

## NGA Transition in Turkey: A Comparative Analysis of LLU and FTTX in An Immature Broadband Market

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### ABSTRACT

Turkey is a country with an immature broadband industry. No competitive networks are operative in the broadband market and high-speed access is underdeveloped. The country faces critical regulatory junctures that will have strategic importance for future network growth. Open access regimes such as those of the European countries generally refrain from dictating a specific access model, an approach that is also applied to next-generation networks. In contrast, IP-level bitstream access (BSA) has been the predominant model governing broadband competition in Turkey. As the country is at the crossroads of implementing a framework for next-generation, high-

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bit rate broadband networks, it faces the question of whether it should imitate the European path by encouraging local loop unbundling (LLU) and other intermediate access policies or whether it should chart a different course that might lead to faster next-generation access (NGA) deployment. To analyse this question, the article reports a quantitative analysis of two possible transition paths from BSA: reliance on copper LLU as an interim step and a more direct and to-the-end route of fibre deployment (FTTX). For each scenario, the *pay-back periods* and *break-even points* are calculated. It is concluded that broadband competition requires remedies that facilitate FTTX deployment to tackle the problem of lack of innovation as well as to ensure competitive and faster NGA transition in Turkey. Last but not least, mandatory duct sharing rather than unbundling seems to be the most promising way to sustain and develop NGA competition in Turkey.

**Key words:** Turkey, Broadband market, Competition, LLU, FTTX, NGA Transition

## I . INTRODUCTION

ICTs offer a wide range of opportunities by which the information is created and shared. Reaping maximum societal and economic benefit during the Internet era critically depends on appropriate regulatory and policy decisions.<sup>1</sup> Measures to facilitate broadband deployment may include general public policy instruments (e.g., subsidy policies, tax reductions, co-investment strategies) and regulatory tools (e.g., access obligations, pricing regimes). Regulatory tools gain importance in case of an immature industry suffering from insufficient broadband penetration and a lack of widely available networks enabling high-speed and quality. This becomes particularly true with the emergence of next generation platforms. However, the enormous diversity of the next generation value network and its dynamic evolution complicates finding consistent policies.<sup>2</sup>

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<sup>1</sup> See ITU. (2010). Trends in Telecommunications Reform in 2009, p. 27.

<sup>2</sup> Bauer, J. M. (2010). Regulation, public policy, and investment in communications infrastructure, *Telecommunications Policy*, Vol. 34, p. 74.

In this paper, comparative aspects of legacy networks and next generation access (NGA)<sup>3</sup> networks are analysed with a particular focus on the costs of wholesale access products, particularly fibre and copper local access lines, and their usage opportunities in the new ICT era. The analysis aims at clarifying how trade-offs could be dealt with by broadband market actors. From this point of view, the comparison of local loop unbundling (LLU) and NGA models seeks to assess prospective regulatory steps in Turkey, representing an example of an immature industry.

Whether migration from the entrenched DSL services offered via bitstream access (BSA) to nation-wide multi-service NGA facilities is worthwhile is the main question to be answered in this paper. Answering this question also aims at uncovering the micro-level regulatory steps to be taken with a view to creating the necessary competitive conditions in the broadband markets with the ultimate aim of closing the digital gap and spurring initiatives to innovate and invest in new technologies and services.

A migration path along the access models that are used in other countries (*IP level BSA*<sup>4</sup>-*LLU*<sup>5</sup>-*NGA*) generates uncertainty for decision makers regarding rate-of return periods, demand accumulation, etc. To compare costs and benefits of copper LLU and NGA, both quantitative and qualitative parameters have been taken into consideration in this study. First and foremost, an analysis has been carried out to

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<sup>3</sup> Next Generation Access (NGA) networks are new or upgraded infrastructure that will allow substantial improvements in broadband speeds and quality of service compared with current services. The term is used to describe the infrastructure and set of technologies which provide super-fast broadband including Fibre to the Cabinet (FTTC), Fibre to the Home (FTTH), Fibre to the Building (FTTB), and wireless technologies (OECD, Next Generation Access Networks and Market Structure, <http://www.oecd.org/dataoecd/57/36/48223202.pdf>, 2011, p. 14-15, last visited by 30.03.2012). In this study, the term of NGA is used to refer to wireline FTTX models in which fibre optic is used for the full or part of the distance between end-users and the central exchange.

<sup>4</sup> Bitstream access (BSA) is a wholesale product that provides alternative operators with the ability to transmit the traffic from the switching points which can be IP or ATM nodes, e.g. broadband remote access servers (onwards Internet backbone) in return for the related costs to be given to the incumbent who has the entire control of the network before the switching points. Incumbent (network operator), before traffic hand over towards the alternative operators' switches, has the ability to make the changes as to the specifications, interfaces and other technical details. The BSA model allows a low level of product differentiation, which is generally dependent on the ability of ISPs to have control over the upstream network elements (e.g. backbone transmission) that enable price cutting against incumbent.

<sup>5</sup> In LLU either in full unbundling or shared access, alternative (LLU) operators rent the copper pair (local loop) and pay a monthly rental. LLU operator receives the traffic in co-location point and conveys it to the Internet backbone.

find the *pay-back periods* and the *break-even points* for each model (LLU and NGA/FTTB). The quantitative analysis is supplemented with a qualitative diagnosis of Turkey's needs and by discussing possible regulatory remedies.

In the following (second) part of the paper a discussion on crucial aspects of NGA deployment is made from the viewpoint of an immature industry. In this situation service-based competition prevail in broadband markets, often accompanied by non-innovative packages, lowered goals of competition (e.g., low-profile targets dependent on incumbent offers) and a considerable unserved consumer base in terms of next-generation services. In the third part of the paper, broadband progress in Turkey is discussed by elaborating on whether it reveals a pattern diverging from or converging with the EU, as an immature industry. In the fourth part, capital expenditures pertinent to NGA and LLU are analysed. The goal is to find the rate-of-return periods of LLU and NGA (FTTX) investments and to devise a long-term approach for Turkey. In this context, the applicable wholesale prices pertaining to IP level BSA and copper LLU in Turkey are taken as the reference values, whereas the NGA costs are factored into the evaluation on the basis of market data gathered for the study. After measuring the differences between transition costs of LLU and NGA from BSA, an analysis of the possible access products particularly of duct sharing and fibre unbundling is given in the following part of the paper.

The paper concludes that a strategy of differentiation-enabling, investment-inclusive access models based on FTTX is most advantageous for Turkey. From this point of view, mandatory duct sharing rather than fibre unbundling is suggested as a more efficient and long-term path to ensure effective facility-based competition as well as a level playing field in the emerging NGA environment. Last but not least, in order to enable operators to take innovative steps, further invest in NGA, and effectively compete with each other via their individual fibre networks, the complementary nature of dark fibre and vertical wire cabling remedies is underlined to enforce an effective mandatory duct sharing.

## **II . REGULATING AN IMMATURE INDUSTRY**

Broadband markets have been regulated in parallel with liberalization to safeguard against the risks of monopolization and competitive restraints as well as to enhance

infrastructure and service penetration. How to regulate immature broadband markets has been a worldwide concern and some progress has been achieved in political and regulatory terms. The EU has sought to promote conventional (copper/DSL based) broadband services with service competition and regulated access at various levels to the incumbent networks. Access and pricing remedies are determined by examining the market power of competitors, presumed to be climbing a ‘ladder of investment’.<sup>6</sup> According to this line of thought, “[T]he development of competition starts with services competition, allowing competitors to develop knowledge of operations and customers by granting them access to the incumbent’s network. After some time, experience, confidence and a critical mass of customers would prompt investment in networks, which would also allow the competitor to differentiate its service. They would then step up a rung on the ladder”.<sup>7</sup>

The process is complicated in NGAs, where the ‘top of the ladder’ that exists in the current generation (DSL-based) broadband—namely the local exchange where local loops are unbundled—is missing.<sup>8</sup> Occasionally combined with copper lines and generally provided through dedicated fibres to the homes or nodes,<sup>9</sup> FTTX platforms promise much more than conventional broadband services. On the other hand, their seamless topology, accompanied by network upgrades and technologically advanced QoS structure, require great capital expenditures and risky investments. FTTX platforms have distinctive costing features that are attributed to network construction and fiber deployment within a time frame that is not easily predictable under a self-sustaining business model. In immature industries, where service-based competition models have not completed their life circles and broadband take-up has not reached a satisfactory level (e.g., the OECD or EU average), FTTX deployment constitutes a far shakier ground for policy

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<sup>6</sup> See Cave, M. (2004), Making the ladder of investment operational, [www.ictregulationtoolkit.org/en/Document.2916.pdf](http://www.ictregulationtoolkit.org/en/Document.2916.pdf), last visited by 30.03.2012, p. 28.

