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Recent Developments on the Way to Upgrade Fixed Broadband Networks from Economic and Regulatory Perspectives: Analysis of Turkish Broadband Market

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ABSTRACT

This study aims to examine recent developments related to upgrading fixed broadband networks from economic and regulatory perspectives and analyze Turkish broadband market in detail. Most studies emphasize that high quality broadband network is a key economic driver that indirectly generates an overall annual increase in the gross domestic product of a country. Data, video, and voice services offered over fixed networks create significant increase in broadband traffic. One of the most important results of major efforts to handle traffic demand is to upgrade fixed networks. Upgrading fixed networks up to ultra-fast speeds of 100 mbps is expected to generate significant direct and indirect benefits. Within this context, developments in global fixed broadband networks and related regulatory issues, international practices including EU and US approaches and developments in Turkish broadband market are the main points scrutinized in this study. As a result, considering success in the fiber deployment and subscription in Turkey, a controlled regulatory holiday is an appropriate policy for those countries not having facilities-based competition in an emerging NGA environment.

Keywords: broadband, fixed network, regulation, Turkish broadband market.

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LIST OF ABBREVIATIONS

DOCSIS		Data Over Cable Service Interface Specification
DSL		Digital Subscriber Line
EC		The European Commission
EU	:	European Union
FCC	:	The U.S. Federal Communications Commission
FTTC	:	Fiber To The Cabinet
FTTH	:	Fiber To The Home
FTTB	:	Fiber To The Building
ICT		Information and Communication Technologies
ICTA	:	Information and Communication Technologies Authority of Turkey
ISP		Internet Service Provider
NGA	:	Next Generation Access
NRA		National Regulatory Authority
OECD		Organization for Economic Co-operation and Development
SMP		Significant Market Power
US		The United States

CHAPTER 1: INTRODUCTION

Broadband has dramatically affected our personal lives, business world and national economies. It is the great infrastructure challenge of the early 21st century. From economic perspective, broadband can facilitate growth and innovation in the ICT sector and throughout the economy by serving as a vital input for each sector that strengthens the economy as a whole. Also, broadband can provide job creation and consumer surplus. Hence, broadband is accepted as a transformative platform that impacts the ICT sector as well as other sectors of the economy through productivity gains when the appropriate policies are determined and implemented. Broadband networks also drive economic growth and development by improving global competitiveness and attracting international investors and provide a platform for addressing social issues such as health care and education.

Broadband impacts a country's economic output and GDP in multiple ways by: 1) enhancing the role of human capital through easier acquisition of knowledge and technical skills; 2) improving the efficiency and productivity of enterprises; 3) increasing community competitiveness by attracting knowledge-based businesses; and 4) sparking new and innovative technologies, services, applications and business models. (Qiang and Rossotto, 2009)

Numerous studies have found a positive impact on economic growth, but the estimate of its actual magnitude varies. While McKinsey & Company estimated that a 10 percent increase in broadband household penetration delivers a boost to a country's GDP

that ranges from 0.1 percent to 1.4 percent, World Bank studies also found that low-income and middle-income countries experienced about a 1.38 percentage point increase in GDP and high-income countries enjoyed a 1.21 percentage point increase in per capita GDP growth for each 10 percent increase in broadband penetration. (Broadband Toolkit, 2011)

Data, video, and voice services create significant increase in broadband traffic in the past few years as a result of innovation and growth on the Internet. For instance, new digital platforms and rich content from voice-over-IP and video conferencing connect family and friends around the world at little or no cost, while high quality video streams facilitate online learning, provision of telehealth services and watching movies and TV shows online.

The goal of broadband network policy should be to ensure that conditions exist that will promote continual improvement in the deployment, adoption, performance, and price of broadband networks; to ensure that all citizens enjoy the positive influence of innovation on their lives and on the economy.

Fixed broadband networks play major role in meeting those services requiring high capacity, as they provide more consistent and continuous connection with respect to mobile networks. Moreover, the growth of mobile and local wireless data actually increase demand for fixed networks, since they only transmitted over the air for a short distance and after that they are carried on high capacity fixed/wired connections on the backbone segment.

One of the most important results of major efforts to handle traffic demand is to upgrade fixed networks. Upgrading fixed networks up to ultra-fast speeds of 100 mbps is expected to generate significant direct and indirect benefits. Both operators and governments are looking in particular at mechanisms to encourage deployment of fiber connections. New technologies for traditional networks such as vectoring, G.fast and DOCSIS 3.1. are also another alternative method to improve broadband services.

This study aims to examine recent developments related to upgrading fixed broadband networks from economic and regulatory perspectives as well as analysis of Turkish broadband market in detail. Within this context, first fixed broadband technologies, developments and regulatory policies are reviewed in chapter 2. Then broadband targets and models in European Union (EU) and the United States (US) were given as well as comparison of EU and US practices in 3rd chapter. In the 4th chapter Turkish broadband market, next generation broadband practices and regulatory issues in Turkey is presented. Finally the conclusions are given in the 5th chapter.

CHAPTER 2: FIXED BROADBAND TECHNOLOGIES AND REGULATORY POLICIES

In this chapter broadband definition, major fixed broadband technologies, main regulatory approaches for next generation broadband networks, service-based and facilities-based competition are examined.

2.1 Broadband and Major Fixed Broadband Technologies

Broadband is a term applied to transmission media with bandwidths that can carry multiple signals by dividing the total capacity of the medium into multiple, independent channels. The standard wireline broadband technologies in most areas are digital subscriber line (DSL) technologies, cable modems and fiber optic technology.

The OECD, providing the most widely cited international rankings of broadband adoption, has defined broadband as a service that enables users to upload or download data or both at a speed of 256 Kbps—and this rate is the most common baseline that is marketed as “broadband” around the world.

The U.S. Federal Communications Commission (FCC) defined broadband as a service that enables users to upload or download data at speeds of 200 Kbps; it has recently upgraded its definition of broadband to 4 Mbps download speed or better (Bennett, 2013).

DSL Technologies

DSL technologies transform telephone lines into high-speed digital lines by using the higher frequency range to deliver data while leaving the lower frequencies for analog voice. The term "xDSL" refers to all types of DSL technologies. The availability and speed of your DSL service may depend on the distance from your home or business to the closest telephone company facility.

The main categories of DSL for residential subscribers are Asymmetric DSL (ADSL) and Very High Speed DSL (VDSL), while Symmetric DSL (SDSL) provides businesses with services that need significant bandwidth both upstream and downstream. (Bennett, 2013; Broadband.gov, 2014)

The next generation DSL is DSL Acceleration technologies, supporting speeds up to 100 Mbps. VDSL2 Vectoring and G.fast technologies employ noise-cancellation technology that enables operators to significantly increase the speeds offered over their existing copper infrastructure. These technologies offer an economic alternative to Fiber-technologies (FTTH/B) and provide an interim solution that can offer customers faster speeds in a much shorter timeframe and at a much lower cost than FTTH/B. In other words, these technologies offer operators a solution that can address the immediate time-to-market, competitive and regulatory challenges; while allowing operators to prepare their networks for the eventual migration to FTTH[1] (Broadbandtrends, 2013).

