CHAPTER 3

Infrastructure Deployment and Developing Competition

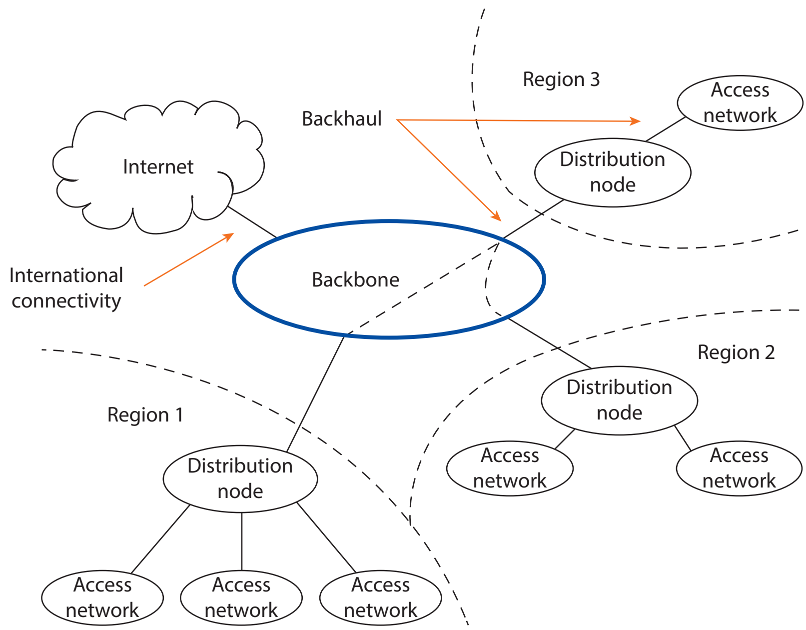
Most countries in the Middle East and North Africa (MENA) are in the emerging and developing phases, and broadband markets are expected to grow significantly in the near future given the strong and increasing demand for broadband service. According to Cisco,[1] from 2012 to 2017, Internet traffic in the Middle East and Africa (excluding South Africa) is expected to grow at the highest rate when compared with other regions, a compound annual growth rate of 39 percent. Moreover, peak Internet traffic will grow 5.5-fold from 2012 to 2017, a compound annual growth rate of 41 percent. In 2017, Internet traffic will be equivalent to 204 times the volume of the entire Middle East and Africa (excluding South Africa) Internet in 2006.

This growing traffic has direct implications in terms of the capacity requirements for the underlying broadband infrastructure. All three network components of this broadband infrastructure, that is, international (and regional) connectivity, national backbone, and access networks, have to be in place and optimally used to meet increasing demand in the most cost-effective way (see figure 3.1). Challenges in terms of investment differ significantly, however, for each of the three network components.

The first network element is the **international and regional infrastructure** that provides connection to the rest of the world. In the MENA region, there is already good international connectivity, with the vast majority of data traffic transferred internationally through submarine cables, with terrestrial fiber, microwave, and satellite transmission accounting for a smaller amount.

As detailed later in this chapter, there is nevertheless a remaining investment challenge for international (and regional) infrastructure, related to setting up a coherent terrestrial infrastructure where needed to cater for expanding subregional broadband traffic and ensuring redundant and competitive access to submarine cables.

Figure 3.1 Network Components of Broadband Infrastructure



Backbone Network Infrastructure

The second network element is the domestic **backbone network (including backhaul[2]) infrastructure** that carries traffic from the landing point of the international communications infrastructure or from the nearest point of the border in a landlocked country to the different regions of the country. An increasing share of data traffic is transferred nationally through terrestrial fiber, with microwave and satellite transmission accounting for a steadily decreasing amount.

Taking into account the dynamic growth of mobile broadband in MENA, the key requirement in servicing the growing demand is to supply sufficient national fiber capacity for the backbone, including backhaul connectivity to base stations, which are currently mostly using microwave radio links on networks designed for second generation of mobile telecommunications technology (2G). Without being able to accommodate and handle the growing amount of traffic on the backbone level of the network, operators would not be able to expand their retail offerings and increase the speed of broadband connections in the access network infrastructure to serve end users.

As detailed later in this chapter, accelerating the rollout of backbone infrastructure and promoting affordable broadband access for all is a significant investment challenge requiring a holistic approach combining (a) active infrastructure sharing, (b) passive infrastructure sharing, and/or (c) deployment of own infrastructure. Both (a) and (b) must also aim to leverage excess capacity on fiber-optic networks of other utility companies.

Access Network Infrastructure

The third network element is the **access network infrastructure** that links the backbone network to the customer. At this access network level, two main groups of "last mile" broadband access technologies are available: fixed broadband technologies and mobile broadband technologies.

- **Fixed broadband technologies** refer to those technologies where the end user must remain basically at the same location to use the broadband service because the access is associated with a specific physical location. The physical location can be connected in different ways:
  - By a wireline connection: these can be: (a) the traditional copper line of the telephone network equipped with digital subscriber line (of any type) (xDSL) technology; (b) the traditional cable television network upgraded to provide broadband Internet; or (c) a newly built fiber-optic network.[3]
  - By a wireless connection: these are generally based on Worldwide Interoperability for Microwave Access (WiMax)[4] technologies. The current technology version provides data rates up to 1 gigabits per second (Gbps) within a signal radius of about 50 kilometers (km) (30 miles) from the base station serving the area.
  - By a satellite connection, generally used in remote or rural areas when wireline or wireless connections cannot be made available. Data rates range from 2 megabits per second (Mbps) to 1 Gbps downstream and from 2 Mbps to 10 Mbps upstream.
- **Mobile broadband technologies** refer to those technologies where the end user can use the broadband service while on the move and from any physical location subject to coverage by its mobile broadband provider (directly or via roaming[5]). The two main technologies used nowadays to deliver mobile broadband are (see box 3.1):
  - Third generation of mobile telecommunications technology (3G), such as Universal Mobile Telecommunications System High Speed Packet Access (UMTS HSPA) (14.4 Mbps down; 5.8 Mbps up).
  - Fourth generation of mobile telecommunications technology (4G), such as long-term evolution (LTE) (100–300 Mbps down; 50–75 Mbps up).

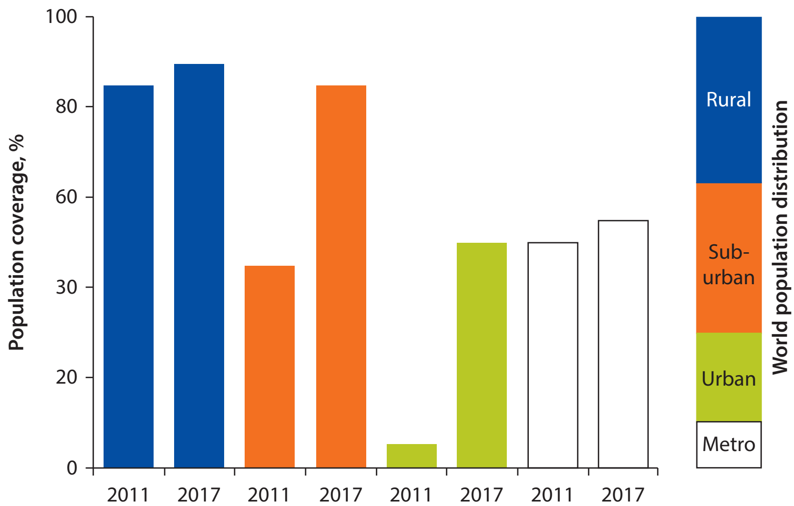
It is important to mention that this mix of broadband access network technologies is strongly determined by network deployment technical and financial constraints, that is, fixed broadband technologies tend to be prevalent in highly populated areas (in conjunction with rapid development of complementary mobile broadband access), while mobile broadband solutions are more prevalent in less densely populated areas.

This is the most significant investment challenge. Given the relative footprints of fixed and mobile networks, in all MENA countries where commercial 3G services have been launched, mobile broadband has quickly emerged as the dominant broadband access technology. However there is an increasing demand for

Box 3.1 Mobile Broadband Technologies

According to Ericsson mobile networks, third generation of mobile telecommunications technology (3G) is expected to cover 85 percent of the world's population (and about half of the world's population living in rural areas) by 2017, and fourth generation of mobile telecommunications technology (4G) will be available in 2017 in about the same footprint as 3G in 2011 (namely metro/urban/suburban) (see figure B3.1.1).

Figure B3.1.1 Mobile Broadband Technologies



Metro: >4,000 people/sq km Urban: 1,000–4,000 people/sq km

Suburban: 300–1,000 people/sq km Rural: <300 people/sq km

Source: Ericsson 2012.
Note: CDMA = code division multiple access; GSM/EDGE = Global System for Mobile Communications/Enhanced Data rates for GSM Evolution; LTE = long-term evolution; sq km = square kilometer; WCDMA/HSPA = wideband code division multiple access/high speed packet access.

higher speed rates in urban areas or economic zones that are best served with newly built fiber-optic networks, where the sunk costs and the uncertainty of demand could significantly impact the business case from the point of view of a potential investor.

International and Regional Infrastructure

Good International Connectivity but Less Developed Subregional Level

MENA has good potential international broadband connectivity. All economies (except the West Bank and Gaza) are currently connected with at least two international submarine cables, though the number of submarine cables per country varies widely across MENA with 12–13 cables landing in the Arab

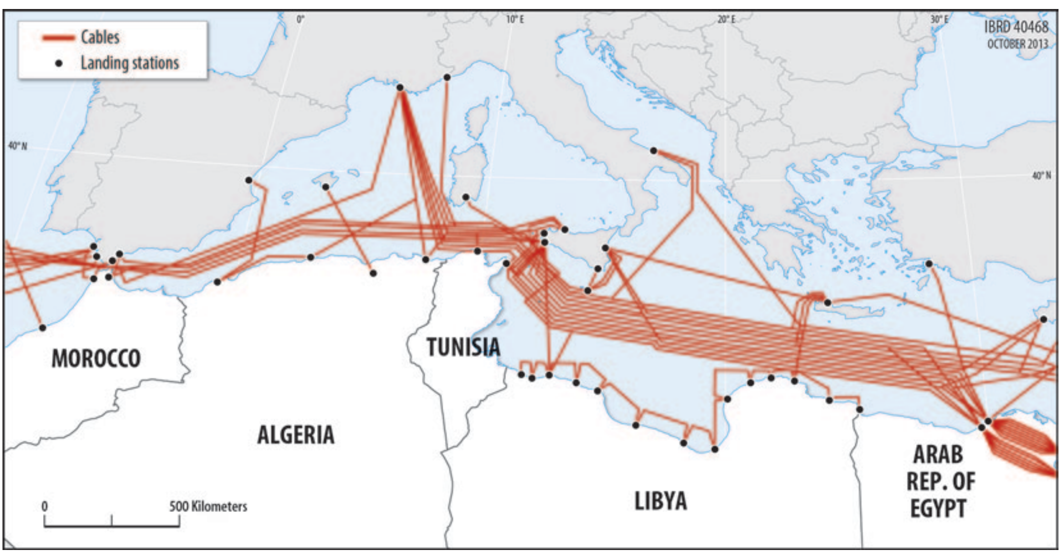
Republic of Egypt as well as in the United Arab Emirates (as key countries on the Asia to Europe route), but only two in the Republic of Yemen as well as in Jordan (see maps 3.1 and 3.2). In addition, landing stations for new submarine cables are planned in 13 countries in MENA, which will further increase international broadband connectivity in the coming years.

On average, the total design capacity of submarine cables serving MENA is 594.09 kilobits per second (kbps) per capita (see table 3.1). However, this indicator varies widely across the region, with 10,020 kbps per capita in Bahrain and 53 kbps per capita in the Republic of Yemen, that is, a ratio of 1:19.

International submarine cables have not been built primarily to provide regional connectivity within MENA, but rather to link individual countries in MENA with Europe and Asia. **Consequently, there is patchy submarine connectivity between the Middle Eastern part and the North African part of MENA, with Egypt playing a pivotal role.** The physical location of the infrastructure is concentrated, making the Red Sea Corridor a particularly sensitive geographic area from the standpoint of network redundancy. The FALCON submarine cable lands in the highest number of MENA countries (12), but all of them are located in the Middle Eastern part (except Egypt). The South East Asia–Middle East–Western Europe 4 optical fiber submarine communications cable system (SEA–ME–WE4) submarine cable is the only international submarine cable reaching both Middle Eastern (Saudi Arabia, the United Arab Emirates) and North African (Algeria, Tunisia) countries passing through Egypt.

