CHAPTER 4

Recommendations to Accelerate the Development of Broadband Infrastructure

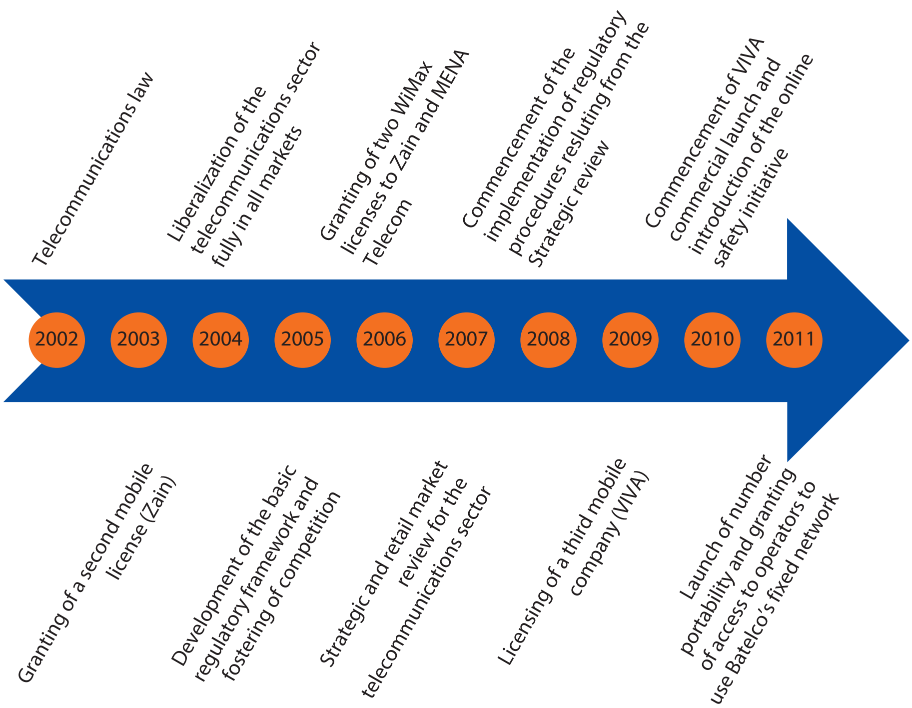
The experience of the past decade has clearly shown that competition, and in particular facilities-based competition, is the most important driving force for accelerated and sustainable telecommunications market development together with the set-up of independent regulatory authorities. Competition enables private investment, incentivizes operators to be more efficient, and, as a result, ensures maximum benefits for end users both in terms of quality and prices (Broadband Commission 2012). Reforms towards competitive mobile communications markets allowed developing and emerging countries to reach levels of penetration similar to those of high-income countries in a short period of time.

In terms of market structure, most advanced telecommunications markets have eliminated all entry barriers, allowing as many operators as the market can sustain to compete. In all of the countries of the European Union (EU), for example, this crucial step was achieved through the 1998 liberalization directive. Countries in Eastern Europe have also implemented this policy as part of their accession process.

In the Middle East and Africa (MENA), however, only Bahrain and Jordan have implemented a policy of full liberalization in telecommunications (see figure 4.1). All other countries have a limit on the number of licensed operators. For example, in Tunisia, the government is obliged by law to go through an open and competitive tender process whenever it decides to award a new telecommunications license. While this approach has merits in case of scarce resources (e.g., the radio spectrum), it also offers the opportunity to the government to play an active role in deciding the number of competitors in the market, and the market itself. There is therefore a need to finalize this first phase of sector reforms in order to fully implement a model based on low barriers to entry, multiple technological options, and competition, in particular in countries with monopolies or duopolies.

With respect to broadband, the key factors limiting its development in most countries of the MENA region are lack of effective competition and lack of

Figure 4.1 Liberalization of the Telecommunications Sector in Bahrain



Source: Kingdom of Bahrain, Telecommunications Regulatory Authority, Telecommunications Liberalization Plan, available at http://www.tra.org.bh/EN/marketLib.aspx.
Note: WiMax = Worldwide Interoperability for Microwave Access.

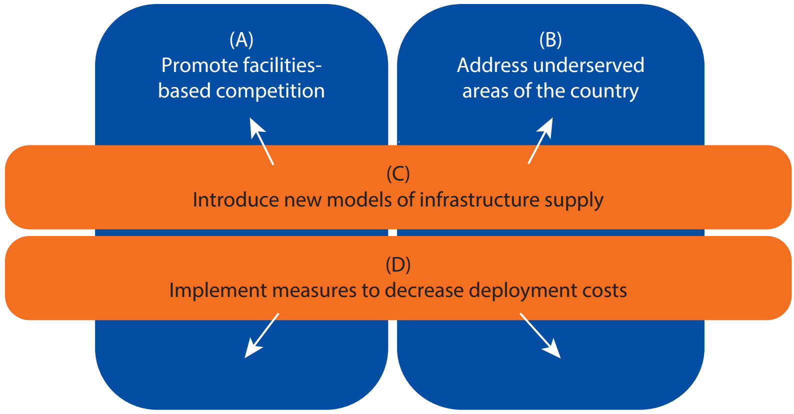
appropriate regulation and/or frameworks to deploy over the territory and/or fully utilize infrastructure where it already exists.

From the supply side,[1] a holistic approach combining the four following strategic policy measures would enable the countries in the region to accelerate broadband development by providing investors appropriate predictability on the policy and regulatory regime and a reasonable expectation that they will recover their costs and make a return on their capital:

- Promote facilities-based competition;
- Address underserved areas of the country;
- Introduce new models of infrastructure supply; and
- Implement measures to decrease deployment costs.

The promotion of facilities-based competition will lead to the development of broadband infrastructure in commercially attractive areas of the country (see figure 4.2). In the remaining underserved areas, an approach to infrastructure development that leverages public resources should be considered to avoid a digital divide. However, specific criteria for government intervention will need to be established to prevent crowding out private sector investment.[2]

Figure 4.2 Supply-Side Policy Measures to Accelerate Broadband Deployment



Governments should also proactively foster initiatives that will contribute to expanding the frontier of commercial viability, new modes of infrastructure supply, and measures to decrease deployment costs. For example, innovative models for public-private partnerships (PPPs) between municipalities or utility companies and operators could address both deployment of the fiber-to-the-x (FTTx) access network in urban areas or could address backbone deployment to connect more isolated territories. Troulos and Maglaris (2011) discuss the factors behind the emergence of municipal broadband networks in Europe. Emerging models of PPPs in the Netherlands and Italy are discussed in Nucciarelli, Sadowski, and Achard (2010). The business model for a PPP in fiber-to-the-building/fiber-to-the-home (FTTB/FTTH) in rural Greek villages is discussed in Troulos, Merekoulias, and Maglaris (2010). Similarly, a more effective construction process could save time and financial resources whenever infrastructure deployment is taking place with significant associated civil works.

The four strategic policy measures are not intended to be undertaken in strict time sequence. The promotion of facilities-based competition, however, should be the key policy in the emerging phase of market development, combined with implementing measures to decrease deployment costs and PPPs in order to push the frontier of pure private investment to the limit before considering subsidies (see table 4.1).

Promote Facilities-Based Competition

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

In order to accelerate broadband development in MENA, the key recommendation of this study is to eliminate all entry barriers in the telecommunications

Table 4.1 Supply-Side Policy Measures in Accordance with Broadband Market Development

	(a) Promote facilities-based competition	*(b)* Introduce new models of infrastructure supply	*(c)* Implement measures to decrease deployment costs	*(d)* Address underserved areas of the country
Emerging	+++	+	+++	+
Developing	++	+++	+++	++
Mature	+	++	++	+++

Note: +++ = very important; ++ = important; + = less important.

sector and promote facilities-based competition, so as to implement a market structure similar to all other advanced telecommunications markets in the world. Whenever possible, this should be fostered under the promotion of a harmonized regulatory framework that would allow investors to consider MENA as an integrated regional market.

