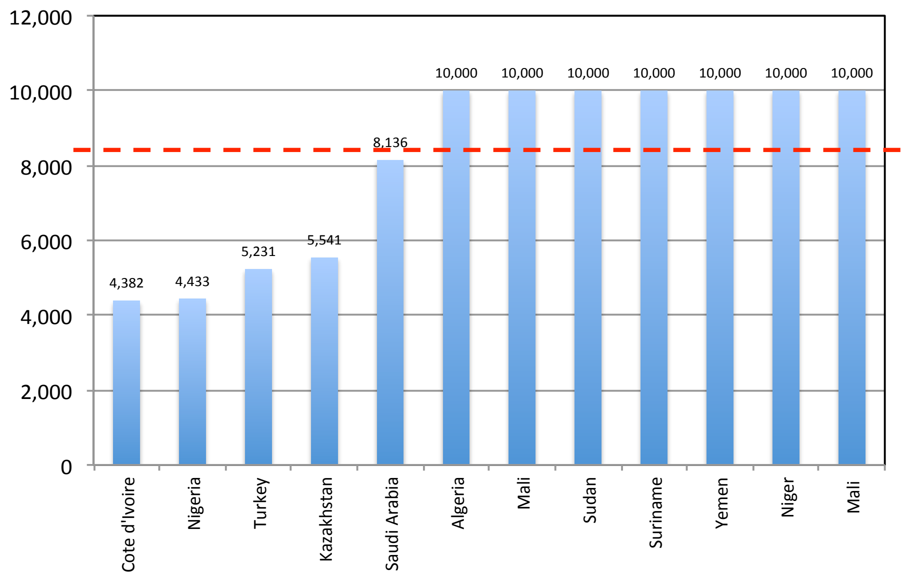
Table 28: OIC Member Countries: Fixed broadband market structure (2016)

Country	Number of operators
Albania	4 (2013)
Algeria	1 (2016)
Benin	4 (2016)
Côte d'Ivoire	5 (2016)
Indonesia	3 (2016)
Iran	1 (2013)
Jordan	3 (2106)
Kazakhstan	9 (2015)
Kuwait	5 (2016)
Mali	1 (2015)
Morocco	2 (2014)
Niger	1 (2013)
Nigeria	6 (2016)
Oman	1 (2013)
Pakistan	4 (2016)
Qatar	3 (2016)
Saudi Arabia	5 (2016)
Senegal	2 (2016)
Sudan	1 (2013)
Suriname	1 (2016)
Tunisia	7 (2014)
Turkey	6 (2016)
United Arab Emirates	2 (2016)
Yemen	1 (2013)

Source: Telecom Advisory Services case studies and survey; Business Monitor International; Point Topic; compilation of regulatory authority sites

However, based on this structure and the correspondent market shares of countries where complete information is available, the Herfindhal-Hirschman Index[35] (an indicator of industry concentration) indicates that only four OIC Member Countries have a somewhat healthy competitive environment while the remainder are either concentrated or operating under monopolistic market conditions (see figure 19).

Figure 19: OIC Member Countries: Herfindahl-Hirschman index of the fixed broadband industry (2016)



Sources: GSMA Intelligence; Regulatory Agencies; Telecom Advisory Services analysis

As figure 19 indicates, Cote d'Ivoire, Nigeria, Turkey, and Kazakhstan tend to have fixed broadband industries comprising a sufficient number of mobile broadband providers with important market shares. On the other hand, the mobile broadband market structure in the OIC Member Countries exhibits, in the aggregate, a moderate level of competitive intensity. Of the countries with available information, twenty have more than three operators, seventeen countries have three carriers, while twelve have less than three (an indication of low competitive intensity) (see table 29).

[35] The Herfindahl-Hirschman Index is calculated by adding the square power of the market share of all industry participants. An index of 10,000 indicates a monopolistic market structure while an index lower than 3,500 is considered to depict an industry with a healthy level of competition. An index higher than 3,500 would indicate moderate competitive intensity.

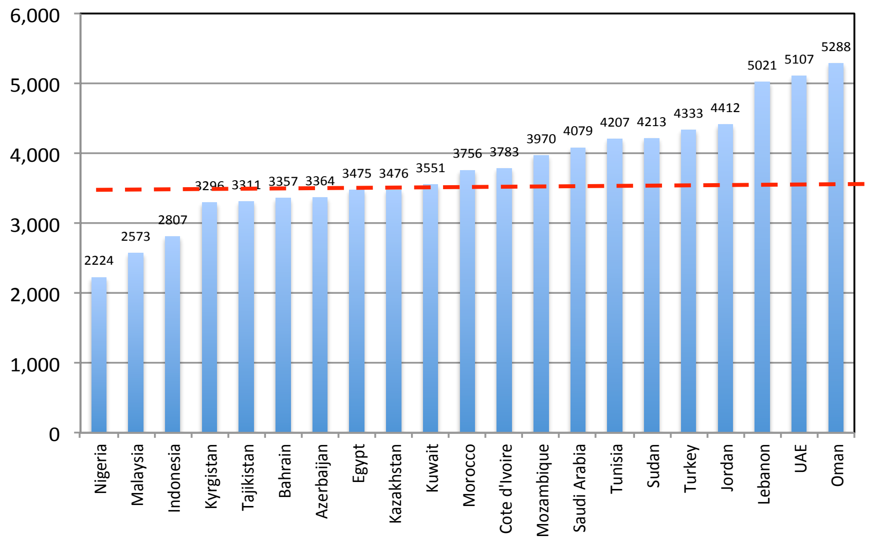
Table 29: OIC Member Countries: Mobile broadband market structure (2016)

Country	Number of Operators
Afghanistan	6
Albania	3
Algeria	2
Azerbaijan	3
Bahrain	3
Bangladesh	8
Benin	5
Burkina Faso	3
Cameroon	4
Côte d'Ivoire	3
Egypt	3
Gabon	4
Guinea	4
Guyana	2
Indonesia	8
Iran	6
Iraq	7
Jordan	3
Kazakhstan	4
Kuwait	3
Kyrgyzstan	6
Lebanon	2
Libya	3
Malaysia	6
Maldives	2
Mauritania	3
Morocco	3
Mozambique	3
Nigeria	4
Oman	2
Pakistan	9
Qatar	2
Saudi Arabia	4
Senegal	3
Sierra Leone	3
Somalia	9
Sudan	3
Syria	2
Suriname	2
Tajikistan	4
Togo	2
Tunisia	3
Turkey	3
Turkmenistan	2
Uganda	7
UAE	2
Uzbekistan	5
Yemen	4

Source: GSMA Intelligence

Based on this structure and the correspondent market shares of countries where complete information is available, the Herfindhal-Hirschman Index indicates that eight OIC Member Countries have a healthy competitive environment while thirteen exhibit moderate competitive intensity (see figure 20).

Figure 20: OIC Member Countries: Herfindahl-Hirschman Index of the mobile broadband industry (2016)



Sources: GSMA Intelligence; Regulatory Agencies; Telecom Advisory Services analysis

As the figure indicates, Nigeria, Malaysia, Indonesia, Kyrgyzstan, Tajikistan, Bahrain, Azerbaijan, and Egypt tend to have mobile broadband industries comprising a sufficient number of mobile broadband providers with important market shares.

Major providers

The broadband industry within the OIC Member Countries is composed of global operators and some smaller local carriers. An assessment of global players active in these countries indicates that, at least, seven global and/or regional operators have a significant footprint across the OIC Member Countries (see table 30).

Table 30: OIC Member Countries: Presence of global mobile broadband operators (2016)

Country	Orange	MTN	Vodafone	Airtel	Etisalat-Maroc Telecom	Zain	Millicom	Others
Afghanistan		MTN			Etisalat			Afghan Wireless (TSI), Roshan (TDCA), Salaam (Afghan Telecom), Wasel Telecom
Albania			Vodafone					ALBtelecom, Plus, Telekom Albania (OTE)
Algeria								Djezzy, Mobilis (Algerie Telecom), Ooredoo (NMTC)
Azerbaijan								Azercell (Fintur), Bakcell, Karabakh Telecom, Nar Mobile (Azerfon)
Bahrain						Zain		Batelco, Viva (Saudi Telecom)
Bangladesh				Bharti				Bangla link (Global

Country	Orange	MTN	Vodafone	Airtel	Etisalat-Maroc Telecom	Zain	Millicom	Others
								Telecom), Banglalion Communications, Citycell (Pacific Bangladesh), Grameenphone (Telenor), Qubee (Augere), Robi(Axiata), Teletalk
Benin		MTN			Moov			Bell Benin Communications, Benin Telecoms, Glo Mobile (Globacom)
Burkina Faso				Bharti	Telmob			Telecel (Planor afrique)
Cameroon	Orange	MTN						CamTel, Nexxtel (Viettel)
Chad				Bharti			Tigo	Sotel, Tchad Mobile
Comoros								Huri (Comores Telecom)
Cote d'Ivoire	Orange	MTN			Moov			GreenN (Oricel), KoZ (Comium), YooMee
Djibouti								Djibouti Telecom
Egypt	Mobinil		Vodafone		Etisalat			
Gabon				Bharti	Moov			Azur (Bintel), Libertis (Gabon Telecom)
Gambia								Africell (Lintel), Comium, Gamcel (Gamtel), QCell
Guinea	Sonatel	MTN						Cellcom, Intercel+ (Sudatel)
Guyana								Cellink (ATN), Digicel
Indonesia								3 (CK Hutchinson), BOLT! (Internux), Ceria (Sampoerna Telekom), Indosat Ooredoo, Smartfren, Telkomsel (Telekomunikasi Indonesia), XL (Axiata)
Iran		Irancell						MCI (TCI), MTCE, Rightel (Tamin Telecom), Taliya, TKC
Iraq						Zain		Asiacell (Ooredoo), FastLink (Regional Telecom), Kurdistan, Korek Telecom, Mobitel, Kurdistan
Jordan	Jordan Telecom					Zain		Umniah (Batelco)
Kazakhstan								ALTEL (Kazakhtelecom), Beeline (VimpelCom), Kcell (Fintur), Tele2
Kuwait						Zain		Ooredoo (NMTC), Viva (KTC)
Kyrgyzstan								Beeline (VimpelCom), Katel, MegaCom (Alfa Telecom), Nexi (SoTel), O! (NurTelecom), Saima Telecom, Sapatcom (Winline)
Lebanon						Touch		Alfa (OTMT)
Libya								Almadar Aljadeed, Libyana, LibyaPhone Mobile (Libya Telecom & Technology)
Malaysia								Celcom (Axiata), DiGi, Electcoms, Maxis, P1

Country	Orange	MTN	Vodafone	Airtel	Etisalat-Maroc Telecom	Zain	Millicom	Others
								(Telekom Malaysia), Telekom Malaysia, U Mobile, Yes (YTL Communications)
Maldives								Dhiraagu (Batelco), Ooredoo (NMTC)
Mali	Orange				Malitel			
Mauritania					Mauritel			Chinguitel (Sudatel), Mattel (Tunisie Telecom), Mauritel
Morocco					Maroc Telecom	Zain		Inwi (Wana), Meditel
Niger	Orange			Bharti	Moov			SahelCom (Sonitel)
Nigeria		MTN		Bharti	EMTS			GIo Mobile (Globacom), Multi, Links (Capcom), Smile, Visafone
Oman								Omantel, Ooredoo
Pakistan					PTCL			Mobilink (Global Telecom), PTCL, Qubee (Augere), Special Communications Organization, Telenor, Warid Telecom (Abu Dhabi), Wateen Telecom (Abu Dhabi), wi-tribe (Ooredoo), Zong (China Mobile)
Qatar			Vodafone					Ooredoo
Saudi Arabia					Etihad	Zain		Mobily, STC (Saudi Telecom)
Senegal	Sonatel						Tigo	Expresso (Sudatel)
Sierra Leone				Bharti				Africell (Lintel), Sierratel
Somalia								Golis Telecom, Hormuud Telecom, NationLink Telecom, Somafone, Somtel, Somaliland, Telcom, Telesom, Somaliland
Sudan		MTN				Zain		Sudani (Sudatel)
Suriname								Digicel Telesur
Syria		MTN						Syriatel
Togo					Moov			Togocel (Togo Telecom)
Tunisia	Orange							Ooredoo (NMTC), Tunisie Telecom
Turkey			Vodafone					Türk Telekom, Turkcell
Turkmenistan								MTS (Sistema), TMCELL (Altyn Asyr)
Uganda		MTN	Vodafone Afrimax	Bharti				Africell (Lintel), i-Tel, Smart, Smile, UT Mobile (Uganda Telecom)
U.A.E.					Etisalat			Du
Uzbekistan								Beeline (VimpelCom), Perfectum Mobile Ucell (TeliaSonera), UMS (MTS), UzMobile (Uzbektelecom)
Yemen		MTN						Sabafon, Y, Yemen Mobile

Source: GSMA Intelligence

Orange, the French-based telecommunications multinational, is present in 9 OIC Member Countries. With revenues of US$ 6.35 billion across Africa and the Middle East (growing at 7% year-on-year), Orange employs 22,000 professionals to serve 110 million customers. In the past three years, the operator has been consolidating its presence in Africa and the Middle East by strengthening its distribution network, developing its infrastructure and innovating to introduce new services. For example, Orange Money, the payment service is available in 13 countries: Côte d'Ivoire, Senegal, Mali, Niger, Madagascar, Kenya, Botswana, Cameroon, Jordan, Mauritius, Guinea, Egypt (under the name Mobicash), and Tunisia (under the name Mobimoney). By the end of 2014, Orange Money had over 13 million customers, and handled the equivalent of 4.5 billion euros in 2014. In order to promote the service, Orange has signed partnerships to enable payment of water and electricity bills in several countries, and initiatives in fields such as a savings and insurance offer in Mali in partnership with insurance company Nouvelle *Société Interafricaine d'Assurance*), e-commerce (payments on cdiscount.com in Côte d'Ivoire and Senegal), mobile access to Orange Money via an Android app in Senegal, Mali and Madagascar, and online from a bank account, through partnerships with the banks BNPP and BOA. Similarly, Orange has launched Orange Healthcare, which provides modern communication services in support of health professionals and patients in Africa. The service includes a medical advice hotline in Cameroon and is now opening out-of-hours pharmacies in Senegal and Côte d'Ivoire.

The MTN Group, headquartered in South Africa, is present in 11 OIC Member Countries. The carrier has total customers of 232.5 million and generates revenues of US$ 10.7 billion (2015) with an EBITDA margin of 40.9%. The carrier is in the midst of a transformation of internal structures aimed at becoming a data and digital organization. This includes enabling sales channels to provide digital services, and improve network service quality and customer service at all touch points. The carrier is the largest distributor of digital music in Africa supported by 'caller ring back tones'. It has also made progress in e-commerce by signing joint ventures with AIH and MEIH. For example, AIH recorded 2.3 million customers and 4.4 million transactions in 2015. Additionally, the carrier is focused on developing the enterprise and public sector markets. In 2015, the operator launched MTN Cloud business and a Pan African 'Internet of Things' platform. It has also expanded the MTN Global, multi protocol label switching (MPLS) bringing the footprint to 25 points of presence in Africa. MTN is preparing for broadband services in several OIC Member Countries by rolling out LTE and advanced LTE in Nigeria, and Cameroon, and FTTH in Nigeria, Cote d'Ivoire and Iran.

The Etisalat Group is the leading telecommunications operator in the Middle East and Africa. Headquartered in Abu Dhabi, the carrier had revenues of US$ 42.9 billion and EBITDA margin of 51% (2015). Fifty-six percent of its revenues were generated in the United Arab Emirates, 15.2% and 8.6% were generated in Morocco and Egypt respectively. The operator is present in 15 OIC Member Countries through partial capital ownership that provides operating control (for example, 53% in Maroc Telecom, 66% in Etisalat Egypt, 51% in Gabon Telecom), although some operations are fully owned (such as the Moov wireless carrier in West Africa, Etisalat Afghanistan, and obviously, Etisalat in the UAE). This presence is the result of an aggressive international expansion aimed at positioning the operator as a strategic rather than financial investor and to focus on investments which provide EG with operational influence over its assets. It is expected that the operator continue reinforcing its presence in core markets and regions internationally. In parallel with its international expansion, the operator is aiming at deploying new digital services such as e-Commerce platforms, M2M and Cloud solutions across its international footprint. The product strategy is driven by a central Digital Services Unit. This is emblematic of a strategy aimed at leveraging scale across the Group.

Headquartered in Kuwait, the Zain Group is present in the mobile broadband segment in eight OIC Member Countries, serving 45.6 million customers, and employing 6,700 employees. With US$ 3.8 billion in revenues and 44.7% in EBITDA margin, Zain's porfolio of subsidiaries comprises a mix of fully owned operations (Kuwait, Sudan, and South Sudan), partially owned with operational control (Jordan, Iraq, Bahrain, and Saudi Arabia), and financial investment and/or management contracts (Morocco, and Lebanon). The carrier has been consistently increasing its capital spending oriented toward deploying broadband LTE networks in Kuwait, Saudi Arabia, Jordan, Bahrain, and Lebanon.

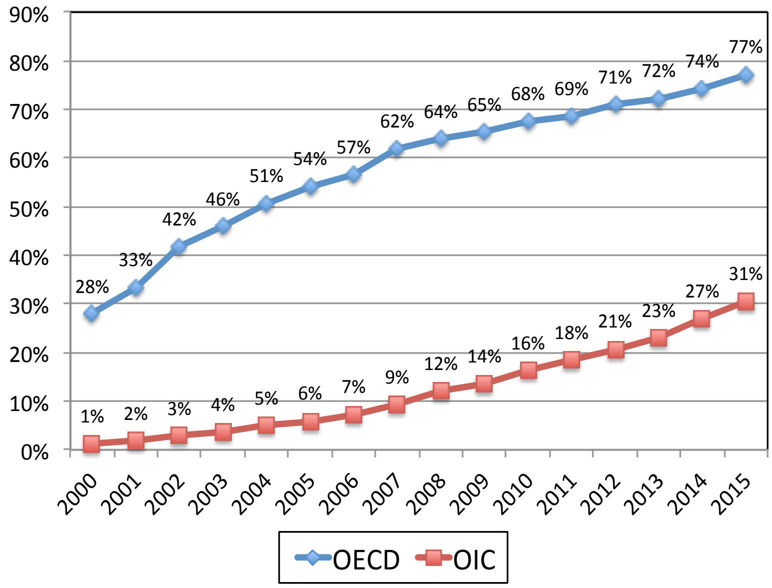
Bharti Airtel, headquartered in India, is a mobile broadband provider present in eight OIC Member Countries, all in Africa. The operator has been actively deploying new services, such as mobile money (Airtel Money), One touch Internet, Wynk Music Video and Games. At the same time, the operator has launched a 4G network in Gabon. The operator has a total of 15,406,000 data customers across its 3G and 4G networks in Africa. The review of global operators' deployment and product strategies indicates a common approach, predicated on five strategies:

- Expand across the OIC Member Countries based primarily on investment that grants operational control,
- Leverage global scale in product development, brand equity, and synergies in best practices and expertise,
- Consolidate positions in markets where they are either 1 or 2,
- Gradually migrate to 4G technology and FTTH (further to the home) only in selected markets, and
- Launch product strategies around digital products (mobile money, e-commerce, digital music).

IV. 2. Broadband Demand in the OIC Member Countries

Thirty-one percent of individuals residing in the OIC Member Countries access the Internet on a regular basis. Internet penetration has been growing at a fast pace since 2008 when the gap between these states and OECD countries has begun to narrow down (see figure 21).

Figure 21: OECD versus OIC Member Countries: Internet penetration



Sources: International Telecommunications Union; Telecom Advisory Services analysis

However, as of 2015, at this point the proportion of Internet users in the OIC Member Countries (30.59%) is half that of OECD countries (77.24%). As expected, the percentage of Internet users varies significantly across the OIC Member Countries. For example, Internet penetration in African OIC Member Countries reaches 27.90%, while in Arab countries it is 39.53%, and in Asian OIC Member Countries it is 28.05%. The difference between the OIC and all countries in each of the regions is presented in table 31.

Table 31: Internet Penetration: OIC Member Countries vs. all countries

	OIC Member Countries	All Countries (only major countries cited)
Africa	27.90%	• Eastern Africa (Burundi, Comoros, Djibouti, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Tanzania, Uganda, Zambia, Zimbabwe): 15.57% • Middle Africa (Angola, Cameroon, Central African Republic, Chad, Congo, Equatorial Guinea, Gambia): 8.34% • Northern Africa (Algeria, Eritrea, Libya, Morocco, Sudan, Tunisia): 37.00 % • Southern Africa (Botswana, Egypt, Lesotho, Namibia, South Africa): 48.26% • Western Africa (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo): 31.09%
Asia	28.03%	• Australasia (Australia, New Zealand): 85.13% • Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan): 43.98% • Eastern Asia (China, Korea, Mongolia, Taiwan): 54.71% • Melanesia (Fiji): 13.79% • Micronesia: 42.11%

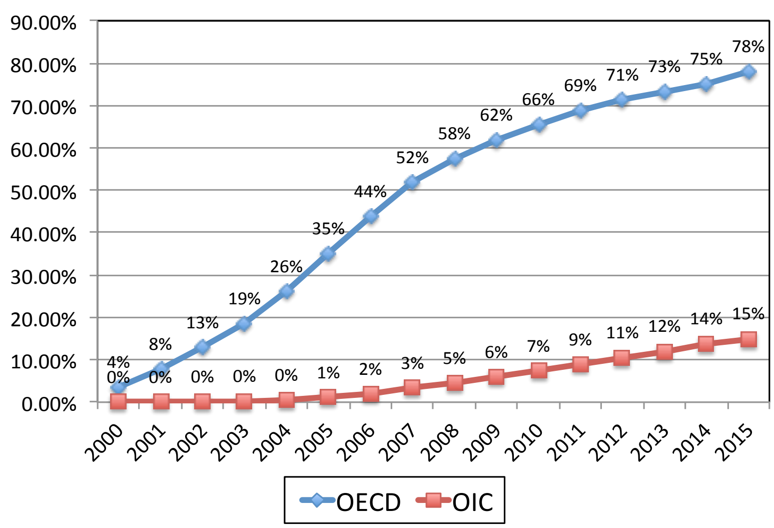
	OIC Member Countries	All Countries (only major countries cited)
		• Polynesia: 47.33% • South-Eastern Asia (Brunei, Cambodia, Indonesia, Lao, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, Vietnam): 34.17% • Southern Asia (Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, Singapore): 24.53%
Arab	39.53%	• Western Asia (Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, Turkey, UAE, Yemen): 50.35%

Sources: International Telecommunications Union; Telecom Advisory Services analysis

The differences between OIC Member Countries and all other countries by region have to be interpreted with caution. For example, the 10 percentage point difference between Arab OIC Member Countries and Western Asian countries is due to the fact that the latter includes Armenia, Azerbaijan, Cyprus, Georgia, Israel and Turkey, countries with high Internet penetration which increase the prorated average. On the other hand, the Asian OIC Member Countries (Internet penetration: 28.03%) represent a prorated average of Central Asia (43.98% Internet penetration) and some Southern Asian countries (Internet penetration: 24.53%). Finally, African OIC Member Countries (Internet penetration: 27.90%) represent the average countries in all African regions, except for Southern Africa.

In the case of fixed broadband, as of 2015, penetration within the OIC Member Countries has reached 14.95% of total households, compared to 78.07% in OECD countries. In addition to the significant difference between both groups of countries, it should be noted that fixed broadband among the OIC Member Countries has not been increasing at a pace comparable to Internet adoption (see figure 22).

Figure 22: OECD vs. OIC Member Countries: Fixed broadband penetration (2000-2015) (percent of households)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Due to the limited statistics for fixed broadband coverage, the fixed broadband demand gap can only be calculated for only few countries (see table 32).

Table 32: Selected OIC Member Countries: Fixed broadband demand gap (percent of households) (2016)

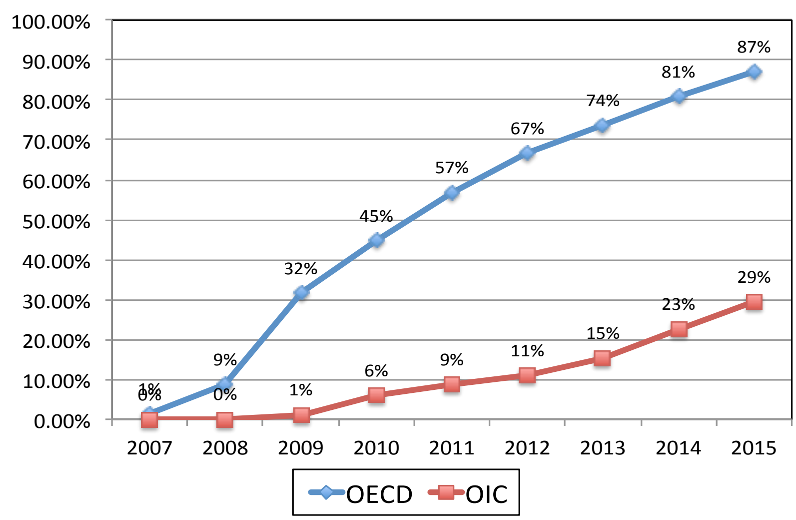
Country	Fixed Broadband Coverage (%)	Fixed Broadband Penetration (%)	Demand Gap (%)
Benin	5.00	3.36	1.64
Cote d'Ivoire	20.00	4.00	16.00
Jordan	85.00	24.00	61.00
Kazakhstan	85.00	50.23	34.77
Saudi Arabia	80.00	77.56	2.44
Suriname	60.00	50.63	9.37

Source: Study survey and interviews

It is difficult to draw inferences from the fixed broadband demand gap. It would seem that in the case of Suriname and Saudi Arabia (and Benin due to the low coverage), supply and demand of fixed broadband have reached an equilibrium, while in the case of Cote d'Ivoire, Kazakhstan and Jordan the demand gap is significantly high.

In the case of mobile broadband, as of 2015, penetration within the OIC Member Countries has reached 29.41% of total population, compared to 87.17% in OECD countries. However, in this case, the penetration growth trends indicate a slowing down among OECD countries (which implies a gradual saturation) and an acceleration among the OIC Member Countries, which reveals a convergence in adoption between both groups (see figure 23).