[1] For instance, Deutsche Telekom stated that they are not abandoning FTTH and in fact believe that 50 percent of the CAPEX used for the FTTC + Vectoring will be applicable to FTTH networks in the future with FTTH being the long-term target for the wireline network.

Cable Modems

Cable modems allow users to have a broadband connection that operates over cable TV lines. Cable Internet works by using reallocated TV channel space for data transmission, with certain channels used for downstream transmission, and other channels for upstream transmission. Because the coaxial used by cable TV provides much greater bandwidth than telephone lines, a cable modem can be used to achieve extremely fast access to the Internet.

In the upgraded next generation version, cable modems support speeds up to 160 Mbps with DOCSIS 3.0, and even higher speeds with the new standard, DOCSIS 3.1 (320 Mbps and higher).[1] The cable network as a whole has a capacity of approximately 4 Gbps, but most is dedicated to traditional TV today. (Bennett, 2013)

Fiber Optic

The deployment of fiber in the access network is major technology trend for broadband services. Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by hundreds of Mbps.

The actual speed consumers experience vary depending on a variety of factors, such as how close to the user's computer the service provider brings the fiber and how the service provider configures the service, including the amount of bandwidth used. The

[1] DOCSIS is an international telecommunications standard that permits the addition of high-speed data transfer to an existing cable TV (CATV) system. It is employed by many cable television operators to provide Internet access over their existing hybrid fiber-coaxial (HFC) infrastructure.

same fiber providing broadband can also simultaneously deliver voice (VoIP) and video services, including video-on-demand (Broadband.gov, 2014).

Fiber optic can be deployed as far the home (FTTH), the building (FTTB) or further back in the network to the cabinet (FTTC) or the node (FTTN). The different levels of fiber deployment are illustrated in Figure 2.1.

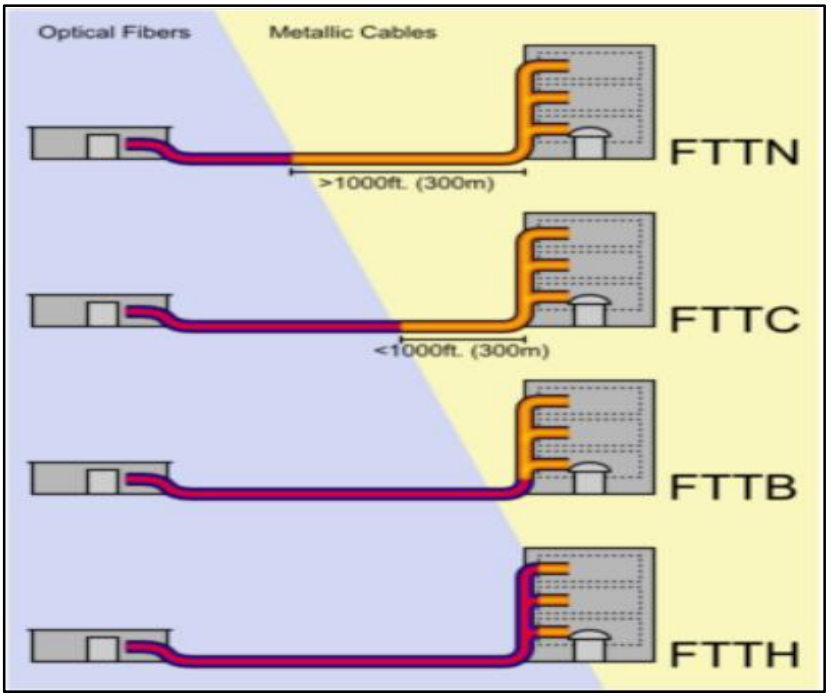


Figure 2.1. Fiber Deployment Topologies

FTTH/B platforms, reaching to the end of the network hierarchy, maximize the consumer benefit and meet the long-term bandwidth needs. While they bring out innovative and higher speed platforms, but also incur significant amount of long-term investments. Telecommunications providers currently offer fiber broadband in limited

areas and have announced plans to expand their fiber networks and offer bundled voice, Internet access, and video services.

Next Generation Access (NGA) Networks

Next Generation Access (NGA) networks are new or upgraded infrastructure that will allow substantial improvements in broadband speeds and quality of service compared with the services provided by traditional networks. The term is used to describe the infrastructure and set of technologies which provide super-fast broadband including DSL acceleration technologies, FTTC, FTTH and FTTB, and wireless technologies (OECD, 2011). NGA networks promise utterly more than conventional (copper-based or cable TV) broadband networks.

Fiber optic is an important technology and the foundation of all modern broadband networks, but the economic question is to what extent fiber should be brought to every household. While searching for the answer for this issue, the cost of deployment (many thousands of dollars per household), the low level of adoption (it is difficult to get a critical mass of a community to subscribe given diverse needs), and that other broadband technologies continue to improve speed and price should be considered by related parties. So, before deploying costly FTTH networks, the feasibility to improve existing DSL and cable networks -especially for rural areas- should be considered.

2.2 Main Regulatory Approaches for NGA

ITU (2012) highlighted the vital importance of a solid national regulatory framework in accelerating broadband roll-out and stimulating the development of new digital goods and services.

There is no common strategy either globally or across Europe representing policy makers' approach regarding whether or how to regulate NGA platforms. The need to meet the increasing bandwith demand, digital gap reasons and global competitiveness in the Internet era makes NGA investments a high-profile target for many countries. Main regulatory policies can be taken into consideration through a categorization of four options (Unver and Ilhan, 2013):

(i) Conventional (e.g., copper-based) type regulation: National regulatory authorities (NRAs) define and analyze the related markets, and then impose relevant remedies (such as access and pricing) on operators having significant market power (SMP) with the ultimate goal of ensuring effective competition.

(ii) No imposition of mandatory access, NRA does not regard ex-ante regulation as necessary in related market, since relevant market has been found effectively competitive, meaning non-existence of SMP operator(s)

(iii) Regulatory holiday: NRA provides a temporary or conditional situation of non-regulation (e.g. until a sunset is realized) without conducting a market analysis for especially emerging markets

(iv) Deregulation: NRA does not regulate broadband platforms in no manner.

2.3 Service-Based vs. Facilities-Based Competition

In network industries such as telecommunications, two regulatory means can be chosen to introduce competition (Bergman, 2008):

- ✓ *Infrastructure-based competition*, whereby operators are incited to invest in infrastructure and fully compete on both the infrastructure access market (upstream or wholesale market) and on services delivered through infrastructure (downstream or retail market).
- ✓ *Service-based competition*, whereby service providers have an equal and non-discriminatory access to a unique monopolized infrastructure, is considered an essential facility and required to offer services in competition on the retail market.

In a similar way, competition in broadband services can also be service-based or facilities-based. While under facilities-based competition each service provider acts in the market using its own physical network, the resources of a common network are shared so as to reach to the customers in service-based competition (Blevins, 2009). In other words, from the aspect of broadband services, when the entrant uses the facilities of the incumbent, competition is called service-based and can be realized either through resale or through unbundling schemes. When the entrant builds its own facility, competition is facility-based.