The removal of entry barriers is implemented through a licensing regime that allows for increased and unlimited entry in the sector. New licensing tools, such as class licenses and simple authorizations, should be considered. The legal status of Internet service providers (ISPs) should be upgraded so as to give them the right to reach final customers with their own infrastructure (see box 4.1).

Independent national regulatory authorities (NRAs) should be strengthened or established to follow an appropriate regulatory process for determining and successfully implementing *ex-ante* regulatory provisions that will allow for the effective utilization of existing infrastructure in case of market dominance or when a government fully finances infrastructure. These include

- Regulated access to submarine cable lending stations;
- Nondiscriminatory and transparent access to utilities' networks;
- International and national interconnection regulation;
- Wholesale offer for the copper network: unbundling in the local loop (ULL), bitstream access; and
- Regulation of leased lines.

Furthermore, where price regulation is imposed as an *ex-ante* regulatory provision, it should enable recovery of (efficiently) incurred cost and a return on capital commensurate with the risk profile of the investment.

The path toward developing the mobile broadband potential in MENA will involve stimulating competition in the mobile broadband market, which will foster more broadband usage on the networks in place, as the price of handsets and other mobile broadband devices drop. Key reforms to be considered include

- Awarding new licenses for third generation of mobile telecommunications technology (3G) and fourth generation of mobile telecommunications technology (4G) operators, including making sufficient spectrum available to licensed operators;

Box 4.1 Relaxing Regulations for Aerial Wiring to Stimulate Broadband Development

In the case of upgrading of Internet service providers (ISPs) to full licensed operators, there is some evidence that a relaxation of aesthetic policy to avoid "aerial" wiring can have an impact on the development of broadband for countries in the "emerging" stage of development. The city of San Francisco commissioned a study in 2007 to assess the cost of connecting every home in San Francisco with fiber, covering 900 miles of streets (Slater and Wu 2009). The study assumed half aerial construction, for a cost of US$41.9 million, and half underground, for a cost of US$327 million. "Aerial" matters.

The relaxation of aerial wiring regulations has been documented to have had an impact on the early development of broadband in Eastern Europe, in countries like Lithuania and Bulgaria. It should be stressed, however, that Lithuania allowed aerial wiring in the early phase of market development but then passed regulations to prevent it.

In 2005, Bulgaria had slightly above 1 percent broadband penetration, one of the worst penetration levels in the European Union. In the following years, "broadband LAN [local area network] has developed into the dominant type of access technology in use" (Rood 2010). Rood notes that the incumbent operator, Vivacom, had stalled the development of digital subscriber line of any type (xDSL) up to 2005, and because "access to the copper and ducts network was impossible, ISPs and CATV [community access television] firms decided to find their own way to launch broadband with self-constructed small aerial cable networks" (Rood 2010). These networks, concentrated in Sofia and in the main cities, were built "on an amateur basis and with minimal regulation by local or national governments." Broadband penetration in Bulgaria in December 2012 was 47.6 percent.

- Sound spectrum management policy and planning, including road maps for transition from analog to digital broadcasting, international harmonization, and so on;
- Transparent, effective, and technology neutral spectrum allocation procedures; and
- Introducing mobile number portability to increase marketplace fluidity.

Introduce New Models of Infrastructure Supply

According to estimates of cost distribution per different broadband infrastructure layers (see table 4.2), the passive infrastructure layer constitutes up to 80 percent of all the investments needed with a payback period of 15 years, which causes operators to increasingly look for opportunities to reduce network deployment costs (see box 4.2).

Deployment of new fiber infrastructure is a great investment challenge for operators all over the world, including in high-income economies. In the case of MENA, only the six Gulf Cooperation Council (GCC) countries are

Table 4.2 Distribution of Costs Between Different Infrastructure Layers

	% of network costs	*Payback period*	*Examples*
Passive infrastructure layer	70–80	15 years	Trenches, ducts, dark fiber, etc.
Active infrastructure layer	20–30	5–7 years	Electronic equipment, OSS, BSS
Service layer	N/A	Few months–3 years	Content, services, and applications

Source: Broadband Commission 2012.
Note: BSS = business support system; OSS = operations support system; N/A = Not applicable.

Box 4.2 Mobile Network Operators Are Pioneers in the Optimization of Network Costs

Mobile network operators are pioneers in the optimization of network costs. With penetration reaching saturation point and increasing margin pressure toward competitive levels, optimization solutions have already gone far beyond traditional infrastructure sharing on active (e.g., radio access network [RAN]) or passive (towers, sites, and so on) levels to creation of more advanced capacity outsourcing models. Indeed, beyond more "traditional" network optimization approaches (one network–one operator), alternative network models (many operators–one network, many operators–outsourced network) promise new cost savings and are being explored in particular between mobile operators (see figure B4.2.1).

(1) Network outsourcing is a partnership between a telecom operator and an equipment vendor under which the equipment vendor builds and operates network infrastructure for which a telecom operator is purchasing capacity needed to provide its services. This kind of partnership is also known as a managed capacity agreement and is well established. For instance, such a form of cooperation was established in 2005 between Bharti Airtel (operating under Airtel brand) and Ericsson. Today, under a managed capacity agreement, the Airtel network is managed by Ericsson and Nokia Siemens Network (NSN), while Alcatel Lucent was awarded a contract to supply mobile backhaul, and transmission towers are being supplied by Bharti Infratel.

(2) Network sharing is a form of partnership between telecom operators aiming to decrease capital investment in infrastructure and lower operational costs though rollout and operation of shared network infrastructure. This model is increasingly popular in the case of third generation of mobile telecommunications technology (3G) and fourth generation of mobile telecommunications technology (4G) network rollout. Under the deal, separate networks of participating operators are transformed into a single network infrastructure that is shared by all the participants. In the case of new deployments, each operator may be responsible for coverage of a certain geographic area. For instance, T-Mobile UK (now Everything Everywhere following the merger between T-Mobile and Orange) and 3 UK entered into an infrastructure consolidation agreement naming the joint venture Mobile Broadband Network Limited (MBNL). The reduction in capital investment in infrastructure, the decommissioning of an estimated 5,000 sites, and the lower operational costs achieved by jointly managing and maintaining a shared network were expected to generate a joint saving of US$2 billion over 10 years. A similar agreement was negotiated

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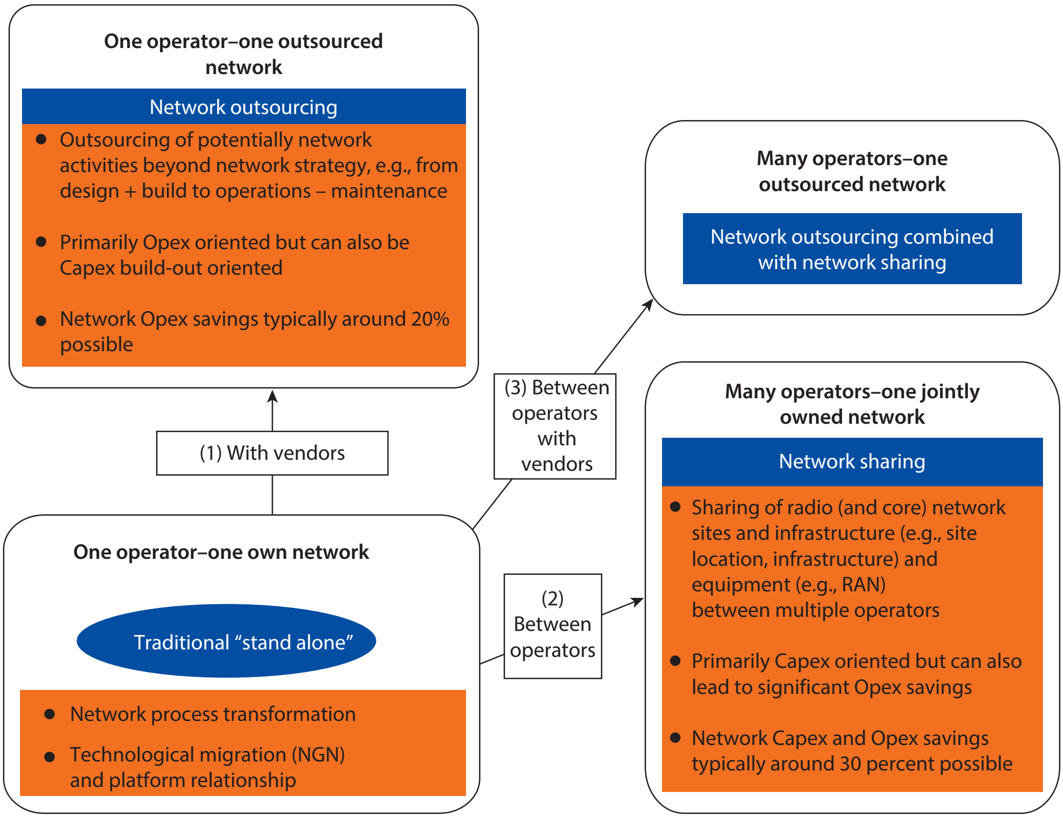
Box 4.2 Mobile Network Operators are Pioneers in the Optimization of Network Costs *(continued)*