<sup>7</sup> Cave, M., and Huigen, J. (2008). Regulation and the promotion of investment in next generation networks – A European Dilemma, *Telecommunications Policy*, Vol. 32, p. 718.

<sup>8</sup> *Ibid*, p. 718.

<sup>9</sup> Many European incumbents and some alternative operators have made plans and in some cases commenced to deploy large scale fibre investments, resulting in significant changes to European fixed-line markets. The technologies used and the pace of development vary from country to country. Almost commonly, the incumbents’ preferred choice is FTTCab (fibre to the street cabinet) while the alternative operators’ choice is FTTH (fibre to the home), bypassing completely the incumbent’s network.

making. One may ask a critical question related to the prospects of NGA in an immature market: could the progressive steps foreseen for copper networks be adapted to fibre networks?

As NGA topologies differ from one country to another, the same answer will not fit all. First and foremost, building NGA platforms requires a critical optimization with regard to capital expenditure on part of alternative operators.<sup>10</sup> Second, not only horizontal access but also vertical remedies, particularly in-building wiring, arise as a need for access seekers involved in the NGA competition, thus marking a difference from copper-based competition. In the face of this and other complementary reasons, such as rights of way fees, fibre networks may require a longer rate-of-return period when compared with copper, which may increase uncertainty. Finally, considering the critical nature of fibre networks, many municipalities and governmental agencies launch some financial mechanisms, take some measures that new entrants could avail of. This is another parameter which regulators and/or competition authorities need to consider in the course of market intervention in an emerging NGA environment.<sup>11</sup> Considering such peculiarities which did not exist for copper networks, the ‘ladder of investment’ theory may not apply in a straightforward way to FTTX.<sup>12</sup> Such features unique to fibre networks constitute critical inputs before the new entrants at the juncture of switching to NGA business plans.

These facts provide hints that collaborative actions might be necessary for purposes of NGA deployment. In fact, alternative opportunities such as utility infrastructures as well as public-private partnerships (PPP) projects are emphasised by both policy makers and entrepreneurs.<sup>13</sup> These alternative models generate

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<sup>10</sup> See Ragoobar, T., Whalley, J. and Harle, D. (2011). Public and private intervention for next-generation access deployment: Possibilities for three European countries, *Telecommunications Policy*, Vol. 35, p. 827-829.

<sup>11</sup> Regarding the factors that determine municipal strategies in fixed NGA networks and the implications of municipal broadband to regulation and markets see Troulos, C., Maglaris, V. (2011). Factors determining municipal broadband strategies across Europe, *Telecommunications Policy*, Vol. 35, p. 842-856.

<sup>12</sup> See also Bourreau, M., Doğan, P. and Manant, M. (2010). A critical review of the “ladder of investment” approach, *Telecommunications Policy*, Vol. 34, p. 693.

<sup>13</sup> See Gómez-Barroso, J. L., Feijóo, C. (2010). A conceptual framework for public-private interplay in the telecommunications sector, *Telecommunications Policy*, Vol. 34, p. 487-495; Falch, M., Henten, A. (2010) Public private partnerships as a tool for stimulating investments in broadband, *Telecommunications Policy*, Vol. 34, p. 496-504.

competing platforms for transmission and access segments. At the same time, they reduce reliance on the incumbent's network facilities. In this context, the creation of reliable ladders, which would act as alternative stepping stones, gains importance in the NGA environment. From the viewpoint of an immature industry facing a lack of inter-platform competition (e.g. between cable-DSL) as well as inadequate FTTX investments, NGA competition would be an important leverage for spurring next generation networks/services. That is to say, deployment of FTTX networks in the immature industries would rather emerge within the context of the "best use of existing resources" phenomenon.

Best use of the resources requires elaborating how to map network level competition on the market forces. Ensuring competing fibre networks could therefore be deemed as the core attribute of NGA market regulation. This argument is similarly, even more persuasive for immature industries, where alternative operators have not completed their incubation periods and/or still rely on resale of the incumbent's services. While NGA competition may start at the service level through resale or bitstream access, this is not the intended eventual level of competition at all. When competitive and faster broadband penetration is taken as a priority, broadband market regulations aiming at inter-platform competition have an important role to play in achieving sustainable competition.

From this point of view, identifying what could be achieved through market forces emerges as the first task for policy makers in immature industries. Then the question arises of how to generate maximum welfare through the existing limited resources in the relevant broadband market. In addressing this issue, inter-platform or facilities-based competition should be taken as a priority, even in an immature industry.<sup>14</sup> It is becoming more apparent in time that service models and products

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<sup>14</sup> Many studies prove that there is no empirical support towards the positive correlation between service-based competition and broadband penetration increase. See Bouckaert, J., Van Dijk, T., and Verboven, F., (2010). Access regulation, competition, and broadband penetration: An international study, *Telecommunications Policy*, Vol. 34, p. 670, reading "... [d]ifferent modes of competition, as implied by different regulatory choices by policy-makers, are also responsible for differences in performance: inter-platform competition encourages broadband penetration, whereas service-based intra-platform competition forms an impediment to penetration". See also Choi, S. (2011). Facilitates to service based competition, not service to facilities based for broadband penetration: A comparative study between the United States and South Korea, *Telecommunications Policy*, Vol. 35, p. 815, reading "[F]acilities-based competition policy appears to spur higher broadband diffusion by lowering entry barriers with financial support of government in the case of South Korea. Service-based competition, which seemed to be

including LLU do not promise a way for product differentiation and innovation which are lacking in many immature industries including Turkey.

In the light of the above facts, competitors need to be given correct signals to invest in alternative fibre networks through innovative access.<sup>15</sup> In advance of elaborating the reach of market intervention for NGA purposes an answer to the question of how the required level of investment to achieve massive scales can be realised is sought in the paper. To provide context, the history of broadband development and the regulatory landscape in Turkey as well as the existing competition patterns are first discussed. After the market needs are clarified the comparative costs of LLU and NGA business models are explored and new areas of regulation are identified.

### **III. CHALLENGES AND OPPORTUNITIES FOR THE TURKISH BROADBAND MARKET**

Until 1994, telecommunication services in Turkey were provided by the state-controlled Posts, Telegraph and Telephone Administration (PTT). These services were transferred to Türk Telekom with exclusive rights over establishment and operation of all telecommunications networks in June 1994. Operation of the cable network was also carried out by Türk Telekom via a revenue-sharing model with sub-contracting cable firms until April 2005, when it was transferred to Türksat, a state-owned satellite and cable TV operator.<sup>16</sup>

Liberalization of fixed telecommunications services in Turkey became effective January 1, 2004. Following liberalization, a number of class licences were granted to new entrants for a number of areas, including cable platform services, provision

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unsupportive to promote broadband diffusion in the case of US, can function to deter overbuild of facilities and lessen the financial burden of broadband providers after the establishment of facilities-based competition”.

<sup>15</sup> See Blankart, C. B., Knieps, G. and Zenhäusern, P. (2007). Regulation of New Markets in Telecommunications: Market Dynamics and Shrinking Monopolistic, *European Business Organization Law Review*, Vol. 8, p. 422.

