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Evaluation of the Government's Involvement in Digital Telecommunication Network Development in Hungary

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"It is impossible to overemphasize the correctness of Széchenyi's method: first we must help the Hungarian masses, using regulations to create a material foundation, to live a life fit for humans, and only then can we expect them to be the pillars of patriotic sentiment and culture. At the same time, this is the explanation for the meager results so far of our constant efforts to cultivate the population."

(Gyula Szekfű)

Dedication and acknowledgement

I recommend the results of my research to the attention of experts involved in the development and regulation of the digital telecommunication network, and to everyone thinking about or active in the economic development of Hungary, the improvement of its competitiveness and its social progress.

I would like to express my sincere gratitude to my supervisor, Dr. András Nemeslaki, my advisor, Pál Horváth, as well as Csaba Baboss, Győző Debreceni, András Gál, László Horváth, László P. Kovács, Vilmos Lőrincz, Norbert Madar, Dr. Zoltán Majó, Dávid Nagy, Dr. Iván Schmideg, Péter Sere, András Slyuch, Dr. György Takács, István Tétényi, Szabolcs Timár and Attila Tóth for the professional guidance and valued advice, and to my family for their vital support and encouragement throughout this work.

I. INTRODUCTION

The ever-increasing demand for information and communication technology (ICT) services and the resulting shift in consumer habits and business expectations have drawn considerable attention to the importance of the digital telecommunication network in the national economy. The development of the (information) society, along with its inevitable reliance on ICT services, is fundamentally determined by innovations in broadband infrastructure, particularly by the availability of broadband access to the digital telecommunication network.

I.1. The role of the digital telecommunication network in the national economy

As early as 2002, András Kápolnai, András Nemeslaki and Róbert Pataki pointed out in their book that “the network economy would become far more deeply embedded into society than its business scope would suggest” (Kápolnai, et al., 2002), however, considering the four prerequisites of the new economy[1], this development would be unthinkable if the quantitative infrastructure condition were not met.“ In this sense, the macro- and microeconomic issues are only secondary to the fundamental fact that a significant population must be reached by telecommunications infrastructure and network developments in order for the framework of the new economy to be created, Ádám Török writes, summing up the preconditions. He argues that “in many countries, the development of the network economy and new economy is hindered by the fact that regulatory reforms lag behind the technical advancement of telecommunications devices” (Török, 2004). A more in-depth analysis of the phenomenon is provided by András Nemeslaki, László Duma and Tamás Szántai (Nemeslaki, et al., 2004). The availability of the digital telecommunications network is the key to all information and communication

[1] The concept of the "new economy" and its prerequisites have been widely analyzed, making it possible to clearly identify the necessary conditions in terms of economic theory, corporate finance and corporate management, and infrastructure quantity (Szalavecz, 2002). Other authors have introduced a fourth, sectoral approach as well (Török, 2004).

technology (ICT) services; obviously there is no ICT-based ‘network economy’ if the network is lacking or outdated.

The lack of access to digital telecommunication networks had been an issue of concern in Hungarian society even before the concept of ‘network economy’ was introduced, since many families had needed to wait, at times, decades to have access to landline phone service prior to the political transition. However, telecommunications experts back then had already predicted that the form of access to various telecommunication services would eventually change: “Back in the 80s, when telephone meant landline and broadcasting was limited to analog terrestrial technology, some strategists already talked about a new scenario in the future. In 20 years, voice will be transmitted primarily via mobile technologies, and radio broadcasting will be replaced by cable” (Czinkóczky, 2003). In the mid-90s, the liberalization of the telecommunication market and the emergence of mobile telephony spurred competition in the market of voice services, which also stimulated the development of telecommunication networks that supported these services. However, as the Internet became mainstream in the second half of the 90s, data transfer grew explosively, prompting significant investments in telecommunication infrastructure. Infrastructure owners were urged to modernize the digital telecommunication network at an accelerated pace, which included replacing the copper-based technology with fiber optic solutions. In addition, high-risk investments led to revenue losses from plain old telephone service (POTS) and other high-yield services, escalating the uncertainties associated with the rate of return. At the same time, using simple market structure models, Péter Fülöp and Iván Major described, as early as 2004, how the process of liberalization in the ICT sector resulted in a cut-back in developments, particularly in telecommunication businesses. Their analysis points out that “contrary to the common belief that the slowdown and stagnation were caused by a drop in the stock prices of information technology firms, we argue that the decline is attributable to regulatory shortcomings in the sector” (Fülöp, et al., 2004). Unfortunately, the assumption still holds relevance today: In the majority of the EU countries (except Sweden and Finland), digital telecommunication network developments proceed at a significantly slower pace than in South Korea, Japan, or even in the United Arab Emirates (Begonha, et al., 2010).