Figure 23: OECD versus OIC Member Countries: Mobile broadband penetration (2007-2015) (percent of households)



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Furthermore, mobile broadband penetration within the OIC Member Countries varies widely. For example, penetration among Arab OIC Member Countries has reached 42.09%, while the same statistic for Asian OIC Member Countries is 29.62% and among African OIC Member Countries is 17.30%. Finally, when assessed penetration against coverage, the mobile broadband demand gap can be accurately measured across the OIC Member Countries (see table 33).

Table 33: Mobile broadband demand gap (2015)

Country	Population Covered (%)	Connections Penetration (%)	Demand Gap (%)
Kuwait	100.00	139.31 (*)	0
Bahrain	97.90	131.78 (*)	0
Saudi Arabia	97.00	111.67 (*)	0
Malaysia	92.00	89.94	2.06
Suriname	80.00	75.85	4.15
Algeria	46.00	40.11	5.89
UAE	100.00	91.99	8.01
Chad	13.00	1.38	11.62
Kazakhstan	72.70	59.97	12.73
Uzbekistan	44.00	28.69	15.31
Sudan	45.73	29.41	16.32
Oman	95.00	78.26	16.74
Indonesia	60.00	42.05	17.95
Qatar	98.00	80.03	17.97
Guinea	39.10	13.93	25.17
Uganda	45.00	18.31	26.69
Kyrgyzstan	59.00	30.96	28.04
Somalia	30.00	0.99	29.01
Côte d'Ivoire	71.00	40.39	30.61
Tunisia	94.00	62.63	31.37
Pakistan	46.00	13.02	32.98
Afghanistan	40.00	5.97	34.03
Maldives	100.00	63.64	36.36
Azerbaijan	97.30	60.92	36.38
Iran (I.R.)	59.81	20.02	39.79
Mozambique	50.00	9.37	40.63
Morocco	80.00	39.28	40.72
Benin	45.00	4.24	40.76
Lebanon	96.40	53.43	42.97
Togo	50.00	6.02	43.98
Turkey	95.03	50.94	44.09
Nigeria	66.60	20.95	45.65
Cameroon	50.00	4.27	45.73
Egypt	97.80	50.66	47.14
Iraq	55.00	3.55	51.45
Bangladesh	71.00	13.45	57.55
Albania	99.00	40.58	58.42
Syria	70.00	10.38	59.62
Gabon	95.00	33.12	61.88
Jordan	99.00	35.58	63.42
Gambia	86.00	10.02	75.98
Brunei Darussalam	91.00	4.48	86.52

Demand gap <10% | Demand gap between 10% and 20% | Demand gap >20%

(*) A higher number of connections than coverage could indicate two lines per individual in some cases
Sources: Regulatory Agencies; International Telecommunications Union; Telecom Advisory Services analysis

Only in a few OIC Member Countries, the mobile broadband demand gap is non-existent: Algeria, Bahrain, Kuwait, Saudi Arabia, Suriname, and United Arab Emirates. In other countries, the demand gap ranges between 10% and 20% (Chad, Indonesia, Kazakhstan, Oman, Qatar, Sudan, and Uzbekistan), while in the rest of countries, the demand gap exceeds 20%. When prorated by population, the mobile broadband demand gap across the OIC Member Countries varies widely (see table 34).

Table 34: OIC Member Countries: Mobile broadband demand gap (2015)

	Mobile Broadband Coverage (3G) (%)	Mobile Broadband Penetration (%)	Mobile Broadband Demand Gap (%)
OIC Asian Region	62.69	29.62	33.07
OIC African Region	57.71	17.30	40.41
OIC Arab Region	74.30	42.09	32.21
Total OIC	64.16	29.41	34.75
OECD	97.78	87.17	10.61

Sources: GSMA Intelligence; International Telecommunications Union; Telecom Advisory Services analysis

The difference between the mobile broadband demand gap among OECD countries and OIC Member Countries is clear. Among industrialized countries, the mobile broadband supply and demand are close to reaching equilibrium with only 10.61% of the population covered by networks not acquiring the service. The situation is more worrisome among the OIC Member Countries: while the gap reaches 40.41% among African countries, in the case of Asian and Arab OIC Member Countries, the demand gap hovers at around 33%, bringing the prorated average for the whole community at 34.75%.

The factors driving these high numbers? In Chapter III, it was explained that the residential broadband demand gap is the result of three obstacles:

- Limited affordability: certain portions of the population either cannot acquire a device or purchase the subscription needed to access the Internet,
- Lack of digital literacy,
- Lack of relevance or interest: the value proposition of applications, services, and content does not fulfill a need of the adopting population.

A compilation of research on adoption barriers indicates that affordability remains a preeminent variable in explaining the non-adoption of broadband, particularly in emerging countries. Among the OIC Member Countries, approximately 9 % of non-adopters have responded that affordability is one of the reasons for not acquiring broadband, while 6% mentioned lack of digital literacy and 14% responded that they either did not need the Internet or argued that a cultural barrier prevented them from acquiring the service (see table 35).

Table 35: Reasons of broadband non-adopters for not purchasing broadband (percentage of responses) (%)

Country (year of survey)	Cost is too high		Lack of Digital Literacy	Do not need it or "cultural reason"	Privacy or security concern	Acces Internet elsewhere	Service is not available
	Service	Handset					
Bahrain (2015)	3.70	4.20	6.80	10.30	0.20	3.80	
Egypt	1.60	1.90	0.60	1.60	1.30		56.40

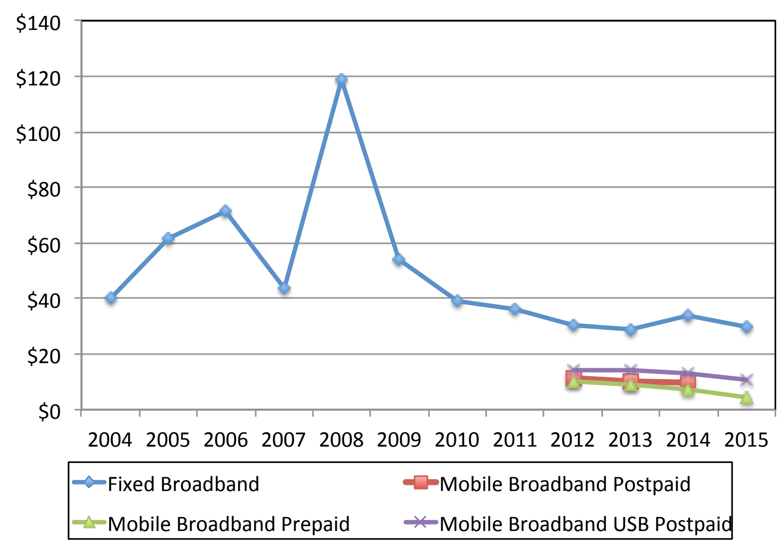
Country	Cost is too high		Lack of	Do not need	Privacy or	Acces	Service is
(2014)							
Iran (2013)	1.70	7.10	13.40	46.90	5.20	19.90	12.80
Morocco (2014)	17.90	23.30	14.80	25.80	4.10	8.60	1.80
Oman (2013)	4.90	2.10	3.80	3.10	0.20	0.50	6.40
Qatar (2015)	0.60	0.40	0.20	2.30		1.50	
Turkey (2013)	13.10	11.00	11.20	17.60	0.60	4.90	0.80
UAE (2014)	28.50	0	0	9.00		25.30	

Source: Surveys compiled by the International Telecommunications Union. ITU World Telecommunications/ICT Indicators Database 2016: ICT Households Access and Individual Use; indicator 17: Household without internet access by type of reason.

As a confirmation of the adoption barriers discussed in chapter III, the survey data indicates that, with the exception of handset cost in Qatar and the United Arab Emirates, limited affordability represents an important barrier. While surveys for African countries are not available, it is reasonable to assume that affordability represents a more important challenge in that region. In addition to affordability, lack of digital literacy and cultural barriers also represent an obstacle to broadband adoption.

In light of these findings, it is pertinent to first examine what the general trend is with regards to broadband pricing. If non-adopters cite pricing as an adoption barrier, how has pricing of broadband evolved over the past years within the OIC Member Countries? Figure 24 presents the average pricing of selected broadband products across the OIC Member Countries.

Figure 24: OIC Average: Pricing of selected broadband products



Sources: International Telecommunications Union; Telecom Advisory Services analysis

Figure 24 presented the average pricing across the OIC Member Countries of four broadband offerings in US dollars: a) most economic fixed broadband monthly subscription; b) most economic mobile broadband postpaid monthly subscription for smartphone (500 MB cap), c) most economic mobile broadband postpaid monthly subscription for USB (1 GB cap), and d) most economic mobile broadband prepaid monthly subscription for smartphone (500 MB cap). In all four cases, pricing has been declining in large part due to competitive intensity, as discussed in the supply section above. The country level pricing trends helps identifying some of the reasons why non-adopters mention cost as being a dominant barrier. For example, in Morocco, where close to 18% of consumers indicated that service cost was a key adoption barrier, pricing of the prepaid plan for smartphones has been relatively stable between 2013 and 2015 (it actually increased from US$ 11.47 to US$ 11.78). The Herfindahl-Hirschman Index for Morocco's mobile broadband industry is 3,756 indicating moderate competition. At the opposite end, only 3.70% of Bahraini mobile broadband non-adopters single out pricing as a barrier. Monthly price of the prepaid mobile broadband product dropped from US$ 13.30 in 2013 to US$ 7.98 in 2015. The Herfindahl-Hirschman Index for Bahrain mobile broadband industry is 3,357. To sum up, competition leads to price reduction, which, in turn allows more vulnerable consumers to acquire broadband service.

Potential risks related to the increased use of broadband

While this area is not generally well researched in the literature, it is beginning to be investigated particularly in those countries that have achieved high broadband penetration, such as Korea and the United States.

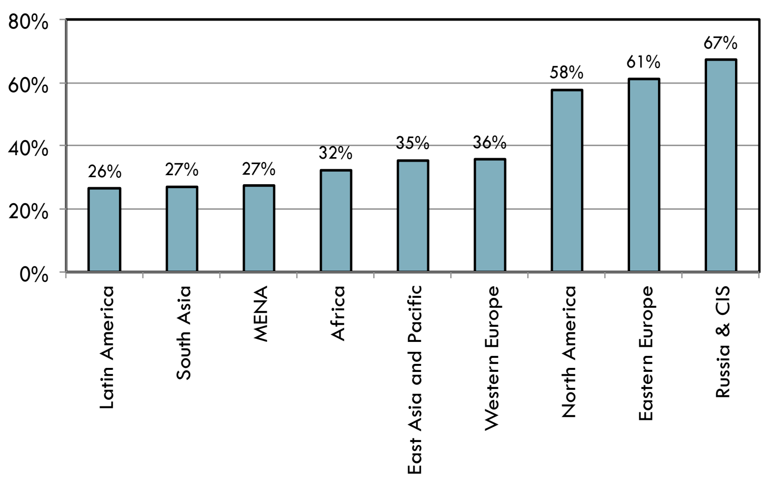
The first risk is the degradation of human relationships resulting from intense digital consumption. Americans spend an average of five and a half hours a day with digital media, more than half of that time on mobile devices, according to the research firm eMarketer. Among some groups, the numbers range much higher. Once out of bed, users check their phones 221 times a day—an average of every 4.3 minutes—according to a UK study. This number actually may be too low, since people tend to underestimate their own mobile usage. Research by Sherry Turkle (2015) argues that the digital revolution, by its intensity, is degrading the quality of human relationships. Turkle finds the roots of the problem in the failure of young people absorbed in their devices to develop fully independent selves. She argues that digital devices disrupt the ability of children to separate from their parents, and raise other obstacles to adulthood. Because they are not learning how to be alone, Turkle contends, young people are losing their ability to empathize. Along these lines, social media offer respite from the awkwardness of unmediated human relationships.

The second risk, particularly among adolescents, is the decline in conducting other knowledge gathering activities such as reading. In a research by Prof. Raul Katz (Katz, 2012), high school students in the United States spend on average 554.80 minutes (or 9.25 hrs.) a day using technology devices during the week. Of these, 279 minutes are spent in front of a PC and 191 in front of a cellphone. Given the increasing capability of cellphones, it is expected that future studies would yield a much higher time allocation to smartphones at the expense of the PC.

Conversely, the study found that teenagers read for leisure an average of 5.6 books per year. Along these lines, girls tend to read more than boys (6.6 vs. 3.9). The higher levels of video game playing amongst boys could partly explain this trend. Furthermore, when it comes to human interaction, most adolescents prefer texting to calling on their cellphones.

A third risk that has been studied particularly in developing countries is cultural uprooting. An analysis conducted by Prof. Raul Katz of the most popular Internet sites accessed by region indicates that in MENA countries, only 27 of 100 most popular sites, measured by number of visitors and time spent on the site are produced locally, while the remaining are either produced overseas or developed overseas and translated to local language (see figure 25).

Figure 25: Percentage of local internet content by region (2013)



Source: Katz (2013) based on Alexa data

The data in figure 25 indicates two important patterns. First, developed regions appear to have a higher percentage of the most popular Internet sites to be local. Second, regions with linguistic specificities (such as Russia) appear to have a higher percentage of local content. Conversely, developing regions with use of one of the world languages (Latin America for Spanish, South Asia for English, MENA and Africa for French and English) tend to have a lower percentage of local Internet content. The implications of these data are that as result of limited local content production, the Internet could act as vehicle for cultural uprooting. This finding is also confirmed by the in-depth case study of Cote d'Ivoire presented in section V.1.

A fourth risk related to the increased use of broadband pertains to the economic disruption of an Internet shutdown. As discussed in chapter II, world economies are increasingly reliant on the Internet. Furthermore, and again as explained in the same chapter, broadband is vital for economic development. In this context, it is reasonable to consider what the economic impact might be of a disruption of the Internet as a result of either natural or man-made causes. These appear to be fairly common as documented by Howard, Agarwal, and Hussain (2011). The authors identified 606 government-imposed shutdowns of the Internet between 1995 and the first part of 2011, for a total of 99 countries. In 2010 alone, the number of man-made shutdowns reached 111. Between July 2015 and June 2016, West (2016) counted 81 government-imposed disruptions, of which 36 affected the national broadband network and 22 impacted subnational mobile networks. Beyond government-initiated downtime, the Internet is constantly affected by localized downtimes. According to the disruption tracking platform Pingdon, at any hour period worldwide, the Internet is affected by approximately 16,000 outages. Man-made and technology disruptions have an economic impact. The economic impact per day varies by the type of disruption, ranging, according to West (2016) from $ 3,816,000 for a national app (such as Twitter or Google) to $ 14,968,000 for the national Internet[36].

So far, the cultural, social and economic risks to the OIC Member Countries related to achieving high broadband penetration have been reviewed. This section should also address the risks that exist for the OIC Member Countries if they do not achieve high broadband penetration (this has been called the "opportunity cost"). As discussed in Chapter II, broadband has been found to have an impact on economic development, competitiveness, and social inclusion. This means that the OIC Member Countries need to foster the development of broadband while acknowledging the social and cultural risks it entails and implementing the necessary remedies to control them. First and foremost, the development of local content is an imperative that would limit the potential negative effects of cultural uprooting.

[36] This impact only looks at GDP, and excludes lost tax revenues, impact on worker productivity, barriers to business expansion, and loss in investor or consumer confidence.

V. COUNTRY CASE STUDIES

To complement the study of the situation of broadband development in the OIC Member Countries, three countries were selected to conduct case studies. The objective was to gain a deeper understanding of trends and issues by visiting the country to interview industry stakeholders and collect data that would otherwise not be available in public international databases. The three countries selected were chosen to represent not only a specific geography but also particular challenges with regards to the development of broadband. In particular, the categories considered for selection included economic development (as measured by GDP per capita), broadband supply (measured by fixed and mobile broadband coverage) and demand (with regards to penetration) (see table 36).

Table 36: State of broadband supply and demand of the OIC Member Countries

	GDP per capita	Supply			Demand	
		Fixed Broadband Coverage (ADSL)	Mobile Broadband Coverage (3G)	Mobile Broadband Coverage (4G)	Fixed Broadband Penetration (households)	Mobile Broadband Penetration (population)
OIC Average		**53.33%**	**64.16%**	**46.82%**	**14.95%**	**29.41%**
Advanced	**High**	**>70 %**	**>70%:**	**>70%**	**>70%**	**>70%**
Medium	**Medium**	**70%-40%**	**70%-40%**	**70%-40%**	**70%-40%**	**70%-40%**
Limited	**Low**	**<40%**	**<40%**	**<40%**	**<40%**	**<40%**

Source: Telecom Advisory Services analysis

The three countries selected were fairly good representations of each of three categories (see table 37).

Table 37: OIC Member Countries: State of broadband supply and demand

	GDP per capita	Supply			Demand	
		Fixed Broadband Coverage (ADSL)	Mobile Broadband Coverage (3G)	Mobile Broadband Coverage (4G)	Fixed Broadband Penetration (households)	Mobile Broadband Penetration (population)
OIC Average		**53.33%**	**64.16%**	**46.82%**	**14.95%**	**29.41%**
Advanced	Saudi Arabia: US$ 37,729	**>70 %** Kazakhstan, Saudi Arabia	**>70%:** Cote d'Ivoire, Kazakhstan, Saudi Arabia	**>70%** Kazakhstan, Saudi Arabia	**>70%** Saudi Arabia	**>70%** Saudi Arabia
Medium	Kazakhstan: US$ 9,873	**70%-40%**	**70%-40%**	**70%-40%**	**70%-40%** Kazakhstan	**70%-40%** Cote d'Ivoire, Kazakhstan
Limited	Cote d'Ivoire: US$ 1,373	**<40%** Cote d'Ivoire	**<40%**	**<40%** Cote d'Ivoire	**<40%** Cote d'Ivoire	**<40%**

Source: Telecom Advisory Services analysis

Cote d'Ivoire is a country challenged by low income distribution, low fixed broadband coverage and penetration, high 3G coverage but low 4G coverage, and medium mobile broadband adoption. Kazakhstan is a middle-income country with high fixed and mobile coverage (both 3G and 4G) and medium service adoption. Finally, Saudi Arabia is a high-income country, with high supply and demand of fixed and mobile broadband service.

V.1. COTE D'IVOIRE

The following case study assesses the state of broadband services in the Cote d'Ivoire. It assesses the trends in demand and supply, the broadband industry structure, and the state of investment and technology infrastructure. Broadband plays an important role in driving the country's economic growth and overall prospects. On the economic side, telecommunications can increase the inter-linkages among Ivoirian enterprises as well as facilitate their exports. Additionally, telecommunications can improve the productivity of small farmers by enhancing their access to inputs while facilitating market reach. From a development standpoint, broadband can serve to enhance the delivery of public services (e.g., education, health), improve social inclusion of rural populations, and enhance the economic prospects of the urban poor.

V.1.1. Demand for Broadband Service

Fixed and mobile broadband usage rates

The adoption of broadband services in Cote d'Ivoire is a fairly recent phenomenon. The diffusion of fixed broadband begun in 2003. The initial rate of growth was modest until 2009, with adoption increasing at a rapid pace from 2010 to 2014. However, as table 38 indicates, despite the high growth that took place through 2014, fixed broadband penetration has only reached 3.72% of households.

Table 38: Fixed broadband lines (2003-2016)

	2003	2007	2009	2010	2011	2012	2013	2014	2015	2016
Lines	413	10,000	10,000	27,123	73,564	119,526	133,982	126,857	109,707	101,955
Percent household (%)	0.02	0.44	0.42	1.11	2.94	7.82	5.13	4.74	4.00	3.72

Sources: International Telecommunications Union; Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

On the other hand, mobile broadband has the potential to become the dominant mode of Internet access in the country, reaching 7.5 million subscribers in 2Q2016 after launching only in 2011 (see table 39).

Table 39: Mobile broadband subscriptions (2011-2016)

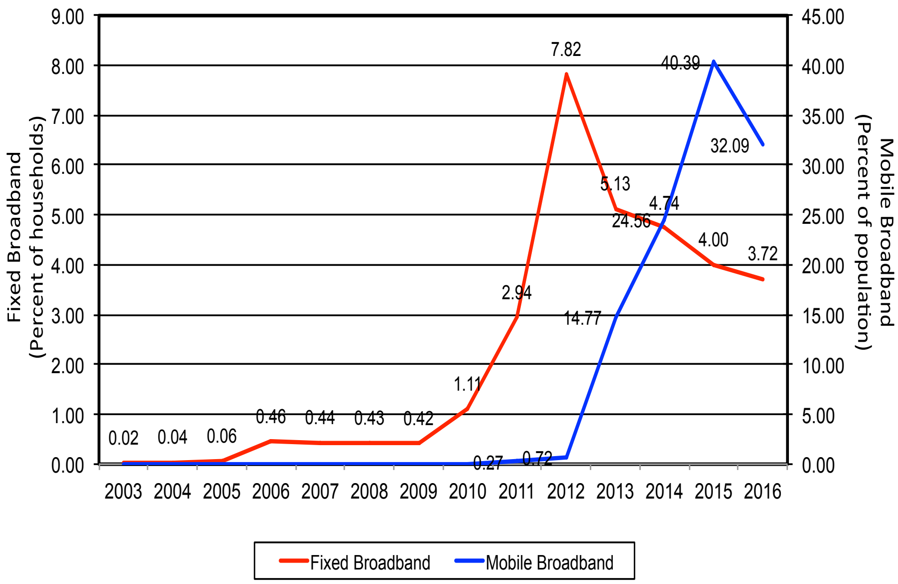
	2011	2012	2013	2014	2015	2016 (2Q)	CAGR
Subscriptions	52,741	143,291	3,000,000	5,108,718	8,602,170	7,498,587	170 %
Percent Population (%)	0.27	0.72	14.77	24.56	40.39	32.09	160 %

Sources: GSMA Intelligence; Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

Due to the mobile broadband suitability, the technology penetration has been growing at the high annual rate of 170%, reaching 32.09% penetration at the end of the second quarter of 2016. The decline from the high point at the end of 2015 is partly due to the closing of operations of two mobile operators (see market structure section below).

The comparative analysis of adoption trends between fixed and mobile broadband indicates a clear substitution pattern, whereby the latter is capturing share from the former (see figure 26).

Figure 26: Cote d'Ivoire: Comparative adoption of fixed and mobile broadband (2003-2016)



Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; International Telecommunications Union; Telecom Advisory Services analysis.

As figure 26 indicates, the deployment of mobile broadband networks in Cote d'Ivoire resulted in a massive substitution effect. As soon as mobile broadband adoption picked up, the penetration of fixed broadband started to decline.

Average monthly broadband consumption in Cote d'Ivoire indicates a variance between 3G and 4G subscribers. This is to be expected since 3G technology does not provide an adequate user Internet experience. On the other hand, 4G and fixed broadband consumption is somewhat in line with what is observed in other OIC Member Countries (see table 40).

Table 40: Comparative broadband usage (2016)

	Cote d'Ivoire	Middle East and Africa (2015)	Saudi Arabia (2015)
Monthly 3G use	400 MB	908 MB	673 MB
Monthly 4G use	1 GB		
Monthly ADSL use	67 GB	- - -	50.7

Note: Saudi Arabia fixed broadband reflects a wider adoption universe with lower usage intensity
Source: Field trip interviews; Cisco Visual Networking Index

The broadband consumption volume for Cote d'Ivoire has been growing at 57% annually for the past two years[37], twice the rate of what is observed in Saudi Arabia (27%). The consumption increase in Cote d'Ivoire is similar to the average growth rate reported for the whole Middle East and Africa (46%)[38].

While usage in mobile devices is concentrated on visits to Facebook and Google/YouTube (see figure 27 below), the use in ADSL also includes video-streaming sites (like Netflix), and Peer-To-Peer downloading sites (like Bit Torrent).

Most common purposes of Internet use

The International Telecommunications Union reports that 21% of the population of Cote d'Ivoire in 2015 accessed the Internet on a regular fashion[39] (see table 41).

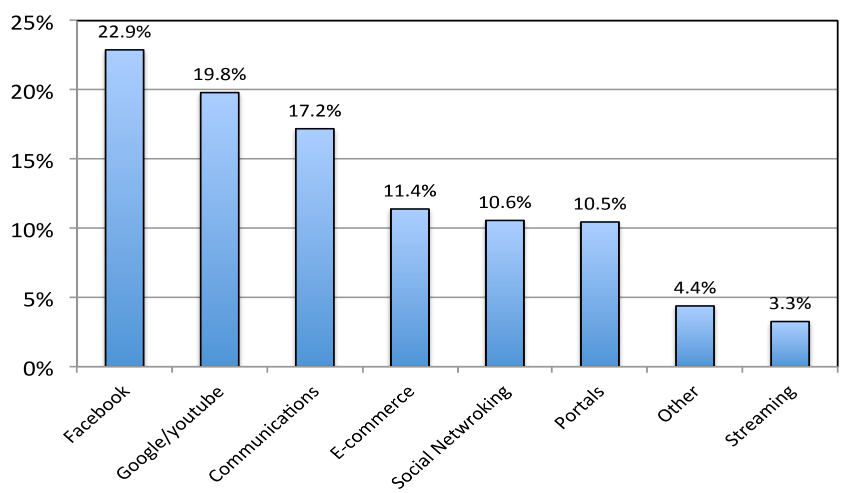
Table 41: Cote d'Ivoire: Population accessing the Internet (2003-2015)

	2003	2005	2007	2009	2010	2011	2013	2014	2015
Users	128,510	180,890	323,080	372,020	512,370	562,310	1,706,550	3,037,490	4,472,010
% Pop.	0.76	1.04	1.80	2.00	2.70	2.90	8.40	14.60	21.00

Sources: International Telecommunications Union; Telecom Advisory Services analysis

Internet usage is fairly strong with regards to accessing Facebook and Google sites (including YouTube), which represent 43% of unique visitors (see figure 27).