<sup>16</sup> Meanwhile, Türk Telekom was (partially) privatised, and 55% of its shares have been acquired by Oger Telecom in return of 6.55 billion USD after a tendering made in November 2005. In April 2008, Oger Telekom bought some additional shares of Türk Telekom, once 15% of the state-owned shares have been put on sale to the public.



of infrastructure, and internet service provision. Broadband development in Turkey started in the cable industry in 2000 on the basis of a revenue-sharing agreement between Türk Telekom and (unlicensed) cable firms. However, no competition from cable companies emerged since their coverage was limited to 21 cities whereas Türk Telekom adopted a strategy of investing in DSL nation-wide. For the time being, DSL covers 98% of the country. Türk Telekom's strategy of accelerated DSL roll-out made broadband competition dependent on access to the copper network until today.

Until its privatization, Türk Telekom was providing both retail broadband services to the end-users and wholesale DSL services to Internet service providers (ISPs). The Competition Authority rendered a decisive opinion setting forth the prescribed conditions for privatization. This decision held that TTNNet, who has formerly been managed under Türk Telekom as a unit dedicated to offering Internet services, should be separately organised in a distinct legal entity with the view to eliminating cross-subsidy and making relevant costs transparent. Upon this opinion, which subsequently was reflected in the tendering process, Türk Telekom was restructured post-privatization as a provider of wholesale Internet (access) services only. Provision of (retail) Internet services was transferred to TTNNet, who has started its activities as an ISP in June 2006. At present, there are nearly 150 authorised ISPs offering broadband services, yet only 36 of them are actively competing with TTNNet, having signed wholesale broadband agreements with Türk Telekom.

Many variables could be used to document the status of the Turkish broadband market. In the context of this paper, high-speed broadband coverage, the penetration rate, and the levels of service/facilities-based competition shall be touched upon briefly.

By the end of 2011, the number of DSL subscribers in Turkey reached 6.7 million if all the fixed access technologies are included. Given that the Turkish population is exceeding 74 million, this corresponds to a penetration level of 10.3%, which places Turkey at the bottom of the OECD countries. However, 49% of the population report using the internet, and internet household penetration is 40%, placing Turkey in a somewhat better position with regard to internet usage.<sup>17</sup>

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<sup>17</sup>Information and Communication Technologies Authority (ICTA), (2012). Market Figures, [http://www.btk.gov.tr/kutuphane\\_ve\\_veribankasi/pazar\\_verileri/ucaylik11\\_4.pdf](http://www.btk.gov.tr/kutuphane_ve_veribankasi/pazar_verileri/ucaylik11_4.pdf), last visited by 30.03.2012, p. 28-40.

**<Table 1> List of Selected OECD Countries by broadband penetration<sup>18</sup>**

Country	Number of Subscribers	Penetration (subscribers per 100 inhabitants)
United States	84.672.000	27.3
Japan	34.360.672	27.0
Germany	26.615.000	32.6
France	21.895.000	33.8
United Kingdom	20.274.861	32.6
Korea	17.604.503	36.0
Italy	13.507.951	22.3
Mexico	11.753.458	10.9
Spain	10.933.389	23.7
Canada	10.653.342	31.2
Turkey	7.315.418	10.3

26% of the households can get a broadband speed of 30 Mbps or higher. Fibre access networks reach 9% of the households, which is approximately double the level of the EU average, representing a good starting point for high-speed broadband competition. Nevertheless, among fixed broadband technologies, DSL dominates the retail market with a market share of 88%. Cable and fibre internet follow DSL respectively with 6% and 3.5% market shares. The data indicate that in Turkey inter-platform competition is very weak or non-existent; competition is predominantly realised at the service level.<sup>19</sup>

Demand for high-speed broadband demonstrates a great potential for Turkey. Monthly average capacity demand of DSL subscribers has steadily increased at a rate of about 4%. The average capacity demanded in terms of download speed trebled with an increase of 200% during the period of last 30 months. This reality points to a need for a transition from copper to fibre and the market is forced to increase high-capacity deployments, which will often be fibre, by this demand

<sup>18</sup> OECD (2012). Fixed and wireless broadband subscriptions per 100 inhabitants, [http://www.oecd.org/document/54/0,3746,en\\_2649\\_34225\\_38690102\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/54/0,3746,en_2649_34225_38690102_1_1_1_1,00.html), last visited by 30.03.2012.

<sup>19</sup> ICTA, (2012). Market Figures, [http://www.btk.gov.tr/kutuphane\\_ve\\_veribankasi/pazar\\_verileri/ucaylik11\\_4.pdf](http://www.btk.gov.tr/kutuphane_ve_veribankasi/pazar_verileri/ucaylik11_4.pdf), last visited by 30.03.2012, p. 30.

pressure. Given this fact, competing operators upgrade their networks in order to meet the increasing demand, even though making progress mainly in local areas and constrained by limited resources. In fact, Superonline is the single operator choosing to deploy its own fibre access network, whereas the incumbent is determining the innovation path of the industry by deploying FTTC and FTTB across the country.

On the other hand, the current access models used by the ISPs provide no signal for inter-modal competition: While the number of bitstream access and resale subscribers reached 6.7 million, the total number of LLU subscribers was only 8,521 by the end of 2011<sup>20</sup>. BSA is chosen for 99% of the DSL lines. The share of simple resale is only 0.9% in wholesale broadband access markets, and 0.1% is based on LLU. This situation is aggravated by the long-lasting retail dominance of TTNNet, the subsidiary of Türk Telekom, over DSL lines.<sup>21</sup> Considering all these facts together, Turkey's development story reveals a rather diverging pattern from EU.<sup>22</sup>

Mobile broadband has a very low market share in terms of the capacity used (downloaded data amount), but the number of 3G broadband users is growing fast and has reached 6.4 million, after a 345% annual increase over the last year. On the other hand, considering the number of subscribers, the annual increase of DSL lines has been stagnant and stuck at the level of 2%. Although a negative correlation could be gauged between these two trends, the slow growth of DSL reflects that almost all the ISPs rely on the network facilities offered by the fixed incumbent, who has been strategically promoting BSA for the years. The current situation of BSA in Turkey

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<sup>20</sup> ICTA, (2012). Market Figures, [http://www.btk.gov.tr/kutuphane\\_ve\\_veribankasi/pazar\\_verileri/ucaylik11\\_4.pdf](http://www.btk.gov.tr/kutuphane_ve_veribankasi/pazar_verileri/ucaylik11_4.pdf), last visited by 30.03.2012, p. 37.

<sup>21</sup> Since mid-2006, which marks the date of divestiture of TTNNet from Türk Telekom, the increase of the market shares of all ISPs other than TTNNet has been at around 14.2%. TTNNet now holds a 89% market share in the DSL retail market and 81% of the market in fixed broadband if all the fixed technologies (fibre, cable) are included (ICTA, (2012). Market Figures, [http://www.btk.gov.tr/kutuphane\\_ve\\_veribankasi/pazar\\_verileri/ucaylik11\\_4.pdf](http://www.btk.gov.tr/kutuphane_ve_veribankasi/pazar_verileri/ucaylik11_4.pdf), last visited by 30.03.2012, p. 32, 38).

<sup>22</sup> It is notable that the EU average of LLU lines in the fixed wholesale broadband market is equal to 71% (European Commission, Digital Agenda Scoreboard 2011, last visited by 29.03.2012, p. 37). Incumbent share of DSL lines also denotes a very different situation. It is about 26% in UK, while the EU average is approximately 55% (ICTA, 2012, Market Figures, [http://www.btk.gov.tr/kutuphane\\_ve\\_veribankasi/pazar\\_verileri/ucaylik11\\_4.pdf](http://www.btk.gov.tr/kutuphane_ve_veribankasi/pazar_verileri/ucaylik11_4.pdf), last visited by 30.03.2012, p. 39).

does not allow product differentiation, and this does not constitute a sustainable model for the future. BSA as the entrenched model in the broadband market is an outcome of promoting access and pricing conditions that favour market entrants, but it also is a result of ISPs' short-term strategies towards capturing market penetration even in return for very small margins. The limited strategies and business models are also a consequence of the inability of ISPs to provide triple-play services over Türk Telekom's network because of numbering delays and/or number portability problems. Moreover, they reflect the legal/judicial problems concerning local telephony services that lasted for a two-year period.<sup>23</sup> The result is neither inter-modal competition nor intra-platform competition (based on the same access model).