Starting in the mid-90s onward, Internet-accessible content and the prospect of conducting business transactions online suddenly became a top priority for households, corporations and public administration alike. The increasingly easy access to information as well as the new communication channels and innovative business opportunities evidently transform the economic environment and have a profound impact on society as a whole.

“From a business-cycle point-of-view, the literature refers to the social dimensions of technological progress by the term ‘information society” (Majó, 2006). In an effort to promote the development of the information society, leaders of the European Union implemented numerous initiatives, including two important milestones: the White Paper of 1993 as well as the Bangemann Report[2] published in 1994, with the latter pointing out back then that the creation (arrival) of the information society is inevitable and is similar in scope and significance to the industrial revolution. The Bangemann Report and the Commission's work program paved the way for an action plan titled ‘Europe’s Way to the Information Society,’ which articulates the guidelines for the establishment of the information society. This publication was followed by a number of strategic documents, proposals and action plans sponsored by the European Commission, which increasingly moved into the center of attention after the Lisbon Summit in 2000[3]. The eEurope action plans (eEurope 2002, 2005 and 2010) were created to promote the concept of information society for each individual member state. Broadband infrastructure

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2 The Bangemann Report, named after Martin Bangemann, the leader of the work group, was published under the title “Europe and the Global Information Society” on May 26, 2004 and approved by the European Council at the Corfu Summit of June 1994.

3 At the summit the European Council set out its vision for Europe to become the most competitive and most dynamic knowledge-based economy of the world, capable of fulfilling the requirements of sustainable development, enhancing social cohesion, creating jobs and improving work conditions.

development as an objective was most clearly stated in iEurope 2010[4], a five-year action plan announced on June 1, 2005, with the ambitious goal to allow all citizens of the European Union to have access to broadband Internet by 2010. However, the global economic recession that started in 2008 prompted the European Commission to rethink its development plan, which resulted in the adoption of the European Economic Recovery Plan on November 28, 2008 (Communication from the Commission to the European Council, 2008). The call for universal access to high-speed Internet[5] is one of the ten specific action points proposed in the document, in which the Commission urges member states to develop a coordinated broadband strategy with the goal of reaching 100% high speed Internet coverage. In an attempt to achieve this objective by 2010, the Commission provides financial support to promote the coverage of underserved regions and areas where roll-out costs are excessive.

In an effort to promote the information society, the Hungarian government also adopted a number of strategic concepts and action plans, which formed the basis of many calls for proposals to be funded by the government and the European Union alike to achieve the institutional vision. The Hungarian Information Society Strategy[6], adopted in 2003, was the first document that contained strategies for the development of this area. Preparations for the first comprehensive program focusing on the development of the basic infrastructure, titled National Broadband Strategy, started in the second half of 2004 at what was then the Ministry of Informatics and Telecommunications. Following intense debates among experts, and after several

[4] "i2010 – A European Information Society for growth and employment". The program itself is different from the regularly updated eEurope action plans except in terms of objectives.

[5] The actual name of the program was "High-speed Internet for all."

[6] The Hungarian Information Society Strategy, launched in 2003, laid down the fundamental directions of the government's agenda, prioritizing the issue of content and infrastructure development as a condition of progress in broadband digital communications. The (new) Digital Telecommunications Act, which went into effect on January 1, 2004, was an attempt to pave the way to these development goals by providing a favorable environment.

adjustments, the plans were eventually released in 2005 under the title "National Broadband Strategy 2005"[7] (Informatikai és Hírközlési Minisztérium, 2005).

Over the years that followed, the government's role had to be repeatedly redefined to ensure the balanced development of the information society and to enhance the effectiveness of the implemented programs. As a result, new strategies were designed by the Prime Minister's Office Senior State Secretariat for Infocommunication in 2008, including the Broadband Action Plan, the Digital Literacy Action Plan and the E-Economy Action Plan, which, although updated in 2009, did not materialize before the end of the government's term of office.