The choice between service-based competition and facilities-based competition is a complex one. At the bottom lies the choice between the benefits of free competition and the benefits of returns to scale. Facilities-based competition offers the potential of less

regulation and hence less regulation-induced inefficiency, such as distorted investment incentives, lobbying and pure bureaucracy costs. On the other hand, service-based competition allows the industry to realize greater returns to scale. Furthermore, technological developments may have the effect that returns to scale in infrastructure are not as big as they appear to be (Bergman, 2008).

CHAPTER 3: INTERNATIONAL BROADBAND PRACTICES

This chapter is focused on broadband targets and models in European Union and the United States. Then comparison of European Union and the United States practices is presented.

3.1. European Union: Broadband Target and Model

'Digital Agenda' of European Commission (EC) specifies goals in terms of high - speed broadband coverage and penetration. The Digital Agenda "seeks to ensure that, by 2020, (i) all Europeans have access to much higher internet speeds of above 30 Mbps and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps" (EC, 2010). While the first target refers to a coverage level of 100%, the second target is related to a minimum household adoption level subject to quality characteristics that can be realized only with NGA technologies.[1]

In terms of fixed broadband technologies, DSL remained by far the most important fixed broadband technology in Europe. DSL coverage had grown slightly in 2012 and realized as 93% of EU households, while standard cable covered just over 42% of households. Looking at the NGA technologies, DOCSIS 3 (also included in the standard cable figures) was the most important with nearly 40% coverage. VDSL (included in the DSL figures) was next at 25%, and FTTP was available to 12% of

[1] The EC's Digital Agenda defines NGA as 30 Mbps service and its mapping study defines NGA to include three technologies: VDSL, cable broadband provided through DOCSIS 3, and fiber-to-the-premises (FTTP), which includes both fiber-to-the-home (FTTH) and fiber-to-the-building (FTTB). VDSL was in turn defined to include services capable of supporting download speeds of at least 25 Mbps.

households. VDSL coverage grew by more than 5 percentage points in 2012, making it the fastest growing fixed broadband technology in that period. (Point Topic, 2013) As a result, fixed network coverages are not appropriate for facility-based competition in Europe. Therefore competition mostly depends on the DSL network and is identified as intramodal (service-based), even the case for a few countries (such as The Netherland and Belgium etc.) is different.

European broadband model emphasize the service-based competition by requiring carriers with significant market power to share their facilities through mechanisms such as local loop unbundling, shared access, and bitstream access. This regime was designed to permit competitors to share those network elements that exhibited natural monopoly characteristics and thus could not be replicated economically. European regulators forced incumbent operators to unbundle their copper networks and sell low priced wholesale access to new entrants. These access obligations apply generally to VDSL and FTTP services provided by incumbent telephone companies (Yoo, 2014).

It was also intended to permit new entrants to climb the "ladder of investment" by gradually replacing the network elements leased from the incumbent with their own infrastructure (Cave, 2006). Some literature mentioned that in reality that doesn't happen because entrants are happy to focus on retailing and avoid the costly, cumbersome job of network construction and management (Layton, 2014).

EU regulatory frame defines imposition of the full set of obligations under the Access Directive. When next generation broadband policies are considered, this approach could be defined as "conventional type regulation". The Recommendations

and Commission's reviews over the market analyses submitted by the NRAs depict a policy approach similar to conventional method. According to that approach, competitive and innovative access measures are centralised on SMP remedies, with some necessary modifications for FTTX topology. While the NRAs have discretion with regard to imposition of the remedies under the Access Directive, the NGA Recommendation prescribes a conventional type regulatory approach along with copper line measures (Unver and Ilhan, 2013)

Additionally, according to EU Framework Directive, NRAs shall be able to impose the sharing of facilities or property, including ducts, conduits, manholes, cabinets. to ensure more competitive conditions for alternative operators.

European operators principally believe that it may be more economical to upgrade existing networks than to build out fiber to every dwelling. The first reason is the improvements in DSL and cable technologies allowing them to deliver near 100 Mbps. Moreover, most consumers don't care how they get their broadband, as long as it is fast enough for their needs and a good value. Because of that European operators focused on upgrading DSL network to VDSL by benefiting recent methods such as vectoring. On the other hand, cable providers can upgrade their speeds without regulatory approval and they focused on upgrading their networks to DOCSIS 3.0 or 3.1 (Layton, 2013a).

3.2. United States: Broadband Target and Model

In early 2009, Congress directed the Federal Communications Commission (FCC) to develop a National Broadband Plan (NBP) to ensure every American has access to

broadband capability. The Connecting America: The National Broadband Plan, released by the FCC on March 17, 2010, sets out a roadmap for initiatives to stimulate economic growth, spur job creation and boost America's capabilities in education, health care, homeland security and more. According to America's 2020 next generation broadband goal; at least 100 million U.S. homes should have affordable access to actual download speeds of at least 100 megabits per second and actual upload speeds of at least 50 megabits per second Moreover, NBP also stated that infrastructure such as poles, conduits, rooftops and rights-of-way play an important role in the economics of broadband networks. Therefore, establishing low and more uniform rental rates for access to poles; improving rights-of-way management for cost and time savings; facilitating new infrastructure construction are some of principles given in the Plan (Kruger, 2013; FCC, 2014a).

The U.S. developed the policy of permitting competitors to share incumbent providers' networks through local loop unbundling and wholesale access in the 1990s, as part of the Federal Communications Commission's Computer Inquiries and the Telecommunications Act of 1996. The U.S. soon gave up this service-based (intramodal) approach in part because of some reasons. One reason is that the type of competition induced by infrastructure sharing seemed quite thin. US also believe that competitors are unable to innovate with respect to services and limited to competing by squeezing their own margins. Moreover, some arguments effective in part stated that because sharing can create disincentives to invest in infrastructure. As a result, the U.S. abandoned local loop

unbundling in favor of a regulatory approach that focused on facilities-based (intermodal) competition (Yoo, 2014).

The FCC also removed the requirement for operators to unbundle FTTH facilities in 2005. After this decision Verizon immediately announced its FTTP deployment. Leading cable television also competitors responded Verizon's action by deploying high-capacity services based on DOCSIS 3.0. A few smaller telephone companies have also deployed fiber, as have a few municipal overbuilders (Crandall, Eisenach and Ingraham, 2013)

The US practice, where FTTX networks are exempted from mandatory access since 2005, is perfectly matched with "deregulation", as a main regulatory approach. FCC has no duty of regular market analysis and has been no longer obliged to re-regulate the industry, while it monitors the developments in the markets, including investment dynamics related to FTTX platforms (Unver and Ilhan, 2013).

From the aspect of competition model, US had an advantage of having concurrent deployment of cable and DSL networks. The high level of coverage by both DSL and cable allows the United States to benefit from an intermodal competition policy, an option that is not available to most nations because they lack significant cable modem coverage. For OECD countries as a whole, only 55.7 percent of homes were passed by cable, but 94 percent of American homes could subscribe to cable if they chose. The intermodal competition model the United States adopted for broadband made it possible for ISPs to compete with each other on the basis of speed as well as on price, unlike the

ISPs that depended on unbundling and struggled to differentiate themselves from each other when speed was out of their control (Bennett et al., 2013).

Americans have also currently greater choice of broadband technologies and speeds than nearly anywhere in the world, including in the EU. Networks capable of providing 100 Mbps speeds reach 85 percent of U.S. homes, whereas just over half of European homes can access speeds of 30 Mbps or greater (Layton, 2014).