While the above problems are related to the absence of comparable fibre networks across the country, efforts toward an increased pace of FTTX deployments are gaining momentum. Notwithstanding, fibre investments of alternative operators have so far not been spread out across the country but focused on specified regions, particularly in metropolitan areas.<sup>24</sup> Türk Telekom is not widely spreading its VDSL2 ports across the country but is planning to deploy FTTH/B in new settlement areas and to replace the existing copper lines with fibre in other areas at an increasing pace. Consequently, only a small portion of the subscribers is now being served by FTTX. The rest of the population is currently deprived of high-speed and innovation-enabling broadband (NGA) networks unless concrete and long-term measures are put in place. However, a transition to NGA from the entrenched BSA model poses high uncertainty for market actors in view of the long rate-of return periods and limited investment capacities of operators. As there is no fiscal policy and no financial instrument specifically adopted by the state for transition to NGA (e.g., state aid or tax rebates), the lack of large-scale

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<sup>23</sup> Regarding the competitive environment, access products, and the cornerstone developments in broadband regulation in Turkey, see Unver, M. B. (2010). Exploring the Ways to Create a National Broadband Policy: A Critical Discussion on the Main Drawbacks and Possible Measures for Turkey, *Competition Journal*, Vol. 11, No. 2, <http://www.rekabet.gov.tr/dosyalar/dergi/dergi47.pdf>, last visited by 29.03.2012, p. 183-253.

<sup>24</sup> Currently, alternative FTTX investments in Turkey have been pursued on a limited basis by a few operators, among whom, Superonline is the leading one. At the end of 2011, Superonline, by using alternative transmission grids (rented from municipalities and natural gas utility) as well as its own infrastructure, has reached 27 000 km fibre network. Superonline, who has been offering FTTH on an increasingly wide scale, has gained near 267,000 fibre subscribers at the end of 2011.

commercial initiatives, in absence of a clear-cut regulatory strategy, would risk the creation of a monopolistic or oligopolistic market structure. Therefore, minimizing the level of uncertainty and emergence of NGA competition out of market forces arises as a matter of regulation that needs careful consideration in Turkey.

#### **IV. A COMPARATIVE ANALYSIS OF LLU AND FTTX**

From the above discussion it is implied that FTTX compares with the last rung of the copper ladder (local loop) in the sense that both require additional investment for BSA operators. To better understand the options for a going-forward strategy, a comparative costing analysis with regard to a probable transition to FTTX and LLU from BSA emerges as an important need from a regulatory viewpoint. To respond to this need and to draw a clearer perspective for investors, we have decided to clarify the time required to reach the profitability threshold for LLU and FTTX. A quantitative analysis was conducted in order to identify the pay-back (rate-of-return) periods and break-even points for LLU and FTTX (within the form of FTTB)<sup>25</sup> on the basis of the data for Turkey.<sup>26</sup>

Within the cost-revenue analysis, demand-side needs and expectations are evaluated in a comprehensive manner. For the basic analysis, we took subscriber density, civil engineering work configuration, cost evaluation of components and demand assessment (prospect of service penetration) into consideration. Before delving into the details of the analysis and the findings, each technology and access model—BSA, LLU and FTTX—shall be briefly explained.

In the BSA model, operators seeking access face wholesale (monthly and one-off) fees, energy and rental prices, backhaul transmission costs, and some other operational expenditures like managerial, marketing and R&D costs.

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<sup>25</sup> In the paper, it is assumed that FTTB network was deployed, and following this standpoint cost of passive optical network architecture is included to the calculations.

<sup>26</sup> In the appendix of the paper, the assumptions lying behind the quantitative analysis including the number of exchanges and subscribers factored into the evaluation of income per subscriber, constituent elements of pricing of each model (e.g. transmission, multiplexer, etc.), common cost items pertaining to each model, topological assumptions for building a new fibre network, the pace of gaining subscribers, etc. are explained.

In the LLU model, in addition to the operational expenses, an operator faces monthly rentals (for line and block usage), prices for co-location, energy, device usage and backhaul transmission costs<sup>27</sup>.

FTTX platforms, although allowing significant opex savings, require great capex (network deployment costs). Fibre deployments include a number of cost drivers, which change on the basis of the technology and equipment used, and function as a means of differentiation. These include F/O cable costs (like feeder, distribution, drop, cable assemblies); passive hardware & equipment costs (e.g., couplers/splitters, connectors, enclosures, splice closures, racks/trays/cassettes); and installation and labor costs (e.g., cable preparation and installation, hardware installation, splicing, termination). In a longer-term perspective, the network architectures and technologies also vary by cost, feasibility risk, flexibility, scalability, complexity, demand structure of market and some other reasons. Fibre platforms offer an advantage, compared to other networks, with their far-reaching social and economic benefits. Fibre has a virtually unlimited bandwidth capacity, and is therefore capable of meeting increasing market and traffic demand. Increasing consumer needs towards innovative services that boost higher bandwidth capacity and introduction of newly growing fibre technologies globally spur the transition from copper to fibre.<sup>28</sup> On the other hand, the timing to invest and strategic choices as to FTTX technologies differ among countries and operators.<sup>29</sup>

As the different access models include different cost items and risk considerations, it is necessary to find a common instrument that would facilitate a comparison between the models. For this purpose, break-even points and pay-back periods were used in this study. *Break-even points* represent the time scales when equality is reached on a monthly basis between revenues and incurred costs. *Pay-back periods* refer to the timeframe for the return on an investment to recover the accumulated investment costs and the initial costs. Both metrics are widely used

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<sup>27</sup> 'Transmission costs' is used to mean IP transit lines rented according to the capacity needed, which is calculated by multiplying the capacity of all subscribers with a contention ratio.

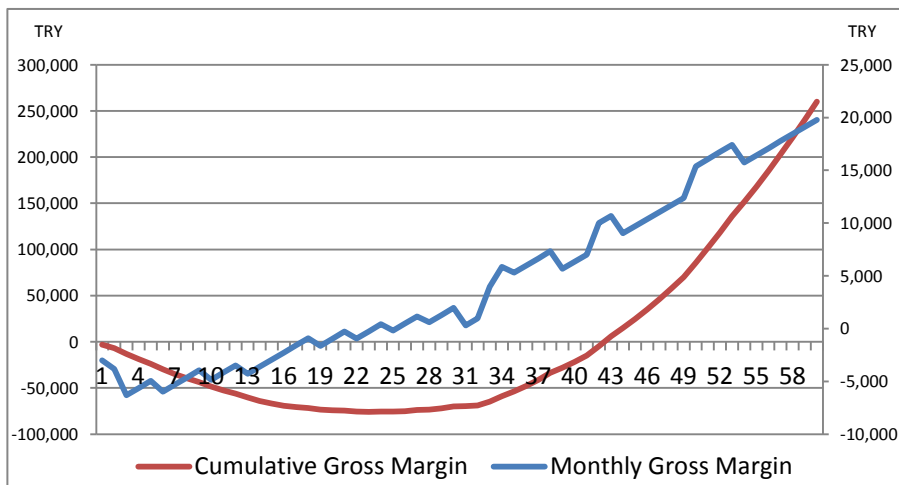
<sup>28</sup> Globally, at the end of 2009, there were close to 41 million FTTH/B subscribers or 15% more than the year before. Over the next five years, this momentum is likely to translate into a significant increase in the number of homes passed: By the end of 2014, it is foreseen that there will be close to 306 million homes passed for FTTH/B, of which more than half will still be located in Asia and 18% in Western Europe (IDATE Press Release, 25 October 2010), <http://www.idate.org/en/News/>, last visited by 30.03.2012.