New international terrestrial cables (Jeddah-Amman-Damascus-Istanbul [JADI],[6] regional cable network [RCN],[7] Europe-Persia Express Gateway

Map 3.1 Submarine Cables and Cross-border Connections in North Africa



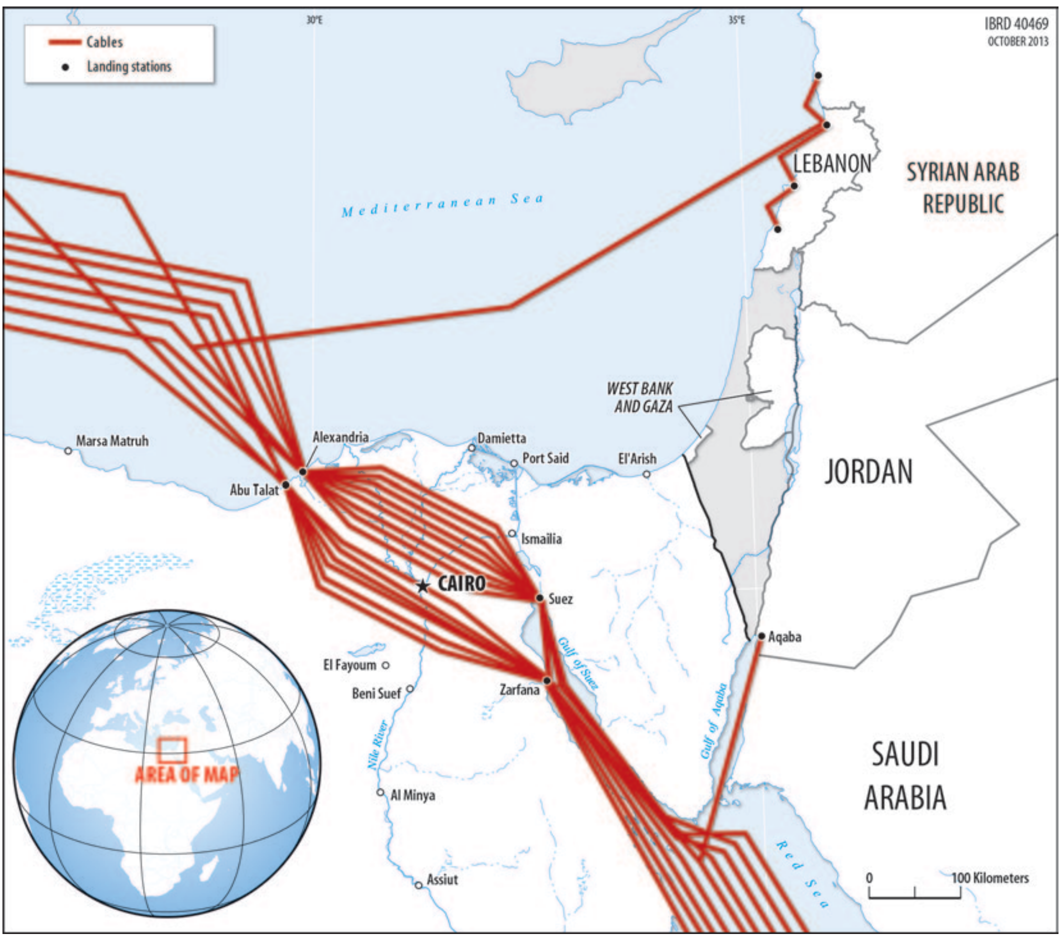
Source: World Bank, based on TeleGeography Interactive Submarine Cable Map (http://www.submarinecablemap.com/, accessed March 2012).
Note: Cross-border terrestrial connections are represented by spheres. Their positions in the map are illustrative and do not reflect the exact geographical position of the corresponding cross-border connection.

[EPEG][8]) have been built across the Middle East to provide an alternative to the Mediterranean and the Red Sea route for submarine cables between Asia and Europe.[9] Linking a few countries within the Middle East, they do not contribute to connecting the Middle East with North Africa. **There have been attempts to build coherent terrestrial infrastructure at the subregional level, for example, in North African and Gulf countries**.

North African Countries

There is only one fiber-optic cable (Ibn Khaldoun) providing regional broadband connectivity between Algeria, Libya, Tunisia, and Morocco (see map 3.3).[10] This cable is owned and operated by incumbents. In addition, there is a direct connection between Algeria (Debdeb) and Libya (Ghadames). Currently, this network is predominantly used for voice transport, with Internet traffic sent directly abroad (mainly to Europe through submarine cables belonging to incumbent operators).[11]

Map 3.2 Submarine Cables and Cross-border Connections in the Middle East



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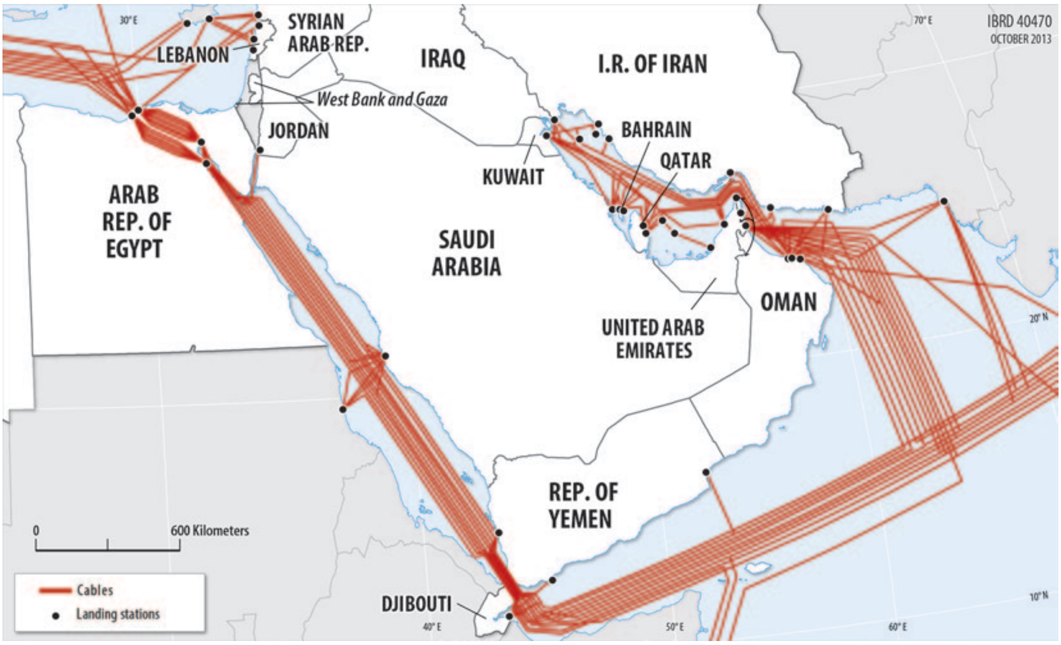
Map 3.2 Submarine Cables and Cross-border Connections in the Middle East *(continued)*



Source: World Bank, based on TeleGeography cable map.
Note: Cross-border terrestrial connections are represented by spheres. Their positions in the map are illustrative and do not reflect the exact geographical position of the corresponding cross-border connection.

Table 3.1 Design Capacity for Existing Cables and Effective Bandwidth per Capita, 2011

Economy	*Number of cables*	*Submarine cable design capacity per capita (kbps)*
Bahrain	5	10,020
Djibouti	4	7,829
Oman	8	7,416
Libya	5	3,312
United Arab Emirates	13	2,672
Qatar	5	2,106
Tunisia	4	1,821
Kuwait	4	1,520
Saudi Arabia	11	985
Lebanon	3	910
Syrian Arab Republic	4	783
Egypt, Arab Rep.	13	481
Iraq	3	275
Jordan	2	213
Iran, Islamic Rep.	6	136
Morocco	5	93
Algeria	3	77

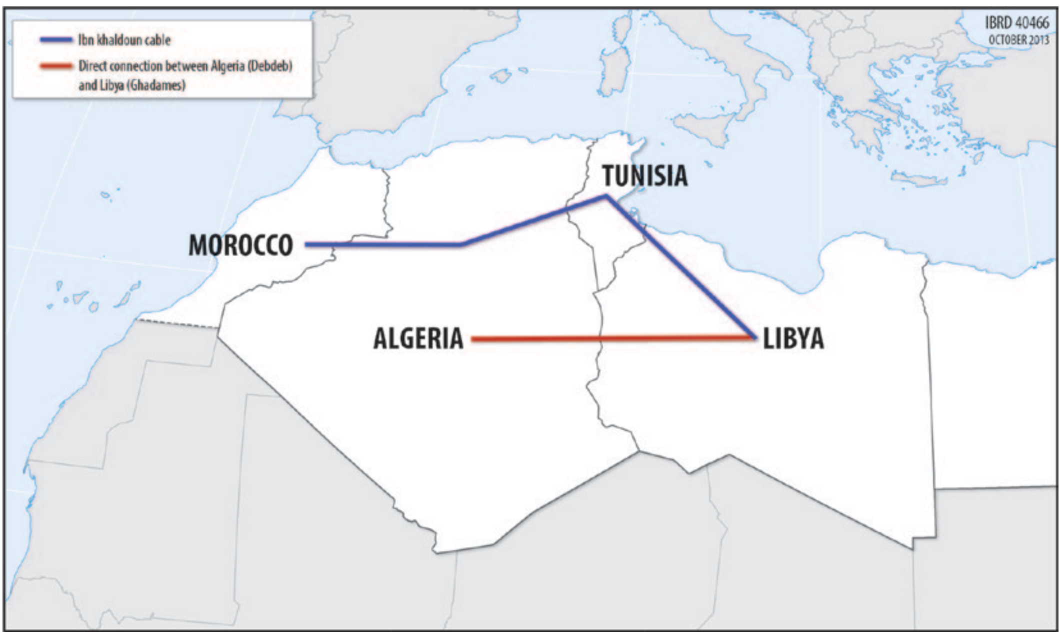
table continues next page

Table 3.1 Design Capacity for Existing Cables and Effective Bandwidth per Capita, 2011 *(continued)*

Economy	*Number of cables*	*Submarine cable design capacity per capita (kbps)*
Yemen, Rep.	2	53
West Bank and Gaza	0	0
Weighted average MENA		594.09
Weighted average North Africa		513.31
Weighted average Gulf		284.79
Weighted average Mashreq		2,037.47
Weighted average Yemen, Rep.; and Djibouti		325.31

Source: World Bank.
Note: kbps = kilbits per second; MENA = Middle East and North Africa.

Map 3.3 Cross-border Connections in Maghreb Countries



	Number of used fiber pairs	*Number of available fiber pairs*	*Design capacity*	*Available capacity*
Ras Ejedir (Ly)—Ben Guerden (Tu)	4	0	155 Mb	—
Tabarka (Tu)—Kala (Al)	4	2	622 Mb	47 E1
Ghadames (Li)—Debdeb (Al)	4	4	34 Mb (PDH)	—
Maghnia (Al)—Oujda (Mor)	4	0	2.5 Gbps	1006 E1

Source: World Bank, Sofrecom.
Note: — = not available; E1 = carries signal of 2Mbs; Gbps = gigabits per second; Mb = megabit; PDH = plesiochronous digital hierarchy.

Gulf Countries

The Gulf Cooperation Council (GCC) Interconnection Authority (GCCIA) is a joint stock company subscribed to by the six Gulf states and is based in Saudi Arabia. GCCIA's core activities consist in linking power grids across the GCC countries and operating and maintaining the interconnection grid.

GCCIA leases out to operators its fiber-optic cable network along its regional power-line network.[12] For example, Viva Bahrain (Saudi Telecom Company [STC] group) leases GCCIA dark fiber to connect Saudi Arabia, and 2 Connect of Bahrain signed a contract with GCCIA to connect Kuwait, Saudi Arabia, Qatar, and the United Arab Emirates. GCCIA's network provides **optical continuity across all Gulf countries.** An example of an innovative method to fund fiber-optic networks in the Gulf is described in box 3.2.

In October 2013, the Vodafone Group, the United Arab Emirates–based Du, and Kuwaiti companies Zain and Zajil formed a consortium for the rollout of a 1,400 km fiber-optic cable system in the Gulf. The Middle East–Europe Terrestrial System (MEETS) will stretch from Kuwait to the United Arab Emirates, via Saudi Arabia, Bahrain, and Qatar, with an initial capacity of 200 Gbps. Du will be the landing party in the United Arab Emirates, Vodafone in Qatar, Zain in Saudi Arabia and Zajil in Bahrain and Kuwait. MEETS is designed to be an economically and technically competitive alternative for connectivity within the Gulf; it will also enable a terrestrial route to Europe for reduced latency and higher reliability. Carriers will be able to access MEETS from the Fujairah Landing Station or at the Datamena carrier neutral hub in the United Arab Emirates.

Box 3.2 Leveraging Sovereign Wealth Funds to Expand Fiber-optic Networks: Gulf Bridge International

Investment in subterranean and undersea fiber-optic backbone infrastructure requires significant funding that has conventionally been provided by governments in the Middle East and Africa (MENA) region in the form of public sector initiatives. However, backbone investments can be administered and managed by the private sector, as illustrated by the example of Gulf Bridge International (GBI).

Established in December 2008 with financial backing by the Gulf region's sovereign wealth funds, GBI was the Middle East's first privately owned submarine fiber-optic infrastructure provider. It aims to deploy and manage a submarine cable system to interconnect all the Gulf countries and provides onward connectivity to the rest of the world.

GBI started deployment of a submarine fiber-optic cable network circling the Arab Gulf peninsula. Subsequently, GBI has expanded the undersea cable network eastwards to India via Mumbai, and to the west via the Red Sea, terrestrially over the Arab Republic of Egypt and then across the Mediterranean Sea to Mazara in Southern Italy (see map B3.2.1).