Figure B4.2.1 Overview of Mobile Network Cost Optimization Models



Source: Based on information from Abertis Telecom, Ericsson, Alcatel-Lucent, Nokia Siemens Networks, Bharti Airtel, Arqiva.
Note: NGN = Next Generation Network; RAN = radio access network.

between Vodafone and O2 in 2012 for 4G network rollout (the joint venture was named Cornerstone Telecommunications Infrastructure) aiming to offer 98 percent of the country's second generation of mobile telecommunications technology (2G), 3G, and 4G indoor population coverage by 2015—two years ahead of the timeline set by Ofcom.

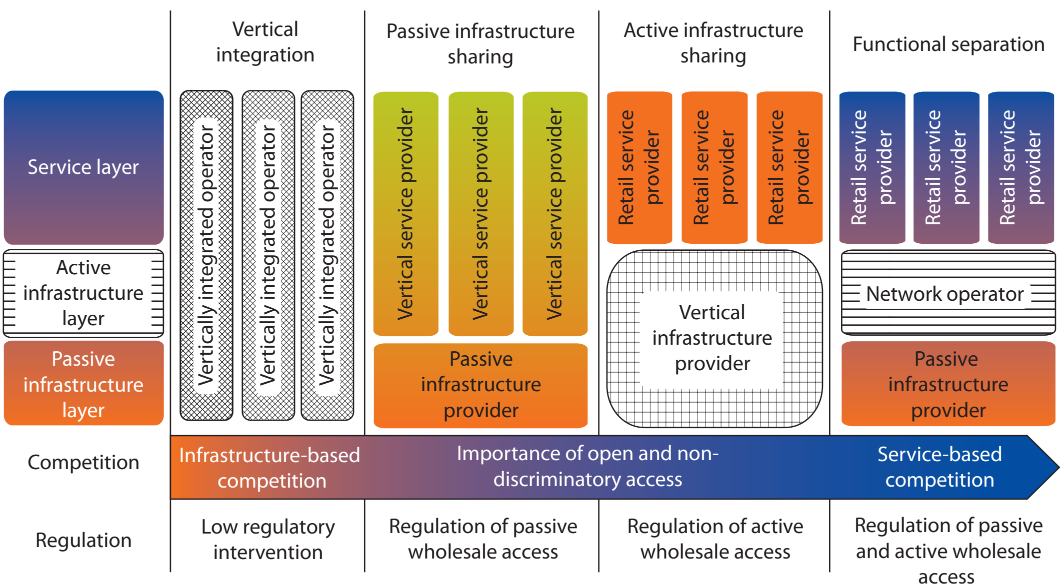
(3) Network outsourcing combined with network sharing is a form of partnership between telecom operators and an equipment vendor under which an equipment vendor builds and operates network infrastructure that is shared by multiple operators. For instance Alcatel and NSN are two of the nine companies selected by the Kenyan government to be co-investors in the 4G network as part of a special public-private partnerships (PPPs) commonly known as the 4G Special Purpose Vehicle (SPV). The partners are the four Kenyan mobile network operators, Telkom Kenya Orange, Airtel, Essar Yu, and Safaricom; three tier-two network operators, MTN, Kenya Data Network (KDN), and Epesicom; equipment vendors Alcatel Lucent and Nokia Siemens Networks (NSN); and the government. The network will operate on an "open access" model, where the shareholders will build the network, then lease it out to different companies and organizations.

high-income countries; therefore, new investment models will play a key role in pushing the limit of commercial viability throughout the region. As for today there are many examples of joint ventures and PPPs setting up passive infrastructure providers or vertical infrastructure providers (see figure 4.3).

The appeal of passive or vertical infrastructure provider models is related to

- The possibility of sharing deployment of costly passive infrastructure;
- Avoiding duplication of civil works, which is the most important component of cost when deploying fiber networks;
- The possibility of structuring the capital of the provider to include investors with a typical passive return on the investment profile. These include mutual funds, banks and financial intermediaries, sovereign wealth funds, national development banks, governments, and individual investors. By opening the capital of the provider to these agents, in addition to licensed operators, the cost of infrastructure is further shared and reduced. This is an appealing alternative to having the whole cost of infrastructure deployment carried out by a vertically integrated operator, which has a different specialization and return on the investment need.
- As a result of these benefits, the significant reduction in the cost of access to passive infrastructure allows, at the same time, the opportunity to have full competition at active network and services levels.

Figure 4.3 Overview of Possible New Models of Infrastructure Supply



Note: Issues pertaining to converged Next Generation Networks arise mostly at the service layer.

The main risks of such models are related to the complexity of their design, the need to have a strong regulator to ensure that the passive or vertical infrastructure providers operate according to open access principles and in the public interest, and the complexity of structuring such deals, in the presence of possible entrenched vested interests.

For instance, in Qatar the aim of the National Broadband Network (QNBN) is to accelerate the deployment of FTTH and deliver coverage in excess of 95 percent by 2015 (100 megabits per second [Mbps]). QNBN is wholly owned by the Qatari government and, as a vertical infrastructure provider, offers equal, nondiscriminatory access to its FTTH network to any operator that will use the infrastructure to deliver its services to end users.

The government of the Arab Republic of Egypt is currently studying, among different options, the possibility of creating a Special Purpose Vehicle (SPV) to build, maintain, and upgrade a broadband backbone that meets and fulfills the operators' requests as a vertical infrastructure provider. In its eMisr Strategy, Egypt's National Broadband Plan, Egypt recognizes that[3]

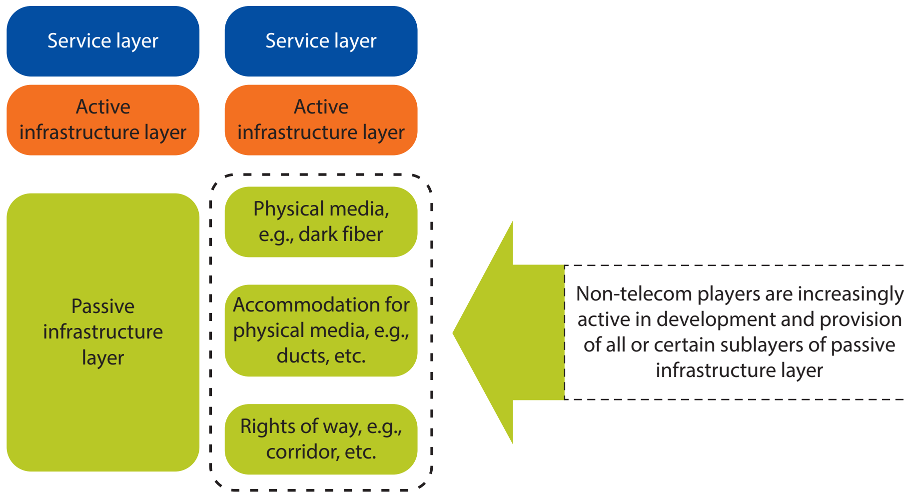
> *...as most of the capital investment in fiber networks is in the civil work, sharing in its deployment will help lift the burden off the operators. Creating a Special Purpose Vehicle (SPV), with existing operators as shareholders, is one option. The whole responsibility of this SPV is to build, maintain and upgrade a broadband backbone that meets and fulfills the operators' requests. This action will create competition at the infrastructure level. NTRA [National Telecom Regulatory Authority] will create a task force with the mandate of studying the creation of this new SPV. The main responsibilities of this task force include: a) Study the need for creating an SPV for co-sharing in fiber deployment; b) Set a suitable structure for this new SPV, its rights, obligations, and roll out plan; c) Study the needed legislative amendments to the current licensing regime in order to cope with this new approach; and d) Consult with the operators. In case Telecom Egypt is part of this SPV, then functional or structural separation for Telecom Egypt is a must. In that case, this task force will join efforts with the task force on structural separation to study the inclusion of Telecom Egypt in that SPV.*