<sup>29</sup> See *supra* note 9.

instruments in developing investment strategies and business plans. In this study, common and general costs pertaining to LLU and FTTB model were eliminated to simplify the analysis. Only the specific cost items related to each model were taken into consideration, and other operational expenses such as financial, managerial and business-related cost items were ignored. Also, the present value of the future income and operational and capital expenses were ignored in the model. Net present value of income and expenses was not calculated as they are assumed to have been constant during the analysis period, and are not included in the analysis to simplify the model. This seems justified because the study focuses on a comparison of alternatives. While the variables and technology used in traffic management represent more or less an equivalence for the operators entering different markets, costs used in the model analyses are unique to Turkey. These costs were either approved by the regulator or prevailed in the Turkish market commercially.

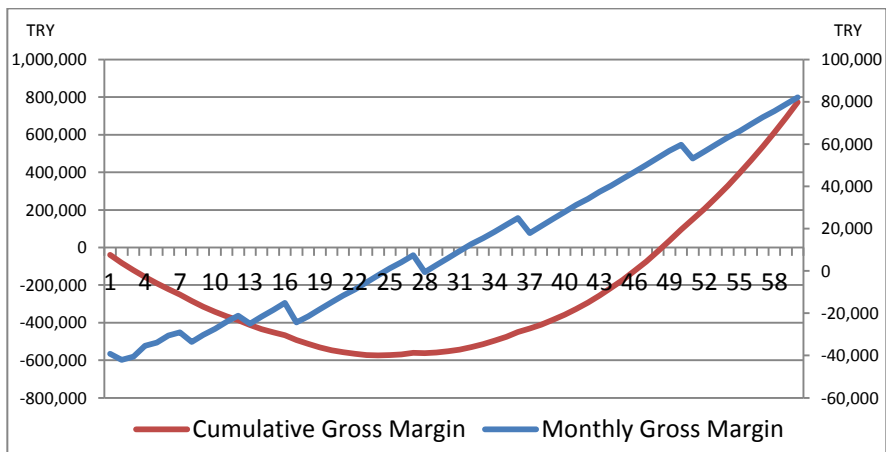
The evaluation of costs and revenues of the BSA model reveals that the break-even period is equal to 23 months. Operators experience losses in every month in their operations until the 23<sup>th</sup> month. Consequently, the operations turn profitable after 43 month, when the pay-back period for the BSA model is reached (see Figure 2).

**<Figure 1> Pay-back and break-even points of the BSA model**



In the LLU model, pay-back and break-even points are respectively 25 and 49 months (see Figure 3). Compared to BSA, a somewhat longer timeframe is needed to ensure a positive return on investment and backhaul costs of LLU, as the profit threshold is comparably higher in this model requiring a higher subscriber base for profitability. Figure 3 also shows that for an operator with the necessary capital to offer its service at the required economic scale LLU is economically more feasible than FTTB, whereas the longer-term perspective marks a contrast in view of the efficiency gains, competitive advantages and higher profits accompanied by a widening spectrum of fibre-based networks and services.

<Figure 2> Pay-back and break-even points of the LLU model

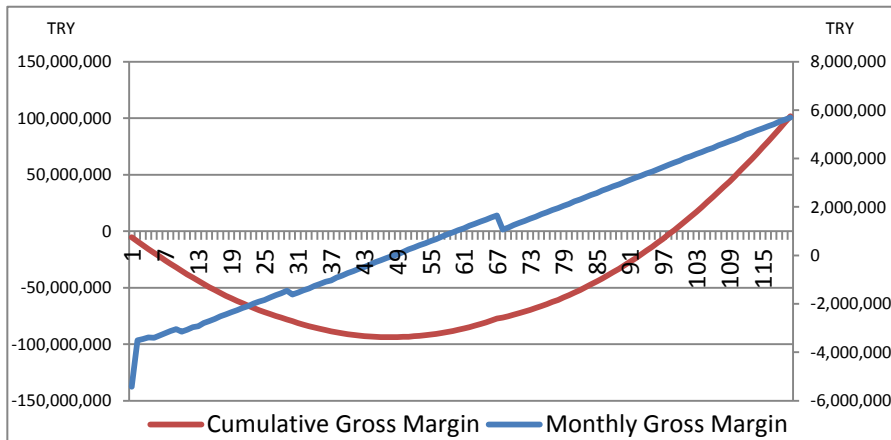


As considerable initial capital investment is required for FTTB, such operations entail a longer period to achieve a return on investment costs and to reach profitability (see Figure 4). In the FTTB model, the pay-back period is equal to a period of 99 months, which approximately doubles the pay-back periods of LLU and BSA. The break-even point is reached in month 49. An operator therefore will have to be able to incur monthly losses during a four-year period in the FTTB model. However, exceeding that point implies a great potential competitive advantage, given the fact that the growing demand requiring high-speed next generation broadband services is apparent both globally and across Turkey.<sup>30</sup>

<sup>30</sup> See footnote 28 and the information given about Turkey under the 3rd section of the paper titled 'Challenges and Opportunities for the Turkish Broadband Market'.



<Figure 3> Pay-back and break-even points of the FTTB model



## V. DISCUSSION AND LESSONS

The above comparative analysis depends on market data and the utilised numbers and assumptions. Nonetheless, it is fair to say that the results provide first hints for potential future action by policy makers in Turkey. Further evaluations are required to better understand how to achieve successful NGA competition. Such a success seems a precondition for the introduction of innovative access and sustainability, for which business models have a large role to play. To a certain extent, the financial analysis also shows the reasons why BSA has become the entrenched model in Turkey. At the same time, the results shed light on the key parameters of a successful NGA prospect for Turkey.

BSA is the forerunner access model thanks to the investments and promotions done by Türk Telekom in favour of this model<sup>31</sup> as well as the advantageous pay-back period. The unsuccessful history of pricing regulations aiming to encourage LLU,<sup>32</sup> and the failure of inter-modal competition to emerge are complementary

<sup>31</sup> The network upgrades (e.g. deployment of outdoor DSLAMs) dedicated to BSA and introduction of new BSA products (e.g. launch of “up to” packages with higher speeds) pursued by Türk Telekom in the recent years illustrate this situation.

<sup>32</sup> Despite the fact that the price-related differences (those arising out of one-off set-up fees, promotions applied to each model, transmission costs for LLU) have been minimised via regulatory interventions and reductions in the last two years, LLU investments have not increased meanwhile.

reasons. Although mandatory unbundling preceded BSA regulations, LLU has not grown and is not widely adopted in Turkey.

Major reasons for the failure of LLU are the fact that BSA has been supported with investments (e.g., via outdoor DSLAMs), new technologies (e.g., VDSL2) and new packages (e.g., naked DSL) that meet consumer demands across the country. Moreover, the belated and unsuccessful process of liberalization has had an effect.<sup>33</sup> These reasons cumulatively impeded full unbundling. LLU not meeting the differentiation needs to the expected level as well as not being able to offer triple-play type innovative services<sup>34</sup> has also become one of the key impediments hampering success of this model.