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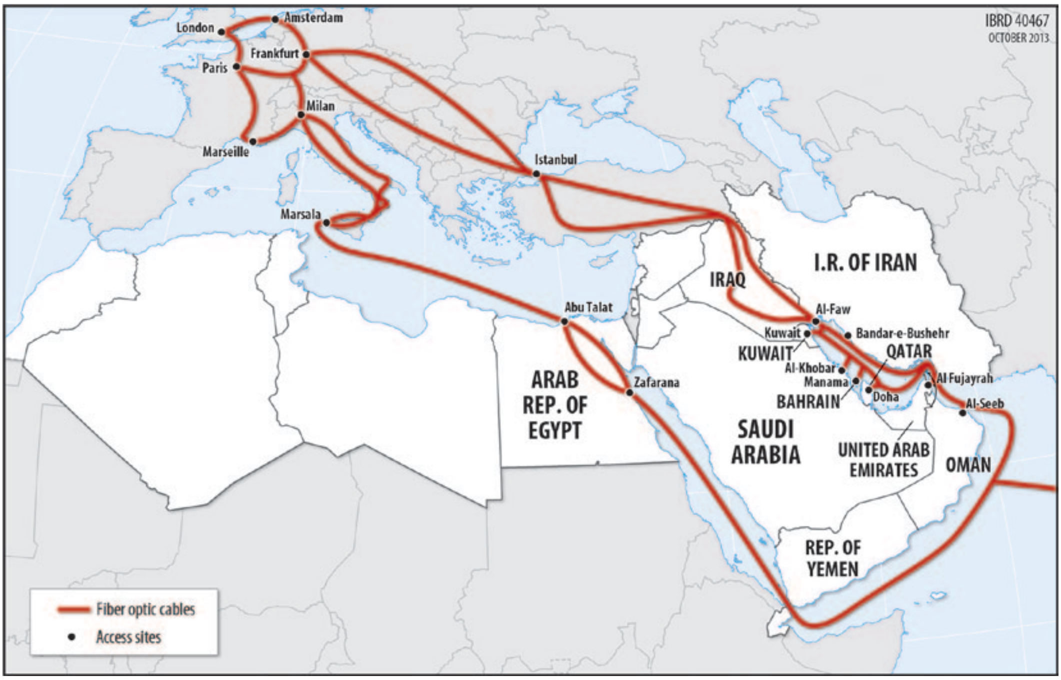
Box 3.2 Leveraging Sovereign Wealth Funds to Expand Fiber-optic Networks: Gulf Bridge International *(continued)*

Map B3.2.1 Fiber-optic cables



Source: World Bank.

In March 2013, GBI launched the first subterranean cable connecting the Gulf to Europe. The terrestrial link was established through a landing station in Al-Faw, Iraq, crossing Iraq, Turkey, and onwards to Frankfurt.

In just five years GBI has created a cable system improving the connective capacity and resilience of the Gulf region. By leveraging public funds through Sovereign Wealth Fund investors in addition to other private sector players including telecom operators, GBI has created a new model for the expansion of fiber-optic networks in the Middle East that can be replicated in other countries and areas of the region.

In an interview with the World Bank, GBI indicated the great potential of the Middle East in terms of broadband development and the high capacity demand of the region's population. In addition, GBI stated that the Gulf was evolving into a global hub for high capacity data transmission. In this respect, GBI's model can be extended to the Mashreq and North Africa regions in order to improve both intraregional and international connectivity.

Sources: World Bank, GBI.

Lack of Competition and Limited Open Access Regulations

The lack of competition and limited open access regulations pose significant constraints to the effective use of international and regional connectivity infrastructure in most of the MENA countries. In 13 out of the 19 countries under consideration in MENA, access to international submarine cable connectivity is under the sole control of the incumbent operator (see table 3.2). By contrast, there is one international submarine cable owned by an operator other than the incumbent in Jordan, Morocco, Oman, and Saudi Arabia. In Bahrain, there are two cables not owned by the incumbent operator. Bahrain is the only country in the MENA region to have removed all barriers to entry in the telecommunications sector.

Competition for terrestrial cross-border connectivity exists in only three out of the five countries (Bahrain, Jordan, Morocco, Oman, and Saudi Arabia) where there is also competition for international submarine connectivity. In three of the countries, Bahrain, Jordan, and Saudi Arabia, the process for granting licenses for the installation and operation of international telecommunications facilities is based on a class-licensing model. The class-licensing model consists of granting licenses to all applicants that meet a minimal set of criteria. The benefits of competition in international submarine cable connectivity can therefore also accrue to neighboring countries via terrestrial cross-border links, as new operators in fully competitive markets seek a better return on investment by selling international connectivity on a regional scale (see box 3.3).

In addition to a lack of effective, facilities-based competition in most countries of the region, the regulatory framework is usually not conducive to a fair and

Table 3.2 Competition for International Submarine Cable Connectivity

	Number of relevant economies 19	*#*	*Economies*
North African countries	Partially competitive	1	Morocco
	No competition	4	Monopoly: Algeria; Egypt, Arab Rep.; Libya; Tunisia
			Monopoly:
Mashreq countries	Competition	1	Jordan
	No competition	4	Monopsony: West Bank and Gaza
			Monopoly: Iran, Islamic Rep.; Iraq; Lebanon; Syrian Arab Republic
Gulf countries	Competition	3	Bahrain, Oman, Saudi Arabia
	No competition	3	‘Monopoly: Qatar, United Arab Emirates, Kuwait’
Djibouti; Yemen, Rep.	Competition	0	n.a.
	No competition	2	Monopoly: Djibouti; Yemen, Rep.

Source: ITU.
Note: Monopsony in the case of the West Bank and Gaza: the only buyer of international connectivity is Paltel.
Bahrain is the only country to have eliminated all entry barriers, allowing an indefinite number of operators in the market.
n.a. = not applicable.

Box 3.3 Open Access to International Submarine or Terrestrial Cables

The concept of "open access" refers to access to terrestrial or submarine fiber-optic systems by operators or service providers (holders of a telecommunications operating license or permit to engage in the provision of telecommunications infrastructure or services) on nondiscriminatory and transparent terms (for pricing and nonpricing aspects) and cost-based pricing.

Previous experience with fiber cables in East and South Africa shows that supporting the development of infrastructure while improving the policies and regulatory framework has a secondary impact on the market through a rapid increase in demand when the price of bandwidth decreases.

The ACE (Africa Coast to Europe) submarine cable connects Europe with 13 countries along the West African coast (Mauritania, Senegal, The Gambia, Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Benin, Nigeria, Equatorial Guinea, Gabon, Principe, and São Tomé). The World Bank is providing financing, under its regional projects WARCIP (West Africa Regional Communications Infrastructure Program) and CAB (Central African Backbone), to several African countries to join the ACE, which is committed to public-private partnerships (PPPs) and open access principles.

The open access, nondiscriminatory treatment of all entities fosters transparency, facilitates market entry, and promotes reasonable tariffs, maximizing the financing's developmental contribution. Access to new submarine capacity on an open access basis via ACE is expected to directly feed into lower retail prices and higher bandwidth available in these countries. A significant increase in penetration will be set in motion both for fixed (via asymmetric digital subscriber line [ADSL] or metropolitan fiber) and mobile (via third generation of mobile telecommunications technology (3G) dongles or smart phones) broadband.

Source: Kelly and Rossotto 2012.

equal access to submarine cable fiber infrastructure. Although access to submarine landing stations could be deemed to be covered by interconnection and colocation domestic regulations, this is usually not the case in those countries with a monopoly on this essential infrastructure. In Tunisia (see box 3.4) as well as in Egypt, access to landing stations has been addressed through specific regulations and/or the law.

In most of the MENA countries, access to terrestrial cross-border connectivity also remains under the sole control of the incumbent operator. This is due to two reasons. In some countries, the incumbent operator holds exclusive rights (Djibouti, the Islamic Republic of Iran, Iraq, Kuwait, Lebanon, Libya, the Syrian Arab Republic and the Republic of Yemen). In other cases, there are regulatory barriers to entry related to the individual licensing model combined with the need to obtain a fixed/mobile license (Algeria, Morocco, Qatar, Tunisia, and the United Arab Emirates). Obtaining a fixed-line license with coverage obligations is a deterrent to entry by submarine cable operators that have a business model focused on providing international connectivity. The required investment is also a multiple of the pure international backbone infrastructure.

Box 3.4 Regulated Access to Submarine Cable Landing Stations in Tunisia

Among North African countries, Tunisia currently has the highest cost for incoming international voice calls and for international bandwidth for Internet and data. A SkypeOut call to Tunisia costs US$0.395 while Morocco is at US$0.25, Algeria, Libya, and the Arab Republic of Egypt are between US$0.15 and US$0.20, and Turkey is at US$0.036 (by comparison, France is at US$0.023). Tunisia has a monopoly on the physical layer of international communications (all calls and data communications need to transit through the submarine cable landing stations that are owned by incumbent Tunisie Telecom. Alternative operators Tunisiana and Orange have plans to jointly build an alternative submarine cable and landing station but it will take 2–3 years before it comes into service. As an immediate reform, because of its short-term impact on wholesale prices offered on a commercial basis by Tunisie Telecom to access international connectivity, the Tunisian ICT regulatory authority (INT) issued a decision enforcing the interconnection regulation on the access to submarine cable landing stations of the incumbent operator.

It is well established under international law that submarine cables and cable landing stations, either on a given territory or in its territorial waters, are under the full jurisdiction of the coastal state.[a] In accordance with Article 2 of the United Nations Convention on the Law of the Sea of December 10, 1982, a coastal state has sovereignty over its territorial sea. It has the right to establish the breadth of that territorial sea up to 12 nautical miles from the coast (Article 3).

Access to submarine cable landing stations is a necessary part of interconnection with Tunisie Telecom, as are any backhaul arrangements that are required to enable connection with the landing stations. INT regulates the interconnection regime in accordance with the Code,[b] Ordinances, and Decisions. Under the Code, every operator of a public telecommunications network is subject to the interconnection regime.

In its Decision 67/2012 (Décision n°67/2012 de l'Instance Nationale des Télécommunications en date du 4 octobre 2012 portant sur le complément de l'Offre Technique et Tarifaire d'Interconnexion de la Société Nationale des Télécommunications pour l'année 2012, relatif à l'accès à la station terrienne d'atterrissement des câbles sous-marins.), INT approved the first interconnection offer to incumbent Tunisie Telecom's submarine cable landing stations comprised of: (a) colocation in the submarine cable landing station; (b) access to the submarine cable; and (c) backhaul.

a. See, for example, Mudrić (2010).
b. Loi nº 1-2001 du 15 janvier 2001 portant promulgation du code des télécommunications, as amended.

Jordan

New market entrant VTEL Jordan (in operation since 2007) signed an agreement with Reliance Globalcom to be the landing party for the FALCON submarine cable in Jordan (Aqaba) and herewith access multiple high bit rate channels (synchronous transmission mode [STM]-96) of international transmission capacity. Complementing its international cable landing station and domestic network, VTEL Jordan also started setting up direct connectivity with neighboring economies to extend its services' reach and potentially offer services to operators in these economies (the West Bank and Gaza and Saudi Arabia initially, then Syria and Iraq).

Saudi Arabia

New market entrant ITC (in operation since 2005), part of the diversified Saudi conglomerate Al Mawarid Group, owns and operates two cable landing stations in Al Khobar and Jeddah. These international gateways provide wide international connectivity through the Reliance Globalcom cable and to the rest of the world with its exclusive access to the FALCON system. ITC also owns border crossings via terrestrial cables to Jordan, Egypt, Qatar, and the United Arab Emirates, and also soon to Bahrain and Kuwait.

Oman

In Oman, following the separation of its operations into fixed and mobile segments, Omantel has been able to raise its international profile by extending international connectivity services to India in addition to other network expansion and investment activities in partnership with other regional telephone companies.[13] Furthermore, the Omani Telecommunications Regulatory Authority (TRA) announced its intention to adopt such a class-licensing approach and launched a consultation to this end, but there has been no indication yet on implementation.

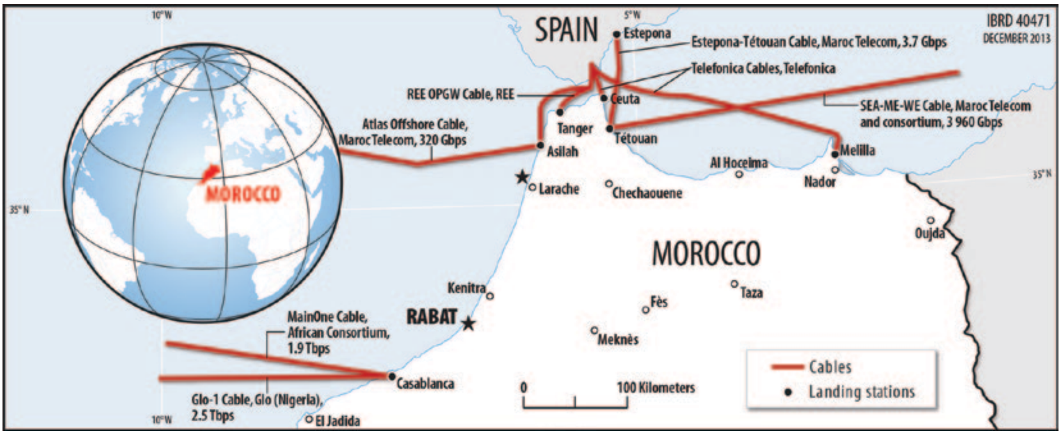
Morocco

In Morocco, Maroc Telecom has been able to complete a number of submarine cable investment projects with Europe. In April 2007, it completed a new submarine cable linking Asilah in northwest Morocco with Marseille, France. In January 2012, the telephone company started deployment of an additional submarine cable between Morocco and Spain. With a combined capacity exceeding 10 terabits per second (Tbps) and a variety of different submarine cables and landing stations, Morocco's international connectivity is secure and has sufficient capacity to meet current and future medium-term needs. All three telecommunications operators have access to international connectivity, with full competition resulting in a favorable price for international bandwidth. Maroc Telecom controls three submarine stations where it is a shareholder (Sea-Me-WE4 Atlas OffShore, and Estepona-Tetouan). Méditel has redundant connectivity with more than two different physical submarine stations and submarine cables, while Wana-INWI had only the cable leased from the national electricity grid (see map 3.4) and a more fragile and insecure international connectivity, but as of December 2012, the situation was improved. In 2013, two other independent cables are expected to land in Morocco: Glo1 and MainOne.