The core concept of each and every strategy and accompanying action plan, whether past or future, involves the goal of universal access to information and online services. Hence, the elements of the infrastructure that provides access to the digital telecommunication network and additional services should be viewed as public services (not unlike electricity); all residential areas need to be covered, and it is the government's duty to promote, foster and coordinate this development.

The development of the information society[8] is propelled by the information and communication technology sector, which is owned mostly by economic actors. However, the cooperation and interactions of the government and the public sector are essential for its evolvement. "The convergence of the telecommunications, information technology and media industries is an increasingly prevalent, markedly expanding development. The importance of this phenomenon is underlined by the fact that the technologies of the three sectors are commonly referred to as

[7] As part of the eEurope action plan, the European Commission urged all member states to develop their own national broadband strategy in an attempt to coordinate and harmonize the objectives of the entire union and the individual member states. In response to this requirement following the accession on May 1, 2004, Hungary formulated its National Broadband Strategy in 2005.

[8] Studies aimed at defining the concept of information society, both international (van Dijk, 1991), (Castells, 1996) and domestic (Dessewffy, 2002), (Z. Karvalics, 2002) are in accordance as to the assertion that the technical background penetrating the various layers of the ecosystem are only relevant in the early, adaptation phase, indicating that it is the necessary and sufficient condition of growth in the information society.

’information society technologies’ (IST)” (Abos, et al., 2007). Information society consists of three basic components:

1. availability of technological devices and access to digital telecommunication networks (infrastructure) fundamental to their use;
2. people with technology skills (digital literacy);
3. content (digital information).

The development of the information society is contingent on the combination of all three factors; the simultaneous presence of the three elements is necessary for permanent progress. “The availability of broadband telecommunications infrastructure (including an appropriate physical transmission medium, digital telecommunication networks and services) is only one of the prerequisites for the growth of the Internet” (Sallai, et al., 2009). The development of the information society faces a number of other challenges that shape its trajectory, including the access of households to telecommunication devices, effective demand for telecommunication products and Internet services (household expenditures for these purposes as a percentage of the disposable income), appealing content, solutions to information security concerns, as well as commitment to enhance digital literacy. “The Internet cannot expand successfully unless all these conditions are met, with the weakest link of the chain defining the dynamics of the overall progression” (BME-TMIT munkacsoport, 2004).

In addition to the literature published in the field and development programs implemented in Hungary over the recent ears, numerous studies have discussed the human (knowledge) dimension of the digital divide, pointing out that factors such as the lack, or poor accessibility, of essential basic infrastructure, insufficient user skills, or the absence of appealing content can be equally impeding to the advancement of the information society.

I.2. Dissertation structure and research question

In my doctoral dissertation I explore the first of the three factors listed above, namely the accessibility of technological devices, in particular the development of the digital telecommunication network crucial to their utilization. The first component of the issue – the accessibility of technological devices – is shaped by research groups specializing in this field, as well as by the competition among multi-national corporations providing products and services to the global market[9]. The use of these devices can be promoted by a wide range of government actions (and these will be discussed later). My primary focus, however, is the second component of the essential infrastructure: the development of the digital telecommunication network, including the various aspects of the basic infrastructure required for information and communication services:

- The nature and extent of the digital divide;
- Its causes and origins;
- Tools available to bridge the gap;
- Methods previously used in Hungary to overcome market failures[10].

It is not my goal in this study to analyze the socio-economic impact of the digital divide associated with the lack of infrastructure, as this area has been explored extensively by other researchers.[11] Neither do I attempt to create strategies, given that my research focuses on past achievements (which constitute only the situation assessment component of strategy design[12]). Based on my research findings I will offer suggestions in an effort to contribute to the success of relevant development

[9] Technological innovations frequently produce devices that consumers find indispensable once they have tried them (cell phones, World Wide Web, etc.) Government plays a prominent role in promoting these types of innovations, as well. However, in such cases the primary purpose is to improve the competitiveness of a country and to boost economic growth.

[10] A wide range of market failures are possible in terms of broadband access, however, their symptoms typically fall into the following three categories: coverage (who has access), market structure (monopolistic or competitive), pricing (prices associated with the level of services, in a regional breakdown or in international comparison).