The way forward for the BSA operators is not straightforward. The fact that Turkey, for a long time, has been facing lack of differentiation in broadband services is a crucial input affecting potential competition at all. Considering that, as of January 31, 2012, more than 99% of all DSL subscribers use the BSA model one could conclude that Turkey's differentiation needs are closely tied to its NGA prospects. Not only the emerging innovation models but also Turkey's penetration and information society needs could be addressed with NGA. The current fixed broadband platforms do not promise such progress and are of limited help in Turkey's long path to closing the digital divide. Limitations regarding LLU in conjunction with the overarching bandwidth demands and digital divide point the way to NGA transition. It should also be kept in mind that contemplation of similar reasoning is not directly applicable to Asian and EU countries because they have had a historical experience of either inter-modal or inter-platform competition following liberalization. By contrast, in Turkey without injecting competition via a NGA blueprint, it seems no longer possible to create a competitive marketplace in the traditional broadband platforms. Nor does it seem possible for Turkey to close

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<sup>33</sup> The so-called other reasons behind the historical process consist of the delayed fixed number portability and number allocations, the legal and judicial barriers that blocked the local voice telephony services being opened to competition (For the details regarding this process, see Unver, *supra* note 23, p. 199-200).

<sup>34</sup> While triple-play services are brought via LLU operators across EU, this development history has not happened in Turkey mainly because of the lack of synchronization between LLU and liberalization of fixed telephony services. While the former was mandated in 2005 resulting with the first lines rented at the beginning of 2008, the legal barriers against fixed voice liberalization (for inner-city calls) were barely removed in the second half of 2009. Meanwhile, BSA has been the entrenched model of ISPs who first aimed at market penetration and set up their operations accordingly.

the gap in broadband penetration and the digital divide without a more advanced and clear-cut policy mechanism.

Taken all these factors into account, it seems critical to have access products that allow innovative retail services in the emerging NGA environment. Therefore, allowing the choice of wholesale NGA access model will be as crucial as the encouragement of fibre deployment (e.g., via some pricing rules). In order to achieve the purpose of *innovative access*, access to active and passive infrastructure (e.g., *point-to-point fibre unbundling, point-to-multi point access to end users (via GPONs), dark fibre provision, duct and facility sharing*) a number of regulatory choices are relevant. Against such possibilities, the remainder of the paper focuses on an analysis of duct sharing and fibre unbundling, which are acknowledged as widely used effective tools for achieving the abovementioned NGA purposes.

In investing in NGA type networks and services, capital expenditures and accumulated cash flow are of high importance. Building a new infrastructure requires civil engineering operations, deployment of fibre cables, and installment of the equipment and software on the exchange and end-user sides. All are long-lasting, potentially troublesome and difficult processes. In this respect, Türk Telekom, like fixed incumbents in other countries, enjoy competitive advantages compared to its competitors in terms of local access segments. It is crucial that this superiority not be transformed into a bottleneck during the emergence of NGA platforms, which are currently passing through their infancy.<sup>35</sup> At this juncture, duct sharing stands out as a possible solution as it can allow follow-on innovation. Moreover, it may help ensure effective competition without threatening the fibre investments of access providers. While achievement of a level playing field can be deemed as the common denominator of fibre unbundling and duct sharing, the former would not be sustainable in the long term as incumbents could get a biased position against it by labelling the fruits of unbundling as undeserved and disincentivising future NGA deployments.<sup>36</sup>

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<sup>35</sup> Concept of emerging market is not applicable to a marketplace where competitive infrastructures are absent. This fact is stated by Blankart et al as follows: “[A]s far as infrastructure is concerned, one has to distinguish between competitive infrastructures and monopolistic bottlenecks. Regulation is required only for the latter, as duplication is unreasonably expensive. The former, however, should not be regulated, as barriers to entry are absent”. (Blankart, Knieps and Zenhäusern, *supra* note 15, p. 420).

<sup>36</sup> While characterization of natural monopoly in combination with sunk costs is peculiar to building of new ducts, the same is not directly applicable to the fibre deployment itself. See also

A roadmap toward effective and long-term competition cannot rely on mandatory (copper) unbundling, which has failed to inject broadband competition in Turkey. Although fibre unbundling would ensure faster market entry and short-term competition on the same infrastructure, simply replicating models of other countries (e.g., Sweden) where unbundling has been successfully implemented does not appear to be the right solution, given the different starting conditions. The unsuccessful history of copper LLU in Turkey requires more than a fine-tuning approach for NGA. At this juncture, a long-term and large-scale remedy would largely be effective to solve the key dilemma between ensuring competition and preserving incentives for investment in the NGA.<sup>37</sup>

Remarkably, this trade-off decision is of high importance for the necessity of eliminating the possibility of duplicate infrastructures, which is a serious requirement for an immature industry. Considering the fact that the public works (civil engineering) component is roughly 70% of the total cost of the network roll-out,<sup>38</sup> it is possible to say that the marginal benefit of fibre unbundling does not guarantee and warrant entrances of “reasonably efficient” operators into the market.<sup>39</sup>

Duct sharing fits all types of business models and FTTX type network hierarchies, e.g. point-to-point deployment or combination of fibre with copper/Ethernet. Each fibre provider could meet consumer demands within a range of solutions, collaborative actions and innovations via this remedy. This feature implies a competitive race for the creation of individual fibre networks. It also

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Blankart, Knieps and Zenhäusern, *supra* note 15, p. 426-427. As a corresponding fact, duct sharing would constitute a better way of optimizing the resources since de facto contemplation of inefficient new entrances could not be linked to this way of granting access as passive infrastructure means an already established network before the incumbent under huge public investments.

<sup>37</sup> See Cave, M. (2010). Snakes and ladders: Unbundling in a next generation world, *Telecommunications Policy*, Vol. 34, No. 1-2, p. 85, reading “Whereas the costs of the copper network were sunk a long time ago, NGAs in most countries are still in the course of construction; unless large scale duct-sharing is attainable, the regulator is thus confronted by an apparently intractable conflict between promoting competition on the network and creating incentives to build it in the first place”.

<sup>38</sup> See OECD (2008). Broadband Growth and Policies in OECD Countries, OECD, Paris, <http://www.oecd.org/dataoecd/32/57/40629067.pdf>, p. 34, last visited by 30.03.2012. See also the results of the calculations based on market data shown under the Appendix.

<sup>39</sup> On the other hand, the same could not easily be contemplated for duct sharing as the market players dependent on this model have to be more investing and innovative, facing a longer rate-of-return.

renders fibre unbundling unnecessary in the long run.<sup>40</sup> Distinctive approaches of the public stakeholders with regard to granting access to their (utility) infrastructures in a country (e.g. such in Turkey) may also be deemed a critical factor pointing to the need to open the available ducts owned by the incumbent.<sup>41</sup> What's more, the essential facility doctrine, which has become a source of inspiration for many access regulations, serves as a rationale to mandate third party access to civil engineering infrastructure.<sup>42</sup>

In fact there is no duct market promulgated by regulators within the meaning of the widely acknowledged regulatory rules. For instance, the EU Framework Directive considers 'facility or property sharing' as a bottleneck (in other words an 'essential facility'), making a distinction between other access obligations imposable on significant market power (SMP) undertakings.<sup>43</sup> This demonstrates that open access to the ducts is a legally acceptable regulatory path within the NGA context. As implied above, while ducts, most of which are controlled by incumbents, denote a natural monopoly, installing electronic equipment and cabling represent a less onerous and difficult process of building an individual FTTH/B platform.<sup>44</sup>

While fibre unbundling is a remedy enabling competitors to provide NGA services through the same platform in return of a rental fee, the technical details and processes pertaining to unbundling require a long timeframe.<sup>45</sup> Solving new issues such as the dismantling of equipment (e.g., DSLAMs), and copper lines could easily delay the process.

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<sup>40</sup> See Bauer, *supra* note 2, p. 6, reading "[I]n the absence of unbundling rules, the likelihood that multiple investors will initiate projects in different locations is increased. Whereas this may not initially lead to parallel investment in any location, a diverse market structure may emerge with alternative providers co-existing in sufficient proximity to exert credible competitive threat".

<sup>41</sup> Even in the countries (e.g. Portugal) where both incumbent ducts and utility infrastructures have been mandated for third party access, the former is preferred by the access seekers to a great extent.

<sup>42</sup> A. Renda, Competition-regulation interface in telecommunications: What's left of the essential facilities doctrine?, *Telecommunications Policy*, Vol. 34, No. 1-2, p. 32.