Bahrain

Since 2004 all restrictions on the number of individual licenses have been eliminated. Operators are allowed the termination, landing, and establishment of international connectivity. Licenses foresee the obligation and right to connect to other licensed networks in Bahrain. Bahrain is the only country in the region to have followed a market structure and regulatory model similar to the European Union (EU). In 2010, a third mobile operator, STC, signed a dark-fiber leasing contract with GGCIA. In 2011, data and Internet operator 2Connect expanded

Map 3.4 International Submarine Cable Connectivity in Morocco



International gateways			
Sea cables			
Submarine stations	*Cable*	*Owner*	*Destination*
Tetouan	Tetouan Tepona	Maroc Telecom	Spain
	SEA-ME-WE	Maroc Telecom and consortium	Europe
Kelibia	Atlas offshore	Maroc Telecom	Spain
Ceuta (Spain enclave)	Telefonica	Telefonica	Spain
Melilla (Spain enclave)	Telefonica	Telefonica	Spain
Tangiers	REE OPGW	REE	Spain
Casablanca	MainOne	African consortium	Africa
Casablanca	Glo-1	Glo (Nigeria)	Africa-Europe
Terrestrial			
Maroc Telecom gateways		Algerian border	Algeria Telecom
		Mauritanian border	Not open

Source: World Bank.
Note: OPGW = optical ground wire; REE = Red Electrica de Espana; SEA–ME–WE4 = South East Asia–Middle East–Western Europe 4 optical fiber submarine communications cable system.

its presence to include Kuwait, Saudi Arabia, Qatar, and the United Arab Emirates also via the GCCIA regional fiber-cable system.

In Bahrain, the national regulator requires that wholesale access be made available at all network levels—international, domestic backhaul, and customer premises—at "internationally competitive" prices to encourage broadband take-up for operators declared dominant.

Recently the Bahrain Internet Exchange (BIX) entered into a partnership with India's Tata Communications in addition to four Middle Eastern telecommunications companies to build an international submarine cable Global Network (TGN) connecting the Gulf region directly to India and the rest of the world. BIX has received a government grant to bring in the new cable and will resell capacity to any operator.

Conclusions

Despite abundant international connectivity, the limited competition in international (and regional) connectivity has translated into high international charges for the region, as shown by the benchmarking of SkypeOut tariffs in the region (see table 3.3). Lack of competition and limited open access regulations pose significant constraints to the effective use of international and regional connectivity infrastructure in most of the MENA countries, with potential adverse consequences on the affordability of broadband services to end users.

National Backbone and Backhaul Infrastructure

Assuming that the constraints on the effective use of existing international infrastructure in the MENA countries are alleviated through appropriate policy measures (as detailed in the Chapter 4), national backbone (including backhaul) infrastructure based on fiber-optic technologies could play an essential role in enabling the development of broadband access and maintenance of the quality standards in the provision of broadband services. In the absence of fiber backbone

Table 3.3 How Ready are MENA Economies for Affordable Broadband?

Economies	*Fixed broadband market development stage*	*Mobile broadband market development stage*	*Competition in international submarine cable connectivity*	*SkypeOut rate (USc/min)*
Algeria	Emerging	n.a.	No	17.5
Iran, Islamic Rep.	Emerging	n.a.	No	13.4
Iraq	Emerging	n.a.	No	39
Djibouti	Emerging	Emerging	No	39
Libya	Emerging	Emerging	No	30.2
Yemen, Rep.	Emerging	Emerging	No	21
Syrian Arab Republic	Emerging	Emerging	No	39
Tunisia	Emerging	Emerging	No	39.5
Morocco	Emerging	Emerging	Yes	25.9
West Bank and Gaza	Developing	n.a.	No	25
Egypt, Arab Rep.	Emerging	Developing	No	15.2
Oman	Developing	Developing	Yes	18.9
Kuwait	Developing	Developing	No	13.2
Lebanon	Developing	Developing	No	12.6
Jordan	Developing	Developing	Yes	20.8
Saudi Arabia	Developing	Developing	Yes	18.8
Qatar	Developing	Developing	No	39
United Arab Emirates	Developing	Developing	No	27.5
Bahrain	Mature	Mature	Yes	25.5
MENA, Simple average	n.a.	n.a.	n.a.	25.3
Competitive countries	n.a.	n.a.	n.a.	21.9
Other countries	n.a.	n.a.	n.a.	26.5

Source: Skype 2012. www.Skype.com/en/rates
Note: USc/min = US cents per minute; MENA = Middle East and North Africa; n.a. = not applicable.

networks aggregating increasing data traffic and thereby reducing average costs, broadband services are unlikely to be commercially viable anywhere other than in the major urban areas of a country.

Given the importance of backbone infrastructure to broadband sector development, initiatives related to the deployment of national backbones have increasingly often become an integral part of the national broadband policies across the MENA region. Indeed, a national strategy for domestic backbone development has been defined in seven countries (Algeria, Jordan, Lebanon, Morocco, Oman, Qatar, and Saudi Arabia). In five countries (Jordan, Morocco, Oman, Qatar, and Saudi Arabia), open access to backbone infrastructure has been identified as a key element in the implementation of this strategy. Most often, national initiatives target the digital divide by bringing connectivity to the population groups and/or areas that are not attractive from the economic standpoint (e.g., Algeria, Jordan, and Morocco). However, none of the policies adopted systematically address the full set of issues facilitating backbone connectivity, including infrastructure deployment.

Lack of Holistic Approach to Expand National Infrastructure

In order to systematically address the issue of the availability of appropriate national backbone (including backhaul) infrastructure from the policy and regulatory perspective, it is important to understand the options which operators should normally be given to enable expansion. These are essentially through (a) active infrastructure sharing, (b) passive infrastructure sharing, and/or (c) deployment of their own infrastructure (see table 3.4).

The first two options normally provide cheaper alternatives for increasing national backbone infrastructure and could be implemented more quickly, while the third option implies much higher costs and is time consuming taking into account the necessary procedures, such as obtaining construction permits, rights of way, and so on. All three options should be possible under the legal and regulatory framework.

A common constraint that prevents operators from benefitting (or fully benefitting) from the options discussed above and effectively expanding the overall national backbone infrastructure is limited competition in supply of this capacity. Limited competition is caused by different factors, as shown in table 3.5. According to the operators, there are also difficulties with administrative

Table 3.4 Options for Expansion of National Backbone Infrastructure

Options for expansion	*Description*
1. Active infrastructure sharing	Leasing of the capacity from backbone infrastructure provider Among potential providers are incumbent operator and utility companies
2. Passive infrastructure sharing	Leasing of ducts (where operator could deploy its own fiber cables) or leasing of dark fiber (which could be lit by own active equipment of the operator) Among potential providers are incumbent operator and utility companies
3. Deployment of own infrastructure	Performance of civil works and laying down of own fiber infrastructure

Table 3.5 Options for Expansion of National Backbone Infrastructure in Selected Countries

Country	*Options for expansion*
Iraq	The second and third alternatives to increase backbone capacity are not available, while the first option is limited to one company owing to a *de jure* monopoly at the national backbone level. The state-owned Iraqi Telecoms and Post Company (ITPC) is the only provider of backbone connectivity in the country. Passive infrastructure sharing is not possible. Deployment of backbone infrastructure is not possible.
Egypt, Arab Rep.	All three alternatives to increase backbone capacity are available, while the first and second options are limited to one state-owned company. Telecom Egypt is the only provider of backbone connectivity. Three main utility companies possess alternative infrastructure (ducts and/or fiber); however, their existing excess fiber capacity is not made available to licensed operators.
Morocco	Backbone connectivity is being addressed by leveraging the second option, that is, passive infrastructure sharing, and the third, deployment of own infrastructure. A law obliging licensed operators to share telecoms' infrastructure was enacted in 2004. Three infrastructure operators provide backbone capacity: two utility companies (railways and electricity grids) and one passive infrastructure provider. However, the two utility companies are bound by exclusive agreement with an alternative telecommunications operator: railways (Office Nationale des Chemins de Fer, ONCF) has an exclusive agreement with Méditel (30-year contract: 2005–35); and electricity grids (Office National de l'Electricité et de l'Eau Potable, ONEE) with Wana-INWI. ONCF's and ONEE's infrastructure have a different geographical coverage and complement each other; however, because of exclusive agreements, usage of each infrastructure is limited to one operator only. Therefore, neither of those two backbone networks would be available to a new entrant. "The third provider of passive infrastructure is Finetis Maroc whose legal status and rights are currently not fully clarified. Its infrastructure has been deployed mainly on the land of the Morocco highway administration, Autoroutes du Maroc (ADM) and consists of a large capacity of fiber-optic cables (72 fiber pairs) to be leased as dark fiber to operators. Finetis Maroc also deployed infrastructure along other roads and metropolitan networks.
Tunisia	Similar to Morocco, backbone connectivity is being addressed by leveraging the second option, that is, passive infrastructure sharing, and by the third, deployment of own infrastructure. Despite a number of alternative infrastructure providers, only one is proactive and open to any operators' request. Currently there are three major providers of alternative infrastructure: the Tunisian Electricity and Gas Company (STEG), the Tunisian Railways National Company (SNCFT), and Tunsie Autoroutes. While STEG has deployed about 2,700 kilometers (km) of optical cables in its facilities to manage high voltage and extra high voltage distribution, despite various requests from other operators, STEG has not leased excess capacity. Tunisie Autoroutes has placed three pipes to deploy optical fiber cables on about 435 km of its highways. Despite the potential of this infrastructure, currently Tunisie Autoroutes has a conservative strategy and there is no installation of optical cables for its own use. SNCFT is the most advanced in its awareness and use of fiber infrastructure. The rail company already has a network based on synchronous transmission mode (STM)-16 to manage its own operations, and its strategy on use of its network is proactive and open to any operators' request. In addition, it has extensive colocation facilities.

table continues next page

Table 3.5 Options for Expansion of National Backbone Infrastructure in Selected Countries *(continued)*

Country	*Options for expansion*
Jordan	From a policy perspective, there are no impediments to the implementation and use of alternative infrastructure, and the utility networks have excess capacity that could be made available to licensed telecommunications operators and also for private networks. However, tariff regulation may be necessary to ensure that these resources are accessible at an economically feasible price. The national energy supplier, National Electricity Power Company (NEPCO), has equipped a large number of its high voltage and extra high voltage lines with fiber-optic cables. This infrastructure covers most of the country and reaches most large and medium-size cities, as well as providing a metropolitan network in Amman. This infrastructure can be easily used for backhaul networks; however, current pricing of the network is not attractive to operators and requires tariff regulation. For the utility's own use and its ability to rent passive infrastructure without authorization, as well as for the implementation and use of alternative infrastructure and international gateways, the legal and regulatory framework provides no bottlenecks. Jordan Telecom Group (JTG) has a backbone infrastructure covering a large part of the territory, and this infrastructure is available on a wholesale basis to other operators.

Sources: World Bank, STEG (Société Tunisienne de l'Electricité et du Gaz, Tunisian Electricity and Gas Company).
Note: For more information about the cases of Egypt, Jordan, Morocco, and Tunisia, see the appendix.

procedures. Notably, countries facing constraints in expanding national backbone infrastructure also demonstrate a weaker performance in the broadband market.

Utility companies with their nationwide infrastructures have great potential to address competition in the supply of national backbone infrastructure to facilitate the first and second options, as shown by the case studies appended to this report. Optical fiber infrastructure is being built along nearly all of the networks of the utility companies for internal communications and network management purposes (other than commercial provision of capacity). Excessive fiber capacity could be leased to address the development of backbones; however, this opportunity is not yet being leveraged fully across the MENA region. A good example is Tunisian Railways National Company (SNCFT), which facilitates open access to its fiber infrastructure (see table 3.5) by allowing a mobile operator to install fiber infrastructure along the ducts of the railway. The Moroccan energy company, Office National de l'Electricité et de l'Eau Potable (ONEE), is leasing fiber to a licensed mobile operator, providing both national backbone and international connectivity. The case studies in the appendix show the significance of the opportunity created by untapped fiber infrastructure from other utilities, where it can be an opportunity, and how to turn it into a real, value-added solution.

MENA countries have therefore the opportunity to leverage competition in provision of national backbone infrastructure through opening and facilitating access to the excess capacity of utility companies for telecommunications sector needs. A review of the licensing regimes, pricing, and open access frameworks as well as a rebuttal of exclusive agreements between utility companies and operators are key to enabling the optimal benefit from fiber infrastructure that is already in place. This would need to be supported by strong policy will at the government level, as the activities of these utilities in the telecommunications sector would be subject to the legal and regulatory framework governing telecommunications.

However, the role that utility companies can potentially play in addressing the backbone connectivity issue in the MENA region goes beyond active and/or passive sharing of existing fiber infrastructure. When the third option is considered—deployment of own infrastructure—telecommunications operators can also benefit from synergies that arise from coordination of civil works with utility companies. Indeed, one of the often-cited reasons for investment shortfalls is high costs in the current difficult financial climate. For the deployment of utility infrastructure, civil works are widely identified as the dominant cost in overall deployment costs and can constitute up to 80 percent of total costs of the project in telecommunications (WIK 2008; Caio 2008; Analysys Mason 2008). Given the massive investments being made to modernize infrastructure throughout the MENA region, partnerships between utilities and telecommunications operators would make it possible to maximize the benefits of tunneling works and ensure that fiber-optic cables can be installed alongside new utility infrastructure in a cost- and time-effective way to achieve a wider dissemination of broadband (See figure 3.2).