Figure 27: Cote d'Ivoire: Unique visitors among sites with > 100,000 visits (September 2016)



Source: Cote d'Ivoire operator; Telecom Advisory Services analysis

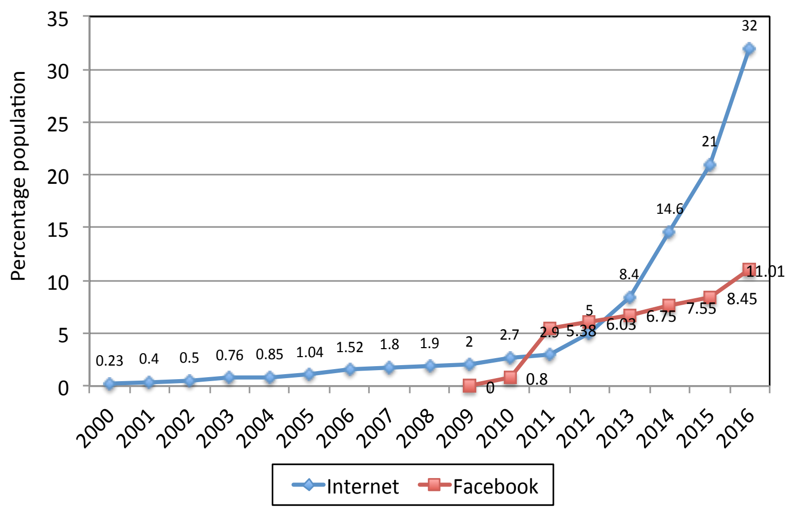
Beyond Facebook and Google, the next categories of destinations are those that are communications platforms (Skype, WhatsApp, QQ, Viber), followed by e-commerce sites (Amazon, Taobao, Jumia) and other social networks (Twitter, Instagram, Linkedin, and

[37] Source: Orange interview.
[38] Source: Cisco Visual Networking Index.
[39] It should be mentioned that a portion of the Ivoirian population accesses the Internet from Internet cafes, estimated to reach 1,347 in the whole country (ARTCI).

Tumblr). Interestingly enough, only 3.3% of Internet users access video streaming sites, excluding YouTube.

A comparison between Internet and Facebook members indicates that approximately one third of Internet users are also Facebook members. As indicated above, Facebook is the dominant social network in Cote d'Ivoire (see figure 28).

Figure 28: Cote d'Ivoire: Internet users and Facebook members (2000-2016)



Sources: International Telecommunications Union; CITC; Owloo; Telecom Advisory Services analysis

Data in figure 28 indicates that Internet usage is growing at a faster rate than Facebook membership. This usage pattern in which a large portion of Internet users are not necessarily Facebook members is fairly common in other regions of the world such as Sub-Saharan Africa, (see table 42).

Table 42: Facebook members as regular internet users (2015)

Region	Internet Users	Facebook Members	Facebook Members as % of Internet users
Western Europe	195,230,709	98,992,670	50.71
Rest of Europe	369,232,406	213,950,740	57.94
North America	274,225,765	213.075.500	77.70
Latin America	338,482,028	297.638.420	87.93
Asia - Pacific	1,704,885,395	1.431.361.831	83.96
Sub-Saharan Africa	210,735,220	69.052.400	32.77
Cote d'Ivoire	4,472,010	939,122	21.01
North Africa	67,924,936	55.667.000	81.95
World	3,160,716,459	2.379.738.561	75.29

Sources: International Telecommunications Union; Owloo; Telecom Advisory Services analysis

Sub-Saharan Africa is an area of the world where social networking significantly lags the population of Internet adopters. For example, in Latin America Facebook members in 2015 represented more than 87% of Internet users. On the other hand, Cote d'Ivoire even lags the rest of Sub-Saharan Africa, confirming the statistics in figure 28 indicating that Ivorian Internet users tend to rely on the Internet for applications other than Facebook.

Beyond communications and e-commerce, one of commonly used applications is mobile money. Cote d'Ivoire is one of the most vibrant mobile money markets in Africa. All three mobile operators and two non-bank e-money issuers offer mobile money services (see table 43).

Table 43: Cote d'Ivoire: Mobile money services

Mobile Money Service	Service Provider	Partner	Date of Launch
Orange Money	Orange	BICICI (BNP Paribas)	12/2008
MTN Mobile Money	MTN	SGBCI (Société Générale)	10/2009
CelPaid	CelPaid	---	2/2011
Flooz	Moov	BIAO	1/2013
Mobile Banking	Qash Services	---	11/2013

Source: GSMA (2014)

As a result of this activity, there are close to 7 million registered mobile money accounts, more than all bank and microfinance accounts put together. This development is fostered by the forced introduction of electronic transactions. For example, as of 2015, all secondary school fees had to be paid using mobile money, while half of electric bills are paid using the platform. As a result, the number of subscribers to mobile money in 2016 reached almost 7 million (see table 44).

Table 44: Number of MNO-only subscribers to mobile money (2014-2016)

	2014	2016 (2Q)
Orange	3,524,717	4,819,769
MTN	1,467,264	1,492,726
MOOV	1,068,551	426,245
Total	6,090,532	6,873,309

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire

Major factors that influence use of fixed and mobile broadband

The major factors that influence non-adoption of the Internet in Cote d'Ivoire will now be assessed. For this purpose, one should start by measuring the extent of the broadband demand gap. The demand gap measures the difference between the population that can purchase broadband service because of service availability, and the population that actually acquires service, which quantifies the number of non-adopters for reasons other than coverage. Considering that mobile broadband coverage of the population has reached 83% at the end of 2015, this would indicate that the demand gap is 51%. As table 45 indicates, the demand gap has been increasing over time because the rate at which operators are deploying 3G networks is higher than the speed of subscriber growth (see table 45).

Table 45: Cote d'Ivoire: Mobile broadband demand gap (2011-2016)

	2011	2012	2013	2014	2015	2016 (2Q)	CAGR (*)
Population coverage (%)	10.00 (*)	15.00 (*)	21.78	43.56	71.00	83.00	60
Subscribers as % of Population	0.27	0.72	14.77	24.56	40.39	32.09	160
Demand gap (%)	9.73	14.28	7.01	19.00	30.61	50.91	35

(*) Compound Annual Growth Rate
Sources: GSMA Intelligence; Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

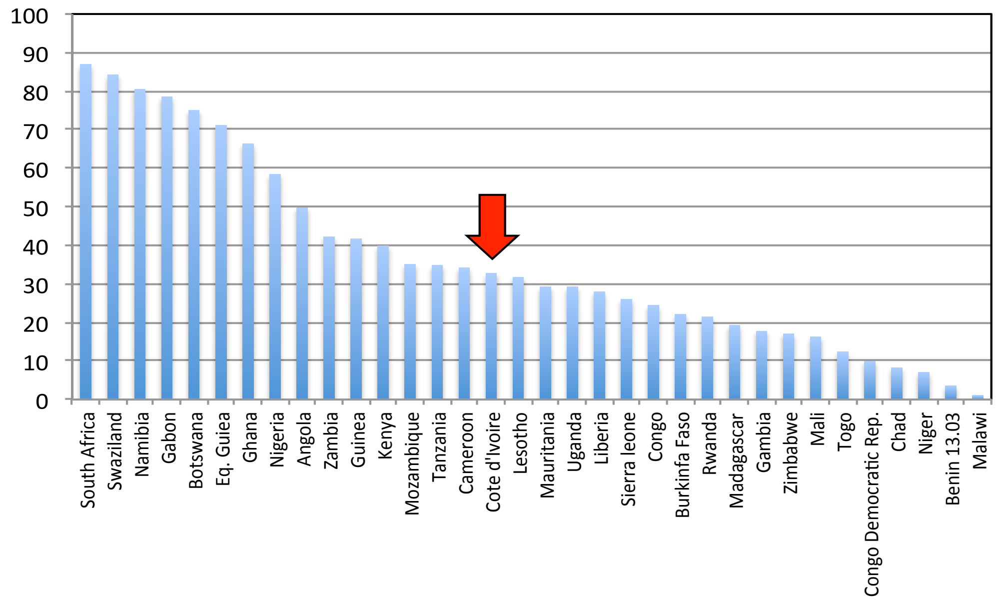
Table 45 illustrates the dynamics between mobile broadband coverage and adoption in Cote d'Ivoire. Both trends do not evolve in parallel. At some points in time, such as in 2013, adoption outpaces the speed at which coverage is increasing. This is why the demand gap is cut in half. When operators accelerate their deployment (such as the period between 2013 and 2016 when coverage increases from 21.78% to 83%), demand for subscriptions increases at a slower pace. This is the time when the demand gap increases. Obviously, it is expected that when the coverage growth rate slows down, the demand gap will contract.

Therefore, almost half of the population currently reached by broadband networks does not purchase the service. Other research conducted by Prof. Raul Katz (Katz and Berry, 2014) concluded that there are three factors that drive broadband non-adoption: affordability, cultural relevance, and digital literacy. While there are no surveys in the Cote d' Ivoire that explore the relative importance of each of these three barriers, some conclusions can be drawn from interviews and the analysis of related data.

Starting with affordability, Cote d'Ivoire has a telecommunications affordability index of 32.78[40]. This index reflects in the aggregate the total cost of ownership of telecommunications services (including taxes) as a function of income. When compared with the rest of African countries, Cote d'Ivoire is at the middle of the affordability range (see figure 29).

[40] The digital affordability index is a composite index calculated on the basis of six indicators: Residential fixed line tariff adjusted for GDP per capita; Residential fixed line connection fee adjusted for GDP per capita; Mobile cellular prepaid tariff adjusted for GDP/capita; Mobile cellular prepaid connection fee adjusted for GDP per capita; fixed broadband Internet access cost adjusted for GDP per capita; and mobile broadband Internet access cost adjusted for GDP per capita (see Katz and Koutroumpis, 2013).

Figure 29: Sub-Saharan Africa: Telecommunications Affordability Index (2014)



Source: Telecom Advisory Services analysis

The intermediate position of Cote d'Ivoire among its regional peers would indicate that the pricing of telecommunications services represents a barrier to adoption. In general terms, two policies can serve as levers to improve the affordability of broadband (see Katz and Taylor, 2014): (1) reduce taxes born by consumers on the purchase of broadband; and (2) increase the level of competitive intensity to stimulate price competition. Along these lines, with the objective of reducing the consumer broadband acquisition cost, the government has enacted in 2016 an exemption of import duties and VAT for customer terminal equipment (including smartphones, tablets, modems and routers). Under this program, the price of a low-end smartphone starts at CFA 20,000 (US$ 33). This policy will remain in place until 2018. This measure is expected to greatly facilitate broadband adoption. As a demonstration of the policy's positive effect, with 10 months into the program, subscriptions for Orange have jumped from 80,000 sold in 2015 to an estimated 200,000 in 2016.[41]

Another program aimed at dealing with the affordability barrier, now under development, entails lowering the price of broadband connections. A benchmarking study conducted by the regulatory authority indicated that the price of broadband service in Cote d'Ivoire is higher than that of Senegal, a country considered as having similar socio-economic characteristics. The results of the study are expected to be reported to the operators by the end of 2016, and an affordability price point will be set up, specifying the cost of broadband service. In response to this, the operators are expected to provide policy alternatives and suggestions, which would in turn be used to design the program.

[41] Source: field trip interviews.

For example, operators could request a reduction in customer subscription taxes usually added to the customer monthly payment. The possibility of extending the terminal tax exemption mentioned above to the purchasing of a service subscription could be quite powerful in improving affordability. Right now, when purchasing a mobile wireless subscription a consumer pays 3% in a telecommunications specific tax and 18% in VAT. Since both taxes are compounded, they amount to approximately 21% of the monthly subscription cost. A tax exemption could significantly improve broadband affordability. If the regulator agrees with such a recommendation, it would be presented to the Ministry of Digital Economy and Postal Services, which would then draft a recommendation to the Council of Ministers, the authority that needs to approve such a measure.

Let's now turn to digital literacy. While lacking survey data on the country's digital literacy, it is safe to assume that there is a direct relationship between overall literacy and digital literacy. Literacy is a foundational skill needed to attain higher levels of learning in all domains. According to UNESCO, in Cote d'Ivoire, the literacy rate is 48% among the youth population; this is lower than the average youth literacy rate in other lower middle-income countries. Furthermore, nearly 34% of fifth grade students in Cote d'Ivoire performed below the lowest performance benchmark in reading. In sum, Cote d'Ivoire is scoring at a low level in literacy, and is reported as having low performance standards in the educational system.

These metrics would necessarily have an impact on the population's ability to conduct the most basic broadband Internet tasks such as search for information, utilize e-government platforms and perform financial transactions. To deal with this barrier, the government is implementing two initiatives:

1. "One citizen, one computer, one connection": This initiative is based on the premise that there is a direct relationship between social inclusion, digital literacy and ownership of a device connected to the Internet. The program relies on the schools as the anchor point for three reasons: a) there is a school in every village; b) schools have multimedia centers to provide training on digital literacy; and c) given the high illiteracy rate, it considers that literacy comes hand in hand with digital literacy.

   The program works as follows: the broadband service provider is responsible to provide both the terminal and the broadband connection. There is tax exemption for acquiring the PC. As a result, total prices range between 50,000 CFA (US$ 83) and 150,000 CFA (US$ 249). Additionally, the program allows for payment in installments to facilitate affordability.

2. Rural multimedia centers: A related initiative is the construction of multimedia centers in all rural schools. This program is under the responsibility of the *Agence Nationale de Service Universel de Télécommunications*, which funds the deployment of such centers to link the literacy programs to digital literacy.

Finally, Cote d'Ivoire has limited capability to produce local Internet content and applications, which explains part of the demand gap. However, the lack of country specific information precludes us from assessing the importance of limited cultural and linguistic relevance as a barrier to broadband adoption. Nevertheless, an assessment of the 100 most popular Internet sites measured by number of visitors and time spent on the site by region of the world indicates that only 32% of the most popular Internet sites have been developed in Sub-Saharan Africa (see Katz and Callorda, 2014). The lack of linguistic and cultural relevance would appear to be a barrier to broadband Internet adoption. In response to this hurdle, the government is targeting the development of e-government functions as a way to create an incentive for the population to access the Internet.

To sum up, all three broadband Internet adoption barriers – affordability, digital literacy, and local content – appear to be present in Cote d'Ivoire. The government has put in place several initiatives to deal with at least the first two constraints, along with the development of e-government applications.

V.1.2. Supply of broadband services

Availability of fixed and mobile broadband infrastructure

The development of broadband infrastructure in Cote d'Ivoire has undergone four phases. In phase 1, between 1996 and 2002, both last mile distribution and long haul connectivity were fulfilled via satellite. The second phase started in 2002, when ADSL started to be installed. In addition, the deployment of a submarine cable in 2008 improved the quality of fixed connectivity. The third phase started in 2012 with the deployment of mobile broadband via 3G technology. When this phase was completed in 2016 (when 4G started to be deployed), 3G current coverage reached 50% of the population and 40% of the territory for Orange, meanwhile the MTN network is reported as covering 70% of the population[42]. The fourth phase begun in 2016 with the launch of 4G and will continue with the deployment of FTTH.

Currently 4G coverage reaches between 20% and 30% of the population[43], while it is expected to achieve full coverage by 2020 for MTN and Orange. On the other hand, the target of deployment of FTTH is to cover the large cities that concentrate upscale residential segments and most economic activity centers (Abidjan, Yamoussoukro, Bouake, San Pedro, etc.).

[42] Source: Field trip interviews.
[43] MTN is deployed only in Abidjan.

Broadband market structure

The fixed broadband market is comprised by five players (see table 46).

Table 46: Cote d'Ivoire: Fixed broadband market structure (2Q2016)

	Number of Subscribers	Market Share (by Subscribers) (%)	Revenues (in US$)	Market Share (by revenues) (%)
MTN	27,966	27.42	2,564,278	20.80
Orange	65,389	64.14	8,111,219	65.79
VIPNET	2,198	2.16	1,224,877	9.94
ALINK	49	0.05	26,388	0.21
Yoomee	6,353	6.23	402,034	3.26
Total	101,955	100	12,328,795	100

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

The market structure, as measured by number of subscribers and revenues, has been quite volatile. MTN has been consistently losing share since 3Q2014 when it controlled 56% of the market. Conversely, Orange has increased its share to 66% in 2Q2016 from 42% in 3Q2014[44]. When measuring by the Herfindahl-Hirschman Index (HHI), one can determine that the Ivoirian fixed broadband market has been gradually become more concentrated in the past year (see table 47).

Table 47: Cote d'Ivoire: Fixed broadband Herfindahl-Hirschman Index (by number of subscribers) (2013-2016) (%)

	4Q2013	1Q2015	3Q2015	4Q2015	1Q2016	2Q2016
MTN	58.04	47.86	44.80	40.36	36.37	27.42
AVISO	40.28	49.07	48.52	52.43	55.99	64.14
VIPNET	1.54	1.67	2.08	2.03	2.03	2.16
ALINK	0.12	0.12	0.11	0.11	0.05	0.05
Izinet	0.02	0.02	0.02	0.02	0.02	0.02
Yoomee	- - -	- - -	4.49	5.07	5.56	6.23
HHI	4,993	4,821	4,385	4,408	4,493	4,909

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

On the other hand, the mobile broadband market included five players by the end of 2015 (see table 48).

Table 48: Cote d'Ivoire: Mobile broadband market structure (4Q2015)

	Number of Subscribers	Market Share (by Subscribers) (%)	Revenues (in US$)	Market Share (by revenues) (%)
Orange	10,798,183	42.50	38,594,862	61.25
MTN	8,130,003	32.00	16,987,950	26.96
MOOV	5,408,048	21.29	6,566,265	10.42
Comium	710,592	2.80	643,359 (E)	1.02
GreenN	360,784	1.42	214,453	0.34
Total	25,407,610	100	63,006,889	100

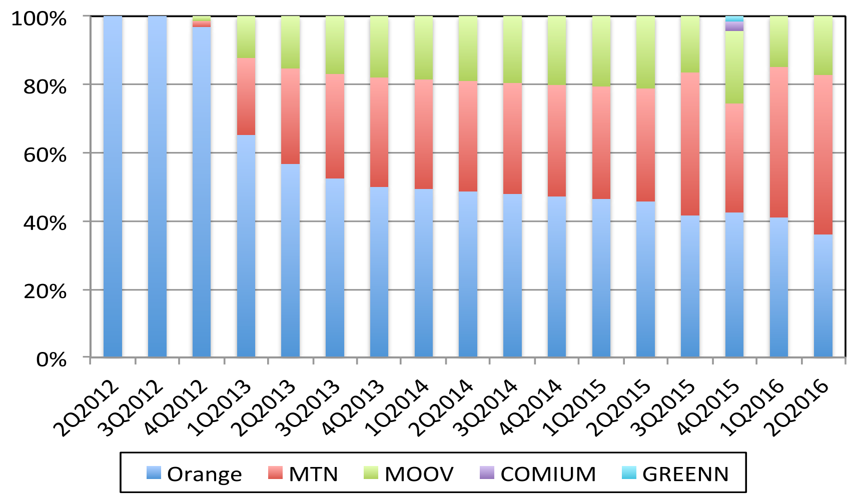
Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

However, in March of 2016, the regulator canceled underperforming operators (Comium and GreenN), and the defunct Niamoutie Telecom of their respective licenses, as a result of unpaid taxes and license fees. Furthermore, the government stripped Warid Telecom of its license

[44] Sources: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

awarded in July 2006 that was never activated[45]. In parallel with the exit of minor players, the market has been gradually migrating to a more balanced structure (see figure 30).

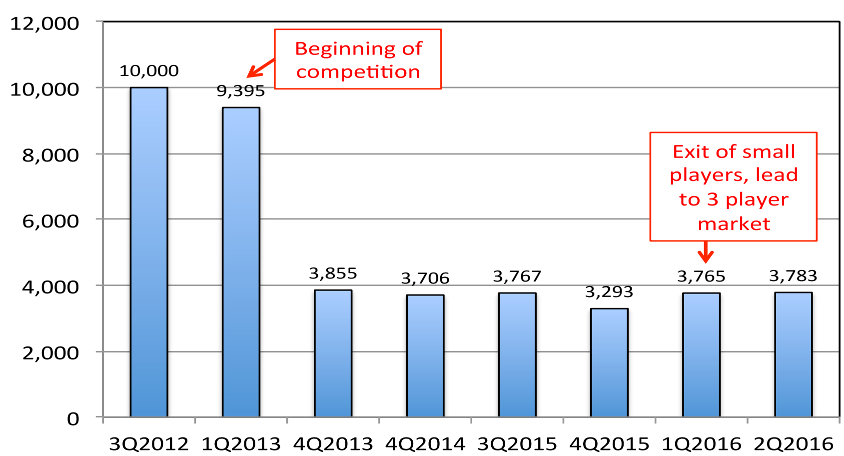
Figure 30: Cote d'Ivoire: Mobile broadband market shares (by subscribers) (2012-2016)



Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; GSMA Intelligence; Telecom Advisory Services analysis

The exit of smaller players has triggered a moderate increase in consolidation, as indicated by a rise in the Herfindahl-Hirschman Index (see figure 31).

Figure 31: Cote d'Ivoire: Mobile broadband Herfindahl-Hirschman Index (2012-2016)



Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

[45] Telegeography. *ARTCI revokes Comium, GreenN licences.* 4 Apr 2016

As a result, the market structure as of 2Q2016 consists of three subsidiaries of global players (see table 49).

Table 49: Cote d'Ivoire: Mobile broadband market structure (2Q2016)

	MNC	Number of Subscribers	Market Share (by Subscribers) (%)
Orange	Orange Group	2,707,779	36.11
MTN	MTN Group	3,505,557	46.75
MOOV	Maroc Telecom	1,285,251	17.14
Total		7,498,587	100

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; GSMA Intelligence; Telecom Advisory Services analysis

In this context, the government has sought to reconfigure the mobile sector as a four-player market, by means of introducing a new convergent player capable of supporting mobile and fixed telephony, data transmission and Internet access. In September of 2016, the fourth convergent license was given to the Libyan Post, Telecommunications and Information Technology Company[46]. This move intended to foster competition is not yet reflected in the market's competitive intensity, since the entry of the new operator is planned for 2017[47].

In addition, to further stimulate competition the government has been promoting the entry of Mobile Virtual Network Operators. Youmee, the fixed broadband player, is in negotiations with Orange to launch service[48].

State of competition in broadband market

As a result of exits and entries that took place in the last year, the Ivorian market is composed of two convergent players (Orange and MTN) and one pure mobile play (Moov). As of May 2016, Orange signed an agreement with the Ivorian government to merge the assets of CI-Telecom (a jointly owned company between Orange and the government of Cote d'Ivoire) and Orange mobile. After the merger, the government's position in the new entity will be of 31%, the remainder being in the hands of Orange[49].

Similarly, MTN is present in the wireline, fixed and mobile broadband segments. The convergent license assigned to Libyan Post, Telecommunications and Information Technology Company is currently under implementation. While the forced exit of the minor wireless players has increased the HHI index, reducing the level of competitive intensity, the entry of the fourth player is expected to reestablish an adequate level of competition.

[46] The new entrant is leveraging the assets of GreenN, the closed operator. This company was fully owned owned by the Libyan Post, Telecommunications and Information Technology Company (source: field trip interviews).
[47] Source: field trip interviews.
[48] Source: field trip interviews.
[49] Telegeography. *Govt, Orange strike agreement to merge fixed, mobile assets in Cote d'Ivoire*. May 3, 2016.

Technologies and trends regarding broadband market

The technological infrastructure utilized for delivering broadband services in Cote d'Ivoire consists of a mix of ADSL and fixed wireless for fixed networks, and 3G and 4G for mobile broadband.

Regarding fixed broadband, four out of the five operators have displayed a mix of wireline (ADSL, fiber optics) and wireless technology (WiMAX, CDMA, and satellite). As a result, according to regulatory reports, as of the end of 2015 50% of fixed lines (55,803) are wireline and the remainder (54,653) are wireless. There is one operator, YooMee, which relies exclusively on Time Division - Long Term Evolution (TD-LTE) operating on the 2300 MHz frequency band to offer fixed wireless service to Abidjan's five million plus inhabitants[50].

At the same time, both Orange and MTN are planning to deploy FTTx focusing on enterprises and selected neighborhoods in key cities. FTTH deployment plans for both carriers target upscale residential neighborhoods and business concentration areas in large cities (Abidjan, San Pedro, Bouake, Yamoussoukro). Both operators recognize that the economics do not favor fiber optic last mile deployment in the Ivoirian context. Each home connected in Abidjan, for example, would cost approximately US$ 1,000[51]. Charging consumers a monthly subscription fee to compensate for the investment. Is not feasible, as consumers would not recognize the value-added of FTTH in terms of incremental speed. Therefore, customers would not be willing to pay a price increase using the faster infrastructure. Additionally, with an underdeveloped *Over The Top* market, the demand is still not high enough to fully use an FTTH connection. Despite these considerations, both operators are pursuing FTTH deployment because it is needed to serve the enterprise market. Moreover, they need to provide a competitive response to players already active in Cote d'Ivoire, and to the potential entry of Google, which has already deployed fiber in Accra (Ghana).

The split between fixed and mobile broadband reflects the demand trends discussed above: as of the end of 2015, 99% of all broadband accesses are mobile, supported by 3G technology. By auctioning technology-agnostic licenses at the beginning of 2016, the government authorized the launch of 4G LTE mobile broadband service[52]. As of this date, all three wireless operators have deployed 4G technology. However, service coverage is restricted so far to the largest cities. Even within the target cities, 4G coverage is not complete, with operators estimating coverage between 20% and 30% of the population[53].

[50] Telegeography. *YooMee TD-LTE user base reaches 4,000*. 8 Apr 2015.

[51] If a residential consumer is close to an enterprise location already benefitting from a fiber loop, the deployment cost would be much lower.

[52] Telegeography. *Cote d'Ivoire watchdog set to authorize 4G in 1Q16*. 3 Dec 2015.

[53] Source: field trip interviews.

Fixed and mobile broadband speeds and quality of broadband services

International statistics of broadband service quality in Cote d'Ivoire are relatively scarce. Available data is limited to the International Telecommunications Union, which reports a breakdown of fixed broadband speeds for three categories (see table 50).

Table 50: Cote d'Ivoire: Fixed broadband speeds

	2014 (%)	2015 (%)
Share Fixed-broadband 256 Kbit/s to less than 2 Mbit/s subscriptions	36.62	38.98
Share Fixed-broadband 2 Mbit/s to less than 10 Mbit/s subscriptions	21.13	18.86
Share Fixed-broadband equal to or above 10 Mbit/s subscriptions	42.25	41.16

Source: International Telecommunications Union

According to table 50, in 2015 41 % of total fixed broadband lines offered a speed equal to or above 10 Mbps. It should be noted, however, that advertised speed does not equal real performance. It is very common that, due to network quality issues or traffic saturation, advertised speeds represent approximately 60% of real performance[54]. However, a comparison between Cote d'Ivoire statistics with other relevant countries provides a relative context for assessing the country's fixed broadband speed levels (see table 51).