A variation of the model presented in the eMisr Strategy would be to create an SPV that deals with purely passive infrastructure development (passive infrastructure provider), and that leases access to ducts and passive infrastructure to active infrastructure operators.

Non-telecom private players are also becoming increasingly active in development and provision of all or certain sub-layers of passive infrastructure. There are many examples to be found in the public sector (e.g., water supply companies, sewers, electricity, and so on). Of particular interest for MENA countries, however, are investment models driven by real-estate sector players (see figure 4.4).

A first set of measures, as detailed later in this chapter, should aim at the establishment of coordinated procedures and regulations for civil works. When a real-estate developer reaches a new building or a new neighborhood, it should be mandated to coordinate the necessary civil works, bringing electricity, water/sewerage, and broadband as a single, coordinated effort. In addition, in the case of

Figure 4.4 Involvement of Real-Estate Companies in the Passive Infrastructure Layer



multihome dwellings, it is important to make sure that there are adequate rules to build and open up existing infrastructure to telecommunications operators.[4]

But the role of the real-estate industry could be much broader and MENA has the opportunity to create local models of their involvement in the development of broadband, leveraging the strong demand for broadband related to the demographic pressures on real-estate development and on the evolution of cities in the region. In a seminal paper, Slater and Wu introduce the idea that the owner of a dwelling could also own the Internet connection, according to a "condominium" model (Slater and Wu 2009). Another significant experience in involving the real-estate industry in the provision of broadband Internet access is the case of the Netherlands. Rood (2010) indicates that housing corporations in the 1990s, servicing university accommodation, started offering broadband Internet to student dormitories. This business quickly evolved to address other market segments, first elderly home complexes and care centers, then general population apartment complexes. Lehr and others (2006) discovered that zip codes in the United States with broadband in the period 1998–2002 experienced faster job growth (1.0–1.4 percent), had higher rental rates (by 6 percent), and experienced a favorable shift toward higher value added information and communications technology (ICT)-intensive sectors. Similarly, Rood (2010) found that in the Netherlands, university dwellings with broadband had lower vacancy rates, and this presented an incentive for real-estate developers to enter the broadband business. There is, therefore, a natural incentive to define models where the real-estate industry plays an active role in ensuring that broadband is provided to newly built neighborhoods and buildings. This is a particularly important consideration for the MENA region, characterized by a demographic pyramid that will put tremendous pressures on new construction in the next 25 years.

Egypt has seen the opportunity to provide broadband Internet to new v and has granted specific operators licenses for this purpose. The Telecommunications

Table 4.3 Operational Models Involving Real-Estate Developers and Telecommunications Operations

Telco functions	*Integrated Telco*	*Duct provision*	*Dark open access*	*Lit open access*	*Developer Telco*	*Developer functions*
	Services	Services	Services	Services	Services	
	Network operations	Network operations	Network operations	Network operations	Network operations	
	Physical transmission medium	Physical transmission medium	Physical transmission medium	Physical transmission medium	Physical transmission medium	
	Ducts (FNO) Space (MNO)	Ducts (FNO) Space (MNO)	Ducts (FNO) Space (MNO)	Ducts (FNO) Space (MNO)	Ducts (FNO) Space (MNO)	
	Corridor	Corridor	Corridor	Corridor	Corridor	

Source: Juconomy Consulting 2008.
Note: FNO = Fixed Network Operator; MNO = Mobile Network Operator; Telco = telecommunications company.

Regulatory Authority of the Kingdom of Bahrain commissioned a study (Juconomy Consulting 2008) to explore different options to develop ultra-fast broadband in new buildings, including different options for real-estate developers and telecommunications operators to share different elements of the active and passive infrastructure elements, network operations, and services. The involvement of a real-estate developer, according to the simple model presented in table 4.3, can span from the simple provision of rights of way (in the Integrated Telco Model), to the provision of ducts to licensed telecom operators on an equal basis (in the Duct Provision Model, in which the developer is responsible for civil works), to the provision of passive infrastructure and fiber optic cables without active components (Dark Open Access Model), to the provision of network operations (Lit Open Access), to the last model where the developer would play all of the roles described above, and would also provide telecommunications services (Developer Telco Model). Each of these models has strengths, weaknesses, and deep regulatory implications (Juconomy Consulting 2008).

Implement Measures to Reduce Deployment Costs

Infrastructure investment involves high costs that are difficult to meet in today's challenging financial climate for most countries in MENA. Both the overall costs and the cost components of rolling out networks vary greatly according to the technology deployed. For instance, the main cost components for FTTx networks comprise: ducting, installing the fiber, internal wiring, and consumer premises equipment. For mobile broadband, the costs typically consist of physical infrastructure, base station and microwave backhaul, and customer premises equipment. Despite the variation in cost items, the costs of civil works (ducting, excavation, and physical infrastructure) form the dominant component in both cases.

However, countries in MENA have the great opportunity, as had Romania, Latvia, and Lithuania in Eastern Europe, to quickly deploy broadband networks, leapfrogging countries with a significant "legacy" fixed infrastructure. These Eastern European countries inherited decrepit, ill-planned, and obsolete fixed networks from the Soviet era, and within in a few years and thanks to an effective market liberalization approach, combined with effective measures to lower deployment costs, surpassed Western European countries for selected broadband indicators, such as broadband Internet deployment (see box 4.3).

Network rollout processes typically comprise four main phases, as shown in figure 4.5: (a) commercial and technical planning; (b) applying for rights of way and other permits; (c) civil engineering works; and (d) connecting end users.

Therefore it is of crucial importance to ensure that all the steps are taken at the policy and regulatory level to achieve all possible cost savings with respect to infrastructure deployment through sharing of existing infrastructure, and that faster rollout is not impeded by lengthy, nontransparent, or cumbersome procedures for clearing rights of way and obtaining all necessary permits at the national or local levels (see box 4.4).

Box 4.3 Leapfrogging in Lithuania

At the end of 2012, fiber-to-the-x (FTTx) coverage in Lithuania reached 100 percent of households, and cable coverage was greater than 76 percent at the end of 2011. According to the Lithuanian national regulatory authority (NRA), the Communications Regulatory Authority (RRT), overall, broadband penetration stood at 81 percent of households at the end of 2012. As a result, Lithuania has one of the highest levels of high-speed broadband take-up in Europe—according to the RRT, at the end of 2012, 36.6 percent of connections were between 30 megabits per second (Mbps) and 100 Mbps, and 10.1 percent were faster than 100 Mbps, while only 8.5 percent of all connections were below 2 Mbps.

The incumbent, TEO LT (TeliaSonera group), dominates the fixed broadband market, with a market share of about 49.8 percent (by subscribers), while the rest of the connections are supplied by the alternative market players (out of them only 1,100 connections were wholesaled as of December 2012). TEO LT operates both a copper-based asymmetric digital subscriber line (ADSL) network as well as a fiber-to-the-home (FTTH) network, with an estimated coverage of 57 percent of households in 50 towns and cities at the end of 2011. For historical reasons, there are more than 100 Internet service providers (ISPs) in Lithuania, and according to RRT, a distinguishing feature is that almost all of these providers have their own networks. This has resulted in both intense service-based and infrastructure-based competition among the ISPs, especially in the larger cities (see figure B4.3.1).