Frameworks for coordination of civil works are, however, rather an exception than a common practice across the MENA region. To date, the issue has been systematically addressed solely in Bahrain, but unfortunately the framework is limited to coordination of civil works between telecommunications operators only (see box 3.5). When supported by strong policy coordination and will at the

Figure 3.2 Synergies from Utilities' Investments: Roads and Water Distribution/ Sanitation in Jordan

Source: World Bank.

Box 3.5 Joint Infrastructure Deployment Framework in Bahrain

In December 2008, the Telecommunications Regulatory Authority (TRA) of Bahrain adopted a Guideline on Telecommunications Infrastructure Deployment (Guideline). The Guideline aims to facilitate the deployment of telecommunications network infrastructure through defining technical specifications and simplifying construction procedures. A joint infrastructure deployment framework was part of the facilitation process.

According to the Guideline, "Telecommunications Infrastructure Providers are required to adopt joint infrastructure installation methods when more than one provider wishes to lay telecommunications infrastructure at the same location and within a timeframe not exceeding one year from the date of notifying other providers of the intention of the first Telecommunications Infrastructure Provider's intention to carry out infrastructure works."

TRA is of the opinion that this method of joint work shall reduce the cost for constructing networks and shall help in effectively utilizing the available telecommunications corridor space.

Source: Telecommunications Regulatory Authority 2008.

government level, successful coordination of civil works between telecoms and other utilities would bring significant benefits to the MENA region.

Nevertheless, examples of volunteer partnerships between utility companies and telecommunications operators occur from time to time, proving that there could be a mutual benefit from joint infrastructure deployment. One of the most recent examples is a partnership between Oman's state-owned utility company, Haya Water, and telecommunications operators. Under its ongoing water reuse project, Haya Water simultaneously covers tens of thousands of homes and offices across the Muscat Governorate of Oman and installs fiber-optic cables alongside its new pipelines. From the perspective of telecommunications operators, such a synergy provides a highly cost-effective solution for telecommunications infrastructure deployment. From the perspective of the state, the synergy reduces the impact on the environment by avoiding a second round of construction work in the future. At the same time, the partnership is beneficial not only for backbone connectivity, but most importantly for the access part of the network, which, both in terms of time and financial resources, is considered the most costly part of network infrastructure deployment.

Government-Led Initiatives to Deploy National Backbone Infrastructure

In a number of instances, national policies in MENA are empowering the state to deploy infrastructure (see box 3.6). An often-quoted reason for that is the unsatisfactorily low pace of private investments. Governments in a number of countries, particularly in the Gulf, are increasingly taking the lead in bringing connectivity, aiming to leverage the promised benefits of broadband much sooner than the private sector could potentially ensure by itself.

Box 3.6 National Infrastructure Deployment Project in Lebanon

In late 2010, Lebanon embarked on improving the status of its domestic fiber-optic backbone infrastructure by expanding the country's fiber-optic network and linking it to telephone switchboards, thereby increasing the potential of high-speed data transmission for households and businesses.

The project, led by Lebanon's Ministry of Communications, invested around US$166 million in the incumbent fixed line operator's domestic local Internet backbone, by completing a 4400 kilometer (km) fiber-optic transmission network connecting all major locations in the country. The Ministry of Communications announced the finalization of this project in April 2013.

Sources: World Bank; Ministry of Communications of Lebanon.

Public-private partnerships (PPPs) could provide a useful alternative in such a context to accelerate the rollout of backbone infrastructure and promote affordable broadband access to all. PPPs refer to various types of long-term contractual relationships between the authorities and the private sector for the design, execution, operation, maintenance, and financing of equipment or infrastructure and/or the organization of services to the public. PPPs enable a government to leverage the management skills of private enterprises, the productivity gains and cost savings that they can achieve, and the innovations that they can provide, with the prospect of releasing public finance for other projects.

When private investment cannot be guaranteed up front in the amount or the speed required, a PPP could serve as a catalyst for broadband rollout, but a clear exit strategy is required that states that public assets will be transferred to the private sector when a private sector player is ready to become involved. The experience of Jordan has shown that even in the case of socially oriented connectivity initiatives aiming to achieve specific social inclusion goals and bridge the digital divide, the sunk costs related to the operation, maintenance, and expansion of national broadband networks (NBNs) are too high. Following that conclusion, Jordan's draft national information and communications technology (ICT) strategy considers ways of eliminating operational costs and freeing up of public sector funds (see box 3.7).

Access Network Connectivity

The access network (or local loop) provides the link between the domestic backbone network and the end users. Achieving widespread availability and use of broadband in MENA implies that appropriate access networks are in place to provide high-speed data connectivity above a minimum bandwidth. In terms of the broadband technology mix, mobile broadband access is predominantly measured by the number of broadband customers in the MENA region and is generally considered to have the greatest potential to ensure quick availability of broadband services in most of the countries.

Box 3.7 Jordan's National Broadband Network

Jordan deployed and launched its first national broadband network (NBN) in 2004, aiming to connect eight universities (university broadband network). This project was followed by a school broadband network, a secured government network, and a medical entities network. Future plans are being studied to utilize the network to support the business sector in Jordan.

With sunk costs related to operation, maintenance, and expansion of the network proving to be too high, the draft national information and communications technology (ICT) strategy is exploring possible solutions, including the transfer of NBN as a whole or operational usage of the NBN by the private sector for exploitation. It is foreseen that a potential partial or complete handover to the private sector will eliminate operational costs and will free up public sector funds.

Source: Draft Jordan ICT strategy 2013.

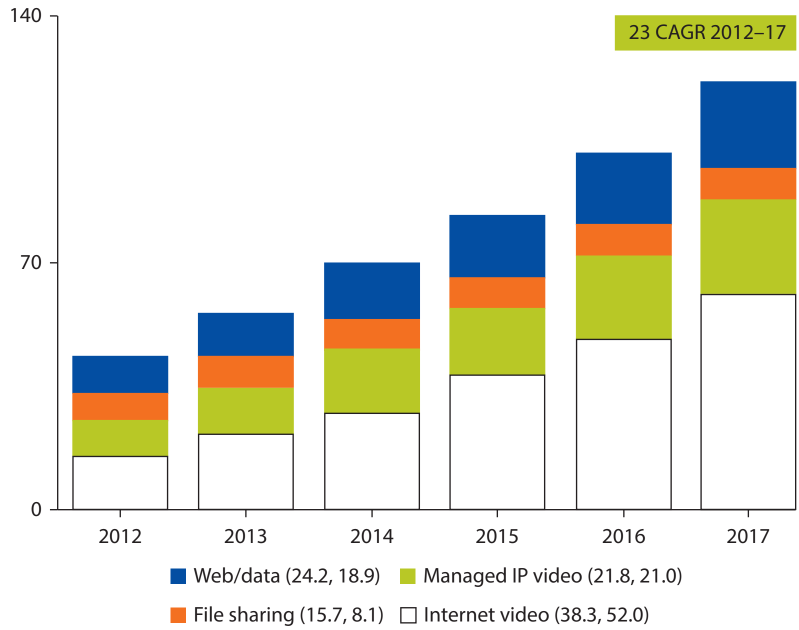
However, despite the expected increased coverage of 4G technologies (with much higher data rates), the widespread availability of mobile broadband technologies is unlikely to translate as rapidly into significantly higher mobile-originated data traffic. Mobile data[14] was 7 percent of total Middle East and Africa (excluding South Africa) Internet Protocol (IP) traffic in 2012, and is forecast to be only 26 percent of total IP traffic in 2017.[15] This suggests that fixed broadband technologies are likely to play a key role in sustaining the growth of data traffic because of the higher data rates offered (usage of demand-hungry applications as shown in figure 3.3, e.g., Internet video to personal computer (PC), Internet video to television (TV), video calling, and so on) as well as differences in consumption patterns. Mobile broadband, at least when it comes to mobile handsets and tablets, is highly personalized, that is, linked to "one person Internet connection," while in the case of fixed broadband, the connection is mostly dedicated to heavy usage and is not so personalized as the typical home fixed connection (as well as the device itself), which is used by all family members. In 2012, the amount of global traffic (web and data) generated from mobile networks was small in comparison to global traffic (web and data) generated from fixed connections (about 3 percent of fixed traffic): this portion of traffic generated from mobile networks will increase dramatically in the coming years; however, it will still represent about 14 percent of fixed traffic in 2017 (see table 3.6).

Taking a forward-looking view, most experts agree that fixed and mobile broadband technologies will complement each other in the future (see figure 3.4), with a mix that will depend heavily on the type of area served (metro, urban, suburban, rural):

- At one extreme, in rural areas, fixed technologies will tend to be less developed than mobile technologies.
- At the other extreme, in metro/urban areas, new, more complementary architectures will emerge with mobile technologies offloading onto fixed

Figure 3.3 Global Consumer Internet Video Traffic

Exabytes per month



Source: Cisco VNI 2013.
Note: The percentage within parentheses next to the legend denotes the relative traffic shares in 2012 and 2017, respectively. CAGR = compound annual growth rate; IP = Internet Protocol.

Table 3.6 Global Consumer Web, Email, and Data Traffic, 2012–17

By type (PB per month)	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*CAGR, 2012–17 (%)*
Fixed internet	31,339	39,295	47,987	57,609	68,878	81,818	21
Mobile data	885	1,578	2,798	4,704	7,437	11,157	66

Source: Cisco VNI 2013.
Note: Mobile includes Internet traffic that travels over second generation (2G), third generation (3G), and fourth generation (4G) of mobile access technologies. CAGR = compound annual growth rate; PB = petabytes.

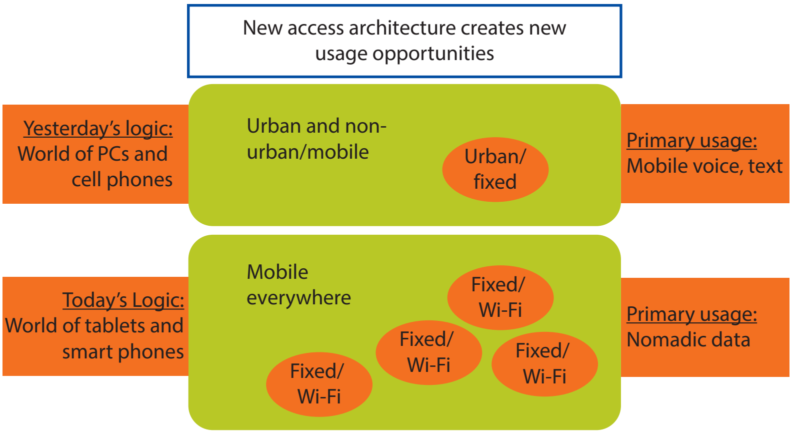
technologies via WLAN products IEEE 802.11 standards (WiFi) and significant traffic generated by tablets and smartphones.

In an ideal situation, the supply of infrastructure should go hand in hand with the utilization of the infrastructure constructed. However, in reality this is not always the case in MENA, and the gap can sometimes be significant depending on the subregion and/or the broadband technology. The following sections examine in more detail the current status of access networks in MENA, focusing on: (a) 3G and 4G technologies; (b) DSL technologies; and (c) fiber in the local loop.

3G and 4G Technologies

The introduction of mobile broadband (3G and 4G) in the MENA region enabled a rapid development of broadband access, providing the first form of

Figure 3.4 Complementary Fixed and Mobile Architectures



Source: Adopted from Blair 2012.
Note: PC = personal computer; Wi-Fi = WLAN products IEEE 802.11 standards.

competition in a broadband market largely dominated by xDSL offered by incumbent fixed operators. However, the MENA region shows a relatively heterogeneous landscape in mobile broadband penetration (see table 3.7):

- The Gulf countries show the highest penetration for mobile broadband (64.8 percent), and this is also the sole subregion in MENA where 4G was launched before December 2012 (Oman, Saudi Arabia, Kuwait, and the United Arab Emirates). In 2013 commercial 4G services were also launched in Qatar and Bahrain. There are at least two 3G operators in each country, causing vibrant competition which led 36.08 percent of the mobile customer base to migrate to broadband offers. However, more harmonized spectrum allocation arrangements may be needed to foster further development of mobile broadband.

- The North African countries show an average penetration for mobile broadband (only 3G at the time of writing) of 18.99 percent. This is partly explained by Algeria not yet having awarded 3G licenses. With the exception of Egypt (which resembles the Gulf countries), the North African countries still have significant growth potential, as only 15.34 percent of mobile customers have migrated to broadband. Competition has not yet shown its full impact on mobile penetration in Morocco (10.14 percent and three operators), and Tunisia (5.10 percent and three operators), but mobile broadband is quickly on the rise in these two countries as well, and they are expected to bridge the gap with Egypt in the next few years.