Table 51: Fixed Broadband Speed Levels: Cote d'Ivoire versus other country averages (2015)

	Cote d'Ivoire (%)	African OIC Member Countries (%)	All OIC Member Countries (%)
Share Fixed-broadband 256 Kbit/s to less than 2 Mbit/s subscriptions	38.98	77.54	56.69
Share Fixed-broadband 2 Mbit/s to less than 10 Mbit/s subscriptions	18.86	15.54	32.20
Share Fixed-broadband equal to or above 10 Mbit/s subscriptions	41.16	6.93	11.11

Source: International Telecommunications Union

According to table 51, Cote d'Ivoire appears to have significantly higher fixed broadband speed levels compared to the average African OIC Member Countries, as well as all OIC Member Countries.

Pricing of fixed and mobile broadband

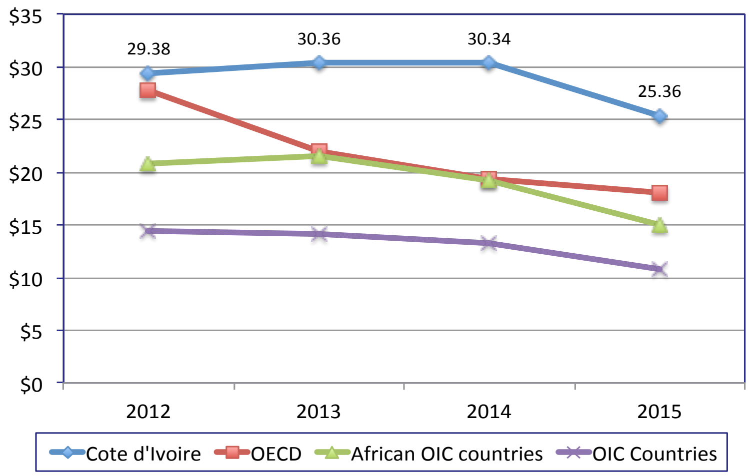
The regulator has recently completed a study benchmarking broadband prices across the region. It has concluded that Cote d'Ivoire prices are high relative to its peers. In particular, the Ivoirian authorities emphasized the comparison with Ghanaian broadband price levels, where broadband prices are 20% lower than in Cote d'Ivoire, suggesting Ghana as a model to imitate[55].

The conclusion of this study appears to be consistent with a comparative assessment of pricing trends of monthly subscriptions across country groupings for 1 GB USB port (see figure 32).

[54] It is not possible to compile statistics on real performance since the "crowdsourcing" sites such as Akamai do not report results for the Cote d'Ivoire.

[55] Source: Field trip interviews.

Figure 32: Monthly subscription of 1 GB cap USB (in US$)



Source: International Telecommunications Union; Telecom Advisory Services analysis

As depicted in figure 32, Cote d'Ivoire pricing only started to decline in 2015, but still remains above the average of all OECD countries, all OIC Member Countries, and the African OIC Member Countries. In a similar finding, the prepaid price for 500 MB cap mobile broadband subscription in the Cote d'Ivoire was US$ 9.98 in 2015, compared to US$ 4.55 for all the OIC African countries, and US$ 4.66 for all OIC Member Countries. The price of the most economical fixed broadband subscription in Cote d'Ivoire is US$ 34.83, compared to US$ 29.87 average pricing for all OIC Member Countries.

On the other hand, Cote d'Ivoire operators have introduced less expensive fixed broadband subscriptions when compared to the average price of other OIC African countries of US$ 75.18. For example, Orange offers a prepaid plan based on ADSL at 1Mbps download speed with a cap of 250 MB for CFA 19,000 (US$ 31.50).

Investments in fixed and mobile broadband infrastructure

The investment of the private sector operators in fixed broadband services is highly variable, reflecting the sector's volatility (see table 52).

Table 52: Cote d'Ivoire: Private sector fixed broadband investment (US$)

	2013	2014	2015	1H2016
Fixed broadband	2,903,002	7,041,809	1,579,421	503,758

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

Until 2014, operators were dedicating a relatively high volume of investment to fixed broadband reflecting the embryonic status of mobile adoption. However, in 2015 investment in fixed broadband declined significantly. By annualizing statistics for the first half of 2016, total investment for 2016 in fixed broadband would only be US$ 1,004,000. The decline in fixed broadband investment by the private sector is expected to be partially offset as the Orange Group is planning to deploy fiber optics in the Abidjan area, with further expansion if possible.

The Ivoirian regulator does not publish statistics for mobile broadband because, given the nature of mobile infrastructure, it is difficult to discriminate between voice and data investments. Assuming that most mobile investment is dedicated to mobile broadband services, the amounts are limited but increasing significantly in 2016 (see table 53).

Table 53: Cote d'Ivoire: Private sector mobile investment (US$)

	2013	2014	2015	June 2016
Mobile (including voice and data)	244,194,256	162,689,686	146,860,420	294,201,228

Source: Autorité de régulation des télécommunications/TIC de Cote d'Ivoire; Telecom Advisory Services analysis

As table 53 indicates, the shift in investment from fixed to mobile broadband is exemplified by the 2016 statistic, which indicates that only in the first six months of 2016 the private sector investment in mobile voice and data has exceeded the entire amount spent in 2015.

In addition to the investment from the private sector, the government has been actively involved in the deployment of a national intercity network. The deployment is being managed by the French firm Bouygues, working alongside SagemCom and Polyconseil. Investment is expected to conclude in 2017, when the network is planned to span around 7,000km. The project started in 2012 when Chinese equipment manufacturer Huawei rolled out a 1,400km cable linking the south-western port city of San Pedro to Ferkessedougou in the central north. Phase two of the project got underway in July 2013, focusing on a 650km link connecting Grand-Bassam and Abidjan in the southeast with the northeastern town of Bouna. This phase was carried out by Chinese state owned manufacturer China International Telecommunication Construction Corporation (CITCC)[56].

Major factors that influence broadband investments

The government has been putting in place a number of demand and supply-side initiatives to promote broadband usage, thereby stimulating capital spending by operators. On the demand promotion side, as described above, the tax exemption on terminal equipment is aimed at reducing the cost of purchasing broadband service, which, in and of itself, acts as a stimulus for market development. As noted earlier, an additional demand promotion policy consists of the promotion of "one citizen, one computer" policy, which entails the subsidization of PC purchasing and also acts as a promotion of demand. However, there are other policies that may act as a disincentive to stimulate demand. For example, wireless carriers cannot sign up a customer if they do not produce a valid ID. A large portion of citizens in the Cote d'Ivoire lack a proper ID, which means that either the carrier cannot sign up these customers or, if they do, they may incur a penalty fee.

[56] Telegeography. *Cote d'Ivoire launches third phase of NBN.* April 22, 2016.

As noted earlier, on the supply-side the government has been investing in deploying a national fiber optic backbone network with the purpose of reducing long-haul connectivity costs and improving the business case for deploying broadband distribution networks in remote areas. Additionally, the auction of technology-agnostic universal spectrum licenses acted as a stimulus for deployment of 3G and 4G technologies. Finally, for improving coverage in rural areas, the government is promoting the sharing of broadband infrastructure, such as backhaul and towers[57].

However, the operator view of this last incentive is that, even under the infrastructure sharing agreement promoted by the government, the business case has not been proven to be positive. The perceived barrier is the lack of "use cases". Given that high illiteracy rate in rural areas, the broadband consumption that could generate revenues is not high enough.

Furthermore, rural deployment is affected by a number of "hidden costs". For example, due to the lack of power, each base station has to be supplied with a generator. Additionally, at the OPEX level, due to the lack of appropriate road access, maintenance and operations costs are higher in rural areas than in urban settings. One way of addressing this problem would be for the government to provide subsidies to cover some of the additional costs.

On the other hand, while enacting policies to promote investment, the government has also implemented a policy that discourages investment. In 2015 the regulator raised the mobile license renewal fees to be paid by the country's operators in 2016 to CAF 100 billion (US$ 162.5 million). The regulator also opted to cut the duration of the concessions, from 20 years to 15 years. These measures are reported as having a negative impact on the operators' willingness and ability to commit capital for the deployment of 4G. While acknowledging that these measures are aimed at collecting additional revenues for the country's treasury, their impact should be evaluated also in terms of the extent that limit the country's transition to new technologies.

In addition to these investment impediments and increased costs reducing the amount of capital for deployment of 4G networks, operators encounter local regulations that delay fixed broadband deployment. For example, once an operator decides to construct fixed broadband access in the last mile, it faces time delays for obtaining permits from municipalities and negotiating construction terms of employment with labor unions.

In the context of the country's development policies that affect the level of investment, there are some macro variables that have a positive impact on the operators' willingness to invest in broadband infrastructure, affecting the strategies of operators such as Orange and MTN to invest in fiber optics. Such companies consider fiber optic deployment as a bet on the future economic development of the country. The government has presented its 2016-2020 National Development Plan with a number of priority objectives that have strong implications for requiring the deployment of fiber optics. Among those goals:

[57] Source: Field trip interviews.

- Project e-gov: digitizing the whole government administration;
- Decentralization of industries to the interior of the country; and
- Promotion of foreign direct investment.

Given the national development priorities, operators consider fiber deployment, as a much needed requisite infrastructure. While the business case is not always positive, in the long run the investment has strategic importance to achieving the country's development[58].

In addition, for the two largest operators, Orange and MTN, fiber optic deployment is envisioned as a competitive tool to either protect its position (in the case of Orange) or gain share (in the case of MTN)[59]. Both operators deploying fiber to the consumer premise recognize that the business case still cannot support the investment. For example, the current fastest ADSL offer (8 Mbps) in Cote d'Ivoire is marketed at CFA 45,000 per month (US$ 74.60). It is estimated that the "psychological" price (also called willingness to pay) for a residential fiber connection should be approximately CFA 50,000 (or US$ 83). Under this pricing assumption, given the income distribution of the Cote d'Ivoire, the addressable market beyond certain neighborhoods in Abidjan is quite small. In order to develop the investment business case under more favorable terms, operators have to increase the ARPU (Average Revenue Per User) by including other services that can pay off the fiber optic deployment. However, these services are not yet defined.

The other variable that could improve the business case is a reduction in operating expenses (maintenance of fiber plant is lower than copper), and copper replacement (significant amount of copper plant is systematically stolen). This is one of the factors being quantified at this stage to try to develop a viable business case for fiber optic deployment. All in all, independently from the uncertainties surrounding the returns on fiber investments, both major carriers in Cote d'Ivoire are proceeding along this path driven primarily by competitive considerations (in other words, the fear of being the second mover and thereby losing competitive advantage).

To sum up, broadband capital spending in Cote d'Ivoire is affected by a number of factors that either encourage or discourage investment (see table 54).

[58] Source: Field trip interviews.
[59] Source: Field trip interviews.

Table 54: Cote d'Ivoire: Factors influencing broadband capital spending

	Positive incentives	Negative incentives
Government demand promotion policies	• Tax exemption on terminal equipment • One citizen, one computer program	• Wireless carriers cannot sign up a customer if he does not produce a valid ID
Government supply Policies	• Deploying a national fiber optic backbone network to reduce long-haul connectivity and improve the business case for deploying broadband distribution networks in remote areas • Auction of technology-agnostic universal spectrum licenses for deployment either 3G or 4G technologies • Promote sharing of broadband infrastructure, such as backhaul and towers • Rules for accelerated depreciation of equipment	• Spectrum license renewal policies (15 years, renewal payment) • No tax exemption for imported network equipment
Local Factors	• Urban development	• Time delays for obtaining construction permits from municipalities • Negotiating construction terms with labor unions
Macro-Factors	• Project e-gov: digitizing the whole government administration • Decentralization of industries to the interior of the country • Promotion of foreign direct investment	
Competition factors	• Protect market position • Gain market share	

Source: Telecom Advisory Services analysis

V.1.3. Institutional structure and policies for promoting broadband

Institutional structure, policies and strategies regarding broadband market

The institutional architecture regulating the telecommunications sector includes three agencies:

- The Agence de Régulation des Télécommunications de Cote d'Ivoire (ARTCI)
- The Agence Nationale de Service Universel de Télécommunications (ANSUT)
- Agence Ivoirienne de Gestion de Fréquences Radioélectriques

The first two agencies report to the *Ministère de l'Economie Numérique et de Postes*.

Cote d'Ivoire assigns regulatory authority of telecommunications, and consequently broadband, to the *Autorité de régulation des télécommunications/TIC de Cote d'Ivoire* (ARTCI). This agency is presided by a regulatory board responsible for the technical, legal administrative and financial management of ARTCI. The board is comprised of seven members.

The organization structure of ARTCI includes nine departments:

- Telecommunications Activities
- Legal Affairs
- Resource Allocation and Controls
- Information Systems and Network Security
- Economic Affairs and International Cooperation

- Auditing and Management Controls
- Post Office Activities
- Human Resources, and Finance
- Communications

The more relevant departments from a regulatory standpoint are the Department of Resource Allocations and Controls (in charge of managing the radiofrequency spectrum), Telecommunications Activities (responsible for monitoring operator performance and establishing rules for infrastructure sharing), Information Systems and Network Security (monitoring cyber-security processes), and Economic Affairs and international cooperation (in charge of monitoring competition).

Major approaches, implementations and challenges in extending fixed and mobile broadband infrastructure

Among the most relevant legal initiatives enacted by the Ivoirian government that have an impact on the development of broadband, five are of special note:

- Assignment of a fourth convergent telecommunications license (which includes fixed and wireless broadband) to the Libyan Post, Telecommunications and Information Technology Company in order to promote sustainable competition
- Two initiatives to fight cybercrime (June 19, 2013), and protection of personal (June 19, 2013)
- Rules for managing Internet domain of Cote d'Ivoire (February 4, 2015)
- Rules for interconnecting telecommunications networks and unbundling the local loop to promote fixed broadband competition (May 2, 2013)
- Tax exemption for importing terminal equipment (December, 2015)

V.1.4. Lessons learned

The assessment of broadband network and services in the Cote d'Ivoire provides a basis for a number of lessons learned. The following are structured around the promotion of enhanced supply and the stimulation of demand.

Supply policies

As the preceding chapters have concluded, the supply of broadband services is currently undergoing a process of transition. When it comes to fixed broadband, the substitution effects resulting from the suitability of mobile broadband have led to a slow down of network deployment (as illustrated by a significant reduction in investment), and a mix of wireline (ADSL, fiber optics) and wireless (WiMax, LTE, satellite) technologies. The evidence suggests that Cote d'Ivoire requires a more coherent broadband technology strategy. While some indications exist that fiber optics will be deployed by Orange and MTN, it would seem that policy makers have not clearly defined which technologies are more suitable to which geographies or provided the needed interventions to enable aligned operator investments.

On the mobile broadband side, the deployment of 3G appears to have been a success. As of the end of 2015, according to statistics of the International Telecommunications Union, penetration has reached 32% of the total population. However, the increase in data traffic is putting pressure on operators to deploy 4G technology. The auctioning of technology-agnostic licenses has been an incentive towards 4G deployment which is planned to reach 100% coverage by 2020.

Beyond the incentives to investment, there are some initiatives that discourage capital spending. One of them is the increase in mobile license renewal fees and the reduction in the duration of the concessions from 20 years to 15. These measures will have a negative impact on the operators' willingness and ability to commit capital for the deployment of 4G and need to be reviewed against estimated negative impacts.

Demand policies

As discussed above, Cote d'Ivoire's broadband demand gap is significant: close to 51% of the population is served by broadband technology but do not purchase service due to economic, digital literacy, cultural or linguistic barriers.

First and foremost, the government has recognized that increased service adoption is dependent on lowering the total cost incurred by consumers by purchasing and operating the technology. The competition lever for stimulating price reduction has been already pulled, given the assignment of a fourth wireless license to the Libyan operator will increase competitive intensity, which could result in lower prices. Beyond, competition, the Ivoirian government has reduced taxes incurred by consumers when purchasing broadband terminals. However, service use is still impacted by 18% in value added tax, to which a sector specific tax is added[60]. In general terms, since high taxation increases the total cost of ownership of wireless services, higher wireless consumption taxes raise the affordability barrier and reduce adoption. In this context, current taxation policies are likely to have a detrimental effect on the public policy strategy aimed at deploying mobile broadband. If taxes limit adoption of wireless broadband, it is relevant to ask what the ultimate impact of reduced penetration might have on economic growth. Hypothetically, it is safe to assume that a reduction in adoption as a result of incremental taxation could yield a negative impact on GDP growth. To address this, the taxation initiative could be complemented with selected targeted subsidies to be assigned to vulnerable households or residents in rural areas.

Moving to the digital literacy domain, the Ivoirian government has been developing policies aimed at improving digital literacy (for example, "One citizen, one computer"). Digital literacy is defined as the "ability to use digital technology, communication tools or networks to locate, evaluate, use and create information" (Hauge and Prier, 2010). Initiatives aimed at building digital literacy need to involve both embedding programs in the formal education system and targeting non-formal initiatives to specific segments of the population (elderly, handicapped, rural poor, etc.).

[60] These levies are documented in the International Telecommunications Union Eye database and have been analyzed in Katz (2015). *The impact of taxation on the digital economy*. Geneva: International Telecommunications Union.

Finally, with regards to lowering the cultural and linguistic relevance barrier, it is critical that both the government and the private sector engage in the development of new platforms, including the development of content and facilitation of Internet usage. Internet access in itself is of little value in the absence of so-called complementary goods that deliver concrete value to Internet access and enable its productive employment.

V.2. SAUDI ARABIA

The following case study assesses the state of broadband services in Saudi Arabia. The country is one of the most advanced in terms of broadband network deployment and usage among the OIC members. As of 20015, approximately 70% of the Saudi population accesses the Internet in a regular fashion[61], while smartphone penetration (80%) and social media usage[62] remain among the highest in the world. From an infrastructure standpoint, 30% of the country is covered by last-mile fiber optic networks.

Nevertheless, despite the progress achieved so far, the Saudi government is seeking to accelerate its evolution towards advanced digitization, aiming to be in the top 20 countries in the world by 2030. Consequently, as part of its Vision 2030, the government has launched an ambitious initiative aimed at accelerating broadband deployment and infrastructure investment in the country.

V.2.1. Demand for Broadband Services

Fixed and mobile broadband usage rates

The adoption of fixed broadband services in Saudi Arabia begun in 2001 when the first 14,000 lines were deployed by the Saudi Telecom Company (STC). After a slow ramp-up through 2008 (reaching a penetration rate of 26%), adoption started increasing rapidly in 2009, achieving an exponential growth after 2011(see table 55).

Table 55: Saudi Arabia: Fixed broadband lines (2003-2015)

	2003	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015
Lines ('000)	46	68	623	1,048	1,438	1,712	1,951	2,540	2,920	3,032	3,590
Percent household	1.24	1.74	15.85	26.07	35.03	40.87	40.00	42.00	48.00	56.00	65.00

Sources: International Telecommunications Union; Telecom Advisory Services analysis

As table 55 indicates, by the end of 2015 fixed broadband penetration reached 65 % of households[63]. This penetration is among the highest within the OIC member group (see table 56).

Table 56: Saudi Arabia versus OIC Member Countries: Fixed broadband household penetration (2015)

Country/Group	Household Penetration (%)
Saudi Arabia	65.00
Arab OIC members	25.59
Asian OIC members	16.96
African OIC members	0.86
Average OIC	14.95

Sources: International Telecommunications Union; Telecom Advisory Services analysis

[61] Source: Communication and Information Technology Commission (CITC).
[62] 61% of Saudis spend more than 2 hrs. per day on social networking sites. All these statistics sourced from Google Consumer Barometer 2016, except for Internet usage, which is sourced from the International Telecommunications Union.
[63] As of 2Q2016, the CITC reports that the number of fixed lines decreased to 3,060,000 as a result of fixed mobile substitution.

In addition to the high adoption of fixed broadband, mobile broadband penetration has reached 33.4 million subscriptions (83.5% individual penetration) in 4Q2015. However, penetration decreased to 26.6 million in the 2Q2016 due to a government-enforced disconnection of unregistered accounts (see table 57).

Table 57: Saudi Arabia: Mobile broadband subscriptions (2010-2016)

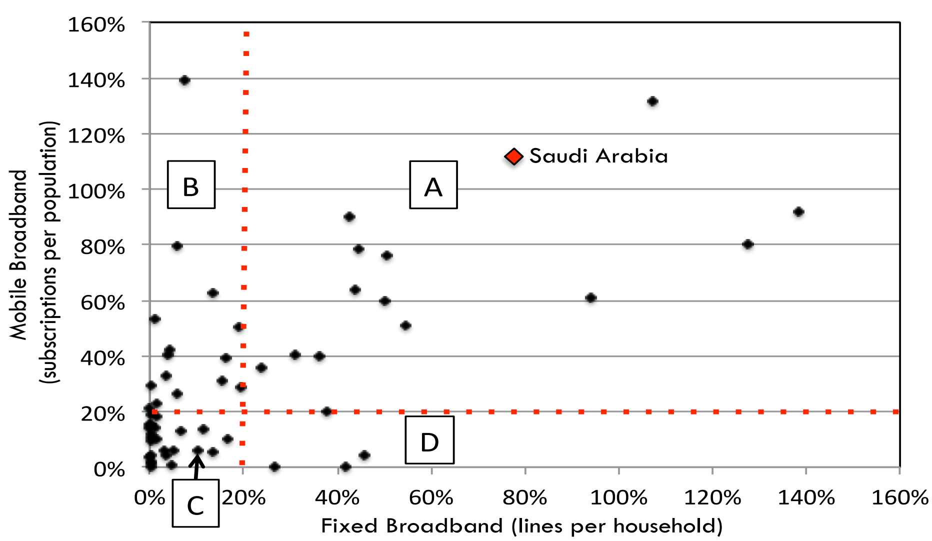
	2010	2011	2012	2013	2014	2015	2Q2016
Subscriptions	7,000,000	11,337,154	15,964,221	24,530,358	29,085,904	33,387,589	26,620,000
Percent Population	9.7	39.6	42.1	47.6	94.5	105.9	83.50

Sources: GSMA Intelligence; CITC; Telecom Advisory Services analysis

Until 2015 the key drivers of mobile broadband growth have been strong competition, significant expansion in smartphone adoption, as well as the offering of a multiplicity of data plans targeted for different market segments.

When comparing fixed and mobile broadband adoption, Saudi Arabia is one of the most advanced among the OIC Member Countries (see figure 33).

Figure 33: OIC Member Countries: Fixed broadband versus mobile broadband penetration (2015)

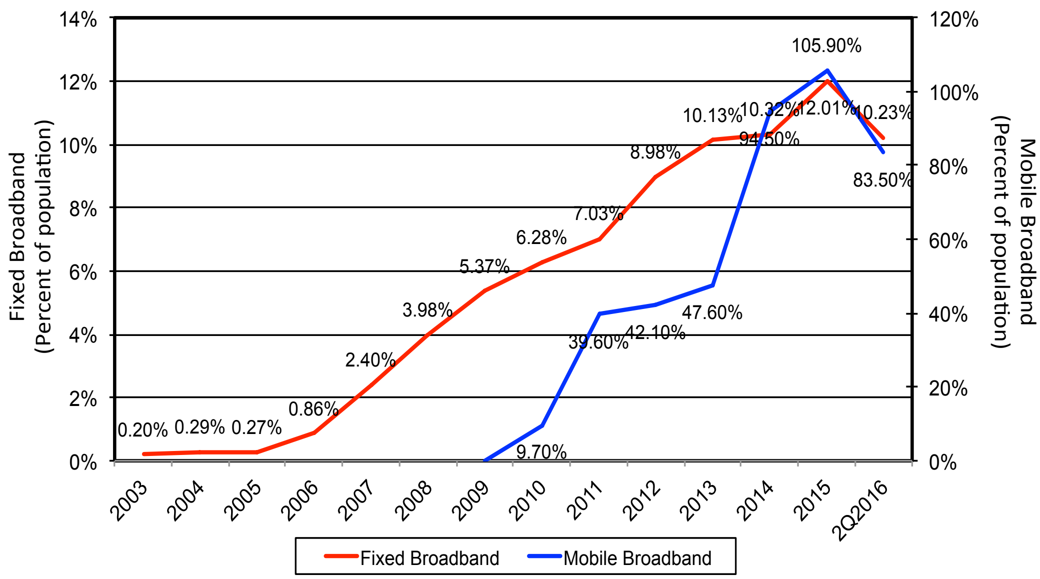


Sources: International Telecommunications Union; Telecom Advisory Services analysis

Figure 33 plots OIC Member Countries in terms of their fixed and mobile broadband penetration. The countries in group (A) have achieved high adoption in both technologies indicating cumulative impact: fixed broadband used for home use and mobile broadband enabling on-the-move access. The countries in this group include, in addition to Saudi Arabia, Bahrain, United Arab Emirates, Qatar, Oman, Turkey, Azerbaijan, Kazakhstan, Jordan, Iran, Malaysia, Albania, Algeria, Maldives and Suriname. On the other hand, the countries in group (B) exhibit an acute substitution process, whereby mobile broadband is assuming the role of principal technology for accessing Internet. The countries in this group include Kuwait, Libya, Tunisia, Lebanon, Egypt, Cote d'Ivoire, Indonesia, Morocco, Nigeria, Gabon, Kirgizstan, Senegal, Sudan, Mauritania and Uzbekistan. The countries in groups C are at lower levels of economic development and, consequently, at an embryonic stage of adoption of either broadband technology. Nations in this group include Afghanistan, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Djibouti, Guinea, Guinea-Bissau, Gambia, Iraq, Mali, Mozambique, Niger, Pakistan, Sierra Leone, Somalia, Syria, Tajikistan, Togo, Turkmenistan, Uganda, and Yemen. Finally, the three countries in group D (Guyana, Palestine, and Brunei) are at an initial stage of mobile broadband adoption and expected to move to either group A or B in the future.

While Saudi Arabia represents a country with high adoption of fixed and mobile broadband technologies, the comparative analysis of adoption trends between both access technologies indicates a clear substitution pattern, whereby mobile is capturing share from fixed broadband (see figure 34).

Figure 34: Saudi Arabia: Comparative adoption of fixed and mobile broadband (2003-2016)



Source: Telecom Advisory Services analysis.