<sup>43</sup> See Directive (EC) 2002/21 of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services, 2002OJ L108/33 (Framework Directive), [http://ec.europa.eu/information\\_society/policy/ecomm/doc/140framework.pdf](http://ec.europa.eu/information_society/policy/ecomm/doc/140framework.pdf), Article 12.

<sup>44</sup> See *supra* note 36.

<sup>45</sup> By contrast, if detailed provisions are available for duct sharing, this means there is no room for further regulatory micro-management by introducing fibre unbundling (See also Renda, *supra* note 42, p. 33). Turkey's position reminds this fact as regulatory prices, terms and conditions, which are currently applicable to duct sharing for backhaul services, are in force. This favourable situation makes application of duct sharing easier when compared to unbundling in the context of NGA.

In order to meet operators' infrastructure needs and to turn duct sharing into a long-term and effective tool, dark fibre provision also needs to be mandated in certain circumstances, such as when there is no capacity in the existing ducts. Mandatory dark fibre provision, which is implemented in many EU countries in addition to access remedies, is generally used for the backhaul purposes. Such a complementary measure may also be required for local access segments because capacity restraints could sometimes affect the feasibility of existing ducts. Dark fibre provision in combination with duct sharing would pave the way for operators to create their respective individual networks and effectively compete against the incumbents.<sup>46</sup>

Last but not least, next generation operators' needs would not be fully met by horizontal type access (passive infrastructure) remedies as the final reach of fibre deployments cover vertical access to the end-users. This final phase, unless solved via negotiation or compulsory obligations, would result in serious conflicts of interests and/or the possibility of duplicate in-building wiring by entrepreneurs. To handle this matter, a symmetrical approach over this last mile issue would be appropriate as applied in many countries (e.g., France, Portugal) given the fact that each fibre provider would seek to be the first to enter buildings and retain this first-moving advantage.<sup>47</sup> Introduction of specific products such as access to dark fibre and building cabling, whilst completing the level playing field for NGA competition, also imply that every regulator and policy maker has to have a broader mind and a holistic approach to ensure a functioning NGA competition.

## VI. CONCLUSIONS

In Europe and many other countries, competitors' capabilities to replicate network elements are assessed by regulators. A number of access and pricing obligations are

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<sup>46</sup> However, for dark fibre provision and duct sharing to be a reliable and applicable tool, existing underground facilities (e.g. manholes, ducts, conduits) and their feasibility should be tested in advance. To that end, creation of database demonstrating all the available ducts and their capacities needs to be taken as a priority as Portugal did. Otherwise, the potential benefits to be reaped from duct sharing could be so limited, resulting in many unforeseen results and complications.

<sup>47</sup> Yan, X., and Xavier, P. (2010). Access to in-building wiring as a barrier to local fixed network competition: The case of Hong Kong, *Telecommunications Policy*, Vol. 34, No. 1-2, p. 45-53.

imposed on SMP operators after a market analysis based on a forward-looking approach. Such an approach is inspired by the ‘ladder of investment’ model. On the other hand, growing technologies and business plans require building new investment ladders for NGA networks and services. However, NGA investment requires high capital expenditures and is fraught with demand uncertainty. This raises a dilemma between creating incentives to invest in NGA and ensuring competition among players. Immature industries, which are characterised by innovation weaknesses and a lack of differentiated products, constitute a special case regarding (NGA) investment ladders. They often stay on one of the copper rungs and not climb up the upper ones that require more investment. Using the case of Turkey and putting it into the broader context, this study reveals the fact that such immature industries are in need of FTTX deployment because of the deficiency of non-differentiation as well as inadequate broadband penetration. In fact, the literature and the former experiences of Turkey reveal important signs demonstrating the necessity of inter-platform competition to fill gaps in availability and use. Yet like most other immature industries, Turkey does not have reliable and long-term strategies that would introduce sustainable competition and threaten the entrenched products of the fixed incumbent. Generally this is the outcome of insistent and strategic promotions towards IP-level BSA, which has been the ISPs’ primary access model for a long time despite regulatory measures that encouraged LLU.

The attractiveness of the BSA model cannot be eliminated unless a completely alternative competitive strategy is adopted in Turkey. That is not to say BSA type service-based models do not promise consumer welfare, and/or a mix of service and facilities based competition is no longer possible. The challenge put forth in this paper is the fact that a key input of product differentiation, an issue lacking in the Turkish broadband market, would effectively be provided via NGA competition and the innovation enabled by it. In order to turn the NGA opportunity into a value chain, and to prevent BSA from recurring the competition pattern, a path of facilities based competition emerges as a pressing need for Turkey. Following the notion of ‘best allocation of resources’, well-advanced access products and long-term policies are required to make Turkey reach its ICT goals to have access to more differentiated, innovation-inclusive, high-speed broadband networks and products.

On this road, Turkey will need to optimise incentives to invest in NGA by putting a regulatory model into effect that facilitates competition across the industry. Although the NGA pay-back period (99 months) doubles that of the copper LLU (49 months), NGA competition, offering efficiency gains as well as other social and economic benefits (e.g., spillover effects for employment, education, healthcare, etc.) in the long run, is required to achieve the intended level of innovation. To close this innovation gap, this paper argued that mandatory duct sharing is the more preferable and effective option, compared to fibre unbundling. Open access to the incumbent's country-wide ducts would ensure a level playing field for new entrants by enhancing their innovation capacity. Having a potential to offer a self-sustaining NGA environment by stipulating a certain level of efficiency as well as preventing duplicate civil engineering infrastructures, duct sharing keeps every stakeholder, including the incumbent, motivated to invest in FTTX. The dilemma between ensuring competition and enhancing investment incentives in the NGA context would effectively be solved with a long-term and large-scale remedy such as duct-sharing rather than a short-term and straightforward measure like unbundling. To facilitate NGA investment and complement the overall picture, dark fibre provision would be a critical supplementary tool particularly where there is no capacity in the existing ducts. Also, vertical remedies, i.e. in-building wiring such as those invoked in France and Portugal, would be necessary in the long run particularly for the purpose of country-wide FTTX deployments. Without these two complementary steps, mandatory duct sharing would be an incomplete step.

To sum up, conventional methods of stimulating intra-platform competition face serious shortcomings in immature industries in absence of alternative investment ladders and effective wholesale products for FTTX type business models. Using Turkey as an example, the paper argued that the ICT market in countries with similar challenges often needs further product differentiation, more innovation capacity and high-speed broadband platforms in competition. Often, these cannot be achieved via the entrenched service models and remedies. The need to eliminate the risk of inefficient entry and to ensure sustainable competition requires these industries to optimise access products and to make all efforts for the best use of resources. To incentivise entrepreneurs in order to realise higher speeds, competing and innovative products, enforcing mandatory duct sharing, and complementary remedies of dark fibre provision and in-building wiring are important tools for policy makers and regulators.



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## <APPENDIX>

Within the scope of this study, for the three alternative models (BSA, LLU, FTTB), several assumptions were made in calculating the break even points and pay back periods. Some of the values used in the calculations are subject to regulation and are determined by the regulatory authority, some others being market based priced. Table 2 lists the numbers used in the scenarios.