The most recent data from the ITU shows that the U.S. has the lowest entry level broadband pricing in the developed world and the OECD recently found that U.S. broadband pricing has fallen drastically in the last two years when measured on a per megabit basis. The U.S. leads the world in broadband investment and technology diversification, and its broadband networks support a vast and growing economy of digital commerce and exports that is the envy of Europe (Layton, 2014). On the other hand, US operators have compensated their investment expenses by high-speed connections which are expensive with respect to other countries.

3.3. Comparison of EU and US Practices

Many specialists and policymakers debate over the best policies and models to drive even more widespread adoption and deployment of broadband technologies. The main question is whether the European model of service-based competition, supported by strict regulation, or U.S. model of facilities-based competition with deregulation outperforms in promoting broadband.

It is generally accepted that coverage is the better way to measure outcomes than subscriptions in order to measure and compare broadband networks. Both the European Commission (EC) and Federal Communications Commission (FCC) in US have broadband coverage studies prepared to generate detailed information regarding broadband availability (including rural areas) by all of the leading broadband technologies as of the end of 2011 and 2012 (EC 2012, 2013a; NTIA and FCC 2012, 2013).

Yoo (2014) analyzed data from US and European coverage reports to compare situations in US and Europe for many broadband metrics given below:

- NGA networks (25 Mbps)[1] was available in 73% of U.S. households as of the end of 2011 and in 82% of U.S. households as of the end of 2012. By contrast, NGA service was available in only 48% of European households by the end of 2011 and in 54% of European households by the end of 2012.
- As of the end of 2011, NGA service was available in 38% of U.S. rural households and 9% of European rural households. By the end of 2012, NGA service increased to 48% of U.S. rural households and 12% of European rural households.
- As of the end of 2011, FTTP service was available in 17% of U.S. households and 10% of European households. By the end of 2012, FTTP service increased to 23% of U.S. households and 12% of European households.

[1] EC (2012 and 2013) accept broadband services with speed at and over 25 Mbps as NGA services. In order to compare Europe and US, the data for connections at and over 25 Mbps are taken into consideration as NGA.

Figure 3.1 displays some comparison of U.S. and Europe for broadband coverage and high-speed access by the end of 2012. U.S. is certainly faring better than Europe in terms of NGA coverage, rural NGA coverage, fiber coverage and LTE coverage.[1] As a consequence of this reality, traditional DSL services makes up only 34% of broadband connections in the U.S., while it makes up a huge 74 percent of broadband connections in Europe (EC, 2013b).

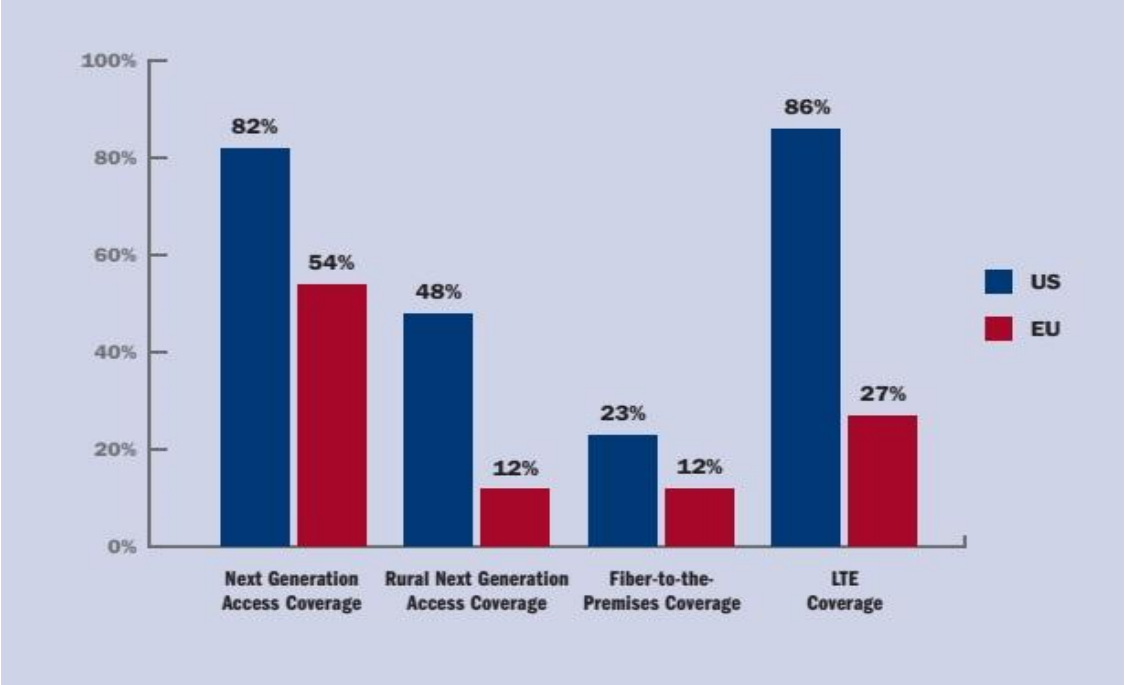


Figure 3.1. Broadband Coverage in the U.S. and Europe, 2012

[1] As of the end of 2012, U.S. download speeds during peak times (weekday evenings) averaged 15 Mbps, which was below the European average of 19 Mbps. There was also a disparity between the speeds advertised and delivered by broadband providers in the U.S. and Europe. During peak hours, U.S. actual download speeds were 96% of what was advertised, compared to Europe where consumers received only 74% of advertised download speeds. The U.S. also fared better in terms of latency and packet loss (Yoo, 2014).

Yoo (2014) brought forward in that disparities between European and U.S. broadband networks stemmed from differing regulatory approaches. Europe has relied on regulations that treat broadband as a public utility and focus on promoting service-based competition, in which new entrants lease incumbents' facilities at wholesale cost (also known as unbundling). On the other hand, the U.S. has generally left buildout, maintenance, and modernization of Internet infrastructure to private companies and focused on promoting facilities-based competition, in which new entrants are expected to construct their own networks (Layton, 2014).

Table 3.1. Broadband Investment in the US and EU, 2011-2012

	2011 CAPEX billions	2012 CAPEX billions	YoY Change	2011 Population millions	2011 $/pers	2012 Population millions	2012 $/pers
US	$72.39B	$77.6B	7%	311.59M	$232	313.89M	$247
EU27	$63.37B	$50.3B	-21%	501.9M	$126	500M	$100

Source: Layton (2013b)

From Table 3.1., we can see that broadband investment in the US has increased by 7% between 2011 and 2012 while it declined in the EU27 by 21%. American operators spent almost 2.5 times more per capita than European. EU27 carriers are spending only 40 cents for every dollar invested in the US. In the big picture, global broadband investment is some $300 billion annually. Americans comprise just 4% of the world's population but they enjoy 25% of the world's broadband infrastructure investment. So US can be described as a country with an outsized investment in broadband.

It is not that European operators don't want to invest, but the open access policies that require incumbents to rent their facilities at low regulated rates create a strong disincentive to investment. Furthermore, the 27 individual European markets each have their own regulatory authority and tax regimes, making the realization of economies of scale near impossible.