Figure 34 depicts several trends affecting the diffusion of fixed and mobile broadband in the country. The first trend is a ramp-up in fixed broadband adoption between 2011 and 2013. This acceleration occurs at the same time that mobile broadband penetration is not increasing at a fast pace. This would indicate that fixed broadband is capturing a large portion of the latent demand. The second trend depicts a slow down in fixed broadband penetration between 2012 and 2014. This occurred because fixed broadband subscriber growth was inhibited by the substitution effect of mobile broadband driven by more competitive plans, such as unlimited packages, coupled with easier setup and the mobility advantage. In fact, while fixed broadband prices remained comparable to global and local benchmarks, mobile plans were relatively cheaper (see pricing analysis below).

The third trend occurs towards the end of 2015, when adoption decreases for both technologies. The drivers for the fixed broadband decline differ from those affecting mobile. The reduction in fixed broadband subscriptions is primarily the result of the substitution effect referred above. On the other hand, the decline in mobile broadband subscriptions is explained by an initiative driven by CITC, the regulator, aimed at disconnecting unregistered mobile subscribers who failed to submit their fingerprints in line with the new security measures introduced in September 2015[64]. In terms of broadband consumption, the average mobile broadband device in Saudi Arabia generated 673 MB per month, while the average fixed broadband connection consumed 50.7 GB[65].

Most common purposes of Internet use

Statistics indicate that 70.4 % of the population of Saudi Arabia accesses the Internet on a regular fashion (see table 58).

Table 58: Saudi Arabia: Population accessing the internet (2004-2016)

	2004	2006	2008	2010	2011	2012	2013	2014	2015	2Q 2016
Users ('000)	978	1,829	3,137	7,775	9,492	10,183	11,176	13,187	15,275	21,048
Percentage Pop.	10.23	19.46	36.0	41.0	47.5	54.1	55.1	63.7	68.5	70.38

Sources: International Telecommunications Union; CITC; Telecom Advisory Services analysis

According to research conducted by the CITC, approximately 87% of Saudi Internet users spend two or more hours daily on the Internet[66], while 40% are connected for at least 5 hours per day[67]. That being said, Internet usage patterns vary between fixed and mobile broadband access (see table 59).

Table 59: Saudi Arabia: Primary internet use (2015)

Activity	Fixed broadband (%)	Mobile broadband (%)
Web browsing	90.01	66.00
Social Networking	85.15	82.23
Get information on goods and services	61.73	37.00
Sending / receiving e-mail	53.30	46.00
Playing videogames or downloading movies	49.64	- -
Reading news	43.13	29.73
Education and learning	26.05	15.22
Posting information or instant messaging	23.15	- -
Internet banking	17.62	20.00
Electronic commerce	15.52	9.69
Video-conferencing	6.47	4.30

Source: Communications and Information Technology Commission. Individuals Report ICT Survey Results, 2015, p. 40, and p. 50.

[64] The CITC said the fingerprint registration is meant to protect personal information of SIM cardholders and prevent buyers from obtaining mobile phones using fake or stolen identification cards. All unregistered users had a grace period of two weeks to submit their details before the service was cut. The regulator said in its report for the first quarter of 2016 that it expected a continued decline in the number of mobile subscriptions in the coming periods as a direct result of the new registration program.

[65] Source: Cisco Visual Networking Index. The fixed network consumption was calculated by dividing total fixed traffic, as reported by Cisco, from the total number of fixed broadband connections.

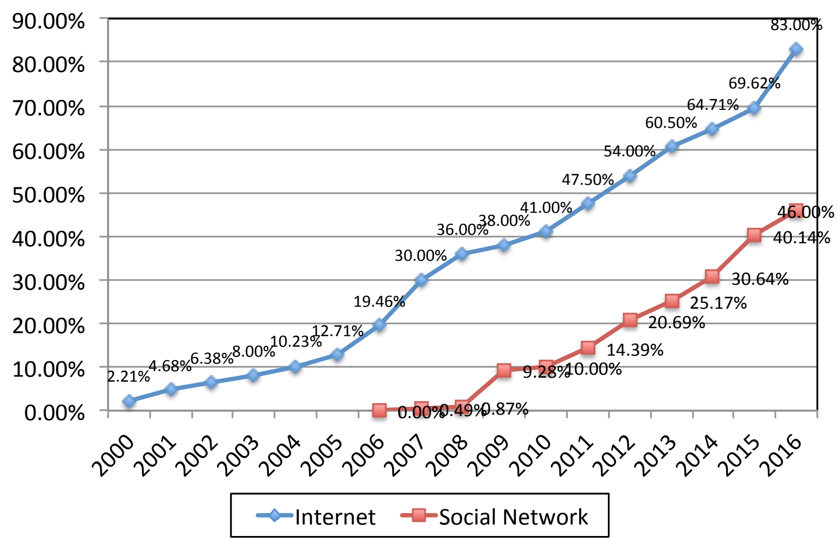
[66] Communications and Information Technology Commission. *Individuals Report ICT Survey Results*, 2015, p. 34.

[67] Source: *Google Consumer Barometer.*

As data in table 59 indicates, web browsing is one of the primary uses of the Internet, although browsing is more intense when accessing the Internet via a fixed network. This could probably be explained by the more user-friendly presentation of information in large screen formats (e.g., PC or tablet) when compared to a smartphone.

Secondly, social networking also represents an important Internet use. A compilation of fixed and mobile broadband subscriber data indicates that 91% of Saudi Internet users access social networks. The most important social network accessed is Facebook: half of social network use is on this site. Beyond Facebook, Saudi Internet users rely on other social networks, such as Twitter (47%), Instagram (43%), Google+ (30%), Snapchat (23%) and LinkedIn (8%). For social network members, Internet usage is fairly intense: 61% of social network members spend more than 2 hours per day connected to those platforms. Facebook membership in Saudi Arabia is growing in parallel with Internet usage (see figure 35).

Figure 35: Saudi Arabia: Internet users and social network members (2000-2016)



Sources: International Telecommunications Union; Owloo; Telecom Advisory Services analysis

A comparison of Facebook membership as a percentage of Internet users across the world indicates that the Saudi population has a more diverse set of uses and destinations than what is commonly found in other regions, except for Sub-Saharan Africa (see table 60).

Table 60: Facebook users as regular internet users (2015)

Region	Internet Users	Facebook Users	Facebook users as % of Internet users
Western Europe	195,230,709	98,992,670	50.71
Rest of Europe	369,232,406	213,950,740	57.94
North America	274,225,765	213.075.500	77.70
Latin America	338,482,028	297.638.420	87.93
Asia - Pacific	1,704,885,395	1.431.361.831	83.96
Sub-Saharan Africa	210,735,220	69.052.400	32.77
Saudi Arabia	21,048,009	9,682,084	46.00
North Africa	67,924,936	55.667.000	81.95
World	3,160,716,459	2.379.738.561	75.29

Sources: International Telecommunications Union; Owloo; Telecom Advisory Services analysis

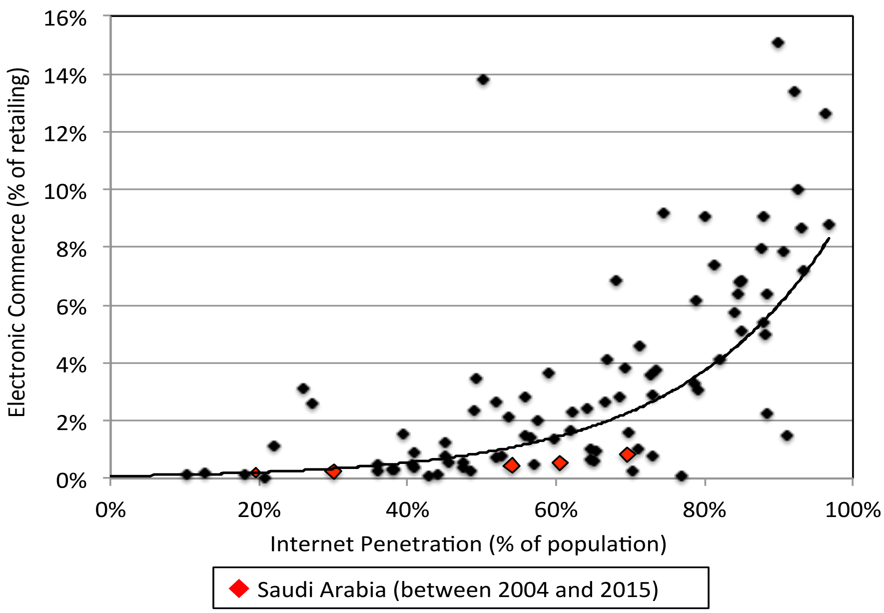
As table 60 indicates, on a world scale, 75% of all Internet users are Facebook members as well. This percentage reaches almost 88% in the case of Latin America. On the other hand, in Saudi Arabia only 46% of Internet users are also Facebook members.

Other than social networking, Saudis tend to access the Internet to watch video programming: 73% of Internet users prefer either downloading programs or videostream content from the Internet. Additionally, use of the Internet for searching information is quite common: 83% of Saudi Internet users rely on the web as the first place to look for information versus 67% in the United States.

On the other hand, some applications still have not achieved the adoption one might expect given the level of Internet adoption. Of note is the use of electronic commerce. Only 21% of Internet users appear to purchase goods electronically[68]. In 2015, only 0.83% of all retail commerce in Saudi Arabia was conducted through electronic channels. A correlation analysis of Internet penetration versus electronic commerce as a percentage of total retailing per country indicates that Saudi Arabia is well below the correlation line (see figure 36).

[68] Communications and Information Technology Commission. *Individuals Report ICT Survey Results*, 2015, p. 79.

Figure 36: Correlation between internet penetration and electronic commerce as percentage of total retailing (2015)



Sources: International Telecommunications Union; Euromonitor; Telecom Advisory Services analysis

Figure 36 indicates that after Internet adoption reaches a threshold of approximately 60%, electronic commerce flows as percentage of retailing tend to grow exponentially. In other words, the Internet creates a new more efficient retail distribution channel, which is massively adopted by consumers. However, the red data points in figure 36 indicate that, while Internet adoption is increasing in Saudi Arabia, electronic commerce remains stagnant. Reasons reported by Internet users for not relying on electronic commerce sites range from the lack of a credit card (53%), to limited digital literacy (18%), to concerns about security (12%)[69].

Major factors that influence use of fixed and mobile broadband

So far, the behavioral patterns of Internet users have been analyzed. The analysis will move now to understand the universe of non-adopters of the Internet. For this purpose, one should start by measuring the extent of the so-called "broadband demand gap". The demand gap measures the difference between the population that can purchase broadband service because of service availability and the individuals that adopt the service, thereby estimating the number of non-adopters for reasons other than coverage. Considering that as of 2Q2016 the Saudi Arabia mobile broadband coverage of the population reached 97% and mobile broadband adoption was 83.5 %, the demand gap is 13.5% (see table 61).

[69] Op.cit., p. 79.

Table 61: Saudi Arabia: Mobile broadband demand gap (%)

	2010	2011	2012	2013	2014	2015	2Q2016
Service coverage	90.00	93.80	95.08	97.00	97.00	97.00	97.00
Percent Population	9.7	39.6	42.1	47.6	94.5	105.9	83.5
Demand gap	80.3	54.2	52.98	49.4	2.5	0 (*)	13.5

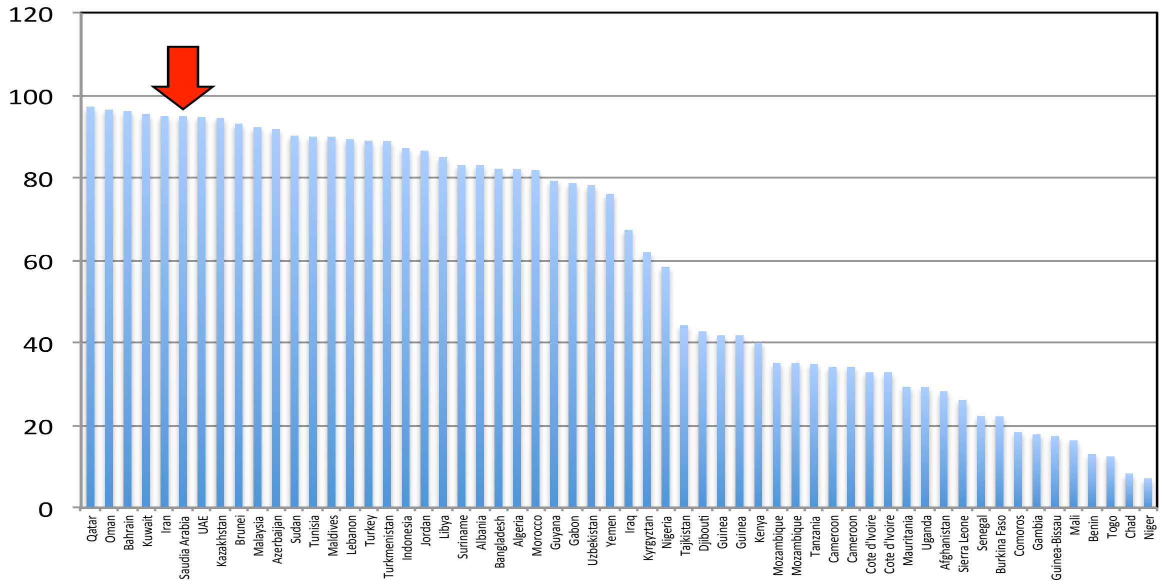
(*) When the demand gap calculation is negative, it is assumed that there are no barriers to adoption.
Sources: GSMA Intelligence; Telecom Advisory Services analysis

Table 61 also illustrates the dynamics between mobile broadband coverage and adoption in a country where adoption is not supply constrained. Saudi Arabia very rapidly achieved a high level of population coverage, which enabled over time a diffusion process that was essentially completed by 2014: a demand gap of 13.5% would indicate that barriers for mobile broadband adoption are fairly low. This estimate is fairly close to the results of a survey conducted by the Saudi regulator on ICT usage in the Kingdom[70]. According to that study, only 9% of all survey respondents aged between 12 and 65 years old were found to be non-users of the Internet.

What are the reasons explaining non-adoption of broadband? First and foremost, the survey data indicates that affordability does not appear to be a significant barrier. Based on the calculation of the digitization index in 2014, Saudi Arabia scored in 2014 a telecommunications affordability index of 94.83[71]. This index reflects in the aggregate the total cost of ownership of telecommunications services (including taxes) as a function of income. In fact, when compared with the rest of the OIC Member Countries, Saudi Arabia is at the top-end of the affordability range (see figure 37).

[70] Op.cit. p. 20.
[71] The digital affordability index is a composite index calculated on the basis of six indicators: Residential fixed line tariff adjusted for GDP per capita; Residential fixed line connection fee adjusted for GDP per capita; Mobile cellular prepaid tariff adjusted for GDP/capita; Mobile cellular prepaid connection fee adjusted for GDP per capita; fixed broadband Internet access cost adjusted for GDP per capita; mobile broadband Internet access cost adjusted for GDP per capita (see Katz and Koutroumpis, 2014).

Figure 37: OIC Member Countries: Telecommunications Affordability Index (2014)



Source: Telecom Advisory Services analysis

The position of Saudi Arabia among its regional peers would indicate that the pricing of telecommunications services, as a function of income does not remain a significant barrier of adoption of broadband. This is also the conclusion derived from analyzing the adoption of mobile broadband plans. The prevalence of pre-paid options among mobile broadband subscriptions would indicate that the current offerings adequately meet the potential pricing constraints that might exist in the country: in other words, if postpaid data plans are too expensive, consumers tend to purchase prepaid plans, which remain quite affordable (see table 62).

Table 62: Saudi Arabia: Pre-paid versus post-paid subscriptions (2012-2015)

	2012			2013			2014			2015		
	Lines ('000' 000)	Pre-paid	Post paid	Lines ('000' 000)	Pre-paid	Post paid	Lines ('000' 000)	Pre-paid	Post paid	Lines ('000' 000)	Pre-paid	Post paid
Data only plans	8.1	99 %	1 %	9.7	99 %	1 %	20.0	99%	1 %	22.2	99 %	1 %
Voice and data plans	4.2	83 %	17 %	4.6	80 %	20 %	9.1	84 %	16 %	9.6	14 %	86 %

Sources: CITC; WCIS

On the other hand, in the case of fixed broadband, the affordability gap exists primarily for high-speed broadband service. As of the end of 2015, despite the availability of fast broadband networks, only 23% of the country's 3.5 million fixed broadband lines have a capacity of >8 Mbps. One of the reasons of limited adoption of existing ultra broadband plans is price.

Let's now turn to the next variable that could be affecting broadband non-adoption: digital literacy. The CITC survey cited above provides ample evidence that lack of digital literacy remains the most important barrier explaining fixed broadband non-adoption. Fifty-three percent of non-adopters surveyed indicated that the primary reason for not accessing the Internet through fixed broadband was lack of knowledge of how to use it. In addition, 19 % did not know what the Internet is, while 8.5 % did not know how to get an Internet connection. All in all, it would appear that lack of digital literacy explains 81% of non-adoption. Interestingly enough, when non-adopters were asked whether they were planning to use the Internet within the next six months, 83% answered "no".[72] In the case of mobile broadband, 18% of individuals surveyed stated to be non-users. In this case, the primary reason was lack of need (88%), while 13.55% reported reasons linked to low digital literacy[73]. Research of Internet adoption has concluded that lack of need is generally linked to limited awareness, and ultimately, to low digital literacy (Katz and Berry, 2014).

Finally, considering that the country's capability to produce local content is relatively low, it would appear that limited availability of applications and content presented in Arabic is likely a barrier for Internet adoption. Research conducted among professors and students at King Abdulaziz University (certainly a highly educated demographic) indicates that for 23% of the people surveyed, the English language remained an obstacle for their Internet usage. A larger share of these respondents was female, which might indicate that this barrier has a different impact by genre[74]. If these findings emerge from research among highly educated subjects, it is reasonable to assume that the language barrier remains relevant for other segments of the population.

To sum up, of all three broadband internet adoption barriers typically found in prior research (Katz and Berry, 2014), limited affordability appears to be not relevant, while low digital literacy and limited local content development appear to be important in Saudi Arabia and require the enactment of public policies to address them.

V.2.2. Supply of broadband services

Having reviewed the state of demand of broadband and Internet usage, the analysis will now turn to an assessment of supply. The current availability of broadband service will be assessed first and then linked it to the state of competition in the industry.

Availability of fixed and mobile broadband infrastructure

Broadband infrastructure is available throughout most of the Kingdom. On the fixed broadband side, ADSL serves 70% of the population, while fiber optics in the last mile covers 38% (1,770,000 households). On the other hand, mobile broadband service coverage has been

[72] See p. 30 in Communications and Information Technology Commission. *Individuals Report ICT Survey Results*, 2015.
[73] See p. 47 in Communications and Information Technology Commission. *Individuals Report ICT Survey Results*, 2015.
[74] See table 4 in Alsaleh, I., and Rashad, S. "Measuring Digital Divide in King Abdulaziz University". *Problems of Management in the 21 Century*. Volume 3, 2012

constantly growing since 2011, reaching 98% in the case of 3G and 90% for LTE technology (see table 63).

Table 63: Saudi Arabia: Evolution of mobile broadband service coverage (2011-2015) (%)

	2011	2012	2013	2014	2015
3G	94	95	97	97	98
LTE	40	65	76	85	90

Source: GSMA

Comparatively speaking, a 97% coverage level for 3G is equivalent to that of OECD countries, and significantly higher than the average for all OIC Member Countries (64.16%), and even Arab OIC Member Countries (74.30%)[75]. These high levels of service coverage can be explained by the incentive resulting from industry competition, which will reviewed in the next section.

Broadband market structure

The Saudi fixed broadband market is serviced by several players, but dominated by two operators: Saudi Telecom Company and Mobily (see table 64).

Table 64: Saudi Arabia: Fixed broadband market structure (2Q2016)

	Number of Subscribers	Market Share (by Subscribers) (%)
Saudi Telecom Co.	2,190,960	71.60
Mobily (Bayanat al Oula)	679,300	22.20
Etihad Atheeb (GO Telecom)	79,560	2.60
Integrated Telecom Co.	15,300	0.50
Other minor players	94,800	3.09
Total	3,060,000	100

Source: Telegeography; CITC; Telecom Advisory Services analysis

On the other hand, the mobile broadband market is served by Saudi Telecom Company and two subsidiaries of Middle Eastern regional players (see table 65).

Table 65: Saudi Arabia: Mobile broadband market structure (2Q2016)

	MNC	Number of Subscribers	Market Share (by Subscribers) (%)
Saudi Telecom Co	STC (Saudi Arabia)	13,310,000	50.00
Mobily	Etisalat (UAE)	7,719,800	29.00
Zain	Zain Group (Kuwait)	5,856,400	22.00
Total		26,620,000	100

Source: CITC; GSMA Intelligence; Telecom Advisory Services analysis

In the 2012-13 time period a fourth wireless operator, Wataniya Telecom, entered the Saudi market. However, it never gained traction and in October 2013, it was acquired by STC. Its exit triggered a moderate increase in consolidation.

[75] Source: International Telecommunications Union.

In this context, the government has sought to increase the number of players in the mobile sector by promoting the entry of Mobile Virtual Network Operators (MVNO). In June 2013 the Communications and IT Commission shortlisted three companies for MVNO licenses: Lebara (targeted to migrant communities and relying on Mobily's network), Virgin Mobile (targeted to the youth segment and using STC's network) and Friendi (aimed at expatriates). The first two launched service in the fourth quarter of 2014[76], while the third had its license cancelled for not having submitted the full application. These two operators have started gaining some market traction, particularly Virgin which has signed up to one million subscribers as of 2016.

State of competition in broadband market

As noted in the earlier section, the Saudi broadband market consists of two convergent players (Saudi Telecom Company, and Mobily), two fixed broadband "pure plays" (Etihad Atheeb and ITC), one mobile broadband operator (Zain), and two MVNOs. Competition in the fixed broadband segment is infrastructure-based, while in the case of mobile broadband, it is a mix between infrastructure-based and service-based[77].

Created in 1998 from the state-owned telecommunications monopoly, the Saudi Telecom Company (STC) remains the dominant player in the broadband market with 2,190,960 subscribers in fixed broadband (71.6 % share) and 13,310,000 mobile broadband customers (50% share). In addition to being the sole ADSL provider in the country, STC started rolling FTTH technology in February 2011 offering speeds of up 200 Mbps. By the end of 2015, the operator had passed 1,770,000 homes with fiber optics in most Saudi cities. STC dominates the fixed broadband market because its copper access network has much greater reach than its competitors, providing direct access to DSL. Furthermore, until recently the fixed network remained largely not liberalized, thereby limiting the competitive threat. Alongside its fixed broadband network, STC has deployed LTE technology, serving approximately 85% of the Saudi market. In July 2016, the regulator issued a draft Market Definition and Dominance Report establishing that STC was dominant in 11 national markets and 4 submarkets. It recommended remedies to promote competition linked to Interconnection and Access to Physical Facilities.

Mobily, partly owned by Etisalat of the United Arab Emirates, is the country's second convergent player, controlling 79,560 fixed broadband (2.6% share) through its Bayanat al Oula subsidiary, and 7,719,800 mobile broadband subscribers (29% share). While remaining a much smaller player than STC, Mobily has been actively deploying fixed broadband infrastructure. The company owns 66% of the Saudi National Fiber Network after the acquisition of Bayanat al Oula, the holder of a WiMax license. As of the end of 2015, existing Mobily and STC fiber networks are 90% overlapping in dense urban geographies.

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[76] "Lebara launches MVNO services in Saudi Arabia".*Telegeography*, December 16, 2014.

[77] Infrastructure-based competition is based on players deploying their own networks, while service-based entails operators purchasing facilities from another provider and competing on the basis of service offering and quality of customer experience.

Etihad Atheeb Telecom Company (also called GO Telecom) is a fixed wireless service provider relying on WiMAX technology. The company is a joint venture of Batelco of Bahrain and the Saudi Arabia-based Atheeb Trading Company. The remaining player is the Integrated Telcom Co (ITC) targeting primarily the business and wholesale markets through WiMAX technology and fiber infrastructure and offering dedicated data communications services. ITC joined forces with Bayanat al Oula to be part of the Saudi National Fibre Network. Most fixed broadband competition has been centered so far around FTTH, WiMAX and fixed TD-LTE technology given that no local loops have been so far unbundled.

The only mobile broadband pure play, Zain Saudi Arabia backed by Kuwait's Zain Group, has been focusing on a mobile broadband strategy, emphasizing a technology strategy around LTE-A, offering service with maximum download speed of 187.5 Mbps[78].

The Saudi broadband industry is facing two key challenges. In the first place, operators are facing increasing pressure on revenues derived from traditional services. Core revenues and margins are declining as result of cannibalization of long distance service by VoIP operators, such as Skype. While fixed and mobile broadband is still growing in most markets segments (consumer, enterprise, and government), it does so at a disproportionately lower rate than the surge in data traffic. This puts additional pressure on capital spending. In this context, only the operators that are monetizing their broadband offerings are capturing the growth opportunity. On the other hand, all mobile broadband players are considering the spin-offs of their tower assets into a separate joint venture in order to save on infrastructure costs[79].

As an additional risk, the increased adoption of Internet and smart devices is shifting market power to *Over The Top* app providers who capture the relationship with customers and appropriate a large share of revenue growth.

Technologies and trends in the broadband market

The technological infrastructure utilized for delivering broadband services has to date consisted of a mix of ADSL, WiMAX and FTTH for fixed networks, as well as 3G and 4G for mobile broadband (see table 66).

Table 66: Saudi Arabia: Current broadband technologies utilized

Company	ADSL	WiMAX	FTTH	3G	LTE
STC	• Yes	• Yes	• FTTH network reaching most urban centers	• Over 2100 MHz band • 98% coverage • HSPA+	• TD-LTE over 2300 MHz • FD-LTE over 1800 MHz • 90% coverage
Mobily / Bayanat al		• Yes	• FTTH in Dammam, Jeddah, Khoubar and Ryadh	• Over 2100 MHz band	• TD-LTE over 2600 MHz

[78] "Zain Saudi launches tri-band LTE-A in Jeddah".*Telegeography,* May 12, 2016.