Following introduction of the cross-sector passive infrastructure-sharing framework in 2004–05, FTTx deployment in Lithuania was driven by alternative operators making use of existing infrastructure. TEO LT joined the club of FTTx operators only a few years later as a result of competitive pressure from the alternative market players. At the end of 2012, FTTx accounted for 52.11 percent of all fixed broadband connections with over 60 percent of all FTTx connections being supplied by alternative operators. FTTx became the dominant broadband technology in Lithuania in mid-2008.

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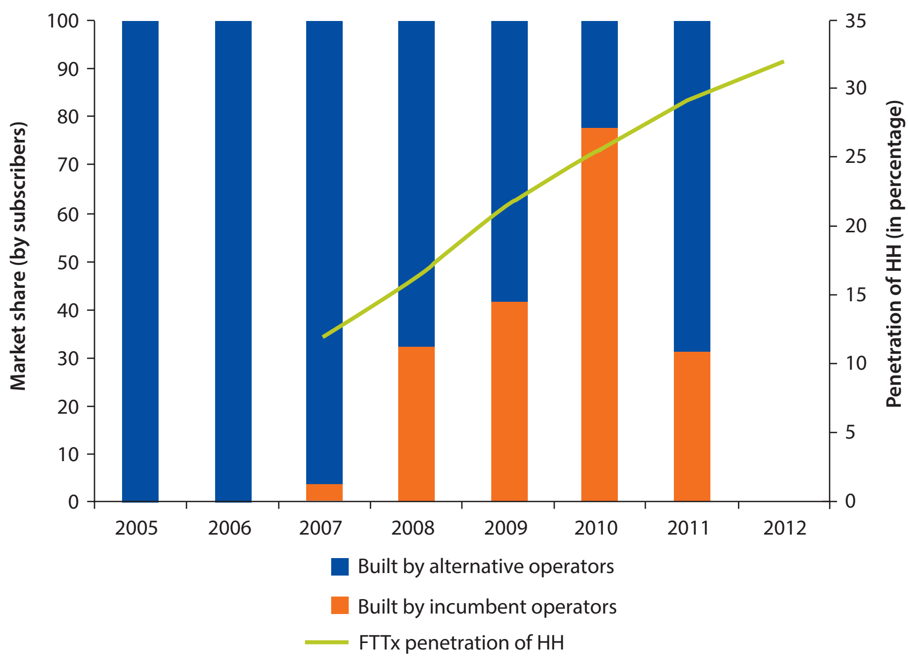
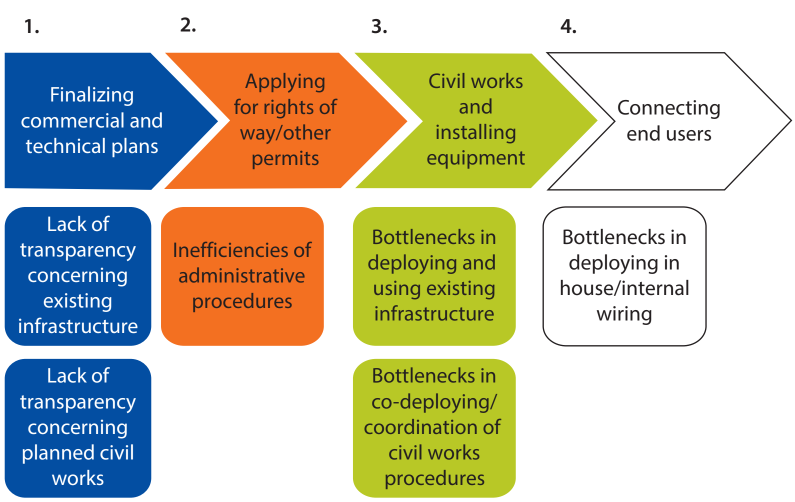
Box 4.3 Leapfrogging in Lithuania *(continued)*

Figure B4.3.1 Evolution of Breakdown of FTTx Deployment by Operator Type in Lithuania



Source: Lithuanian Communications Regulatory Authority (RRT), Fiber-to-the-home (FTTH) Council Europe; Analysys Mason 2012.
Note: FTTx = fiber-to-the-x; HH= households.

Figure 4.5 Typical Stages of the Broadband Network Deployment Chain



Source: Based on Analysys Mason 2012.

Box 4.4 Cutting the Rollout Costs of Broadband Infrastructure in the European Union

In June 2012, the European Commission (EC) launched a public consultation on an *EU initiative to reduce the cost of rolling out broadband communication infrastructure in Europe*, inviting member states, private sector, and public institutions at the national and local levels to give their opinion on possible ways to enhance the environment for high-speed network deployment in the European Union (EU).

The public consultation showed that there was little transparency on existing physical infrastructure suitable for broadband rollout and no appropriate commonly used rules when deploying broadband across the EU. Currently there is no marketplace for physical infrastructure or the potential to use infrastructure belonging to other utilities. Regulations in certain EU member states even discourage utility companies from cooperating with telecom operators. In March 2013, the EC proposed new rules to cut by 30 percent the cost of rolling out high-speed Internet. It is estimated that the new proposal may save companies US$40 billion–US$60 billion, given that civil engineering costs make up to 80 percent of the cost of a broadband network.

More specifically, the estimate is based upon the following assumptions: 25 percent of the deployment is in existing ducts, saving 75 percent in Capex for this part; 10 percent of the deployment connects the network to new housing developments; co-deployment with other operators/utility companies is used, saving 15–60 percent; and 5 percent of the deployment connects the network to prewired multi-dwelling units, saving 20–60 percent. In addition, the EC foresees a number of social, environmental, and economic benefits.

The proposal is built upon practices already employed in a number of EU member states and should be directly applicable to EU member states after they agree with the European Parliament and Council. So far the draft proposal tackles four main problem areas:

(a) Ensuring that new or renovated buildings are high-speed broadband-ready;
(b) Opening access to infrastructure on fair and reasonable terms and conditions, including price, to existing ducts, conduits, manholes, cabinets, poles, masts, antennae installations, towers, and other supporting constructions;
(c) Ending insufficient coordination of civil works, by enabling any network operator to negotiate agreements with other infrastructure providers; and
(d) Simplifying complex and time-consuming granting of permits, especially for masts and antennae, by granting or refusing permits within six months by default and allowing requests to be made through a single point of contact.

Sources: European Commission 2013b, 2013c.

Infrastructure sharing allows operators to avoid the expensive and lengthy broadband infrastructure construction process and make use of already or simultaneously deployed infrastructure in order to roll out their networks cheaper and faster. But at the same time this approach requires a robust regulatory framework in case of disputes between infrastructure owners and operators. Infrastructure sharing is of particular relevance for the emerging MENA broadband markets given the demographic pressures in the region.

There are two possible levels of infrastructure sharing: active and passive. Active infrastructure covers all the electronic telecommunication elements such as fiber, access node switches, and broadband remote access servers; access is provided at the level of signals, for instance, optical or electromagnetic. Passive infrastructure includes all the civil engineering and nonelectronic elements of infrastructure, such as physical sites, poles, and ducts (and also power supplies). Table 4.4 provides relevant examples of passive and active infrastructure sharing.

Active infrastructure sharing is commonly referred to as "providing access" and is traditionally regulated by applying principles of *ex-ante* regulation. *Ex-ante* regulation is asymmetric in its nature because its objective is to ensure a balance between competing operators (empowering those weaker ones and establishing certain restrictions on those holding significant market power [SMP]). The obligation to share active infrastructure, that is, to provide access, is asymmetrical in its nature, because it is only imposed on operators with SMP. The most common active infrastructure sharing products, that is, access products, include interconnection, leased lines, shared access to the local loop, bitstream, and so on. *Ex-ante* regulation is being introduced hand in hand with telecom sector liberalization, as detailed earlier in this chapter. Many countries may easily have over 15–20 years of regulatory experience in terms of dealing with active infrastructure sharing and may therefore be considered mature.