Moreover, the US approach also promoted broadband investment, while the European approach had the opposite effect ($562 of broadband investment per household in the U.S. vs. $244 per household in Europe as of the end of 2012). Yoo (2014) stated that the difference in regulation and competition models also influenced the amount of broadband investment in the U.S. and Europe. In Europe, where it was cheaper to buy wholesale services from an incumbent provider, there was little incentive to invest in new technology or networks. In the U.S., however, providers had to build their own networks in order to bring broadband services to customers. Layton (2014) also emphasized that the American market-led approach of facilities-based competition has resulted in greater investment in next-generation broadband technologies. As a result, many European leaders are increasingly abandoning their regulatory approach and looking to the US broadband model.

Yoo (2014) also applied a regression analysis of the impact of service-based and facilities-based competition on NGA coverage. The analysis indicates that the U.S. approach has proven more effective in promoting NGA coverage than the European approach. More specifically, service-based competition has a statistically significant

negative impact on NGA coverage, while facilities-based competition has a statistically significant positive effect on NGA coverage.

Europeans are used to buying broadband at low rates with the support of mandated access and rate regulations on DSL. The cost of this policy is that telecom carriers don't invest expected amount in infrastructure because they can't make a return on their investment (Layton, 2013a). On the other hand, US operators have needed to compensate their investment expenses through higher retail tariffs for high-speed connections, while especially providing bundle services.

CHAPTER 4: TURKISH BROADBAND MARKET AND FIBER REGULATION

In this chapter firstly national broadband targets in Turkey are given. Then some statistics for Turkish broadband market and situation related to next generation networks compiled. Finally regulatory approach followed for fiber infrastructures in Turkey is presented and the development up to now is analyzed.

4.1.National Broadband Targets in Turkey

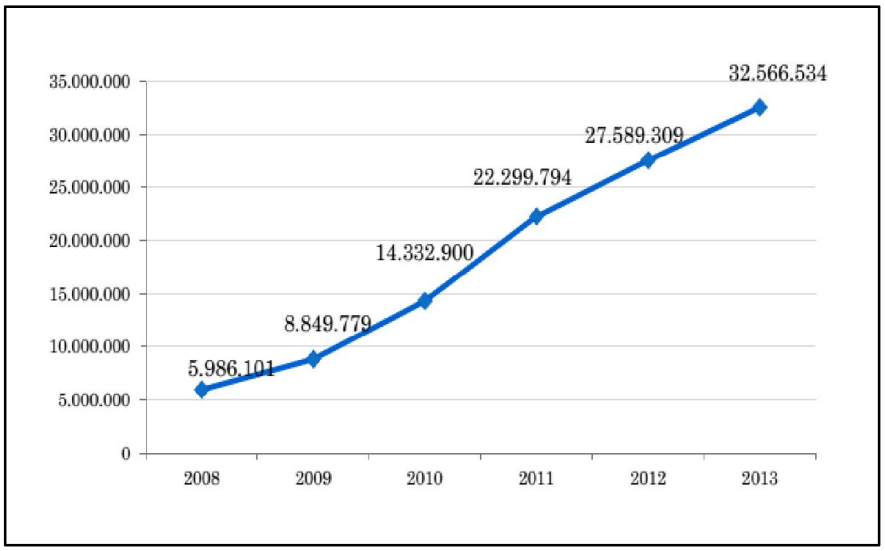
Governments around the world are eager to promote the diffusion of broadband technologies, because the penetration of high speed internet is strongly correlated with economic growth, Turkey adopted first national broadband plan in 2006 with Information Society Strategy report (2006 -2010) and Ninth Development Plan (2007-2013) and then revised the targets several times considering the developments in the broadband market. (Cullen International, 2014a) According to 'Vision 2023: Transport and Communications Strategy report' published in 2011, Turkish government is expecting to have 30 million fixed broadband connections as of 2023. Moreover, the government has targets of extending fiber networks and wireless access networks with access rate of 100% for households and also provision of fiber internet access at a speed of 1000 Mbps to 14 million households (approximately 80% of households) (Ministry of Transportation, 2011).

Besides, "Information Society Strategy Renewal Project" started in November 2012 includes 8 main topics. 'Broadband Infrastructure and Sectoral Competition' is one

of these topics. Draft 2014-2018 Information Society Strategy and Action Plan of Turkey is released for review in June 2014. According to the Plan, The Turkish Government set out ambitious targets for broadband: as of 2018, reaching 70% of population with broadband subscription, 4 million fiber connections, at least 20 Mbps connection for every household and also at least 70 Mbps connection for half of households and, 20 million LTE (next generation mobile broadband) subscription. The project also emphasizes the main focus of broadband internet as *"increasing broadband internet use and ensuring infrastructure rollout especially on NGA networks in order to reap the economic and social benefits of broadband internet".* (Ministry of Development, 2014)

4.2.Turkish Broadband Market Statistics

The number of broadband subscribers, including all means of broadband access (fixed, mobile, cable modem, fiber etc.), was 6 million in 2008 and has reached 32.6 million at the end of 2013 as shown in Figure 4.1 below. Annual growth rate of total number of internet subscribers has reached to 18%. Number of internet subscribers in Turkey increased by 4.9% as compared to the previous quarter thanks to the increase in number of mobile, cable and especially fiber internet subscribers (Figure 4.1)



Source: ICTA (2014a).

Figure 4.1. Number of Broadband Internet Subscribers

Table 4.1 displays number of Internet subscriptions by technology at the end of 2012 Q4, 2013 Q3 and 2013 Q4. Mobile Internet (3G), being provided since 2009, is the platform having highest number of subscriber and has approximately 24.2 million subscribers (computer and mobile handset). Mobile Internet kept growth trend during 2013 with 24% annual growth rate.

Some recent literature stated that mobile operators act like they are in the same market with fixed-line operators as a result of changes in cost and demand structures. This also reflects the increasing competition in the broadband market. The empirical findings pointed to substitution relation from DSL to mobile broadband but not the other way around. Therefore, it is asserted that broadband internet market should be redefined

accordingly to include the mobile internet in Turkey (Oguz, Akkemik & Goksal, 2013; Cetin, 2014).

In Turkey, xDSL network of incumbent operator being provided since 2003 and covering 98% of the population is the most widespread fixed broadband platform. Number of xDSL subscribers is stabilized around 6.6 million users. (Table 4.1).