[79] "Saudi cellcos in discussion to create JV tower business". Telegeography. February 11, 2016

Company	ADSL	WiMAX	FTTH	3G	LTE
Oula			• Part of the Saudi National Fiber Network (17,000 kms)	• 98% coverage • HSPA+	• FD-LTE over 1800 MHz • 90% coverage
Zain				• Over 2100 MHz band • HSPA+	• FD-LTE over 1800 MHz • 90% coverage
ITC	Yes	• Yes	• Part of the Saudi National Fiber Network		

Sources; Analysis Mason; Telegeography

Fixed and mobile broadband speeds and quality of broadband services

Despite the pervasive offering of fiber optic distribution, adoption of high speed fixed broadband is still limited. Out of the 3.5 million lines deployed at the end of 2015, only 23% were at speeds higher than 8 Mbps (see table 67).

Table 67: Saudi Arabia: Line breakdown of fixed broadband speed (2011-2015)

	2011	2012	2013	2014	2015	CAGR
<2 Mbps (%)	39	35	33	39	36	14.2
2-8 Mbps (%)	57	55	49	42	41	6.6
8-20 Mbps (%)	4	9	16	17	20	71.3
>20 Mbps (%)	0	1	2	2	3	48.4

Source: CITC; MCIT Lab

This gap between supply of faster speeds and demand is due to four reasons:

- Lack of local content and applications requiring faster broadband speeds
- Limited fixed broadband quality of user experience
- Relatively high prices for high speed broadband
- Strong fixed mobile broadband substitution

As noted on table 67, 23 % of total fixed broadband lines offered a speed equal to or above 8 Mbps in 2015. It should be noted, however, that advertised speed does not equal real performance. It is very common that, due to network quality issues or traffic saturation, advertised speeds represent approximately 60% of real performance. For example, Akamai reports that 50% of fixed broadband lines in Saudi Arabia actually only provide 4 Mbps performance.

However, a comparison between Saudi Arabia statistics with other relevant countries provide a relative context for understanding the country's fixed broadband speed levels (see table 68).

Table 68: Saudi Arabia versus other country averages (2015)

	Saudi Arabia	Arab OIC Member Countries	All OIC Member Countries
Share Fixed-broadband 256 Kbit/s to less than 2 Mbit/s subscriptions (%)	44.92	53.66	56.69
Share Fixed-broadband 2 Mbit/s to less than 10 Mbit/s subscriptions (%)	22.10	38.60	32.20
Share Fixed-broadband equal to or above 10 Mbit/s subscriptions (%)	32.99	8.92	11.11

Source: International Telecommunications Union

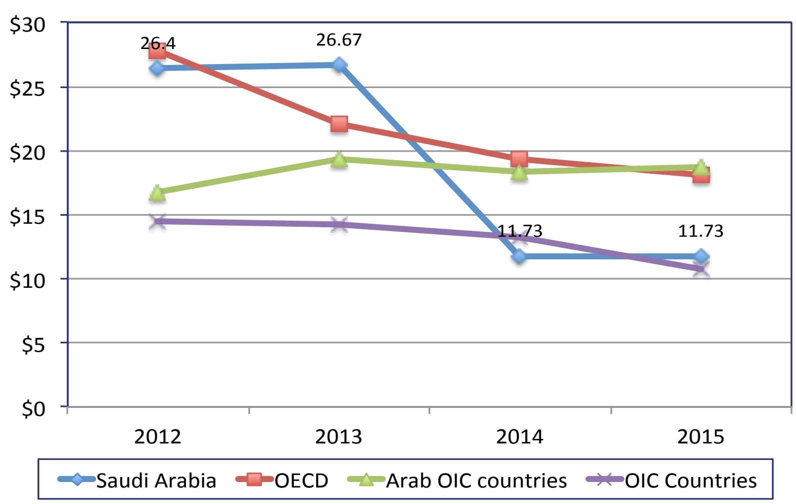
According to the International Telecommunications Union, Saudi Arabian broadband has higher speed than the country averages of all OIC Member Countries and also those located in the Arab region.

Pricing of fixed and mobile broadband

The liberalization of the Saudi telecommunications market has resulted in a significant reduction in prices. For example in 2014, while the cost of living index in the Kingdom increased by 2.7%, the price index for telecommunications services decreased by approximately 0.1%. When considering a longer time period (2007-2014), inflation is reported at 30.1%, while the pricing of telecom services declined by 6.3%[80].

As an example, the monthly subscription for 1 GB USB port has dropped from US$ 26.40 in 2012 to US$ 11.73 in 2016. This decrease is larger than the one undergone in the average of all Arab OIC Member Countries, and that of all OECD countries (see figure 38).

Figure 38: Monthly subscription of 1 GB cap USB (in US$)



Source: International Telecommunications Union; Telecom Advisory Services analysis

[80] CITC Annual report 2014, p. 73.

Pricing of mobile broadband plans is currently more advantageous than fixed broadband, thereby creating an additional incentive to fixed mobile substitution (see table 69).

Table 69: Saudi Arabia: Fixed – Mobile Plan Pricing (2016)

Prepaid Large Screen Mobile Broadband Packages	70 SAR 3GB (1 month)	130 SAR 10 GB (4 months)	300 SAR Unlimited (3 months)
Postpaid Fixed Broadband Packages	99 SAR 2 Mbps	SAR 149 4 Mbps	SAR 199 20 Mbps

Source: Operators websites

Investments in fixed and mobile broadband infrastructure

The annual infrastructure investment in Saudi telecommunications was US$ 2.169 billion in 2014. However, total investment has been consistently declining since 2011 (see table 70)

Table 70: Saudi Arabia: Annual telecommunications Investment (2005-2014)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Annual Investment (US$ '000'000)	1,927	1,928	2,107	3,031	3,105	3,105	3,372	2,674	2,314	2,169
Annual Investment per broadband subscriber (US$ PPP)	230.06	207.00	208.65	253.72	303.19	255.54	239.11	181.17	157.54	150.17

Source: International Telecommunications Union; Telecom Advisor Services analysis

As table 70 indicates, the total annual investment per broadband subscriber has been decreasing from a high point of US$ 303 in 2009 to US$ 150 in 2014. The total investment in telecommunications infrastructure indicates a gradual shift from fixed telecommunications to mobile (see table 71).

Table 71: Saudi Arabia: Annual telecommunications Investment (2006-2014)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fixed Telecommunications	1,850	1,807	2,262	1,367	- - -	- - -	- - -	- - -	- - -
Mobile telecommunications	78	300	769	1,738	- - -	- - -	- - -	- - -	- - -
Total	1,928	2,107	3,031	3,105	3,105	3,372	2,674	2,314	2,169

Source: International Telecommunications Union; Telecom Advisor Services analysis

The change in capital spending mix is driven by a shift in investment from FTTH to 4G. Due to a slow-down in demand for high-speed fixed broadband (mentioned above), operators have reduced their investment in FTTH and focused more on LTE deployment. For example, the number of incremental homes passed by FTTH networks has declined for the first time in 2015 (see table 72).

Table 72: Saudi Arabia: Incremental FTTH Supply (Homes passed '000) (2011-2015)

	2011	2012	2013	2014	2015
Incremental Homes Passed	100	300	430	570	300

Source: Analysis Mason

Major factors that influence broadband investments

The encouragement of broadband infrastructure spending is driven by the Kingdom's 2030 vision which sets clear and ambitious targets for the economy, with implications for broadband networks, in particular last mile fiber optic and LTE.

However, in the short term broadband capital spending in the Kingdom is constrained by three regulatory factors. First, regulatory price control is affecting the overall retail revenues of the telecommunications sector, which have declined 2% year-on-year between 2012 and 2015. Price controls are compounded by ex-ante tariff approvals, which cause revenue stagnation and diminish operator profitability. For example, mobile broadband revenues have declined 62% between January 2014 and December 2015. Third, the telecommunications industry contributes a significant amount of royalties to the Treasury, which limits operators' ability to invest in infrastructure. These regulatory factors have resulted in capital spending decreases in three areas:

- Halt of infrastructure investment in rural areas leaving substantial share of customers uncovered by last generation technologies;
- Slowdown in fiber deployment and uptake of high-speed broadband; and
- Further reduction in network throughput leading to deteriorating customer experience

V.2.3. Institutional Structure and Policies for Promoting Broadband

Institutional structure, policies and strategies regarding broadband market

The institutional structure guiding the development of broadband is in a process of transition. In the recent past, the development and management of broadband public policies was fragmented across a number of agencies and ministries (see table 73).

Table 73: Saudi Arabia: Institutional policy responsibilities

Policy Domain	Initiative	Government Entities
Development and implementation of e-Government services	Yesser	• Ministry of Communication and Information technology • Communications and Information Technology Commission • Ministry of Finance • Ministry of Interior
Implementation of broadband wholesale market	Open Access	• Communications and Information Technology Commission
Address the digital divide	Universal Service Fund	• Communications and Information Technology Commission
Internet applications development	Nitaqat	• Ministry of Labor and Social Development

Source: Telecom Advisory Services

This structure is gradually consolidating under two ministries: Ministry of Economy and Planning and Ministry of Communication and Information technology. The Ministry of Economy and Planning is assigned the responsibility of leading the development and implementation of the digital agenda, On the other hand, the Ministry of Communication and Information technology is in charge of supervising and coordinating the activities of Ministry of Finance, Ministry of Municipal and Rural Affairs, Public Investment Fund, Ministry of Labor and Social Development, Saudi Arabian Monetary Agency, Ministry of Health, and Ministry of Education.

Major approaches, implementations and challenges in extending fixed and mobile broadband infrastructure

The Kingdom's 2030 vision provides an overarching direction for broadband in Saudi Arabia. Several of the vision's economic objectives depend on the continued development of broadband infrastructure. Examples of related objectives include:

- Build a unique logistics hub;
- Integrate the Saudi economy both regionally and internationally;
- Support development of national Saudi enterprises;
- Rehabilitate economic cities;
- Establish special investment zones; and
- Support development of SMEs

Along theses lines, the government considers broadband to be a key catalyst. In particular, competition is considered to be a key stimuli to accelerate the deployment of fiber optics. Additionally, local governments are seen as key partners to operators on the promotion of local infrastructure. The Universal Service Fund is considered to be a critical component for supporting entry-level broadband investment in rural areas. Given the exploding traffic in mobile broadband, the Ministry of Communications and Information Technology is planning on making more frequency spectrum available for deployment of LTE.

V.2.4. Lessons Learned

The assessment of broadband network and services in Saudi Arabia provides a basis for a number of lessons learned. The following lessons learned are structured around the promotion of enhanced supply and the stimulation of demand.

Supply policies

Saudi Arabia has achieved a high level of broadband infrastructure deployment. This has been enabled by two regulatory initiatives:

- Assignment of radio-frequency spectrum to enable the deployment of LTE networks serving 85% of the population
- Promotion of infrastructure-based competition leading to the deployment of fiber optic last-mile networks covering almost 40% of the population

Demand policies

On the demand side, price reduction and infrastructure deployment have eliminated key barriers to adoption. The most important lesson learned so far from the Saudi case is that once the affordability barrier is eliminated, other obstacles emerge as being key to be addressed, such as digital literacy and the development of local Internet content and applications. These issues need to be addressed by the government to enable greater use of the Internet and achieving its derived envisioned benefits.

V.3. KAZAKHSTAN

The following case study assesses the state of broadband services in Kazakhstan. It reviews the trends in demand and supply, the broadband industry structure, and the state of investment and broadband technology infrastructure.

In order to understand the state of demand and supply of broadband services in Kazakhstan it is first necessary to take a look at the country's demographic structure since it provides a perspective of the challenges faced by the government to increase broadband adoption. As of 1 January 2016, the population of Kazakhstan was estimated to be 17,769,475 people[81]. The country's total population density is fairly low: 6.5 people per square kilometer[82]. Fifty-five percent of the population lives in cities, which means that, beyond the urban centers, population density of rural areas approximates 2.9 people per square kilometer. This rural-urban dichotomy is at the root of both the country's technological progress in urban areas and the challenges remaining to bridge the rural divide.

In the aggregate, Kazakhstan is highly advanced in terms of broadband network deployment and usage when compared to other OIC Member Countries. Since 2006, the number of Internet users in Kazakhstan has increased from 8.3% to 73%[83], thanks largely to the development of a modern telecommunications infrastructure. This has also helped raise Kazakhstan's ranking in the 2014 UN E-Government Survey to 28th position. Smartphone penetration (41% of population)[84] and fixed broadband (50% of households) remain among the highest in Central Asia. From an infrastructure standpoint, the industry is actively migrating mobile broadband subscribers to 4G LTE networks, and deploying fiber optics in the distribution networks. In the 2014-15 Global Competitiveness Report of the World Economic Forum, Kazakhstan ranks in 62nd place for number of Internet users and 58th for users of broadband Internet, out of a total of 144 countries.

On the other hand, in part due to the challenges encountered to serve the rural low population density areas, a demand gap related to the urban/rural divide exists. The urban centers comprise a set of fixed and mobile broadband competitors deploying highly advanced technology with high broadband adoption, while the rural areas remain somewhat underserved or relying on underperforming technology in a context of highly concentrated industry structure. This situation is driven both by challenging deployment economics and lower purchasing capacity of rural population.

In this context, the government is pushing to address the digital divide challenge, while attempting to further diversify the country's economy, beyond the oil and gas sector. Along these lines, Kazakhstan aspires to become one of the thirty most competitive countries in the world through an ambitious digitization program. "Digital Kazakhstan 2020" aims to help boost the economy through accelerated digitization. Creating a digital platform to increase

[81] Source: United Nations Department of Economic and Social Affairs: Population Division.
[82] The total area of Kazakhstan is 2 724 900 km^2 according to the United Nations Statistics Division.
[83] Source: International Telecommunications Union, 4Q2015.
[84] Source: GSMA Intelligence, 4Q2016.

competitiveness of sectors of the economy, while increasing connectivity of the rural population are the main objectives of this program.

V.3.1. Demand for Broadband Services

Fixed and mobile broadband usage rates

The adoption of broadband services in Kazakhstan is a fairly recent phenomenon. The diffusion of fixed broadband begun in 2003. The initial rate of growth was modest until 2006, with adoption increasing at a rapid pace thereafter from 2007 to 2015. As table 74 indicates, as of year-end 2015 50% of Kazakh households have already adopted fixed broadband services.

Table 74: Kazakhstan: Fixed broadband lines (2003-2015)

	2003	2005	2006	2007	2009	2011	2012	2013	2014	2015
Lines ('000)	1.0	3.0	30.0	270,.0	577.3	1,193.4	1,637.3	1,958.8	2,148	2,107
Percent household	0.03	0.08	0.79	6.68	14.07	28.54	38.73	45.86	49.79	50.23

Sources: International Telecommunications Union; Just Smart Solutions LLP; Telecom Advisory Services analysis

With 50.23% fixed broadband adoption, Kazakhstan represents the country with highest fixed broadband adoption relative to other OIC Central Asian member states: Kyrgyzstan (15.56%), Tajikistan (0.40%), Turkmenistan (0.31%), and Uzbekistan (19.42%).

On the other hand, after launching in 2010 with the initial deployment of 3G networks, mobile broadband adoption reached 12.5 million connections (or 70.3% of the population) by 4Q2016 (see table 75).

Table 75: Kazakhstan: Mobile broadband subscriptions (2010-2016)

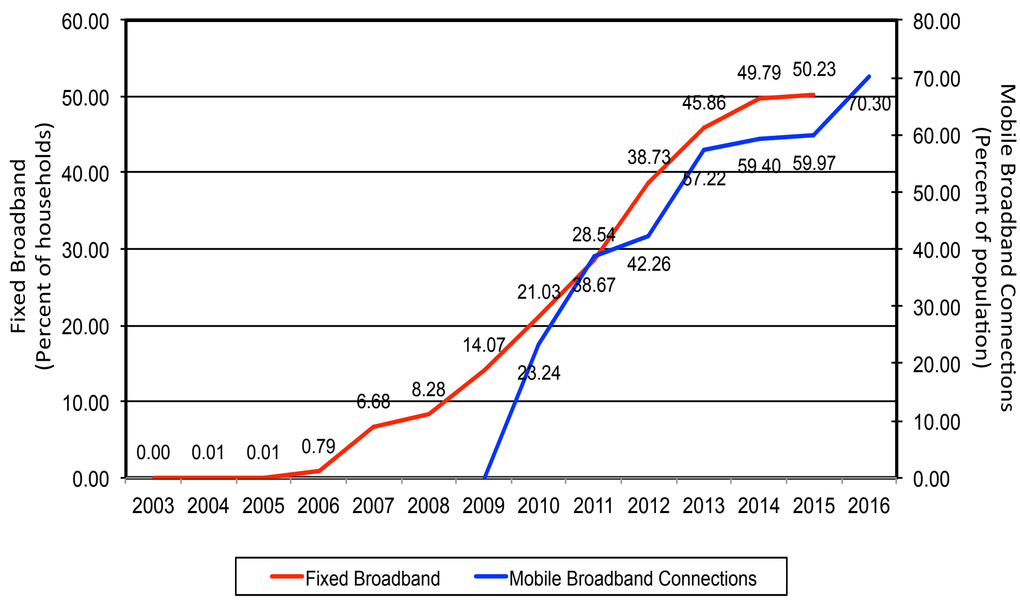
	2010	2011	2012	2013	2014	2015	2016	CAGR
Connections	3,700,000	6,225,000	6,875,600	9,406,900	9,863,700	10,056,700	12,495,374	22%
Percent Population	23.24	38.67	42.26	57.22	59.40	59.97	70.3	21

Sources: GSMA Intelligence; International Telecommunications Union; Telecom Advisory Services analysis

As table 75 indicates, mobile broadband total connections have increased at a 22% compound annual growth rate since 2010. At 70.3% of connections penetration, Kazakhstan again has the highest mobile broadband adoption relative to other OIC Central Asian countries: Kyrgyzstan (68.48%), Tajikistan (41.46%), Turkmenistan (54.25%), and Uzbekistan (32.56%).

Contrary to what is observed in other countries regarding fixed-mobile broadband substitution, the comparative analysis of both adoption trends indicates that the launch of mobile broadband services has not affected the diffusion rate of fixed broadband in a significant fashion. This could indicate that, rather than fixed-mobile substitution, both technologies might be complementary (see figure 39).

Figure 39: Kazakhstan: Comparative adoption of fixed and mobile broadband (2003-2016)



Source: GSMA Intelligence; International Telecommunications Union; Telecom Advisory Services analysis.

As figure 39 indicates, the deployment of mobile broadband networks in Kazakhstan resulted in a complementary effect, whereby each technology is adopted to fulfill specific functions (e.g. video distribution and data rich Internet access in the household vs. light data applications through the mobile platform). This could be explained by the fast deployment of fiber optics, a fixed technology that portends a specific set of differentiated features relative to mobile broadband.

Most common purposes of Internet use

The International Telecommunications Union reports that 73% of the population of Kazakhstan in 2015 accessed the Internet on a regular fashion (see table 76).

Table 76: Kazakhstan: Population accessing the Internet (2003-2015)

	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Users ('000)	295	446	498	619	1,712	2,865	5,031	8,146	8,676	10,358	10,961	12,221
% Pop.	2.00	2.96	3.27	4.02	11.00	18.20	31.60	50.60	53.32	63.00	66.00	72.87

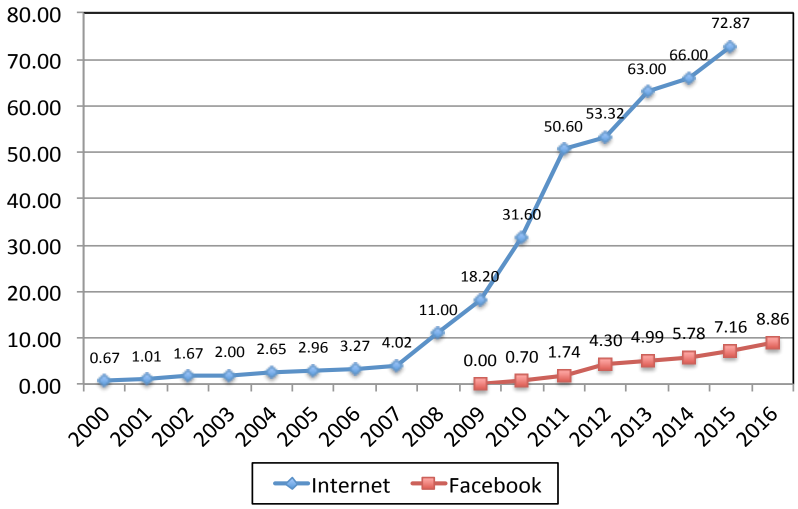
Sources: International Telecommunications Union; Telecom Advisory Services analysis

While there are no official statistics of the geographic distribution of Internet users, some analysts consider that more than 35% of Internet users are concentrated in the city of Almaty[85]. However, Internet usage is fairly limited in terms of accessing a social network such as Facebook. As of 2016, Facebook penetration had reached only 8.86% of the population. A

[85] Revenue of enterprises providing internet access by regions as of January 2015," [in Russian] Ranking, February 24, 2015, http://bit.ly/1DNjp8a.

comparison between Internet users and Facebook members' penetration indicates that only 10% of Internet users are also Facebook members (see figure 40).

Figure 40: Kazakhstan: Internet users and Facebook members (2000-2016)



Sources: International Telecommunications Union; Owloo; Telecom Advisory Services analysis

Data in figure 40 indicates that Internet usage is growing at a faster rate than Facebook membership. This is because social networking is dominated by V Kontakte and Odnoklasssniki, two Russian platforms[86]. Table 77 presents the top Internet sites ranked by traffic in Kazakhstan.

Table 77: Kazakhstan: Top 10 internet sites (November 2016)

Ranking	Site	Category	Percent of visitors in Kazakhstan	Country of origin
1	VK.	Social Network	3.7	Russia
2	Mail.ru	Portal	7.5	Russia
3	Youtube.com	Online video	- - -	United States
4	Google.kz	Search	96.9	US Adapted to Kazakhstan
5	Odnoklassniki (mail.ru)	Social Network	3.0	Russia
6	Yandex.kz	Search	96.0	Russia
7	Facebook	Social Network	- - -	United States
8	Aliexpress	E-Commerce	- - -	China
9	Kolesa	E-Commerce	92.5	Russia
10	Instagram	Social Network	- - -	United States

Sources: Forbes; Telecom Advisory Services analysis

While Internet usage in Kazakhstan does not differ significantly from what is found in other countries around the world (concentrated in online video, search engines, portals, and social networking), Russian sites are prevalent in destination: five out of the top ten sites are of Russian origin.

[86] Source: World Map of Social Networks, January 2016.

Major factors that influence use of fixed and mobile broadband

Despite the high penetration of the Internet, a portion of the Kazakh population has not yet adopted it. To estimate the portion of non-adopters, the demand gap statistic is relied upon. The demand gap measures the difference between the population that can purchase broadband service because of service availability, and the individuals that actually acquire service; this serves to calculate the number of non-adopters for reasons other than lack of coverage. Considering that mobile broadband coverage of the population has reached 75% by the end of 2015, this would indicate that the demand gap is 42%. As table 78 indicates, the demand gap has been increasing over time because the rate at which operators are deploying mobile broadband networks is higher than the speed of subscriber growth.

Table 78: Kazakhstan: Mobile broadband demand gap (2010-2016) (%)

	2010	2011	2012	2013	2014	2015	2016
Population coverage	7.38	14.75	29.50	59.00	59.00	72.70	73.00
Unique subscribers as % of Population	0.34	2.08	4.59	9.17	15.51	22.34	31.18
Demand gap (based on unique subscribers)	7.04	12.67	24.91	49.83	43.49	50.36	41.82

(*) Estimated
Sources: GSMA Intelligence; International Telecommunications Union; Telecom Advisory Services analysis

A note of caution should be made in interpreting the figures in Table 78. To calculate the demand gap, mobile broadband penetration metrics are based not on the number of connections but on unique subscribers, which considers unique users rather than the number of SIM cards. Thus, considering the accelerated geographic deployment of mobile broadband networks, the demand gap has been increasing until 2016, when a slow-down in deployment has resulted in a reduction of the demand gap. While a gradual reduction in the demand gap is forecast, as of now 42% of the population currently reached by mobile broadband networks does not purchase the service. One reason for non-adoption could be limited affordability. However, as indicated in table 79, pricing of some of the more economic broadband subscription plans in the country has been decreasing significantly.

Table 79: Kazakhstan: Pricing of broadband subscriptions (2006-2015) (in US$)

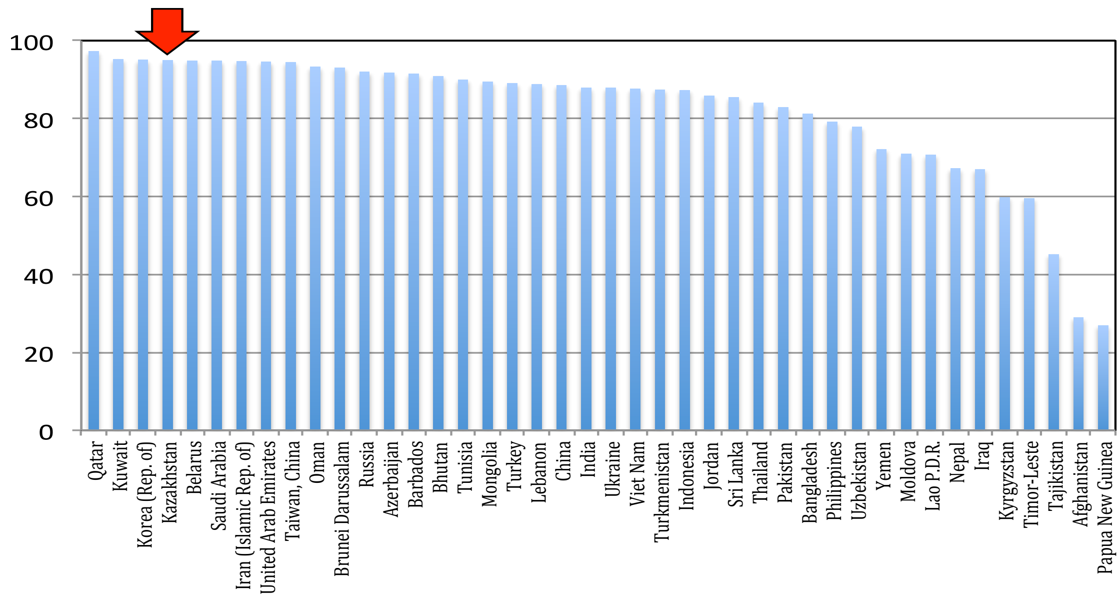
Monthly subscription	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fixed-broadband	157.82	31.01	20.14	13.09	13.10	23.87	12.94	12.69	10.77	8.70
Mobile broadband USB 1GB, postpaid							6.64	6.51	5.52	4.46
Mobile broadband handset 500M							6.64	6.51	5.52	..
Mobile broadband handset 500MB, prepaid							6.64	6.51	5.52	4.46

Source: International Telecommunications Union; Telecom Advisory Services analysis

As data in table 79 indicates, broadband prices have been dropping across the board, primarily driven by competition (see supply section below). Price declines have led to an increase in Kazakhstan digitization affordability index, which has risen from 50.04 in 2006 to 94.98 in

2015.[87]. This index reflects, in the aggregate, the total cost of ownership of telecommunications services (including taxes) as a function of income. When compared with the rest of Asian countries, Kazakhstan is at the high-end of the affordability range (see figure 41).