- By contrast, the Mashreq countries show a lower penetration of mobile broadband (14.04 percent), which is largely explained by economies that have not yet awarded 3G licenses (the West Bank and Gaza) or have only awarded one

Table 3.7 Mobile Broadband Connections per Technology in MENA Subregions, December 2012

Country	*Mobile broadband technologies (3G/4G) penetration per 100 inhabitants (%)*	*Mobile telephony penetration per 100 inhabitants (%)*	*Portion of mobile broadband subscriptions within total mobile telephony subscriptions (%)*	*Number of 3G/4G operators*
North African countries				
Morocco	10.14	121	8.39	3
Algeria	0	104	0.00	0
Tunisia	5.10	124	4.10	3
Libya	23.35	143	16.30	2
Egypt, Arab Rep.	56.37	118	47.91	3
Simple Average	18.99	122	15.34	Not applicable
Weighted Average for North African countries	30.9	117	26.05	Not applicable
Mashreq countries				
Lebanon	26.65	89	29.92	2
Syrian Arab Republic	4.33	63	6.86	2
West Bank and Gaza	0	87	0.00	0
Iran, Islamic Rep.	0.05	126	0.04	1
Iraq	0.49	90	0.55	1
Jordan	52.69	147	35.96	3
Simple Average	14.04	100	12.22	
Weighted Average for Mashreq countries	3.84	107	3.59	Not applicable
Gulf countries				
Bahrain	74.24	155	47.88	3
Kuwait	67.78	209	32.46	3/3
Oman	56.95	185	30.71	2/2
Qatar	64.44	172	37.53	2
Saudi Arabia	55.89	203	27.53	3/3
United Arab Emirates	69.23	171	40.38	2/1
Simple Average	64.76	183	36.08	Not applicable
Weighted Average for Gulf countries	59.95	194	31.33	Not applicable
Other countries				
Yemen, Rep.	1.82	51	3.56	1
Djibouti	2.22	24	9.29	1
Simple Average	2.02	38	6.42	
Weighted Average for Yemen, Rep.; and Djibouti	1.83	50	3.76	Not applicable
Simple average for MENA	30.09	125	19.97	Not applicable
Weighted Average for MENA	22.2	118	16.75	Not applicable

Sources: World Bank analysis based on data from TeleGeography's GlobalComms Database (http://www.telegeography.com, data retrieved August 2013); number of 3G/4G operators: Global System for Mobile Communications Association (GSMA) Intelligence (data retrieved August 2013).
Note: 3G = third generation of mobile telecommunications technology; 4G = fourth generation of mobile telecommunications technology; MENA = Middle East and North Africa.

(the Islamic Republic of Iran, Iraq). Remarkably, Jordan and Lebanon show penetration of the mobile customer base close to those of some Gulf countries such as Oman or Saudi Arabia. In Mashreq, subregion 4G services were launched only in Lebanon at the beginning of 2013.

- The Republic of Yemen and Djibouti show almost no mobile broadband penetration (2.02 percent), 3G being provided by one operator. Weak competition also resulted in only 3.74 percent of mobile customers taking up broadband offers.

The rapid expansion of the mobile broadband in the Gulf is fueled to a great extent by the availability of purchasing power needed to purchase smart phones and other access devices (such as tablets), even if those handsets are generally subsidized by mobile operators. As a consequence, all other things being equal, if the countries in North Africa and the Mashreq implement the same policies as in the Gulf, the natural reduction in prices of access devices will make the growth of the mobile broadband more affordable for the consumer. Given the growing youth population, which is the most active in mobile data usage (see box 3.8), it is of paramount importance that the huge potential to deliver mobile broadband access, which derives from high penetration and coverage of mobile telephony networks, be unlocked in MENA.

Taking into account encouraging preconditions for the fast take-up of mobile broadband services in the region (also those related to demographic patterns of MENA mentioned above), enabling the potential of mobile broadband and its further development depends almost entirely on spectrum management policy in each country. It is widely considered that the ideal combination of spectrum for mobile broadband is the association of lower-frequency bands offering good long-distance propagation (bands below 1 gigahertz [GHz]) and higher bands offering high data rates and large bandwidths (around 2 GHz).

For instance, effective management of frequencies resulted from switchover from analog to digital television broadcasting, that is, the digital dividend (see box 3.9) is considered to be a unique opportunity to accommodate the accelerating growth in mobile broadband services, in particular in terms of coverage, because it opens the possibility to use lower-frequency bands.

Most countries in MENA have now established a digital switchover date and are in the process of, or have already finalized the process of switchover (see table 3.8).

The timely release of spectrum is not the only important spectrum matter. Inappropriate management of other issues such as international harmonization or fragmented allocations may represent barriers for mobile broadband development. International harmonization is important to ensure that new devices, which are being developed around the world (such as tablets, smart phones, ultrabooks, and so on), are able to work. Failure to harmonize spectrum may lead to a situation where a country may be forced to use higher-cost, generic, and less-convenient devices. Fragmented (not paired) allocations prevent the deployment

Box 3.8 Broadband Usage Patterns in the Youth Population

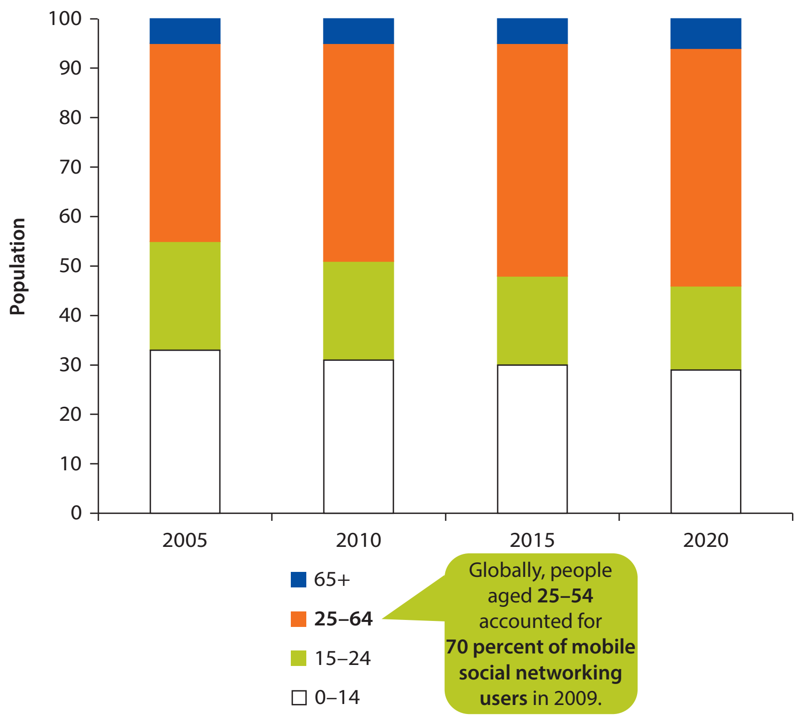
According to forecasts for 2015–20, the 15–24 age group will amount to about 18 percent of the MENA population (see figure B3.8.1).

Statistics of Facebook usage patterns per age group show that the 16–24 age group accounts for between 36 percent (Saudi Arabia) and 50 percent (Egypt) of all registered users as of September 2012, which implies that mobile networks will be increasingly used for mobile social networking (see figure B3.8.2).

Ofcom confirms that the 16–24 age group are the most active users of data with a significant share of downloaded audio/music, social networking, and TV/films on demand (See figure B3.8.3).

Figure B3.8.1 Population Distribution in MENA

Percent



Source: Grail Research based on World Bank and United Nations data.
Note: 2015 and 2020 are estimates.

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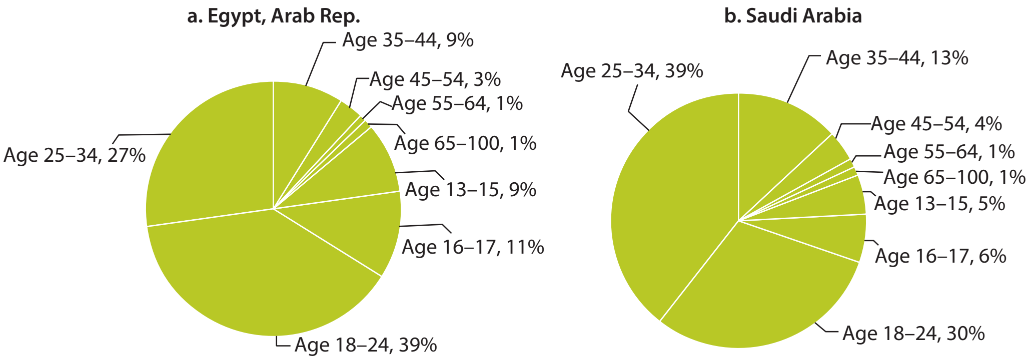
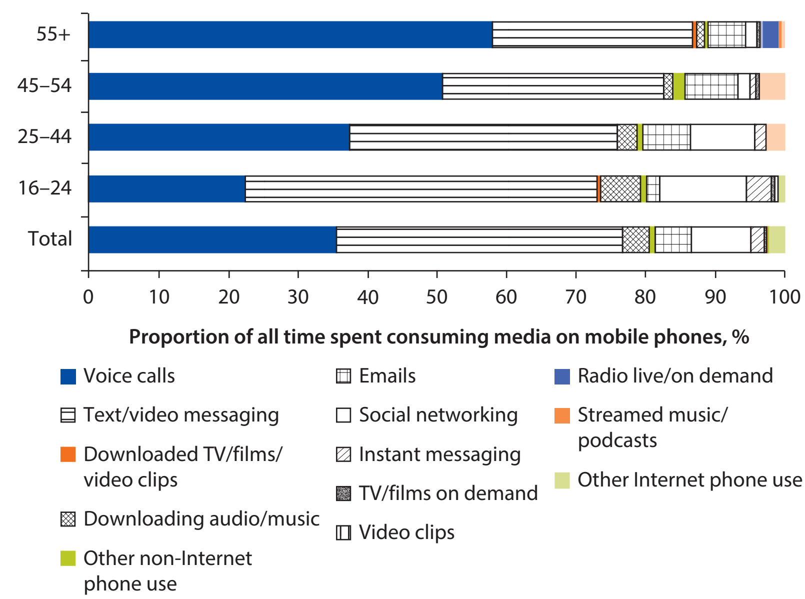
Box 3.8 Broadband Usage Patterns in the Youth Population *(continued)*

Figure B3.8.2 User Age Distribution on Facebook in Egypt and Saudi Arabia



Source: Arab ICT Index Report 2012, based on data from Socialbakers.

Figure B3.8.3 Proportion of Mobile Phone Use, by Age and Activity



Source: Ofcom.

of different LTE modes Frequency Division Duplex (FDD) and Time Division Duplex (TDD), which is important to develop full LTE potential.

Usually absent medium- and long-term spectrum management planning coupled with long and nontransparent spectrum allocation procedures are among administrative concerns that impede the take-up of mobile broadband in the region.

Box 3.9 The Digital Dividend

The Digital Dividend is the spectrum that is freed up after analog television broadcasting switches to digital transmission. Digital television uses spectrum far more efficiently than analog television and allows excess spectrum to be released for other services. Governments around the world have benefited from releasing part of this spectrum to mobile broadband.

The Digital Dividend spectrum is ideal for mobile broadband because it is at a lower frequency than the current mobile broadband spectrum and requires fewer base stations to cover the same geographic area. This lowers deployment costs and allows operators to provide broader, more affordable rural coverage.

The Geneva (GE-06) Agreement set 17 June 2015 as the date after which countries may use frequencies currently assigned for analog television transmission for digital services, without being required to protect the analog services of neighboring countries against interference. This date is generally considered to be an internationally mandated analog switch-off date (at minimum along national borders).

Some regions have foreseen an earlier analog switch-off date. For instance, the European Commission recommended that digital switchover should be completed by 1 January 2012.

Sources: GSMA 2011; The Geneva 2006 (GE-06) Agreement; European Commission, Recommendation 2009/848/EC; Digital Terrestrial Television Action Group 2008.

Table 3.8 Digital Switchover Across the MENA Region

Year	*Countries*
2012	Qatar, Saudi Arabia
2013	Bahrain, United Arab Emirates
2014	Algeria, Syrian Arab Republic
2015	Egypt, Arab Rep.; Iran, Islamic Rep.; Jordan; Kuwait; Lebanon; Libya; Morocco; Oman; Tunisia; Yemen, Rep.

Sources: https://itunews.itu.int/En/2346-Switching-from-analogue-to-digital-television.note.aspx; https://en.wikipedia.org/wiki/Digital_switchover.
Note: MENA = Middle East and North Africa.

At the time of writing, seven countries in MENA had introduced 4G licenses (out them four countries introduced 4G before and of December 2012; see table 3.9). One important element in the move from 3G to 4G will be the availability of mobile broadband-enabled devices. Most 4G phones currently available are the LTE-equipped versions of highly priced 3G devices, such as the Samsung Galaxy S3, or the Apple iPhone 5. As a consequence, the price of devices is expected to be a strong deterrent to the development of 4G in the MENA region. Countries in the Gulf will see faster deployment of 4G since there are more high-income consumers in the subregion who can afford these devices. The evolution of consumer device prices in the next few years will therefore be a key determinant in the transition from 3G to 4G in MENA.

Table 3.9 Launch of 4G Services in the MENA Region, September 2011–December 2012

Launch date	*Country*	*Operator*	*Technology/Frequency, MHz*
September 2011	Saudi Arabia	Zain	LTE/1800
September 2011	Saudi Arabia	STC (Saudi Telecom)	TD-LTE/2300
September 2011	Saudi Arabia	Mobily (Elisalat)	TD-LTE/2600
September 2011	United Arab Emirates	Elisalat	LTE/1800/2600
December 2011	Kuwait	Viva (KTC)	LTE/1800
February 2012	Oman	Nawras (Ooredoo)	LTE/1800
June 2012	United Arab Emirates	DU	LTE/1800
July 2012	Oman	Omantel	TD-LTE/2300
November 2012	Kuwait	Zain	LTE/1800
December 2012	Oman	Omantel	LTE/1800

Source: GSMA Intelligence (data retrieved in August 2013).
Note: Sorted by launch date. In February 2013, Batelco launched first commercial LTE (1800 MHz) mobile broadband service in Bahrain. In April 2013, Zain launched the second LTE (1800 MHz) network in Bahrain. In June 2013, Wataniya Telecom (Ooredoo) became the third 4G operator in Kuwait (LTE, 1800 MHz). In May 2013, both Alfa (Orascom Telecom Media and Technology [OTMT]) and Touch (Zain) launched 4G services in Lebanon. Ooredoo started provision of 4G services (LTE, 800/2600 MHz) in April 2013 in Qatar. 4G = fourth generation of mobile telecommunications technology; MHz = megahertz; KTC ; LTE = long-term evolution; MENA = Middle East and North Africa; STC = Saudi Telecom Company; TD-LTE = .