Passive infrastructure sharing is less mature from a regulatory perspective. Local loop unbundling (LLU) is the only example of passive infrastructure sharing but, as with active infrastructure sharing, its application is limited to telecom operators. Regarding other passive infrastructure, for instance, regulatory authorities across the European Union (EU) were empowered to address passive infrastructure sharing through an *ex-ante* approach, that is, to telecom operators, in 2007. However, the obligation to share passive infrastructure could also cover relevant infrastructure of other non-telecom sector players, for instance, utility companies. In that case, both regulatory and governance models applied within the telecom sector are different from those in active infrastructure sharing.

Sharing of passive infrastructure is, however, associated with the highest cost savings. For instance, estimates of the savings made by sharing ducts range from 29 percent for a mixture of sharing and self-digging, to 75 percent if no self-digging is required (Analysys Mason 2012). Experience has shown that passive

Table 4.4 Examples of Active and Passive Infrastructure Sharing

	Fiber core networks	*Mobile networks*
Passive sharing	Poles, ducts, power supplies	Electrical cables; fiber-optic cables; masts and pylons; physical space on the ground, towers, rooftops, or other premises; shelter and support cabinets; electrical power supply; air conditioning; alarm system; and other equipment
Active sharing	Lit fiber, access node switches, broadband remote access servers	The Node-B (the base station next to an antenna), Radio Network Controller

infrastructure sharing employed on a larger scale is more efficient. Alternative (non-telecom) civil engineering infrastructures may also be considered for passive infrastructure sharing, such as water and sewerage networks (sanitary and storm), gas pipe systems, canals, waterways, other transport tunnels, railways, and electricity networks. For instance, ITU-T Study Group 16 is investigating new, cost-effective solutions for the construction of network infrastructures and for cable laying.[5] Developed recommendations include standardized solutions for installation of cables via micro trenching in gas, water, sewers, and other ducts. From the regulatory and policy perspective it is important to ensure that operators are empowered to take advantage of standardized cost-effective solutions and that existing legal frameworks do not impede technological progress (see box 4.5).

When supported by strong policy coordination and at the local government level (see table 4.5), successful coordination of civil works between telecoms and other utilities can bring significant benefits.

In order to make sharing of passive infrastructure efficient, a robust legal and regulatory framework is required. Entities controlling relevant infrastructure may not have (or do not have sufficient) economic incentive to voluntarily enter into sharing arrangements. When there is no legal basis facilitating such cooperation across utilities, it also makes it more difficult to reach commercial agreements on sharing risks and costs and to find a suitable arbitration mechanism in case of conflicts. Nevertheless the greatest gain from passive infrastructure sharing comes simply from the opportunity to leverage more infrastructure that could be used for the deployment of broadband networks. In order to achieve that aim, passive infrastructure sharing should be legally mandated and obligations should apply to players across different sectors.

Box 4.5 Cross-Sectoral Passive Infrastructure Sharing in Portugal

Passive infrastructure sharing in Portugal was mandated in 1991 but until 2009 was limited to access to the ducts of the incumbent operator, Portugal Telecom. In 2009, the national regulatory authority (NRA), Autoridade Nacional de Comunicações (ANACOM), extended this ruling to all operators and public utility companies and to other "physical infrastructures such as buildings, ducts, masts, inspection chambers, manholes and cabinets for the purpose of the accommodation, setting up and removal, and maintenance of electronic communications transmission systems, equipment and resources." This includes (a) infrastructure owned by the state, local authorities, and Autonomous Regions; (b) infrastructure owned by entities under the supervision of the state, local authorities, and Autonomous Regions; and (c) public infrastructure and utility companies such as water, gas, transport, and sewerage companies, as well as roads, railways, and ports.

The cost of access varies depending on who owns the infrastructure. For example, ANACOM sets the prices for access to local authority-owned infrastructure, whereas telecom companies must charge each other cost-oriented prices.

Source: ANACOM, Decree-Law 123/2009 and Law 32/2009.

Table 4.5 Coordination Mechanisms in Finland, France, and the Netherlands

Country	*Description*
Finland	There are regular meetings among utility companies, municipalities, and telecom companies with a view to cooperating on shared infrastructure plans. For example, the city of Joensuu has for years held regular joint construction meetings between different parties. The meetings are mainly occasions in which the parties are informed about matters. A state-owned company "Johtotieto Oy" has an Internet-based service where operators are able to share information on the planned works with each other to facilitate joint construction. http://www.yhteiskaivu.fi. Prior to the launch of the portal, in December 2010, a guide to best practice was published for jointly constructing infrastructure. The guide was produced after interviewing a number of operators and listed a number of challenges. Currently, there is no dispute resolution process, and in case of a dispute, parties are left to negotiate freely between themselves.
France	Construction companies and builders must inform local communities of works on public buildings and thoroughfares—the DICT (Déclarations d'Intention de Commencement de Travaux). Infrastructure owners who are about to carry out installation or maintenance projects of significant length (~150 meters [m] in urban areas and ~1 kilometer [km] in rural areas) are obliged to inform local authorities about their plans for surface works (such as stripping and replacing surfaces/facades), works on overhead lines, and any works that require excavation. These infrastructure owners are also obliged to allow operators to install electronic communications equipment in any trenches that are created during the work. The operator must compensate the infrastructure owner for any extra costs that are incurred during the process, and the operator subsequently becomes the owner of the electronic communication equipment that has been installed, and thus is ultimately responsible for maintaining it. A 2009 law (L49 CPCE) requires local authorities to inform operators in particular of their willingness to launch new construction projects or to improve existing infrastructure (beyond a given length). In this case, operators or other public authorities can request permission to install their electronic communications cables. This permission can only be refused for reasons of security or network integrity. They must bear the additional costs of hosting the cables and part of the common costs. At the regional level, there are some isolated initiatives. One example is CRAIG (Centre Régional Auvergnat de l'Information Géographique), http://www.craig.fr.
Netherlands	Since 2007 in the Netherlands, local authorities have an increased role in coordinating civil engineering works in public grounds, requiring consent before actual work may start. The Cable and Pipeline Information Center (KLIC) system serves to coordinate works and creates a *cadastre* of underground infrastructures, aimed especially at avoiding damage to existing infrastructure from new works, but potentially also to explore sharing opportunities.

Source: European Commission 2013d.

Experience suggests that the legal and regulatory framework should address the following key bottlenecks (see table 4.6): (a) limited transparency about the existing physical infrastructure suitable for broadband rollout; (b) lack of appropriate legal basis or institutional framework; (c) commercial issues (lack of business interest) or anti-competitive behavior; and (d) technical infeasibility.

Government Intervention to Stimulate Broadband in Underserved Areas

Despite the expected development of mobile broadband penetration through simply letting market forces develop, some rural and remote areas in the MENA countries will remain underserved for broadband. This can result from socioeconomic inequalities, in terms of income, literacy, age, and/or gender

Table 4.6 Bottlenecks and Barriers to More Efficient Use of Passive Infrastructure

Bottleneck/barrier	*Legal/regulatory basis should establish at least*
1. Limited transparency concerning the existing physical infrastructure suitable for broadband rollout	Right to access/obligation to provide information about existing physical infrastructure suitable for broadband rollout Mechanisms to ensure availability of such information (may include establishment of nationwide inventory, facilitating and centralizing access to existing information, etc.) (See Box 4.6)
2. Lack of appropriate legal basis/institutional framework	Scope of entities to be obliged to share controlled infrastructure Scope of infrastructure to be mandated for sharing Governance model distributing relevant functions among public institutions (taking into account cross-sector nature of the infrastructure sharing obligation)
3. Commercial issues (lack of business interest) or anti-competitive behavior	Principles for pricing of infrastructure sharing (commercial, regulated or mixed approach, for instance in case of public and private infrastructures) Dispute resolution mechanism (courts of general competence, arbitrages or specialized dispute resolution procedures at NRAs)
4. Technical infeasibility	List of reasons for refusal of sharing Definition of technical infeasibility (may include establishment of the methodology to undertake technical feasibility assessment)

Note: NRA = national regulatory authority.