Figure 41: Asia: Telecommunications Affordability Index (2014)



Source: Telecom Advisory Services analysis

The position of Kazakhstan among its Asian peers would indicate that pricing of telecommunications services might not represent a barrier to adoption. In fact, the most economic fixed broadband product offered in the Kazakh market represents only 1.40% of the average monthly income of US$ 634[88] as of November 2014. This percentage is well within the parameter established by the UNESCO/ITU Broadband Commission of 5% of monthly income.

If pricing is not a significant barrier to broadband adoption, it is probable that digital literacy and cultural relevance become more prominent in explaining the demand gap. With a literacy rate at 99.7 %, however, it is doubtful that digital literacy represents an important barrier[89]. Furthermore, Kazakhstan's multi-ethnic demographics and the prevalence of the Russian language from the Soviet era do not have significant impact on broadband access: all public institutions are required to provide two language versions on their website, and many private sector actors follow this trend, although currently there is much more domestic content available in Russian than in the Kazakh language.

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[87] The digital affordability index is a composite index calculated on the basis of six indicators: Residential fixed line tariff adjusted for GDP per capita; Residential fixed line connection fee adjusted for GDP per capita; Mobile cellular prepaid tariff adjusted for GDP/capita; Mobile cellular prepaid connection fee adjusted for GDP per capita; fixed broadband Internet access cost adjusted for GDP per capita; and mobile broadband Internet access cost adjusted for GDP per capita (see Katz and Koutroumpis, 2013).

[88] Mojazarplata, "Average Monthly Wages," [in Russian] accessed March 5, 2015, http://bit.ly/1erDCv5.

[89] Official statistics indicate that, as of 2012, only 4.5%of the population lacked all computer literacy (Agency of Statistics of the Republic of Kazakhstan).

On the other hand, 45% of the Kazakh population resides in rural environments[90]. Along those lines, it could be assumed that Internet content relevance might represent one of the most important barriers to broadband adoption. As a confirmation of the rural driven digital divide, fixed broadband penetration in urban areas is 42% of households, while in rural area it remains 13% of households.

V.3.2. Supply of Broadband Services

Availability of fixed and mobile broadband infrastructure

Four facilities-based operators provide fixed broadband services to retail customers. Kazakhtelecom, the fixed broadband incumbent, offers ADSL 2+ service to 70% of the population, as well as fiber optic GPON access to 35% of the population[91]. In addition, the carrier has deployed a national CDMA 450 EV-DO network to serve rural areas. The density in rural areas being extremely low, it cannot render the economics of a fixed wireline network profitable. Even under a fixed wireless network, the carrier incurs losses in serving rural areas[92]. This is why Kazakhstelecom is compensated for losses generated in serving rural areas with funding originated from the 1% of revenue contribution for universal service[93]. The carrier considers that, given the cost of serving extremely low-density areas, the subsidy does not fully compensate for the losses. This affects the spending on base station deployment, ultimately eroding quality of service[94]. The carrier is involved in the *Digital Kazakhstan 2020* plan for the deployment of fiber optic infrastructure to public buildings in rural areas. Villages and towns with over 250 inhabitants will be connected to Kazakhtelecom's fiber network. The project is led in partnership with Kazakhstan's Ministry of Investment and Development[95] (see details in section of major initiatives below).

In competition to Kazakhtelecom, Vimpelcom offers FTTB 100 Mbps service. The network now passes 1.2 million homes in 25 cities, among which it counts the cities of Almaty, Astana, Dzhezkazgan, Karaganda and Oskemen. The third competitor in the fixed broadband market is Alma TV, a cable TV player that offers FTTH GPON offering up to 100 Mbps service. Finally, Transtelecom, an operator partly owned by the national railway, Kazakhstan Temir Zholi (KTZ), offers ADSL service to users located along railway lines.

In addition to the offerings in the retail market, several carriers offer broadband to business customers. Transtelecom also operates a 13,000 km. fiber network along its right of way[96]. Katzteleport, a subsidiary of the Kazakhstan banking group Halyk Bank offers services to business customers. Ducat and AsiaBell offer WiMAX fixed wireless service in 36 major cities.

[90] Source: Agency of Statistics of the Republic of Kazakhstan.
[91] Source: Kazakhtelecom Corporate Strategy presentation, 2016 and field trip interviews.
[92] Field trip interviews.
[93] The carrier submits a report on financial losses incurred in serving rural geographies and the Universal Fund provides a subsidy.
[94] Download speed in rural areas served with CDMA 450 could reach 128 Kbps (source: field trip interview).
[95] Telegeography. *Kazakhtelecom plans rural fibre rollout.* 26 Nov 2014
[96] Telegeography. *Transtelecom upgrades Kazakh backbone.* 16 Dec 2015

On the mobile broadband side, the three wireless carriers have launched 4G LTE services, and offer service in most cities. Kazaktelecom's subsidiary Altel launched 4G LTE service in December 2012[97] in the cities of Astana and Almaty. The operator had an exclusive license for one and a half year. By 2015, the service was offered to 7.2 million people in 22 cities. Another 22 cities of more than 50,000 population were covered in 2015, reaching 65.5% of the population. As of the end of 2016, the carrier covers 70% of the population.

Beeline launched service in the cities of Astana, Aksai and Uralsk. By the end of 2016 it plans to cover eleven more cities: Almaty, Shymkent, Karaganda, Ust-Kamenogorsk, Aktau, Atyrau, Kostanay, Pavlodar, Semey, Zhezkazgan and Satpaev. The operator expects to be covering 70% of the population by end-2017[98]. Due to their obligation by the regulator to extend 4G to rural geographies, and constrained by CAPEX, Beeline and K-Cell negotiated an agreement with the regulator by which the former covers the north of the country and the later covers the south. To achieve nationwide coverage, they have signed a mutual roaming agreement. Table 80 summarizes the covered population by broadband technology and carrier.

Table 80: Kazakhstan: Population covered by broadband (by technology) (2016) (%)

Operator	ADSL	FTTH	3G	LTE
Kazakhtelecom	70	35	73	70
Vimpelcom (Beeline)		27	73	60
Transtelecom				
Alma TV		30 (E)		
K-Cell			73	60

Source: Field trip interviews; International Telecommunications Union

Broadband market structure

As mentioned above, the fixed broadband market is comprised by four retail facilities-based players and several carriers focused on the business market (see table 81).

Table 81: Kazakhstan: Fixed broadband retail market structure (4Q2015)

<table>
<tr><th></th><th>Number of Subscribers</th><th>Market Share (by Subscribers) (%)</th><th>Revenues ('000'000) (US$)</th><th>Market Share (by revenues) (%)</th></tr>
<tr><td>Kazakhtelecom</td><td>1,502,632</td><td>72.7</td><td>57.8</td><td>75</td></tr>
<tr><td>Vimpelcom (Beeline)</td><td>320,000</td><td>15.5</td><td>5.4</td><td>7</td></tr>
<tr><td>Transtelecom</td><td>70,000</td><td>3.4</td><td>1.5</td><td>2</td></tr>
<tr><td>AlmaTV</td><td>42,000</td><td>2.0</td><td rowspan="2">8.5</td><td rowspan="2">11</td></tr>
<tr><td>Other (Astek, Kazinform Telecom, Katzteleport, Ducat and Asiabell)</td><td>132,262</td><td>6.3</td></tr>
<tr><td>Total</td><td>2,066,894</td><td>100</td><td>77.1</td><td>100</td></tr>
</table>

Source: BMI; Kazakhtelecom Annual report; Just Smart Solutions LLP; International Telecommunications Union; Telecom Advisory Services analysis

[97] Telegeography. *Resurgent Altel reaches two million subs milestone.* 10 Apr 2015

[98] Telegeography. *Beeline launches 4G in Kazakhstan*. 7 Jul 2016

Of Kazakhtelecom's 1,502,632 broadband lines, 750,000 are FTTH, and the remainder is ADSL2+. The FTTH service is sold through four plans (30 Mbps, 50 Mbps, 120 Mbps, and 1 Gbps). The ADSL 2+ plan offers 8 Mbps. As the former state-owned monopoly, Kazakhtelecom has a strong advantage built around their brand equity. The operator is considered to be quite an advanced company, even ahead of Rostelecom in Russia; management is open minded, and has been capable at sustaining share, and manage to replace falling voice revenues with broadband and pay TV. The company is not being run as state company, partly because its public shareholders are quite active.

Kazakhtelecom is undergoing a process of privatization. Initially, the carrier's main shareholders were the state-holding company Samruk-Kazyna Fund of National Prosperity (sovereign wealth fund) (with a 51.0% stake), Netherlands-based private investment firm BODAM B.V. (with 16.9%) and the Bank of New York (17.1%). The remaining shares of the company were held on the Kazakhstan Stock Exchange (KASE). As of 2015, Kazakhtelecom's shareholder structure had been altered to State holding company 'Samruk' (51.0%), BODAM BV (16.87%), Bank of New York (9.81%), Deran services (7.60%), and other (14.72%). In January 2016, the Kazakh government announced that Kazakhtelecom is among 65 state-backed firms in line for privatization over the next four years. The sale is likely to take place via a public share offer[99]. However, it is still unclear whether the privatization will go through due to bureaucratic barriers[100].

Vimpelcom is the primary competitor to Kazakhtelecom in the retail fixed broadband market. Vimpelcom owns KaRpTel, which provides service under the Beeline brand (see below). Beeline offers only FTTH service through 30 Mbps, 50 Mbps, and 100 Mbps plans.

The third competitor in the fixed broadband market is Alma TV, a cable TV player that started originally offering fixed broadband through the DOCSIS 3.0 standard, but is moving to FTTH GPON offering up to 100 Mbps service. AlmaTV relies on Transtelecom for backhaul service. While they 500,000 cable TV subscribers, their broadband customers reach approximately 42,000. Transtelecom also has ADSL subscribers in their own right, mainly concentrated along railway lines. The remainder of the market is served by small local building companies offering broadband service on a franchising basis.

When measuring by the Herfindahl-Hirschman Index (HHI) of industry concentration, one can determine that the Kazakh fixed broadband market has been gradually become more fragmented over the past three years, as a result of Kazaktelecom share loss (see table 82).

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[99] Telegeography. *KT to be privatized*. 7 Jan 2016. The original list announced in 2014 included 600 companies, of which 44 should be considered large "Blue Chip" ones.
[100] Field trip interview.

Table 82: Kazakhstan: Fixed broadband Herfindahl-Hirschman Index (by number of subscribers) (2013-2015)

	2013		2014		2015	
	Lines	Share (%)	Lines	Share (%)	Lines	Share (%)
Kazakhtelecom	1,467,520	74.9	1,543,138	71.8	1,502,632	72.7
Vimpelcom	- - -	- - -	- - -	- - -	320,000	15.5
Transtelecom	- - -	- - -	- - -	- - -	70,000	3.4
Alma TV	- - -	- - -	- - -	- - -	42,000	2.0
Others (Astek, Kazinform Telecom, , Katzteleport, Ducat and Asiabell)	- - -	- - -	- - -	- - -	358,000	6.3
TOTAL	1,958,823	100	2,148,000	100	2,066,894	100
HHI						5,359 (*)

(*) Estimated based on equal shares of "other players"
Source: Kazaktelecom Annual reports; Telecom Advisory Services analysis

On the other hand, the Kazakh mobile broadband market currently includes three players (see table 83).

Table 83: Kazakhstan: Mobile broadband market structure (4Q2016)

	Number of Subscribers	Market Share (by Subscribers) (%)
ALTEL/Tele2	944,018	23
Beeline (VimpelCom)	1,641,768	40
Kcell (Fintur)	1,518,635	37
Total	4,104,421	100

Source: GSMA Intelligence; Telegeography; Telecom Advisory Services analysis

The mobile broadband market in Kazakhstan has significantly changed over the past two years. Originally, the market was structured around four players, including the subsidiaries of Kazakhtelecom, Vimpelcom, Tele2, and K-Cell (a joint venture of Turkcell and TeliaSonera). In September 2015, TeliaSonera declared that it would exit all countries in its Eurasia division, which included Kazakhstan [101]. The strategic decision followed a troubled period in which the group was affected by investigations into corruption allegations in Eurasian markets, exacerbated by tough macroeconomic conditions and price competition across the Eurasia footprint. Following the announcement, Turkcell, TeliaSonera's partner in the joint venture, submitted an offer in March, 2016 to acquire the remaining shares of the venture: 59%[102].

In parallel, Tele2 and Altel announced plans to combine their mobile operations, thereby reducing the number of mobile broadband players in the market from four to three. Tele2 Kazakhstan was the country's third mobile broadband provider, while Altel was the smallest carrier. According to the transaction, both operating entities owned via a joint venture holding company incorporated in the Netherlands. Tele2 Group and Kazakhtelecom have, respectively, 51% and 49% of the voting rights and a 49% and 51% economic interest in the venture, with Sweden-based Tele2 Group retaining management control. As part of the transaction, Tele2 Group will purchase Asianet's existing 49% stake in Tele2 Kazakhstan for an upfront consideration of USD15 million and a future earn out equivalent to an 18% economic interest

[101] Telegeography. *TeliaSonera decides to exit Eurasia countries*. 17 Sep 2015
[102] Tomas, J.P. "Turkcell submits offer to acquire TeliaSonera stake in Fintur". *RCR Wireless News*. March 3, 2016.

of the joint venture. This would give Tele2 a fully diluted economic interest of 31%, taking into account Asianet's 18% earn out.[103] The transaction combined Altel 4G presence with Tele2 marketing expertise.

The exit of TeliaSonera and the consolidation of Tele2 and Altel have resulted in an increase in the HHI concentration index in mobile broadband (see table 84).

Table 84: Mobile broadband market shares (by subscribers) (2011-2016)

	2011		2012		2015		2016	
	Lines	Share (%)	Lines	Share (%)	Lines	Share (%)	Lines	Share (%)
Altel	971,100	15.60	667,000	9.70	1,035,000	11.00	2,874,000	23.00
Beeline	3,808,000	61.17	3,031,000	44.08	3,763,000	40.00	4,998,000	40.00
K-Cell	1,289,000	20.71	2,525,000	36.73	3,575,000	38.00	4,623,000	37.00
Tele2	349,000	5.61	652,000	9.49	1,129,000	12.00		
TOTAL	6,225,000	100	6,875,600	100	9,406,900	100	12,495,374	100
HHI		4,446		3,476		3,309		3,498

Source: Kazaktelecom Annual reports; GSMA Intelligence; International Telecommunications Union; Telecom Advisory Services analysis

Between 2011 and 2015, the HHI industry concentration index was gradually declining as a result of increasing competition primarily between Beeline and K-Cell. The pressure resulting from price declines and the economies of scale advantage of Beeline and K-Cell on Altel and Tele2 was a stimulus towards consolidation. The consolidation between the two smaller players has resulted in an increase in the Herfindahl-Hirschman Index from 3,309 to 3,498. However, this value is still within the range of acceptable competition. Some analysts predict that the resulting industry concentration will reestablish some price discipline and that prices will start increasing, and that unlimited plans are going to be phased out.

State of competition in the broadband market

As a result of the consolidations in mobile broadband and diversifications into fixed broadband, the Kazakh market is composed of two convergent players (Kazakhtelecom and Vimpelcom), one pure play wireless (K-cell), and several fixed broadband carriers focusing primarily on the business market.

Given the saturation reached in the wireless market (penetration rates of approximately 158%) and the high adoption in broadband, the market has plateaued. Additionally, intense price competition, coupled with mobile number portability has had an impact on carrier profitability. In consequence, it is highly unlikely that new entrants will venture into the Kazakh market in the near term.

Technologies and trends in the broadband market

The fixed technological infrastructure utilized for delivering broadband services in Kazakhstan consists of a mix of ADSL, FTTB (Fiber to the Building), FTTH (Fiber to the Home), and fixed

[103] Telegeography. Tele2 and Altel to combine Kazakh operations. 4 Nov 2015

wireless (CDMA 450) for fixed networks. Regarding fixed broadband, only Kazakhtelecom has displayed ADSL and upgraded to ADSL 2+ in order to offer close to 8 Mbps service.

In 2011, Kazakhtelecom begun to deploy fiber optics in the local loop under the GPON standard. Vimpelcom, the primary retail competitor to Kazakhtelecom, also deployed FTTB service, initially offering speeds of up to 20 Mbps. Over time, the carrier upgraded download speeds up to 100 Mbps for accessing domestic websites and up to 50 Mbps for accessing external resources. The service is deployed in more than 130 towns and cities[104].

In addition to fiber-based Internet services, a number of Kazakh network operators have invested in the development of fixed wireless networks. Despite Kazakhstan having greater fixed access infrastructure than its regional peers, fixed wireless technologies are playing an increasing role in developing the country's broadband sector. Fixed wireless deployment is generally cheaper than building new fixed-line networks, which gives operators an advantage in areas with little or no fixed-line infrastructure. For example, Kazakhtelecom has deployed a national CDMA 450 network. Other companies that are active in the fixed wireless sector include Ducat and AsiaBell, which offer commercial WiMAX services in a variety of locations.

In addition to CDMA 450 and WiMAX, wireless technologies such as satellite and VSAT are also present in Kazakhstan's broadband sector. These technologies are generally used to provide Internet connectivity in remote regions where communications infrastructure is limited. Finally, Kazakhtelecom has developed broadband wireless networks based on Wi-Fi in libraries, hotels, railway stations and airports across the country.

On the mobile broadband side, three out of the four original carriers were operating under the GSM 2.5 standard (Edge, GPRS), while Altel relied on CDMA2000 1xRTT initially and later migrated to CDMA 2000 1xEV-DO. In 2012, the carrier began switching its customers from CDMA to LTE[105].

In 2010, Vimpelcom launched an LTE trial in Astana, over the 700 MHz frequency band. In the same year, K-Cell started its own migration to LTE. Interestingly enough, Kazakhstan's mobile operators opted to leapfrog toward deploying 4G services based on LTE rather than complete the deployment of 3G technology.

Fixed and mobile broadband speeds and quality of broadband services

International statistics of broadband service quality in Kazakhstan are relatively scarce. Available data is limited to the International Telecommunications Union, which reports a breakdown of fixed broadband speeds for three categories (see table 85).

[104] Telegeography. *Kazakhtelecom boosts broadband speeds*. 9 Jun 2014
[105] Telegeography. *Resurgent Altel reaches two million subs milestone*. 10 Apr 2015

Table 85: Kazakhstan: Fixed broadband speeds (2009-2015) (%)

	2009	2010	2011	2012	2013	2014	2015
Share Fixed-broadband 256 Kbit/s to less than 2 Mbit/s subscriptions	31.34	41.61	42.57	37.17	19.10	16.52	16.33
Share Fixed-broadband 2 Mbit/s to less than 10 Mbit/s subscriptions	66.83	54.65	49.04	44.02	46.14	43.58	43.68
Share Fixed-broadband equal to or above 10 Mbit/s subscriptions	1.83	3.74	8.38	18.80	34.76	39.90	39.99

Source: International Telecommunications Union

According to table 85, in 2015 39.99 % of total fixed broadband lines in Kazakhstan offered a speed equal to or above 10 Mbps. It should be noted, however, that advertised speed does not equal real performance. It is very common that, due to network quality issues or traffic saturation, advertised speeds represent approximately 60% of real performance[106]. However, a comparison between Kazakhstan's statistics with other relevant countries provides a relative context for assessing the country's fixed broadband speed levels (see table 86).

Table 86: Fixed Broadband Speed Levels: Kazakhstan versus other country averages (2015)

	Kazakhstan	Asian OIC Member Countries	All OIC Member Countries
Share Fixed-broadband 256 Kbit/s to less than 2 Mbit/s subscriptions (%)	16.33	53.66	56.69
Share Fixed-broadband 2 Mbit/s to less than 10 Mbit/s subscriptions (%)	43.68	33.36	32.20
Share Fixed-broadband equal to or above 10 Mbit/s subscriptions (%)	39.99	12.98	11.11

Source: International Telecommunications Union

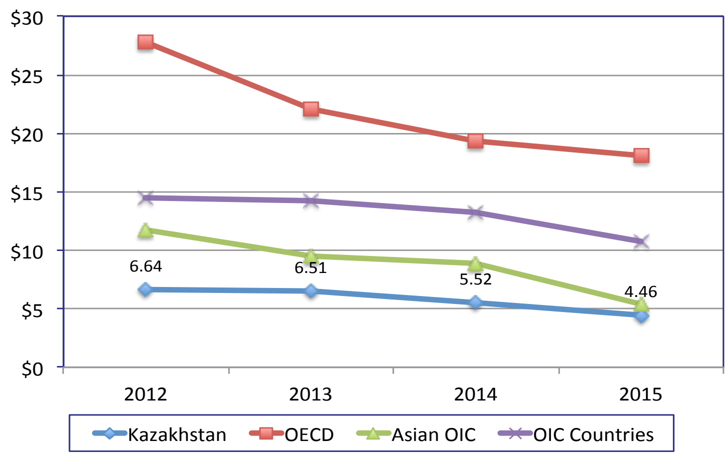
According to table 86, Kazakhstan appears to have a slightly higher percentage of 2 Mbps to 10 Mbps lines compared to the average Asian OIC Member Countries, as well as all OIC Member Countries. When it comes to lines faster than 10 Mbps, Kazakhstan appears to have much higher percentage than the other two groups.

Pricing of fixed and mobile broadband services

A comparative assessment of pricing trends of a monthly postpaid subscription of 1 GB cap for USB ports across country groupings indicates that Kazakhstan consumers have consistently enjoyed lower mobile broadband prices than subscribers in the OECD countries, and OIC Member Countries. It is only in 2015, when other Asian OIC Member Countries seem to have caught up with Kazakhstan low mobile broadband prices (see figure 42).

[106] It is not possible to compile statistics on real performance since the "crowdsourcing" sites such as Akamai do not report results for the Cote d'Ivoire.

Figure 42: Monthly post-paid subscription of 1 GB cap USB (2012-2015) (in US$)



Source: International Telecommunications Union; Telecom Advisory Services analysis

As depicted in figure 42, Kazakhstan postpaid mobile broadband pricing was significantly below other countries'. A consistently similar picture emerges when comparing fixed and other mobile broadband plans (see table 87).

Table 87: Comparative broadband pricing (2015) (in US$)

	Kazakhstan	Asian OIC Member Countries	All OIC Member Countries	OECD
Fixed-broadband monthly subscription	8.70 (*)	13.21	29.87	22.52
Mobile broadband handset_1GB, postpaid	5.52 (**)	6.49	9.73	33.99
Mobile broadband handset_500MB, prepaid	4.46 (***)	3.59	4.46	17.47

(*) This is price for 50 Mbps, unlimited
(**) As of YE 2016, Altel is postpaid 7GB CAP plan for US$ 2.8
(***) As of YE2016, Altel is offering prepaid 10 GB CAP plan for US$ 3.7
Source: International Telecommunications Union; Telecom Advisory Services analysis

According to data in table 87, postpaid fixed and mobile broadband offers in Kazakhstan are less expensive in absolute terms compared to Asian OIC, all the OIC and OECD countries. Kazakhstan appears to have lost the price leadership only in prepaid price plans.

Investment in fixed and mobile broadband infrastructure

The telecommunications sector has been investing considerable amounts of capital in the development of broadband networks. For example, Kazakhtelecom invested US$ 189 million in the deployment of fiber optic distribution networks in Astana and Almaty between 2011 and 2014, US$ 251 million in the deployment of 4G (to proceed between 2012 and 2021), and US$ 32 million to meet the demand of voice and broadband communications in rural areas[107].

[107] Source: Kazakhtelecom 2013 Annual Report.

All in all, capital spending in telecommunications between 2007 and 2014 has remained relatively stable (see table 88).

Table 88: Kazakhstan: Telecommunications investment (in current US$) (2006-2014)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Investment ('000'000)	121	678	- - -	495	- - -	600	725	657	648
Investment per capita	7.95	44.04	- - -	31.44	- - -	37.27	44.56	39.96	39.02

Source: International Telecommunications Union; Telecom Advisory Services analysis

As the aggregate spending indicates in table 88, the telecommunications industry appears to be spending significant amount of capital. A large portion of spending is geared to deploy broadband networks and upgrade their capacity. A dominant driver of broadband investment is the need to compete effectively.

V.3.3. Institutional Structure and Policies for Promoting Broadband

Institutional structure, policies and strategies regarding the broadband market

In May 2016, the Ministry of Information and Communication was created to develop public policies in the information and communications technology domain, including broadband. The ministry is structured around eight departments:

- Informatization
- Communication
- Mass media
- Internal Administration
- Finance
- Strategic Planning
- Kegal
- Human Resources
- Public services Development

The Minister presides the Information Committee, responsible for establishing and implementing national policies to promote the development of information and communications, including mass media. More specifically, the committee is responsible for state regulation of the activity in the fields of communications, informatization, and e-government, implementation of state policy and state regulation and control in the field of natural monopolies and in the regulated markets in the field of telecommunications. In terms of regulation, the Ministry regulates wholesale pricing of shared facilities (ducts, poles, etc.); on the other hand, interconnect pricing is not regulated.

In addition to the Ministry of Information and Communication, Zerde National Infocommunication Holding JSC is an agency with prominent participation in the development of digital strategies, with an impact on broadband development. Zerde was created as a result of reorganization of National Scientific Technological Holding "Samgau" JSC. In 2009, Zerde developed a master plan on the development of "e-government" and e-services for 2010-2014, as well as the regulation acts package on the issues of "e-government" and the provision of the informational security of infrastructure. Furthermore, as a part of the development of new ICT technologies and the initiation of new projects in 2011, the Research Institute of Information Technologies was established and registered as a participant of the special economic zone "Information Technologies Park "Alatau". In 2013, the holding took an active part in the development of the state program *Informational Kazakhstan 2020*[108].