Table 4.1. Number of Internet Subscriptions by Technology

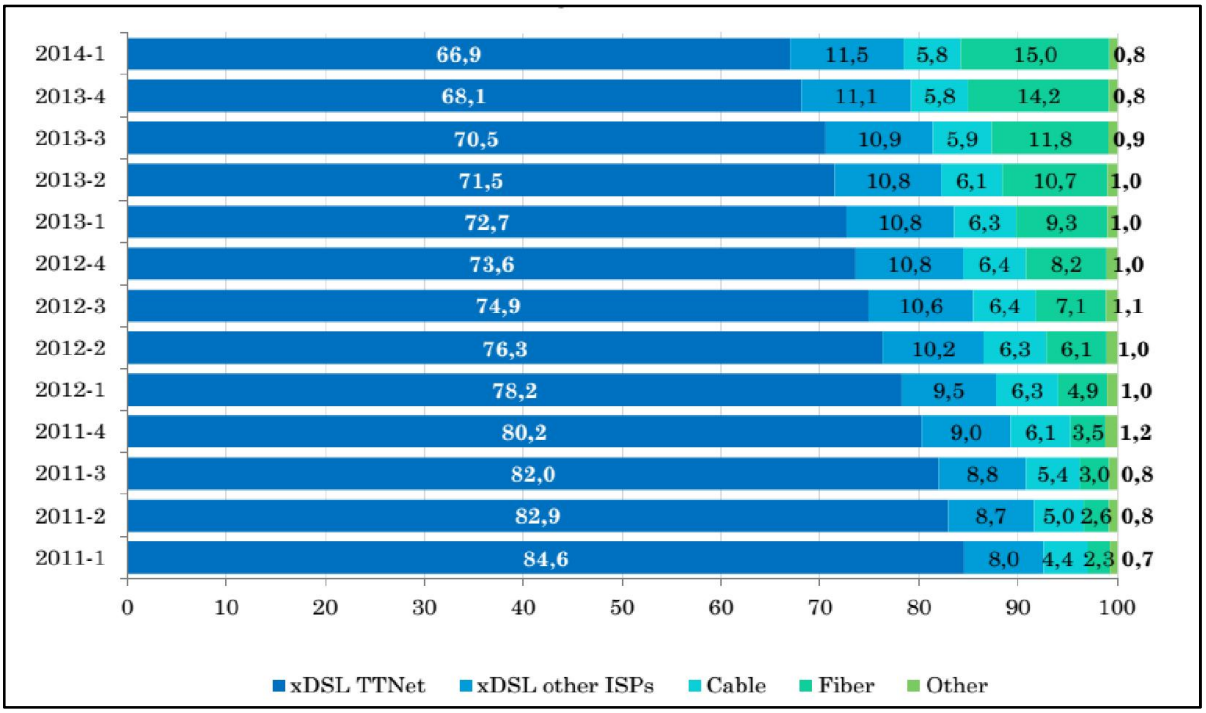
	2012 Q4	2013 Q3	2013 Q4	Quarterly Growth Rate (2013 Q3 – 2013 Q4)	Annual Growth Rate (2012 Q4 – 2013 Q4)
xDSL	6.643.299	6.662.999	6.644.543	-0,3%	0,0%
Mobile Internet from Computer	1.674.533	1.742.995	1.701.014	-2,4%	1,6%
Mobile Internet from Mobile Handset	18.045.808	21.099.677	22.472.129	6,5%	24,5%
Cable Internet	500.658	483.046	486.497	0,7%	-2,8%
Fiber	645.092	967.309	1.193.704	23,4%	85,0%
Other	139.665	120.159	116.043	-3,4%	-16,9%
TOTAL	**27.649.055**	**31.076.185**	**32.613.930**	**4,9%**	**18,0%**

Source: ICTA (2014a).

The most significant development in retail broadband market in Turkey is increasing numbers of fiber internet users. The number of fiber internet subscribers[1] has surpassed one-million threshold for the first time in 2013, reaching 1.2 million, indicating 23.4% and 85% increases with respect to the previous quarter and the year (Table 4.1).

[1] It includes fibre-to-the-building (FTTB) and fibre-to-the-home (FTTH) and excludes fibre-to-the-cabinet (FTTC).

On the other hand, cable TV network realized a steady increase in market shares until 2012 and number of broadband subscribers reached 500,000 (ICTA, 2013). However, a slight decrease in the number of subscribers is observed in 2013 and 486,497 broadband subscribers are served by cable TV network at the end of 2013 (ICTA, 2014)



Source: ICTA (2014b).

Figure 4.2. Fixed Broadband Subscribers by Technology and Operator (%)

Figure 4.2 shows the change in distribution of fixed broadband subscribers by technology as percentage between 2011/Q1 and 2014/Q1 on quarter-basis. The most

significant change that can be recognized easily is steady growth of fiber subscribers from 2.3% in 2011 to 15% in 2014/Q1 as mentioned before.

xDSL platform had gradually been losing market share among fixed networks. Although xDSL subscribers of alternative operators slowly increased their share, number of TTNET's xDSL subscribers decreased in this period (Figure 4.2). The reasons behind this change are competitive offers provided by alternative operators and TTNET's switching subscribers from copper to the fiber network. Additionally, market of share of cable TV network increased until the end of 2012.

When we examine the distribution of the xDSL line numbers by the access model type, it can be seen the most popular access model is IP level bitstream access model, while local loop unbundling has the least number of lines. 3,485 lines are served by local loop unbundling method (2,047 full unbundling; 1,438 shared access) at the end of 2013, whereas number of subscribers by xDSL resale lines is 52,379. The remaining 6,588,679 xDSL lines, including TTNET's subscribers, which correspond to 99,1% of xDSL lines, are served by bitstream access model (ICTA, 2014a).

When market shares of Internet Service Providers (ISPs) based on number of subscribers is considered, TTNET (subsidiary of Türk Telekom)[1] has respectively 85.1%, 81.3%, and 79.9% market share at retail fixed broadband market at the end of 2011, 2012 and 2013. Therefore, it is certain that incumbent operator has a clear dominance in retail fixed broadband market, even though its market share has been

[1] In 2006, when retail subsidiary TTNet was established and the retail and wholesale internet arms of Turk Telekom were separated.

decreasing slowly. On the other hand, Superonline is the biggest alternative broadband operator with %11.2 market share, while Dogan TV digital was serving 4.5% of the retail fixed broadband market (ICTA, 2013; ICTA, 2014a)

Offers providing 4-8 Mbps download speeds is preferred by 68.9% of fixed broadband subscribers in Turkey, which was 79.4% in 2012. The change depends on customers' preference for higher bandwidths. 21.1% of fixed broadband subscribers chose offers providing download speeds more than 8 Mbps in 2013, while it realized as 9.9% in 2012. (ICTA, 2013; ICTA, 2014a)

4.3.NGA-Fiber Networks in Turkey

Turk Telekom (incumbent operator), Superonline (alternative operator) and Turksat (cable TV operator) have some deployments of NGA infrastructure in Turkey. In Turkey, fiber access service was first served to the public in 2010 by Superonline, a subsidiary of the largest mobile operator (Turkcell). The incumbent's subsidiary TTNet and other ISPs using Turk Telekom's infrastructure followed Superonline after two years. Currently, Superonline and Turk Telekom are the owners of the two main fibre access networks, while some smaller alternative ISPs have small scale local networks. Turksat's cable TV network was upgraded to HFC DOCSIS 3.0 technology which can provide NGA services.

Turk Telekom has 181,973 km of fiber optic infrastructure (122,689 km for backbone and 59,285 km for access network) at the end of 2013, while its fiber optic infrastructure was about 167,921 km (122,591 km for backbone and the remaining

45,330 km for access network at the end of 2012. This means Turk Telekom realised approximately 14,000 km of fiber deployment for its access network. On the other hand, alternative operators have a fiber optic length of 45,440 km in 2013, whereas it was 42,364 km. at the end of 2012. (ICTA, 2013; ICTA, 2014a).