Box 4.6 Approaches to Passive Infrastructure Mapping

Development of inventories (or maps) containing information about the infrastructure is a key measure to address the problem of limited transparency concerning the existing physical infrastructure suitable for broadband rollout. Implementation faces a range of considerable constraints including but not limited to availability of information as such, its acquisition, and issues related to confidentiality, economic considerations, sustainability of the technical solution deployed, and so on. From the technical standpoint, possible solutions may range from simple databases containing information on infrastructure operators operating in certain territory, to advanced geographic information systems (GISs) presenting the exact infrastructure routes, details of ownership, and capacity available for infrastructure sharing.

European Union experience has shown that making up-to-date information available about existing civil engineering infrastructure greatly facilitates sharing and provides savings through reducing damage to existing infrastructure during excavation works. However, usually such information, if collected at all from infrastructure operators and public authorities, is presented in different formats and with uncertain levels of accuracy. Table B4.6.1 summarizes best practice in passive infrastructure mapping in selected European countries.

box continues next page

Box 4.6 Approaches to Passive Infrastructure Mapping *(continued)*

Table B4.6.1 Approaches to Passive Infrastructure Mapping

Scope of infrastructure	*Country cases*
Information about all existing infrastructure	In accordance with the **Estonian** Construction Law, civil engineering infrastructure data are kept in an asset register, which is managed by the Ministry of Economic Affairs and Communication. This covers utilities as well as telecoms. A duct database in Estonia is owned by the incumbent and is accessible by all operators. The costs of using and maintaining the database are shared between the incumbent and the operators that make use of the database. The incumbent Elion owns almost 100 percent of cable ducts. In **Lithuania**, information about infrastructure (as well as immovable constructions) deployed on the territory of the municipal authorities has traditionally been collected; recently such information has been collected in electronic format and uploaded into a geographic information system (GIS). In 2011 the Lithuanian national regulatory authority (NRA) Communications Regulatory Authority (RRT) launched a project aiming to provide access through a dedicated portal to the GIS of the municipalities. RRT is also cooperating with municipalities in order to make information available online. ANACOM, the **Portuguese** NRA, decided in 2009 to implement the Centralized Information System (CIS), a central infrastructure atlas aimed at reducing the cost of deploying new electronic communications equipment. Providing and regularly updating information is mandatory for all organizations that own or operate infrastructure suitable for accommodating electronic communication infrastructure (including roads, railways, water, and gas infrastructure). The National Joint Utilities Group (NJUG) is a **British** organization that aims to promote best practice for public street civil engineering works. Members include a number of British water supply and energy companies, as well as Openreach, the local access network provider, and Virgin Media, the United Kingdom's largest cable operator. One initiative of the NJUG is to map existing underground assets to create an infrastructure atlas for the United Kingdom. In addition to the estimated 1 million kilometers (km) of gas and water mains and sewers, and 500,000 km of electricity cables, NJUG believes there are 2 million km of telecoms cabling, all of which it wishes to map. In the **Netherlands**, the new Large Scale Standard Map, which in the future will be integrated into the Registration Large Scale Topography (BGT), is a detailed digital map of Netherlands containing all objects such as buildings, roads, water, railroad, and green objects in a unified way.
Information about telecom infrastructure	The **Swiss** NRA, the information and communications technology regulatory authority (BAKOM), launched a project increasing transparency of existing broadband infrastructure. From digital maps, information operators and service providers may find information on infrastructure deployed, level of competition, and provisioning gaps. In **Germany**, NRA (BNetzA) in cooperation with the private sector has launched its project, Infrastrukturatlas (web-GIS application), aiming to visualize deployed telecom infrastructure. Information was previously collected on a voluntary basis, but in order to build a complete database, since December 2012 information has been provided on a mandatory basis. The **Polish** NRA, the office of Electronic Communications (UKE), launched its Information Broadband Infrastructure System (SIIS) as one of the means to address low broadband penetration. Today detailed information about the entire deployed telecom infrastructure is available for operators and public authorities. Obligation to provide relevant information to UKE was established through a dedicated broadband law.

Sources: Based on material from CEPT 2013; European Commission 2013d.

(the "social digital divide") or by the existence of geographically remote and/or isolated territories, where key services are not available owing to inadequately high connection costs (the "territorial divide").

Depending on the region or country, one or the other type of digital divide may prevail. For instance, in Europe the territorial type dominates. In Finland, Sweden, and Norway, where average income is quite homogeneous and high, it is due to geographical constraints that most of the remote and isolated areas do not have broadband access. In MENA, however, both constraints are important and should be kept in mind when identifying potential commercially unattractive areas for infrastructure deployment. For instance, out of 19 MENA countries, seven are classified as lower middle-income countries and six as upper-middle. At the same time, countries may suffer from significant disparities in income distribution, which may contribute additionally to the development of the social divide. Gender inequality in Internet and mobile phone usage should also be mentioned as a significant contributor to the development of the social divide in MENA. In 2012, the gender gap in Internet usage in MENA was 34 percent, which is the second largest regional gender gap after Sub-Saharan Africa (45 percent). Despite increasing mobile phone ownership, the mobile gender gap in MENA stood at 24 percent (25 million women) in 2009, which was the second largest regional gap, but this time after South Asia (37 percent).[6]

To address the residual issues of geographic reach of services, differences in Internet speed, and affordability in such underserved areas, a combination of supply and demand policies (outside of the scope of this study) may be considered. Supply side policies include

- Including coverage obligations in the licenses of telecommunications operators;
- Using public subsidies for rural broadband network deployment; and
- Exploring technological options, including broadband via satellite, and compromising on the broadband speed.

The mix of policies will depend on several factors. For example, an extensive coverage obligation placed upon licensed broadband operators may place excessive burden on the deployment of infrastructure, and may even discourage private investment from entering the market. For example, second national operator (SNO) licenses did not prove successful in Egypt and South Africa, among other countries. The imposition of coverage obligations on mobile operators has, on the other hand, given better results (see box 4.7). In the context of a second-generation mobile tender process in Morocco, it was noted that the average commitment bids greatly exceeded the minimum targets for population and coverage (Wellenius and Rossotto 1999), and this experience was confirmed in the context of the 3G upgrade of those networks (Wellenius, Rossotto, and Lewin 2004).

The use of public subsidies for rural broadband will also depend on other factors, closely related to regulatory reform and the existence of a rural communication fund. It should be noted that any fee imposed on operators is an implicit

Box 4.7 Coverage Obligations in 4G/LTE Licenses in Germany and Sweden

Some countries such as Germany or Sweden used the award of fourth generation of mobile telecommunications technology (4G) licenses in the 800 megahertz (MHz) band auctions to impose specific coverage obligation for "white spots" or underserved areas, particularly those where broadband services were not yet provided.

In Germany, the auction of the 800 MHz band included specific obligations to cover the country's underserved areas (white-spots) as well as a spectrum cap of 20 MHz (the amount of spectrum which allows for over 100 megabits per second (Mbps)). Operators acquiring spectrum (Vodafone Germany, Deutsche Telekom [T-Mobile], and Telefonica [O2]) in this band were not allowed to provide service in urban areas before covering the white spots. Operators are already deploying long-term evolution (LTE) networks (both as stand-alone networks and over existing second generation of mobile telecommunications technology (2G) Global System for Mobile Communications (GSM) GSM infrastructure) and providing broadband services in rural areas over these networks with comparable prices to those of fixed broadband (Brugger and Kluth 2010).