Major approaches, implementations and challenges in extending fixed and mobile broadband infrastructure

The development of broadband in Kazakhstan has been influenced by two major master plans: *Informational Kazakhstan 2020* and *Digital Kazakhstan 2020*. Approved on 8 January 2013, the *Informational Kazakhstan 2020* program identified four key areas of focus:

- Ensuring the effectiveness of government administration system;
- Ensuring the availability of information and communication infrastructure;
- Formation of an information environment for socio-economic and cultural development of society; and
- The development of the national information space.

According to the plan's basic premise, the improvement of government administration, the development of an "open" and "mobile Government", and the deployment of information infrastructure would be solved through the widespread introduction of ICT. Considering that the development of an information society must be accompanied by the development of human capital, the Program also included provisions for the creation of opportunities for citizens to learn and gain skills in information technology through e-learning and to receive services of available electronic healthcare. In addition, the program recommended implementation of smart systems in basic industries in order to build a more open, accessible and competitive economy. Collectively, the plan assumes that the measures taken for the development of ICT should follow the principles of ensuring conditions of sustainable development. Finally, the plan recognizes that the effectiveness of the policy of transition to the information society depends on consolidation of public and private efforts on a wide application of ICT in all sectors of the economy and social sphere[109].

The *Informational Kazakhstan 2020* program provided a context for the formulation of another program: *Digital Kazakhstan 2020*. The key goal of *Digital Kazakhstan 2020* is the improvement of citizens` life quality and the country`s economy competitiveness through the development of a digital economy. The program comprises four major axes:

- **Digital Silk Way**: develop a digital infrastructure through the provision of broadband Internet in rural localities, the construction of a telecommunication hub, ensuring information security, and deploying data centers;
- **Creative society**: develop human capital through enhancing citizens' digital literacy, provide advanced training of specialists in the field of information and communication

[108] See http://www.zerde.gov.kz/en/holding/history/#hcq=pJgvV2q.
[109] See http://www.zerde.gov.kz/en/activity/program-control/information-kazakhstan-2020/#hcq=2BUeV2q.

technologies, and improve educational programs to develop critical thinking in students;

- **Digital transformations in economic sectors**: promote digitization of production through automating the country's transport and logistics system, implementing digital technologies in the field of agriculture and industry, developing e-Commerce, improving mineral resources` registration system, ensuring geological digital information safety and accessibility, and implementing technologies in the development of smart cities; and
- **Proactive society**: further develop e-Gov and m-Gov applications, increasing the number of public services delivered online, developing Open Government and a national spatial data infrastructure.

The Program's goals to be achieved by 2020, are as follows:

- Internet penetration: 78%;
- Terrestrial broadcasting coverage of Kazakhstani population: 95%;
- Digital literacy level of population: 80%;
- Percentage of ICT sector weight in the GDP: 4.7 %;
- Growth of performance in ICT: 34%; and
- Citizens' satisfaction with the quality of online services obtained independently: 80%.

The Program implementation period is 2017 to 2020. Funding will be supplied from the national budget, quasi-public sector, and private investments as well as the financial organizations and loans from development banks. Implementation of the program will be a key factor for achievement of the goal for Kazakhstan to be ranked in the top thirty most competitive countries in the world by 2050, an objective set by the President of the Republic of Kazakhstan in the "Kazkhstan-2050" Strategy.

In terms of the broadband deployment objective, *Digital Kazakhstan 2020* plans to deploy a fiber optics network to villages and cities of 250 and more population (1st phase). The initial purpose of the plan is to deploy fiber to a village point of presence and from there to hospitals, police, etc. The capital required ($ 300 million over three years) will be paid for by Kazakhtelecom, although the government guarantees revenues to be derived from a master contract to serve hospitals, schools, agricultural bodies, etc. The second phase will consist of deploying be fiber to smaller cities but only if demand from rural geographies can be identified. Still there is no decision to deploy distribution last mile loops to households because the business case has not been developed. The options of technology available at this point for the last mile are fiber optics (GPON), ADSL, and potentially LTE for fixed broadband. In this context, Kazakhtelecom would be gradually replacing the CDMA 450 technology[110] with LTE running on 800 MHz spectrum band[111]. That being said, the plans for addressing the last mile distribution to households under the Digital Kazakhstan plan still need to be addressed[112].

[110] Service quality with CDMA 450 in some areas is no good (some villages get download speeds of 128 Kbps which has an impact on the population willingness to buy).

[111] The 700 MHz band is still utilized by many parties that need to be reassigned before it is used by telecommunications carriers.

[112] Some analysts remain skeptical about the probability of this program to be fully implemented due to the government bureaucratic limitations.

In addition to the two master plans reviewed above, among the most relevant legal initiatives enacted by the Kazakh government that have so far had an impact on the development of broadband, three are of special note:

- Network unbundling: the owners of buildings and structures are now obligated to lease the premises (area) to telecommunications operators on equal terms under an agreement on deployment by operators of telecommunications equipment with a view to providing telecommunications services.
- Sharing of passive infrastructure (ducts, antennae, poles) for broadband network deployment
- Consider wireless broadband with minimum speed of 1.5 Mbps as a universal service

V.3.4. Lessons Learned

The analysis of broadband networks and services in Kazakhstan provides a basis for distilling a number of lessons. The following are structured around the promotion of enhanced supply and the stimulation of demand.

Supply policies

Public policies aimed at enhancing the supply of broadband services in Kazakhstan have focused around the development of competitive incentives. The fixed and mobile broadband segments comprise multiple players actively competing on the basis of state-of-the art networks and quality of service. The Kazakh broadband competition model is built around a limited number of players to allow industry sustainability as opposed of promoting the frictional costs resulting from unrestricted competition. The government recognizes that a three player mobile broadband market is sufficient enough to allow for the development of competition.

Similarly, a *de facto* fixed broadband competition model built around an incumbent and numerous niche players focused either on specific geographies and/or market segments appears to be appropriate. On this basis, the enforcement of network sharing through unbundling of specific physical facilities (ducts, poles, antenna) is aimed at facilitating the sustainability of new entrants.

The pro-competition policies are combined with state intervention in order to foster the deployment of broadband in rural areas. The intervention is based on the formulation of national plans, combined with government funding support.

Demand policies

A demonstration of how successful the Kazakh competition model has been is that broadband pricing has decreased significantly, practically eliminating the affordability barrier. However, the digital divide continues to exist driven potentially by cultural relevance issues. The significant difference in broadband penetration between the urban and rural geographies might indicate that the primary variable standing in the way of further stimulating broadband adoption is linked to the development of content and applications that respond to the needs of the Kazakh rural population.

VI. POLICY RECOMMENDATIONS

The universe of the OIC Member Countries is not homogeneous when it comes to the challenges faced regarding broadband development. Thus, the policy recommendations should not be considered as uniform across the community of members. In the aggregate, OIC Member Countries can be categorized into three groups: advanced, intermediate and developing (see table 89).

Table 89: OIC Member Countries: State of broadband supply and demand (2015)

	Supply			Demand	
	Fixed Broadband Coverage (ADSL)	**Mobile Broadband Coverage (3G)**	**Mobile Broadband Coverage (4G)**	**Fixed Broadband Penetration (households)**	**Mobile Broadband Penetration (population)**
OIC Average	**53.33%**	**64.16%**	**46.82%**	**14.95%**	**29.41%**
Advanced	**>70 %** Azerbaijan, Bahrain, Brunei, Jordan, Kazakhstan, Lebanon, Malaysia, Maldives, Oman, Qatar, Saudi Arabia, Turkey, UAE,	**>70%:** Albania, Azerbaijan, Bahrain, Bangladesh, Brunei, Cote d'Ivoire; Egypt, Gabon, Gambia, Jordan, Kazakhstan, Kuwait, Lebanon, Malaysia, Maldives, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Suriname, Syria, Tunisia, Turkey, UAE	**>70%** Kazakhstan, Kuwait, Pakistan, Qatar, Saudi Arabia, UAE	**>70%** Azerbaijan, Bahrain, Lebanon, Qatar, Saudi Arabia, UAE	**>70%** Bahrain, Kuwait, Libya, Malaysia, Oman, Qatar, Saudi Arabia, Suriname, UAE
Intermediate	**70%-40%** Kuwait, Palestine, Suriname	**70%-40%** Afghanistan, Algeria, Benin, Cameroon, Indonesia, Iran, Iraq, Kyrgyzstan, Mozambique, Nigeria, Pakistan, Senegal, Sudan, Togo, Uganda, Turkmenistan, Uzbekistan	**70%-40%** Jordan, Malaysia, Morocco, Oman,	**70%-40%** Brunei, Kazakhstan, Malaysia, Maldives, Oman, Palestine, Suriname, Turkey	**70%-40%** Albania, Algeria, Azerbaijan, Cote d'Ivoire, Egypt, Indonesia, Kazakhstan, Lebanon, Maldives, Tunisia, Turkey
Developing	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea Bissau, Guyana, Indonesia, Iran, Iraq,	**<40%** Burkina Faso, Chad, Comoros, Djibouti, Guinea, Guinea Bissau, Guyana, Libya, Mali, Niger, Mauritania, Sierra Leone, Somalia, Tajikistan, Yemen	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea Bissau, Guyana, Indonesia, Iran, Iraq,	**<40%** Afghanistan, Albania, Algeria, Bangladesh, Benin, Burkina Faso, Cameroon, Chad, Comoros, Cote d'Ivoire, Djibouti, Egypt, Gabon, Gambia, Guinea, Guinea-Bissau, Guyana, Indonesia, Iran,	**<40%** Afghanistan, Bangladesh, Benin, Brunei, Burkina Faso, Cameroon, Chad, Comoros, Djibouti, Gabon, Gambia, Guinea, Guyana, Iran, Iraq, Jordan, Kyrgyzstan, Mali, Mauritania, Morocco,

	Supply			Demand	
	Fixed Broadband Coverage (ADSL)	Mobile Broadband Coverage (3G)	Mobile Broadband Coverage (4G)	Fixed Broadband Penetration (households)	Mobile Broadband Penetration (population)
	Kyrgyzstan, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Sierra Leone, Somalia, Syria, Sudan, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen		Kyrgyzstan, Mali, Mauritania, Mozambique, Niger, Nigeria, Sierra Leone, Somalia, Syria, Sudan, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen	Iraq, Jordan, Kuwait, Kyrgyzstan, Libya, Mali, Mauritania, Morocco, Mozambique, Niger, Nigeria, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tajikistan, Togo, Tunisia, Turkmenistan, Uganda, Uzbekistan, Yemen	Mozambique, Niger, Nigeria, Pakistan, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tajikistan, Togo, Turkmenistan, Uganda, Uzbekistan, Yemen

Source: Telecom Advisory Services analysis

In general trends, some OIC Member Countries in the Middle East (Bahrain, Oman, Qatar, Saudi Arabia, UAE) and Central Asia (Azerbaijan, Kazakhstan) tend to be advanced in terms of supply and penetration of broadband services. At the opposite end, a large group of African countries (Benin, Burkina Faso, Cameroon, Chad, Guinea, Senegal, Sierra Leone, Sudan, Togo) are still at a limited stage of broadband development both in terms of supply and demand. Finally, a number of countries in North Africa (Egypt, Tunisia, Morocco), Sub-Saharan Africa (Cote d'Ivoire), Middle East (Kuwait) and Asia (Brunei, Kyrgyzstan, Turkey, Uzbekistan) exhibit advanced coverage of the population combined with low adoption. Broadband policies need to be defined for each group. The following are structured around the promotion of enhanced supply and the stimulation of demand. Cognizant that supply and demand stimulation policies could be implemented in all three country groupings, each group has a dominant imperative: advanced countries need to focus on policy initiatives that promote next generation broadband network deployment; countries at an intermediate stage of broadband development need to focus on demand stimulation policies around digital literacy; finally, countries with limited broadband development need to emphasize affordability initiatives.

VI.1. Advanced OIC Member Countries

Advanced OIC Member Countries exhibiting high coverage and adoption are facing the challenge of building a forward-looking world-class infrastructure that will position them in a leading position in terms of digitization. This entails deploying fiber optics both at the backbone and last mile level, completing their 4G coverage and preparing to deploy 5G. Supply related policies for these countries need to recognize that few broadband providers (typically the incumbents) are capable of tackling these challenges. Along these lines, governments need to consider policies that represent appropriate incentives to warrant next generation infrastructure deployment. They typically include tax benefits and regulatory holidays, both applied on a selective basis.

VI.1.1. Promotion of investment of next generation broadband networks

Stimulation of network deployment and investment of next generation technologies should be based on policies that reduce the cost of acquiring network equipment by operators. For example, one approach is to reduce import duties and VAT on the acquisition of broadband equipment. Taxes tend to raise the required pre-tax rate of return of capital invested. In general terms, leaving aside the positive impact taxes fulfill in terms of their contribution to the delivery of public services, they tend to also affect the incentives of a company to make investments and reduce the supply of funds available to finance them. In industries such as telecommunications that provide broadband services, a critical platform to deliver information, public services, and ensure economic growth, taxation tends to reduce the level of capital investment. Therefore, the government should consider an exemption of import duties and maybe VAT for equipment to be used in deploying broadband services. Malaysia has enacted such a policy in order to promote deployment of last mile broadband networks. The tax exemption could be applied on a selective basis. For example, if equipment is acquired in order to be deployed in rural and/or isolated areas, the exemption could be applied. On the other hand, if the equipment is intended to be deployed in urban areas, the service provider should pay the corresponding taxes and levies.

On the mobile broadband side, the deployment of 3G in the OIC Member Countries has been a success. However, the increase in data traffic is putting pressure on operators to continue deploying 4G technology. However, it should be considered that, with only recent advances on 3G deployment, operators in some countries would be reluctant to proceed towards deploying 4G before achieving a reasonable rate of return on the prior generation of technology. In order to accelerate 4G deployment governments should consider the enactment of financial incentives to operators. One of them is the extension of the tax exemption for the purchasing of network equipment mentioned above. Beyond this, governments should consider reducing some of the spectrum licensing costs that are incurred by operators. These measures will have a negative impact on the operators' willingness and ability to commit capital for the deployment of 4G. While acknowledging that these measures are aimed at collecting additional revenues for the country's treasury, their impact should be evaluated also in terms of whether they detract the country from accelerating its transition to new technology. Several approaches exist that could reduce the cost of acquiring spectrum. One of them is to extend spectrum license renewal payment policies. Another one is to implement spectrum auction approaches such as beauty contests that reduce the cost of acquisition when compared to conventional auction approaches.

Approaches combining regulatory holidays and direct subsidies tend to address the problem of how to achieve high-speed coverage in rural and isolated areas (recognizing that for advanced countries, high speed service is already provided in urban and suburban areas). Regulatory holidays exempt incumbents that deploy fiber from the obligation of sharing their network with competitors. Subsidies could entail co-financing mechanisms were governments invest in deploying ultra broadband infrastructure in areas with limited return on investment. These approaches are expanded in the section below.

VI.2. OIC Member Countries at an intermediate stage of broadband development

Countries with advanced coverage but limited penetration face classical demand gap reduction challenges. First and foremost, governments have to recognize that increased service adoption is dependent on lowering the total operating cost incurred by consumers for purchasing the technology.

As it has been considerably researched, the development of competition is one of the major tools for affecting a reduction in telecommunications service pricing. The following features characterize a telecommunications competition model:

- Existence of multiple operators serving the same market based on their own network,
- Existence of multidimensional competitive dynamics (prices, services and user service quality) among industry players,
- Reduction of retail prices for consumers, and intense competition in product differentiation (dynamic efficiencies), resulting in additional consumer surplus,
- Competitive stimulation for each operator to increase the level of investment in its own network,
- Absence of tacit collusion between operators due to the high rate of innovation and competition based on product differentiation.

Along these lines, it is important to emphasize that in order to determine the existence of an adequate level of competition capable of yielding low broadband prices, the regulators need to have access to expertise in market analysis capable to establishing whether the number of players in the market are sufficient to warrant enough consumer benefits or whether additional remedies are required to stimulate competitive intensity. This aspect is particularly critical because unrestricted competitive entry of broadband providers could result in a number of market inefficiencies (for example, low incentives to invest under low market share conditions) and/or frictional costs (the costs incurred by carriers entering and exiting the market after facing unsuccessful competitive strategies, as was the case of the wireless industry in Cote d'Ivoire).

Beyond, competition as a lever for price reduction, governments should consider reducing the taxes incurred by consumers when purchasing broadband services. For example, in Cote d'Ivoire the acquisition of handsets is levied by 18% in value-added tax, 5% in customs duty, and 2.5% in sector specific taxes. On the other hand, the service use is levied by 18% in value added tax[113]. In general terms, since high taxation increases the total cost of ownership of wireless services, it is correct to consider that higher wireless consumption taxes will raise the affordability barrier and reduce adoption. In this context, taxation could have a detrimental effect on the public policy strategy aimed at deploying mobile broadband. If taxes limit adoption of wireless broadband, it is relevant to ask what the ultimate impact of reduced penetration might have on economic growth. Hypothetically, it is safe to assume that a

[113] These levies are documented in the International Telecommunications Union Eye database and have been analyzed in Katz (2015). *The impact of taxation on the digital economy*. Geneva: International telecommunications Union.

reduction in adoption as a result of incremental taxation could yield a negative impact on GDP growth. The taxation initiative could be complemented with selected targeted subsidies to be assigned to vulnerable households or residents in rural areas.

In addition, the reduction of broadband service prices can be achieved through a number of targeted public policy initiatives. These initiatives are generally implemented with the objective of achieving universal broadband adoption. The underlying rationale for these policies is that, beyond a competition model, government policies should be implemented to further price reductions of broadband in order to make it accessible to segments of the population affected by limited affordability.

One approach to achieve this is for the government to offer a subsidy on the cost of broadband access. This could be done in the form of a plain voucher or a tax refund for qualifying segments of the population (e.g. students). In previous experiences, the critical success factors in this approach are two:

- Establish upfront who is supposed to determine what constitutes an "affordable" offer? The public service provider or the regulator,
- Ensure that whoever will define the "social" offer has the right economic expertise.

The second option is to negotiate an agreement between the government and private sector broadband providers to offer low-priced services, but in this case limited to institutions (such as schools, libraries, or health clinics). Several countries have enacted policies in this domain. In the United States, the FCC provides a 65% subsidy to rural public or non-profit rural health care providers to use toward the cost of broadband network deployment or subscriptions through its Health Connect Fund. The Korean government spent $24 billion on a public backbone network, which service providers used to offer broadband to 30,000 government and research institutes and 10,000 schools. Scotland's 2004 Broadband Pathfinder Project offered grants to wire schools, libraries, and public buildings.

The third option comprises offering free Internet access through Wi-Fi services located in public areas, such as squares, libraries, and transportation hubs. The provision of free Wi-Fi Internet access is being conceived as one of the building blocks needed to build a city's international competitiveness. There are several features and options of a free Wi-Fi program:

- Coverage of public spaces: squares and parks, public transportation, including metros, public libraries,
- Type of service: amount of time provided for free access (1hr. limit while commuting, open unlimited access),
- Type of service provider: under contract with telecommunications operators or other broadband player, offered by the city administration,
- Quality of service: basic video streaming quality,

As it is obvious, the options outlined above are not mutually exclusive and can be applied simultaneously.

VI.2.1. Initiatives to promote digital literacy

As mentioned above, up to 29% of broadband non-adopters in certain OIC Member Countries cited limited digital literacy as a reason from not acquiring service. Digital literacy is defined as the "ability to use digital technology, communication tools or networks to locate, evaluate, use and create information" (Hauge and Prier, 2010). Initiatives aimed at building digital literacy need to involve both embedding programs in the formal education system and targeting non-formal initiatives to specific segments of the population (elderly, handicapped, rural poor, etc.).

Addressing this obstacle requires the implementation of programs that build an understanding of the service offerings, and develop user confidence, explaining the benefits of use, and understanding security and privacy constraints as well. In general terms, four types of initiatives targeting digital literacy impediments exist:

- Digital literacy through education programs entail the inclusion of specific programs at all levels of the formal education system, requiring also the implementation of training programs for teachers,
- Targeted digital literacy interventions comprise the implementation of programs addressed to specific segments of the population, such as the elderly, the disadvantaged or the rural population,
- Deployment of community access centers allows supplying non-adopting population with devices and access points to the Internet; in addition, the access centers can become points of delivery of training programs and user support,
- The privacy and security training programs allow building the levels of trust from consumers in order to foster adoption of broadband.

While digital literacy embedded in formal education processes are conducted in school institutions, closely linked to curricula, targeted programs entail group-specific training in the use of computers and broadband typically delivered through a range of public access centers. Programs oriented to fostering digital literacy through formal education consist in embedding ICT training in curricula at the primary and secondary school level complemented with targeted programs focused on teachers. This section addresses the need to introduce fundamental changes in the formal educational system in order to enhance the level of digital literacy.

Digital literacy programs embedded in the formal educational system should be, by definition, large scale and centrally driven, generally hosted within ministries of education. While providing access infrastructure (both devices and broadband), programs tend to generally focus on improving usability. As expected, the initiatives are less focused on delivering standard computer courses, emphasizing the use of IT and broadband access within course material by leveraging e-learning platforms and social networking.

While digital literacy embedded in formal education processes are conducted in school institutions, closely linked to curricula, targeted programs entail group-specific training in the use of computers and broadband typically delivered through a range of public access centers. For example, adult education programs are focused on upgrading the skills of the workforce, therefore preparing it to fulfill a productive role in the digital economy. They can be structured around conventional continuing education courses, as extension programs of universities, or organized under economic development efforts focused on specific regions of a country. Training can be provided in a variety of ways, so long as it is offered in an easily accessible, affordable manner to encourage participation. Many training sessions, for example, are offered at local community access centers or schools, where citizens already feel comfortable, while others are offered online. Sessions can cover a variety of topics, but tend to focus on the development of ICT skills with "real world" application, including, but not limited to e-mail, Internet search, Job search, and CV creation.

Programs focused on rural isolated areas represent a particular case of the examples presented above. As such, they address the complexities of delivering training in underserved regions of a country. The primary foci of these programs is bridging the digital divide and enhancing the employability profile of the targeted population. In this case, the initiatives tend to be large scale and centrally managed and focus on accessibility. While the central government plays a prominent role in program management, it is not unusual to find private sector participants or NGOs. Access in this case is key, as this population cannot easily utilize the physical resources found in urban areas. To this degree, successful programs have:

- Offered online training,
- Built local access centers or cybercafés in areas with limited ICT
- Implemented initiatives in public schools or safe houses
- Partnered with local governments
- Deployed trainers to rural areas

Finally, digital literacy programs conceived as extension of either universities or secondary schools have proven to be very valuable in bridging the generational gap. The overall long-term goal of these programs is to improve social inclusion of the elderly population. The primary content delivered in this type of programs are standard computer courses, in some cases tailored specifically to the needs of the elderly (e.g. email to communicate with the family, photo sharing, use financial applications, purchasing tickets online, etc.). However, in addition, digital literacy courses for the elderly give seniors an opportunity to meet people and develop a social network.

Finally, with regards to lowering the cultural and linguistic relevance barrier, it is critical that both the government and the private sector engage in the development of new platforms. Internet access in itself is of little value in the absence of so-called complementary goods that confer value to such access.

VI.3. OIC Member Countries at embryonic broadband development

For countries that are still at the early development stages of broadband demand and supply, a combination of infrastructure deployment incentives and demand stimulation policies are required. Policy makers in these countries have to recognize that the competitive incentive will not be sufficient to generate the stimuli required to promote infrastructure investment.

Assuming that governments of these countries have limited resources to inject investment in universal broadband reach, it might be necessary to rely on incumbents and provide them with the right incentives to deploy broadband networks. Infrastructure investment stimulation policies should be put in place simultaneously with demand promotion mechanisms that drive uptake to commercialize the supply availability.

VI.3.1. Tackling the broadband affordability challenge in low-income countries

Beyond the competitive stimuli mentioned above, the reduction of broadband service prices can be achieved through several public policy initiatives.

The first one relies on state-owned telecommunications operators to offer, under their public service imperative, a low-priced broadband service. Obviously, this option is only viable in those countries that have not completely privatized their telecommunications industry. Under this option, a state-owned broadband provider assumes responsibility, as a public service entity, for providing a low-price broadband service. The advantage of this option is that, in addition to fulfilling the objective of tackling the economic barrier, the offering can act as an incentive for other private operators to launch their own more affordable service.

The second option entails a negotiation between the government and private operators for them to offer a low-priced broadband service targeted for disadvantaged segments of the population. In this case, government policy makers negotiate with private broadband providers the offering of a low-priced plan. This can be achieved in the context of the formulation of a national broadband plan. Such has been the case of the Brazilian National Broadband Plan, which triggered a negotiation leading to the launch of the "Banda Larga Popular", offered by several operators. Another option to reach such an agreement could be to attach the offering of a low-priced plan as a sine qua non condition for providing regulatory approval of an incumbent plan. Such was the case in the United States, where the government determined that Comcast should offer a low-priced broadband service if it were to receive approval for acquiring NBC Universal. This triggered a process that led all other major cable TV operators to join in the initiative. A slight variance of this option entails a move by an incumbent wireline operator to offer a low priced plan and create good will in order to pre-empt a threatening government regulatory move. Under this option, the critical success factor is the determination of *quid por quo* conditions. In other words, what will the government offer in exchange for gaining an agreement from the broadband operators (e.g. Tax reduction? Regulatory holidays on fiber investment? Authorization to complete an acquisition?)

The third option comprises offering a subsidy for broadband purchase. Under service subsidization policies, the government offers a refund on the cost of broadband access. This option is being increasingly examined as a complement to some income redistribution policies. Three types of programs have been implemented to overcome the personal computer ownership barrier. The first one focuses on the provision of subsidies to reduce the acquisition price of devices. The target in this case could be households at the lower end of the socio-demographic pyramid, primary school to university students, and SMEs (especially micro-enterprises). The second program typically targets students in primary education, with governments distributing “One Computer per Child.” In this case, public school students receive computers free of charge. The third type of initiative entails a reduction of the access price by eliminating or decreasing taxes paid at time of purchasing. Levies affected by this measure could range from sales tax, import duties, and even sector-specific levies.

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