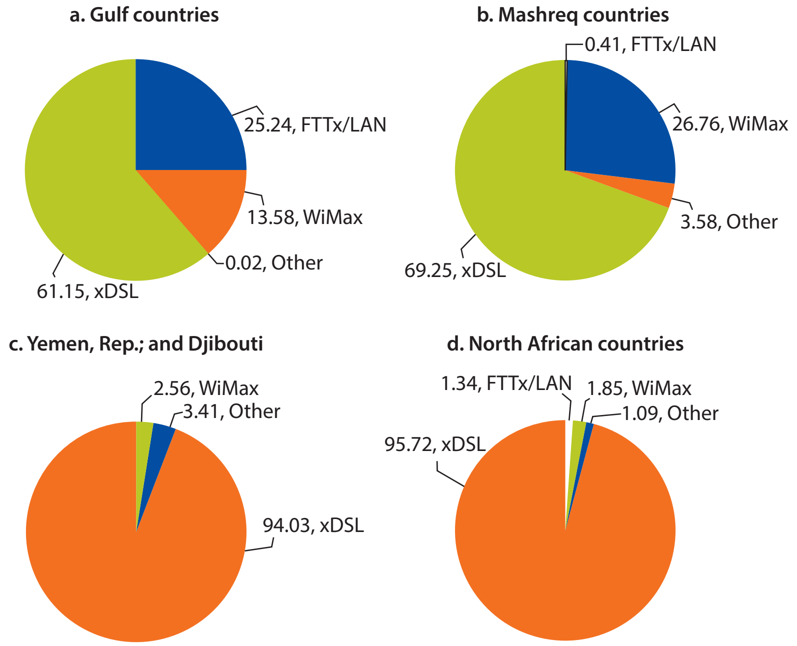
DSL Technologies

The MENA region shows a relatively different technology mix for fixed broadband at the subregional level (see figure 3.5):

- North African countries mainly offer wireline connections, using traditional copper lines of the telephone network equipped with xDSL technology (~96 percent of total), with some limited trials of fiber-to-the-x (FTTx) (~1 percent of total). Wireless connections using WiMax are negligible.
- The Republic of Yemen and Djibouti show a mix similar to North African countries in terms of xDSL (94 percent of total), and a negligible number of wireless connections using WiMax. So far there have been no trials with FTTx.
- By contrast, the Mashreq countries show less dominance of xDSL technology (~70 percent of total) and a more significant offer of wireless connections using WiMax (~27 percent of total). There have been limited trials with FTTx.
- The Gulf countries have moved into higher data rate fixed broadband technologies, with FTTx accounting for ~25 percent of the total. xDSL technology still dominates (~61 percent of total), alongside some wireless connections using WiMax (14 percent of total).

More than 70 percent of fixed broadband connections in all the MENA countries are provided with xDSL technologies, with the remarkable exceptions of Iraq (xDSL not yet launched), Bahrain (nearly 70 percent of fixed broadband connections provided with WiMax technology), and the United Arab Emirates (nearly 70 percent of fixed broadband connections provided with FTTx technology) (see figure 3.6).

Figure 3.5 Distribution of Fixed Broadband Connections per Technology in Four MENA Subregions, December 2012
Percent



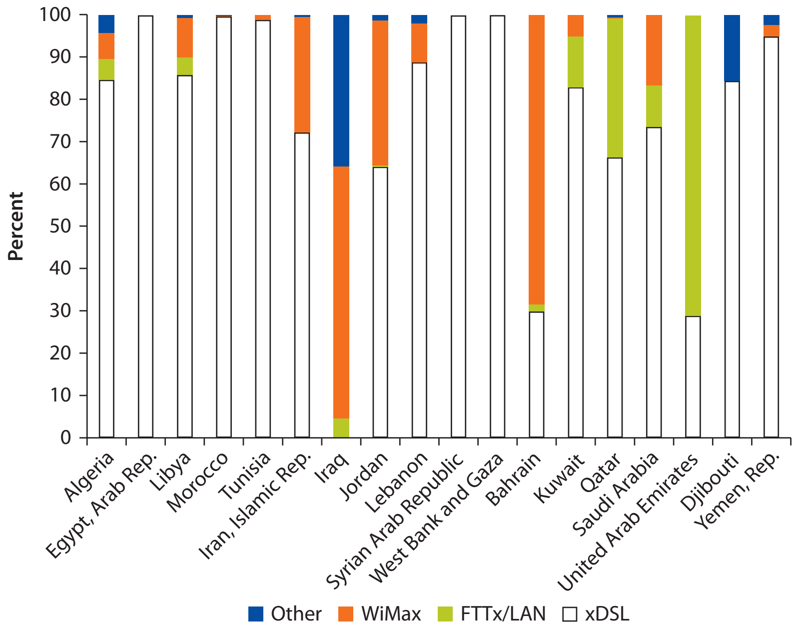
Source: TeleGeography's GlobalComms Database (http://www.telegeography.com, data retreived March–May 2013).
Note: MENA = Middle East and North Africa. Other refers to dial-up and satellite connections.

The competition dynamic in the broadband market is significantly impacted by the existence of such inter-platform competition, either on the basis of WiMax technologies (e.g., Bahrain, Jordan) or via FTTx technologies (the United Arab Emirates) providing alternative broadband access to the traditional copper line telephone network equipped with xDSL technology. The market share of incumbent fixed operators tends to be much lower in countries with vibrant infrastructure-based competition (see figure 3.7).

In other countries, where the market share of incumbent fixed operators is high, it is generally the case that intra-platform competition is either nonexistent (7 out of 19 countries' markets still operate under a monopoly regime) or do not function properly. Intra-platform competition takes place when competitors can access the traditional copper line telephone network of incumbent fixed operators through regulated wholesale broadband offers, such as bitstream or local loop unbundling (LLU) (see box 3.10).

The number of xDSL connections is still growing 20 percent annually in 12 out of 19 MENA countries (60 percent of all incremental fixed broadband subscriptions are xDSL), showing a clear demand for more broadband in the areas where the traditional copper line telephone network is deployed (see figure 3.8). These are predominantly metropolitan and urban areas with some suburban ones.

Figure 3.6 Distribution of Fixed Broadband Connections per Technology in MENA, December 2012



Source: TeleGeography's GlobalComms Database (http://www.telegeography.com, data retrieved August 2013).
Note: Distribution per technology for Oman is not available. In the case of the Republic of Yemen, the total number of fixed broadband subscribers, WiMax subscribers, and subscribers to other technologies are known and the assumption was made that the remainder of the fixed connections are being supplied over xDSL. FTTx = fiber-to-the-x; LAN = local area network; MENA = Middle East and North Africa; WiMax = Worldwide Interoperability for Microwave Access; xDSL = digital subscriber line (of any type).

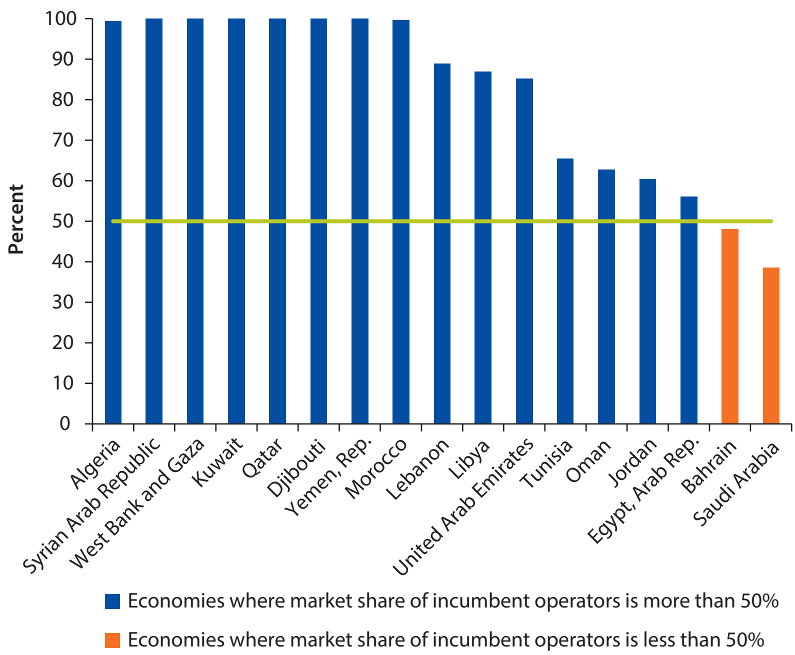
However, there appears to be a significant remaining growth potential to reach the best practice average, which is around 55–56 percent of telephone lines equipped with asymmetric digital subscriber lines (ADSLs) in EU. In Jordan and Morocco, around 50 percent of the lines are equipped, in Tunisia around 45 percent, but in Egypt only 20 percent.[16]

Given the rapid urbanization of the region, it is of paramount importance that the xDSL potential be fully unleashed: on average, MENA countries were 65 percent rural in 1960 but 65 percent urban in 2007.[17] The 3 percent of MENA's surface area that is densely populated is home to 92 percent of the population, with a population density of over 50 persons per km^2. Despite a quite diverse situation at the national level in terms of availability of computers/laptops or other devices (see table 3.10), users tend to be more equipped in urban areas.

Fiber in the Local Loop

Even if FTTx is most developed in the Gulf countries, efforts to develop this technology are taking place throughout the whole MENA region. Nevertheless, the level of penetration (number of customers or homes passed) is low (see table 3.11). This significant gap between the supply and usage of FTTx access

Figure 3.7 Fixed Broadband Market Shares of Incumbent Operators in MENA, December 2012



Source: TeleGeography's GlobalComms Database (http://www.telegeography.com, data retreieved March–May 2013).
Note: Information is not available for the Islamic Republic of Iran and Iraq. MENA = Middle East and North Africa.

Box 3.10 Ladder of Investment and Regulated Wholesale Broadband Offers

In the telecommunications sector, the "ladder of investment" (Cave 2006) refers to a regulatory approach that aims to reconcile service-based competition (where entrants lease access to incumbents' facilities) and facilities-based competition (where they build their own infrastructure). What is the thinking behind this approach? By setting low wholesale DSL regulated prices, the regulator encourages service-based competition. Then, once entrants have built a customer base and gained market information, they can move up "the ladder of investment" and invest in their own facilities. The regulator should then increase the access price in order to encourage entrants to climb up to the next rung, that is, invest in national backbone infrastructure through the use of bitstream and invest in regional infrastructure through local loop unbundling (LLU). Ultimately entrants could develop their own access network, with full facilities-based competition (see figure B3.10.1).

LLU: The LLU product is a set of basic and ancillary services provided by the incumbent to other licensed operators (OLOs) so that they can connect their active exchange equipment and core network to the incumbent's copper access network. These basic and ancillary services are: provision of a twisted metallic path facility (the copper access network) or access to

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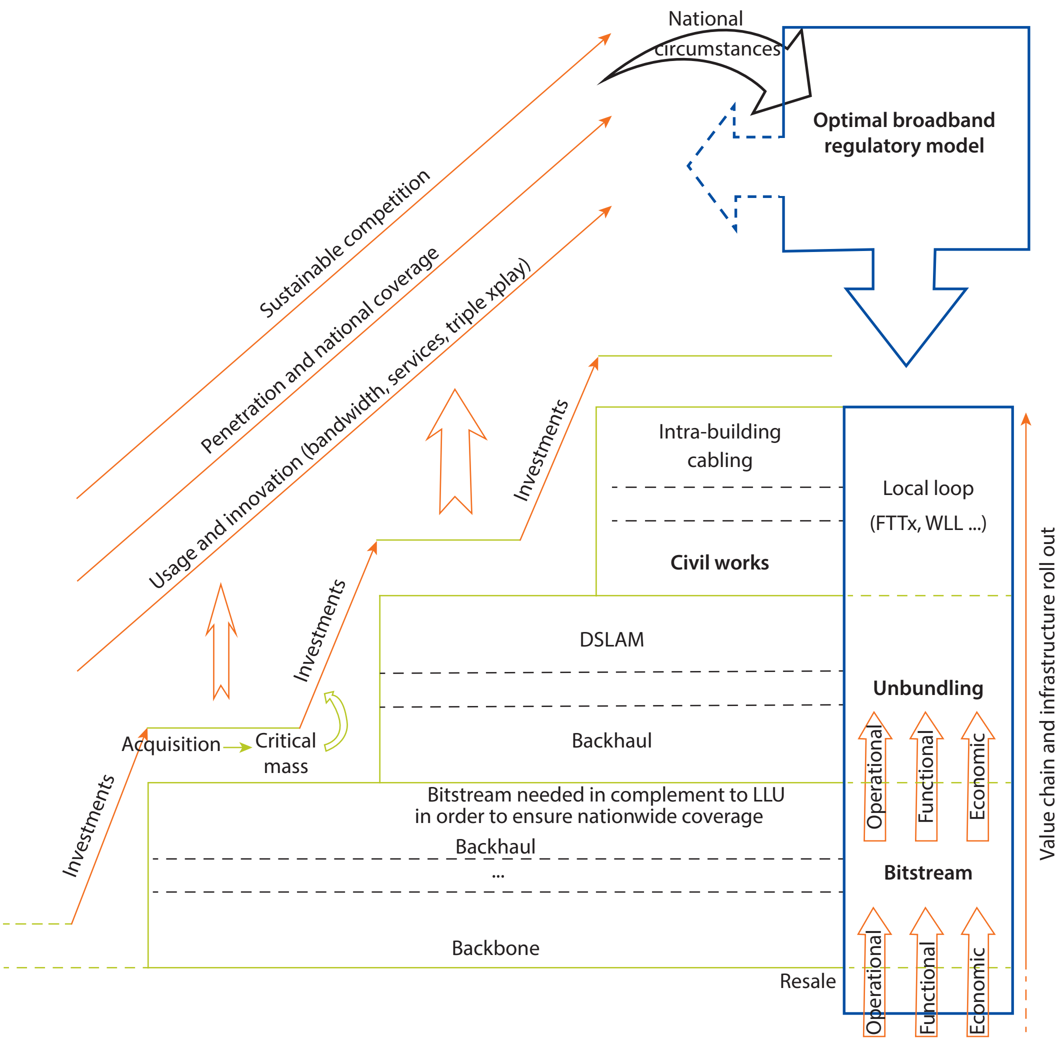
Box 3.10 Ladder of Investment and Regulated Wholesale Broadband Offers *(continued)*