In Sweden, one of the blocks of the 800 MHz auction included the obligation to cover all permanent houses and businesses that had no broadband connection by 2014. To finance this coverage, the winner of this block was given a subsidy of SEK 300 million from the proceeds of the auction.[a] As in the German case, there was a spectrum cap per operator of 20 MHz.[b] Operators in Sweden are currently providing mobile broadband over LTE with higher speeds than asymmetric digital subscriber line (ADSL) connections but with similar prices.[c]

a. http://www.pts.se/en-GB/News/Press-releases/2012/Broadband-arrives-in -120-homes-and-companies-thanks-to-the-PTS -coverage-provision.
b. BNetzA, http://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/Areas/Telecommunications /TelecomRegulation/FrequencyManagement/FlexibilisationFrequency/DecisionPresidentChamberFlexibilisation101022pdf.pdf?_blob=publicationFile.
c. http://www.eiu.com/index.asp?layout=ib3PrintArticle&article_id=1838266568&printer=printer.

barrier to entry in economic terms. Excessive fees may mean higher entry barriers, lower competition, and higher prices for consumers. The use of public subsidies for rural communications deployment also needs to be carefully assessed to ensure that appropriate governance standards are applied in relevant tenders and uses of public money (see box 4.8). The relationship between local government and telecom operators should also be publicly and carefully scrutinized.

Broadband via satellite and other technology options to reach remote areas should also be explored. In some areas of the countries in MENA, broadband via satellite may be the only option. In these cases, it is important to introduce the technology and assess its affordability for the rural population. In some cases, it will be important to formulate targets in the relevant broadband policies to allow compromise in terms of available speed of service.

For instance, Canada established a policy by which broadband should be made available via satellite to underserved areas, giving special attention to reaching aboriginal communities such as First Nations, Inuit, and Métis. The approach was made bottom-up through the initiative and close involvement of the beneficiary

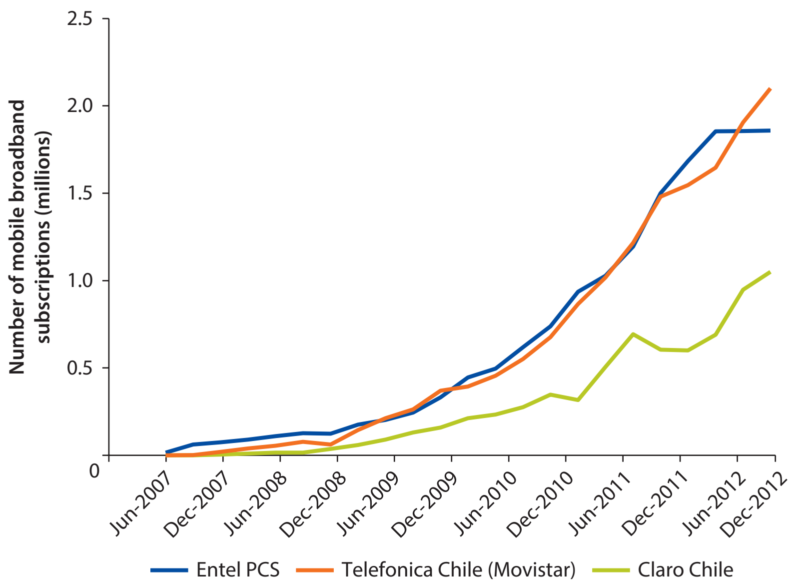
Box 4.8 Designing Public Subsidies for Rural Broadband: The Example of Chile

Chile decided to extend telecommunications infrastructure to those living in underserved areas by providing public funding through its Telecommunications Development Fund (Fondo de Desarrollo de las Telecomunicaciones, FDT). In order to improve efficiency and speed in delivering subsidies, the country successfully used reverse or minimum subsidy auctions to develop the mobile broadband network.

In a reverse auction, the government first identifies a project and then a maximum subsidy. Companies compete for the project by bidding down the value of the subsidy. The bidder requiring the lowest subsidy wins. The reverse auction resulted in over US$100 million of government subsidy.

Coverage obligations included around 1,500 municipalities in rural areas, where no broadband service was provided. Extending coverage to these areas could result in Chile achieving a broadband coverage of 90 percent of the population. Minimum service conditions for broadband access (e.g., a 1 megabit (Mb) downlink) and maximum prices were established. The winner of the auction, Entel Movil, started deploying mobile broadband in these areas in September 2010. The large expansion of mobile broadband services in the country has permitted Entel Movil to achieve the largest share of mobile broadband connections, surpassing its other two main competitors (see figure B4.8.1).

Figure B4.8.1 Mobile Broadband Subscriptions per Operator in Chile



Source: TeleGeography's GlobalComms Database (http://www.telegeography.com, data retrieved August 2013).

Box 4.9 Satellite Rural Broadband in Canada

In Canada, policy responses to the problem of rural broadband have come not only from the federal government, but also from the provinces and even individual cities or districts. The government has been studying the problem of providing service in remote and rural Canada since as early as 2001, and this culminated in the work of the Independent Telecommunications Review Panel, which reported on their findings in 2006.

The panel argued that the government should set a goal of providing affordable and reliable broadband services in all regions of the country by 2010. The panel mapped the availability of broadband and estimated that just under 90 percent of Canadians would have access by 2007, leaving about three million people without access, of which for 300,000 or so living in the most remote communities, satellite would be the most practical solution. Areas that were uneconomic to serve were found to be those with fewer than 1,200 people living within a radius of more than 5 kilometers (km) from a broadband point of presence, and this was further affected by terrain. Worldwide Interoperability for Microwave Access (WiMax) might help reduce the number that could not be served economically by 1.2 million, but for the remaining 1.5 million (plus the 300,000 to be served only by satellite), some form of targeted cross-subsidy would be necessary to achieve the goal of universal broadband service by 2010.

Prior to the 2009 program, all federal government efforts to extend broadband were aimed at extending the main networks to the communities and connecting public institutions and communal facilities. A key principle was that these facilities were also available to any operator willing to extend service to other end users or neighboring communities. Connecting homes and businesses, using these facilities if needed, was left to the private sector.

Projects are primarily generated bottom-up through the initiative and close involvement of the beneficiary communities, not top-down by the government agencies that support and finance these projects. Particular care and extensive public consultation ensure that government subsidies are not used to duplicate or compete unfairly with private sector facilities. Facilities built with public sector support must be available for use by any service provider.

Another related Northern initiative is SSI Micro, a wireless Internet service provider (ISP) in Yellowknife, Northern Territory, which uses a mix of satellite in the backbone and wireless in the access network (in the 2.5–2.6 gigahertz [GHz] band) to provide Internet access.

communities in order to avoid overlapping between the private and the public sector. The government disbursed subsidies for local communities to establish broadband infrastructure (see box 4.9).

The United States also shows a lack of broadband penetration in some rural areas. About 14.5 million rural Americans—or 23.7 percent of 61 million people living in rural areas—had no fast Internet service available for their homes. In order to address that, *Connecting America: The National Broadband Plan* was launched on March 16, 2010, aiming to provide 100 million American households with access to 100 Mbps connections by 2020. The main technology to achieve the goals will be to increase mobile broadband capacity in rural areas. The plan recommends that 300 megahertz (MHz) of spectrum should be made available over 5 years and 500 MHz after 10 years. Since satellite signals can cover large portions or even all of the United States, they are able to provide services to isolated rural areas that may not receive service via cable or wireline or even terrestrial wireless, networks.

Notes

1. Demand-side recommendations are outside the scope of this report and shall be addressed in a forthcoming World Bank publication.
2. For example, recently, the European Commission has elaborated specific guidelines for the application of state aid rules in the rapid deployment of broadband networks (European Commission 2013a). For a discussion of the principles to allow for state aid in the area of broadband see Hencsey et al. 2005.
3. eMisr National Broadband Plan, http://www.ntra.gov.eg/emisr/Presentations/Plan_En.pdf.
4. A good example of the public consultation and rules in this domain was established by the French regulatory authority in 2008.
5. See L series of the International Telecommunication Union-Telecommunication (ITU-T) Recommendations.
6. Source: Authors' analysis based on Broadband Commission 2013; Intel 2013; and Vital Wave 2010.

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