Turk Telekom reported 2.61 million (12.6%) household is covered with its FTTH/B topology, more than 6.5 million (31.4%) household is passed with FTTC topology throughout the whole country as of 2014/Q1 and Turk Telekom's FTTH/B network has 682,000 broadband subscriptions (Turk Telekom, 2014). Superonline has a fiber network of 32,500 km fiber covering 1.8 million (8.7%) household with its FTTH/B topology in 12 cities and 614,000 broadband subscriptions as of 2014/Q1 (Superonline, 2014). However, these provinces are the most populous ones, covering almost three quarters of total population. Both Turk Telekom and Superonline has preferred to concentrate their fiber access networks in city centers, with the intention of decreasing their cost of investments and increasing subscription/home pass ratio. Turksat's HFC DOCSIS 3.0 network providing services in 22 major provinces covered 3.5 million household at the end of 2013. After upgrading cable TV network with DOCSIS 3.0 technology, provision of internet access services upto 100 Mbit/s is possible (Cullen, 2014b)

Turk Telekom is obliged by ICTA board decision 2011/511 to provide wholesale resale and bitstream services over its fibre network in 2011. Superonline started voluntarily to provide wholesale fiber services to other alternative operators in 2014 without being imposed any regulatory obligation (Superonline, 2014).

4.4.Regulatory Approach for NGA broadband services in Turkey

Local loop unbundling, bitstream access and resale services have been regulated since 2005 through determining the operators with significant market power (SMP) and imposing on them the relevant remedies within the context of market analysis for both wholesale physical network infrastructure access market and wholesale broadband market.

Turk Telekom, the fixed incumbent, was determined as the SMP operator and obliged to provide ADSL/VDSL access products in the second round of those market analyses in 2010. On the other hand, since the fiber infrastructure was not included in the market definition because of its limited coverage throughout Turkey and not considered as substitute with copper infrastructure. Therefore the incumbent was not imposed any remedy with regard to fiber access services (FTTH/B) (Unver and Ilhan, 2013)

VDSL services which is served by incumbent operator's FTTC topology is already regulated under reference bitstream offer since 2009, in accordance with related market analysis. In 2010, Turk Telekom announced field trials of DSL vectoring technology, but the project now appears to have been put on hold and Turk Telekom is giving priority to its FTTH/B roll out (Cullen, 2014)

While FTTC, accepted as one component of NGA networks in the literature, is under strict regulation, the other and more effective NGA topologies, FTTH and FTTB, are not on the same route. The regulatory framework for FTTB/H (NGA) broadband

network and services in Turkey has been established on belowmentioned decisions of ICTA.

The most important component of Turkish regulatory approach related to NGA networks is the board decision dated October 3, 2011 and numbered 511. The purpose of the Decision was to encourage new investments, technological development and production in the electronic communications sector, and within this context, promoting increase of newly emerging fiber internet access services and improving infrastructure based competition. The Decision (2011/511);

- excludes the access to the fiber (FTTH/FTTB) from market analyses process for the five year period or till the percentage of fiber internet subscribers reaches the 25% of the whole fixed broadband subscribers, and
- requires Türk Telekom to comply with its commitment on providing resale and bitstream access at wholesale level on fiber infrastructure to ISPs on nondiscriminatory basis and notifying such wholesale tariffs before entering into force.

Fiber access is regarded as an emerging market in the Decision, and thus fiber networks (FTTH/B) was not included into the market analyses until one of the specified criteria (threshold) is met. Therefore, any obligations about fiber technology will not be applied to any of operators within the market analysis meanwhile. The Decision entails a degree of regulatory holiday for the operators investing in fiber access network.

On the other hand, a level playing field has been ensured for the enhancing the service-based competition through Turk Telekom's emerging access infrastructure and market foreclosure possibility is aimed to be preempted by the second part of the Decision. Within this part, Turk Telekom is required to comply with its commitment to provide resale and bit-stream access (BSA) at the wholesale level via the existing fiber infrastructure to alternative operators on non-discriminatory basis, and to notify BTK of the wholesale tariffs pertinent to such services before they become operational.

After the decision of 2011/511, it was observed that the incumbent accelerated its investments towards NGA by the way of transforming its copper access network to FTTB rather than establishing new FTTH access network in the greenfield areas. This investment approach of the incumbent raised the competition concerns since alternative operators were not be able to offer retail services after the transformation via the regulated products under the conditions of the Decision 2011/511 which provided a certain level of regulatory holiday towards NGA.

Hence, in order to provide safeguards for the service based competition (by wholesale copper access services) BTK issued the decision dated July 2, 2012 and numbered 303 and the decision dated July 18, 2012 and numbered 335, taking a complementary step to the decision of 2011/511. The aim of these decisions is to ensure the rights of alternative operators for copper based WBA (LLU/BSA/Resale) services being kept where copper network has been transformed to fiber by the incumbent.

Table 4.2. Number of Fixed Broadband Subscriptions by Technology

	xDSL	Cable	Fiber	Other	Total
2011-1	6,700,198	321,080	163,783	157,052	7,342,113
2011-2	6,726,981	368,055	189,597	164,426	7,449,059
2011-3	6,792,013	407,502	220,777	129,858	7,550,150
2011-4	6,776,036	460,451	267,144	159,383	7,663,014
2012-1	6,736,138	483,843	378,475	139,858	7,738,314
2012-2	6,632,661	485,531	469,668	140,299	7,728,159
2012-3	6,602,030	492,765	548,493	142,753	7,786,041
2012-4	6,643,299	500,658	645,092	139,665	7,928,714
2013-1	6,678,907	501,201	741,675	137,256	8.059,039
2013-2	6,644,571	491,852	860,871	126,904	8,124,198
2013-3	6,662,999	483,046	967,309	120,159	8,233,513
2013-4	6,644,543	486,497	1,193,704	116,043	8,440,787
2014-1	6,671,447	492,288	1,277,711	112,808	8,554,254

Source: ICTA (2014b).

The effects of the regulatory framework have being observed through the numbers. Table 4.2 shows the number and development of fixed broadband subscribers pertaining to each technology from the first quarter of 2011.

A steady increase in the number of fiber subscribers can be seen from the Table 4.2 following the period of Decision 511. The number of fiber subscribers has increased by 480% after the issuance of Decision 511, during two and half years while the total number of broadband subscribers has only increased by 13,3% in the same period.

Moreover, as could be seen from the Figure 4.2., the share of fiber in the fixed broadband subscribers has increase from 2.3% to 15% while the shares of other technologies have almost stayed stable or decreased since the third quarter of 2011. In

order to understand possible effect of the Decision 2011/511, we may compare the increases in the fiber subscribers before and after the third quarter of 2011. From the first quarter to the third quarter of 2011, fiber subscribers increased by 30% in two quarters while it increased by 400% in ten quarters. Thus the average increase per quarter is 15% before the Decision 2011/511, just as it is about 40% after it was issued.

As the percentage of fiber internet subscribers (%15 as of 2014Q1) and fiber adoption take into consideration, it can be expected that one of the criteria (25% of the whole fixed broadband subscribers) will be met until the end of 2015. Meanwhile, the important issue that ICTA should carry out is close follow-up on the fiber subscription data. Audit on the broadband market data can be a conceivable practice for this purpose.