Figure B3.10.1 Investment Ladder and Optimal Broadband Regulatory Model



Source: TRA Bahrain, Dominance Determination 1 of 2009 in Wholesale Broadband Markets, September 14, 2009; ERG, Bitstream Access Consultation Document, July 14, 2003; Implementing the ladder of investment regulation: The case of broadband in France, Forum on Telecommunication Regulation in Africa FTRA-2007; "Infrastructure sharing: regulatory challenges," Jérôme Bezzina, ARCEP, June 6–7, 2007. DSLAM = ; FTTX = fiber-to-the-x; LLU = local loop unbundling; WLL = ; xplay = .

the high frequencies of the copper loop in the case of shared access, provision, and installation of jumpers, provision and installation of tie cables, provision of colocation space (in the form of a dedicated colocation room, co-mingling, etc.) and associated services (power, air conditioning, access to the site, etc.), and provision of backhaul.

Bitstream access: This is where the incumbent installs a high-speed access link to the customer's premises (e.g., by installing its preferred asymmetric digital subscriber line [ADSL]

box continues next page

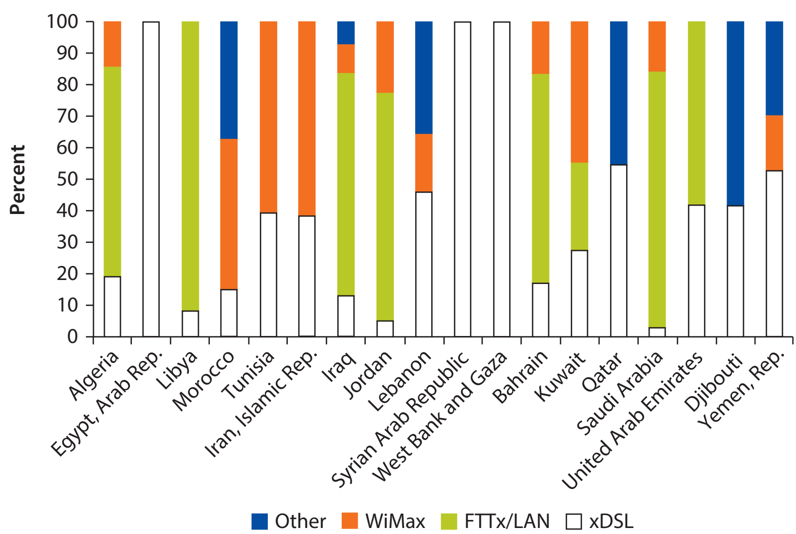
Box 3.10 Ladder of Investment and Regulated Wholesale Broadband Offers *(continued)*

equipment and configuration in its local access network) and then makes this access link available to third parties to enable them to provide high-speed services to customers. The incumbent may also provide transmission services to its competitors to carry traffic to a "higher" level in the network hierarchy where new entrants may already have a point of presence (e.g., transit switch location). The bitstream product may be defined as the provision of transmission capacity (upward/downward channels may be asymmetric) between an end user connected to a telephone connection and the point of interconnection available to the new entrant.

Wholesale DSL: This is where a new entrant receives and sells to end users—with no possibility of value-added features to the DSL part of the service—a product that is commercially similar to the DSL product provided by the incumbent to its own retail customers, irrespective of the Internet service provider (ISP) service that may be packaged with it. In this case, the incumbent is in control of the technical parameters of the service, thus defining the features/profile of the end user product. The ISP buys the end-to-end link provided by the incumbent and markets the product to the end user without being able (either contractually allowed or technically capable) to change the product, whereas the access service is managed by the incumbent.

Source: Kelly and Rossotto 2012.

Figure 3.8 Growth in Fixed Broadband Connections per Technology in MENA, December 2011–December 2012



Source: TeleGeography's GlobalComms Database (http://www.telegeography.com, data retrieved March–May, 2013).
Note: MENA = Middle East and North Africa.

Table 3.10 Penetration of PCs and Internet User–to–PC Ratio in the MENA Region, 2011

Economies	*Computer-installed base*	*Penetration of PCs (%)*	*Internet user–to–PC ratio*
North African countries			
Morocco	3,045,939	9.40	4.18
Algeria	3,763,607	10.14	2.06
Tunisia	1,272,643	11.86	2.70
Libya	892,601	14.88	1.52
Egypt, Arab Rep.	5,878,810	7.23	3.69
Simple average	Not applicable	10.7	2.83
Average (weighted for penetration) for North African countries	Not applicable	8.86	3.29
Mashreq economies			
Lebanon	910,965	21.57	1.90
Syrian Arab Republic	1,819,690	8.51	2.81
West Bank Gaza	396,770	9.38	3.23
Iran, Islamic Rep.			
Iraq	2,545,761	7.58	2.16
Jordan	1,108,866	17.74	1.97
Simple average	Not applicable	12.96	2.41
Average (weighted for penetration) for Mashreq countries	Not applicable	9.76	2.39
Gulf economies			
Bahrain	469,360	35.65	1.53
Kuwait	1,305,955	35.32	1.42
Oman	551,714	19.29	2.08
Qatar	798,715	46.77	1.07
Saudi Arabia	8,098,276	28.54	1.68
United Arab Emirates	3,862,177	45.47	1.18
Simple average	Not applicable	35.17	1.49
Average (weighted for penetration) for Gulf countries	Not applicable	32.33	1.57
Other countries			
Yemen, Rep.	938,623	3.86	3.55
Djibouti	Not available	Not available	Not available
Simple average	Not applicable	3.86	3.55
Average (weighted for penetration) for Yemen, Rep.; and Djibouti	Not applicable	3.86	3.55
Simple average for MENA	Not applicable	19.6	2.28
Weighted average for MENA	Not applicable	12.10	2.86

Source: Madar Research and Development 2012.
Note: MENA = Middle East and North Africa; PC = personal computer.

Table 3.11 Evolution of FTTH/B in MENA Subregions

	Number of homes passed by FTT/B (thousands)		*Y-o-Y growth*	*FTTH/B subscribers (thousands)*		*Y-o-Y growth*
Economies	*2010*	*2011*	*(%)*	*2010*	*2011*	*(%)*
North African economies						
Morocco	0.1	0.1	67	0.1	0.1	67
Algeria	3	20	567	0.2	0.6	200
Tunisia	3.2	5	56	0.5	1.2	122
Libya	—	—	—	—	—	—
Egypt, Arab Rep.	55.3	57.3	4	3.3	4.9	48
Simple average	15.4	20.6	173.5	1.03	1.7	109.3
Weighted average for North African countries	28.7	33.7	148.4	1.75	2.7	91.4
Mashreq economies						
Lebanon	4.7	5	6	0.4	0.5	21
Syria	0.8	1.2	50	0.1	0.4	300
West Bank and Gaza	—	—	—	—	—	—
Iran, Islamic Rep.	—	—	—	—	—	—
Iraq	2.5	8	220	0.2	0.6	250
Jordan	2	2.6	32	0.4	0.6	44
Simple average	2.5	4.2	77	0.3	0.53	153.8
Weighted average for Mashreq countries	2.02	5.02	131.8	0.2	0.53	232.4
Gulf economies						
Bahrain	7.9	10.1	27	2.5	3.1	23
Kuwait	65	80.7	24	4.6	5.4	16
Oman	7.7	10.1	31	0.4	1.6	366
Qatar	13.3	77.7	486	4.9	6.1	25
Saudi Arabia	29.5	115.2	290	5.8	35.4	510
United Arab Emirates	985.7	1186.8	20	301	445.2	48
Simple average	184.6	246.8	146.3	53.2	82.8	164.7
Average for Gulf countries:	201.5	293.9	204.2	58.3	102.4	347.3
Other countries						
Yemen, Rep.	—	—	—	—	—	—
Djibouti	—	—	—	—	—	—
Weighted average for Yemen, Rep. and Djibouti	—	—	—	—	—	—
Simple average for MENA	84.3	112.8	134.3	23.2	36.1	145.7
Weighted average for MENA	51.9	71.5	154	11.08	19.3	169.2

Source: Pyramid Research 2012, Powerpoint presentation on "Middle East and Africa Market Panorama: FTTH/B Deployments for FTTH Council MENA."
Note: For Libya, West Bank and Gaza, the Islamic Republic of Iran, the Republic of Yemen, and Djibouti information is not available. Those countries were not included into calculation of Averages. — = not available; FTTH/IB = fiber-to-the-home/building; Y-o-Y = year-on-year.

technology creates the risk that investments made to deploy fiber optics in the access network may not be profitable and therefore sustainable in the long term. This could have an adverse effect on the development of fiber lines in new housing areas, with a high potential for residential broadband.

Notes

1. Cisco, Visual Networking Index. http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.html.
2. New technologies such as Fiber-to-the-Tower and small cell wireless backhaul are being rolled out to address the rapidly expanding 3G networks.
3. They are commonly known as the fiber-to-the-x (FTTx) family that includes fiber-to-the-building or basement (FTTB), fiber-to-the-Premises (FTTP), fiber-to-the-Desk (FTTD), fiber-to-the-Curb (FTTC), and fiber-to-the-Node (FTTN). These methods all bring data closer to the end user by optical fiber. The differences between them are mostly to do with just how close to the end user the delivery by fiber comes.
4. Some mobility support was added in 2005.
5. Roaming refers to the continued broadband service received when a customer travels outside the geographical coverage of their home network thanks to cooperative agreements between a customer's service provider and other mobile broadband operators (nationally or internationally).
6. Jeddah–Amman–Damascus–Istanbul (JADI) Link. The JADI Link is a fiber-optic cable connecting Jeddah (Saudi Arabia), Amman (Jordan), Damascus (Syria), and Istanbul (Turkey) with a total of 2,530 kilometers of fiber-optic line. Under the JADI Link construction and maintenance agreement signed on 16 June 2010, the four operators (one per country along the route) performed the necessary physical connection on the national main fiber-optic backbones within their borders to make a 200 gigabits per second (Gbps) capacity extension based on dense wavelength division multiplexing (DWDM) technology.
7. Regional Cable Network (RCN). With a round-trip route of 7,750 km (3,875 km in radial length), the RCN system connects Fujairah (United Arab Emirates) to Istanbul (Turkey), passing through Riyad (Saudi Arabia), Amman (Jordan), and Tartus (Syria). The RCN system, based on DWDM technology, has a 1.2 terabits per second (Tbps) (30 * 40 Gbps) carrying capacity.
8. Europe–Persia Express Gateway (EPEG). With a length of 10,000 km, of which about 9,500 km is a terrestrial fiber cable, the EPEG system connects Barka (Oman) to Frankfurt (Germany), passing through Jask (the Islamic Republic of Iran) and Baku/Rostov (Russia). The EPEG, based on DWDM technology, has a 12.8 Tbps carrying capacity with an initial capacity of 54 * 10 Gbps.
9. Submarine cables in the Mediterranean–Red Sea corridor can be affected by earthquakes and tremors that are fairly common in this area.
10. In the mid-1990s, the countries of the Arab Maghreb Union (Algeria, Libya, Mauritania, Morocco, and Tunisia) decided to set up a fiber-optic network linking the member countries except for Mauritania which refused to take part in the project. The realization of the network and its operation were entrusted to incumbent operators in each country.

11. See Programme for Infrastructure Development in Africa (PIDA), ICT Phase III, p. 107.
12. In 2008, the cable consisted of 48 fibers, of which 12 fibers were reserved for electrical power uses and 36 could be used for future applications.
13. This refers to the Europe-India Gateway (EIG) project, valued at US$700 million, for the construction of an international broadband fiber-optic submarine cable extending from the United Kingdom to India and passing through Oman.
14. Mobile data: includes mobile data and Internet traffic generated by handsets, notebook cards, and mobile broadband gateways.
15. Cisco, Visual Networking Index, http://www.cisco.com/web/solutions/sp/vni/vni_forecast_highlights/index.html.
16. The broadband market in Egypt also struggles with the problem of illegal line sharing, which is mainly caused by grey markets of service and resale providers. See Appendix A for more details.
17. *Poor Places, Thriving People*, World Bank. http://go.worldbank.org/0L6QPD2M10.

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