**<Table 2> Cost levels and assumptions used in the model calculations**

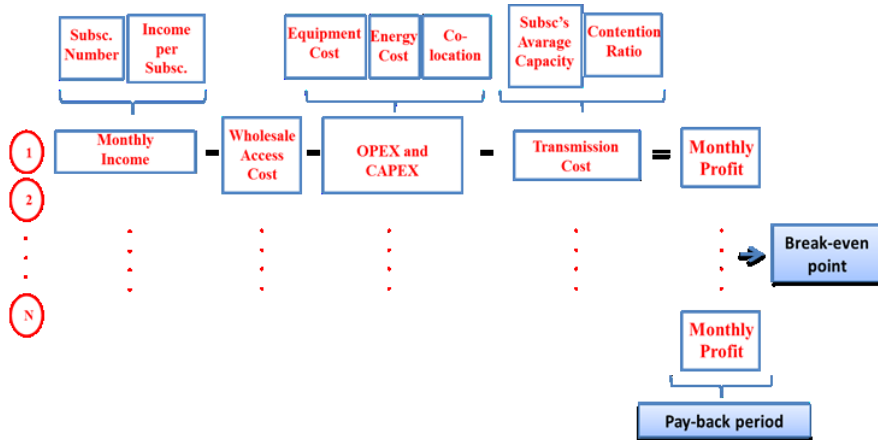
BSA Model Assumptions	Subscriber number at the end of the period	10.000
	BSA POP	1
	Subscriber per POP	10.000
	ARPU (TRY)	26
	Monthly churn rate	0
	Co-location price (TRY)	63
	Energy cost of router (TRY)	215
	Monthly wholesale cost per subscriber (TRY)	17
	SSG cost (TRY)	30.000
	Ethernet switch cost (TRY)	2.250
	Survey cost (TRY)	420
	Application cost (TRY)	420
Uplinks (TRY)	2.000	
LLU Model Assumptions	Subscriber number at the end of the period	10.000
	Number of co-located exchanges	20
	Subscriber per POP	500
	ARPU (TRY)	26
	Monthly churn rate	0
	Co-location price(TRY)	63
	Router energy cost of router (TRY)	215
	Energy cost of DSLAM (TRY)	753
	Monthly wholesale cost per subscriber (Shared Access) (TRY)	6
	Multiplier of block numbers	90
	Block rental	22
	Port per DSLAM	768
	50 Additional port	1.558

	DSLAM cost (TRY)	7.984
	SSG cost (TRY)	30.000
	Ethernet switch cost (TRY)	2.240
	Survey cost (TRY)	420
	Application cost (TRY)	420
	Uplinks (TRY)	2.000
NGA Model Assumptions	Subscriber number at the end of the period (for 60 months)	50.000
	Fibre exchange number	5
	Subscriber number per exchange (for 60 months)	10.000
	ARPU	118
	Churn rate	0
	Ethernet switch price (TRY)	31.000
	Switch installation and maintenance cost	6.000
	MDU cost	375
	Number of accessed buildings	10.000
	Home per apartment	20
	Digging cost (m)	70
	F/O cable cost (m)	3
	Network project cost (TRY/km)	1.500
	Total network distance (km)	1.540
	Total cable distance (m)	555.199
	F/O cable depreciation life (year)	20
	Project cost per POP	462.000
	Digging cost per POP	21.560.000
Cable cost per POP	277.600	
Average cable distance per POP	111.040	

The monthly profit was calculated by deducting the monthly costs from income. If monthly profitability reaches zero, the relevant time point is designated as the break-even point, and if accumulated profitability after a period is zero, the relevant timeframe is designated as the pay-back (return of investment) period.

The calculation methodology used for BSA and LLU models is shown in above figure.

<Figure 5> Calculation methodology of the BSA and LLU models



In LLU and BSA models, monthly profit was calculated by deducting the monthly wholesale access rentals, co-location fees, equipment, and transmission costs from monthly income, which was calculated by multiplying the number of subscribers with the monthly revenue per subscriber. In the NGA (FTTB) model, instead of monthly wholesale access fees, infrastructure installation costs were taken into account. In these three models, it was assumed that the number of subscribers was going to increase during the period and to reach 10,000 at the end of the 60-month period.

Subscribers' preferences for the current tariff packages in the Turkish DSL market were taken into consideration to calculate revenues per subscriber in BSA and LLU models. On the other hand, average tariff package fees, already in force, were taken into account to calculate revenue per subscriber as to the fibre broadband services. In each of the three alternative calculations, to determine the income levels, similar assumptions were made in relation to the number of subscribers and the revenue per subscriber. Besides, fees approved by ICTA and relevant operators' data and equipment cost (based on the applicable charges in the market) were also taken into account to calculate the expenditure levels.

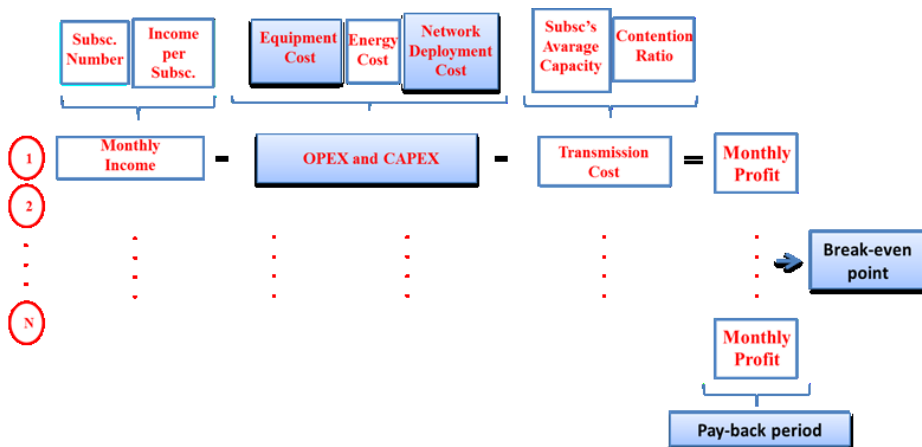
Distribution of subscribers among the current tariff packages was also taken into consideration in the BSA model, and weighted average wholesale access charge was used in this regard. On the other hand, bandwidth demand of subscribers (for carrying them to internet backbone) was taken into account in determining the

transmission costs, and total capacity needed for transmission was calculated on the basis of certain contention ratio. It was assumed that the contention ratio was to decrease in parallel with the increase in the number of subscribers. This ratio reduced during the time as foreseen. Other crucial BSA cost items used in the analysis were those of the equipments such as switch, router and their installation costs, the co-location and energy expenses within traffic handover points.

Similar assumptions were used in the calculations regarding LLU model. Since broadband internet access was focused on in this study, shared access became the subject-matter of the analysis in this regard. It was assumed that services were to be provided through single point under BSA, and via 20 exchanges under LLU, it was thus expected that number of subscribers per exchange would be 500 until the end of 60-month period. In the LLU model, in addition to those items involved in BSA model, one-off and monthly charges of blocks installed on HDF, and DSLAM costs were included. On the other hand, the same method with BSA model was followed for calculations on transmission capacity and transmission cost regarding LLU.

The assumptions envisaged in FTTB calculation were almost the same with BSA and LLU model, but the main difference, as explained above, is there is no wholesale access cost since a new alternative network was hypothetically deployed, having required a huge level of costs. The calculation methodology of BSA and FTTB model is shown in above figure.

<Figure 6> Calculation methodology of the FTTB model



In calculation of the monthly subscriber numbers as to the NGA (FTTB) model, a similar way with BSA and LLU was followed, whereby it was assumed that there was no subscriber in the first month, and subscribers were assumed to increase by a certain percentage although a certain percentage was to leave in each month. Using this assumption, at the end of the 120-month period, the number of subscribers was found to have reached 20,000.

In the model, a fibre network was assumed to have been established with the topology of the existing copper network in five cities (İstanbul, Ankara, İzmir, Bursa and Adana) which have the highest number of subscribers in Turkey. A FTTB architecture was modelled and it was assumed that 10,000 buildings and 200,000 subscribers would be reached with an installation of approximately 990,000 fibre optic cable infrastructure.

Under the model it was assumed that the level of subscriber acquisition was at the rate of 25% with a gradually increasing trend, and it was evaluated that 50,000 fibre broadband subscribers would be reached eventually. As a result of the calculations, it was concluded that approximately 62% of the infrastructure installation was construction and digging costs, 34% was the cost of fibre cables, and 4% stemmed from costs related to devices and equipment. In the other assumptions of the NGA, the existing tariffs, subscriber growth rate, a reasonable level of contention ratio was foreseen to be the same as in the BSA and LLU models.