The number of homes passed of the access network is another indicator in order to understand the take up. Turk Telekom's FTTH/B network covered 0.98 million home in 2012 Q1, while it covers 2.61 million home as of 2014 Q1 (Turk Telekom, 2014) . Superonline's FTTH/B network also covered approximately 1 million home at the end of 2011, whereas it covers 1.8 million home as of 2014 Q1 (Superonline, 2014) Hence, the number of homes passed of fiber has also increased after the decision of 2011/511 in parallel to the increase in the number of subscribers.

Duct sharing -the sharing of passive network items in the local access part of the network- is one of the remedies intended to ensure more competitive conditions for alternative operators. Turk Telekom has been obliged to share its ducts in its access and backhaul network since 2009 as an SMP operator in the market for access to physical network infrastructure. Alternative operators could install their cable (copper/fiber) into

the ducts or onto the poles of Turk Telekom only for purpose of BSA, LLU and interconnection backhaul.

As a result of market analysis, Board Decision dated 12.04.2013 and numbered 188 obliges the fixed incumbent, Türk Telekom, to give access to the physical network (passive) infrastructure in its access network without any purpose restriction. This access obligation for civil infrastructure is believed to give more opportunities to the alternative operators to invest in fiber networks especially in the parts of the network where the incumbent replaced the copper with fiber allowing more spaces for new cables.

On the other hand, all of authorized operators, which are able to establish and operate electronic communication infrastructure, are symmetrically obliged to share their passive infrastructures including ducts, manholes -starting from September 2013- by the Board Decision dated April 12, 2013 and numbered 187. Terms and conditions frame is similar, and more flexible than the frame in incumbent's reference offer.

While terms and conditions for duct sharing in Turk Telekom's access and backhaul network, are set out in its reference offer for co-location and facility sharing approved by ICTA, those for duct sharing in Turk Telekom's backbone/core network and whole networks of other operators are set out in the document approved by the Decision 2013/187.

Besides, in accordance with Board Decision dated 12.04.2013 and numbered 188, Turk Telekom is obliged to offer dark fiber in case of that access to physical infrastructure elements is not available and infrastructure of any other operator available

for facility sharing does not exist in the requested route. However, there is no specific obligation applied about in-building wiring infrastructure sharing yet in Turkey.

For the time this study is prepared, there is no solid evidence about the impact of the recent regulations of passive network sharing on the network development. But it is not misleading to expect their positive effects on fiber networks in the future. Moreover, alternative operators association stated they are expecting decrease in regulated prices for passive network sharing services in Turk Telekom's access network (Telkoder, 2013)

When we consider that ICTA provided a set of conditions upon regulatory holiday in addition to the related Board decision issued (numbered 511), Turkish policy also matches with a distinct approach that is between 'regulatory holiday' and 'no imposition of mandatory access'. This policy could also be categorized as a partial regulatory holiday (Unver and Ilhan, 2013).

On the other hand, even regulatory holiday seems more effective policy in deployment of NGA networks with regard to strict access regulation policy as in European Union, it is worrisome to establish and maintain sustainable competition environment after regulatory holiday.

CHAPTER 5: CONCLUSION

Broadband is a foundation of 21st century for economic growth, job creation, global competitiveness and a better way of life. It is enabling entire new industries and unlocking vast new possibilities for existing ones. It is changing how people access, organize and disseminate knowledge, educate children, deliver health care, ensure public safety, engage government, and manage energy.

Some analysis shows that the level of technology development, not the number of the competitors, drives competition. This is evidenced by 74 percent of broadband subscriptions in the EU being DSL which means many Europeans still have no choice but to rely on DSL, while DSL makes up only 34% of broadband connections in the U.S. and broadband subscriptions in the US are more evenly distributed amongst different broadband network technologies. Cable broadband is available to 93 percent of households in the U.S., but only 42 percent of households in the EU. As the EU Digital Agenda Scoreboard and America's National Broadband Map reports, the US has a higher deployment of next generation networks, FTTH/B networks are available to 23 percent of households in the US but only 12 percent of households in the EU.

The U.S. superiority in broadband is attributable to a bipartisan effort in the U.S. to incentivize investment in better and more advanced networks. Since 1996, the U.S. decidedly moved to a "facilities-based competition" model where ISPs own the underlying networks and are motivated to invest in them in order to avoid losing customers to their competitors. By contrast, Europe's "service-based competition"

approach where ISPs lease broadband lines at regulated rates from incumbent telecom firms, have no incentives to invest in the underlying facility. European regulators forced companies to unbundle their copper networks and sell low priced wholesale access to new entrants. The idea was that new entrants would use this as a boost to build their own network facilities separately. In reality that doesn't happen because entrants are happy to focus on retailing and avoid the costly, cumbersome job of network construction and management.

In Turkey, in order to encourage investments in NGA networks, ICTA decided (2011/511) to exclude fiber (FTTH/B) from market analysis for the next five years or until the percentage of fiber-based subscriptions reaches 25% of all fixed broadband subscriptions. ICTA also imposed an obligation on Turk Telekom to comply with its own commitments made to ICTA, where it pledged to provide wholesale resale and bitstream services over its fiber network on non-discriminatory terms and to notify ICTA of the tariffs for these services before they become operational. Afterwards, the brownfield areas are covered under the realm of former (DSL-based) regulations, in order to ensure that the former (said) Board Decision does not affect the regulatory landscape at the expense of investment incentives. A final step, which could be regarded as the complementary step in fostering fiber products, has been "duct sharing" over the access network owned by Türk Telekom. Additionally, in April 2013 ICTA took a decision imposing duct sharing on all operators (including Turk Telekom) that have their own fixe d electronic communications infrastructure.

In Turkey, The number of fiber subscribers has increased by 480% after the issuance of Decision 511, during two and half years while the total number of broadband subscribers has only increased by 13,3% in the same period. Moreover, the share of fiber in the fixed broadband subscribers has increase from 2.3% to 15% while the shares of other technologies have almost stayed stable or decreased since the third quarter of 2011. Turk Telekom's FTTH/B network covered 0.98 million home in 2012 Q1, while it covers 2.61 million home as of 2014/Q1. Superonline's FTTH/B network also covered approximately 1 million home at the end of 2011, whereas it covers 1.8 million home as of 2014/Q1. These data show the success of regulatory policy for fiber networks in Turkey.

Main regulatory approaches could be listed under four category: 'conventional type regulation', 'deregulation', ('no imposition of mandatory access' and 'regulatory holiday'. While EU's recent regulatory policy towards NGA networks is based on an approach near 'conventional type regulation', US experience clearly exhibits 'deregulation' under the fourth category. Turkey's NGA policy represents a distinct approach that is between 'regulatory holiday' and 'no imposition of mandatory access'.

The empirical literature evaluating the impact of access obligations on investments in NGA concludes that access regulations deters investments in NGA. It is widely accepted that the American market-led approach of facilities-based competition has resulted in greater investment in next-generation broadband technologies. On the other hand, some countries are not lucky to have a competitive infrastructure such as

cable TV against DSL network and can't implement "facilities-based (inter-platform) competition" and also deregulation policy for broadband services. In that case, a controlled regulatory holiday is an appropriate option for those countries with growing broadband markets in an emerging NGA environment, considering regulatory policy and the developments in the fiber deployment and subscription in Turkey.

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