[11] (Fukuyama, 1999), (Kanalas, 2000), (Molnár, 2002), (Róbert, 2005). (Füleki, 2008), among others.

[12] Zsuzsanna Kósa's doctoral dissertation defended in 2006 (Kósa, 2006) provides an excellent summary of literature in the domain of telecommunication-related regulatory strategies, pointing to various schools of thought that can be identified in Hungary.

policy initiatives. My goal is to present the assessment of earlier interventions in order for policy makers to avoid past mistakes or to keep practices in place that proved to be conducive to progress. This dissertation is structured according to the following cause-and-effect framework:

1. The digital divide is a real phenomenon, and it impedes economic progress (competitiveness) and social equality on the long run.
2. Poor information and communication technology infrastructure is a key factor among the causes of the digital divide. Without adequate infrastructure it is impossible to combat digital illiteracy.
3. Based on the institutional economics approach, this dissertation seeks to assess and portray the progression of Hungary's digital telecommunication ecosystem and the effectiveness of the role of government institutions that are in charge of overseeing and promoting its development. I examine the concepts and approaches that the relevant public administration organs have applied to address and mitigate the shortages in the basic digital telecommunication infrastructure, and evaluate their success rates.

My central research question concerns the extent to which government intervention efforts have been effective in terms of stimulating infrastructure development and establishing a regulatory framework that shapes the environment for investment projects.

RQ: What are the impacts of publicly funded broadband infrastructure investments in Hungary, and what areas of digital telecommunication network development call for government participation in order to ensure a more balanced progress of all regions in the country?

I.3. Tools for government intervention

The methods and tools of government intervention aimed at advancing the digital telecommunication network are determined by the overall economic policy approach of the government of the day as a guiding principle, and by the corresponding sector-specific policies and measures that fit in the framework. However, the 'sterile' implementation of isolated economic philosophies often fails to deliver the expected results. What this means in the realm of electronic telecommunications, for example, is that in an environment that prioritizes free competition, investments directed towards basic infrastructure development are concentrated in areas that are profitable in the medium run (3-5 years). Investments with a horizon of 10-20 years or more do not usually materialize (the market obviously does not take care of everything). In these cases, intervention is indispensable in order to fill the digital divide.[13] A comprehensive inventory of intervention tools associated with the individual economic philosophies and the development of a category system could well be the subject of a separate dissertation. In the present study, I have no intention of elaborating on the correspondence between economic philosophies and government intervention tools devised to achieve the desired goals. Thus, in the following inventory, I 'merely' organize these tools into two categories: direct and indirect tools. Later, in the analysis sections, I focus on the issue of what tools seem to be beneficial in achieving the desired development policy goals in light of previous intervention attempts rather than what tools are sanctioned by the individual economic policy approaches.

Direct tools:

1. Investment tax credits.
2. Grants from domestic or EU funds (for business investors, to assist in reducing the required amount of venture capital and to help attain profit expectations).
3. Use of community resources for business investments (creating public property)
4. Granting access to state-owned digital telecommunication resources for commercial use.

[13] Enhancing digital literacy is another objective that requires a more active role on the government's part.

5. Implementation of complex development programs – a new role for the government as project manager. Positioning of the state or a union of states as market participants in the global competition. In this scenario, government measures target the entire country or a group of countries rather than individual cities, regions or companies (union of states based on shared economic development goals).

6. Regulatory tools[14]:

   - Management of limited resources (domain names, rights-of-way, easements, etc.) This involves competitive bidding processes or auctions to grant monopoly concessions (spectrum licensing, forced access regulation, etc.;)
   - Development-friendly regulation of building permits required for telecommunication-related construction;
   - Regulation of retail markets (price cap regulation);
   - Regulation of wholesale markets, obligations in wholesale offerings:
     - Universal service requirements along with price regulation. The 'cost-based pricing and transparent fee structure' requirement does not rule out this option in the case of access services[15]. Universal access requirements are important in several areas beyond end-to-end access services. It could provide a significant boost to broadband coverage if the government required universal access (primarily) to core and aggregation networks – as long as it is warranted by market conditions – in

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[14] With the purpose of avoiding or correcting market failure, in other words making markets effective that otherwise struggle in the absence of regulations." (Kiss, 2008).

[15] Price cap regulation is best suited to regulate the pricing of a wide range of services and commercial offers subject to the same price cap, when the regulator is only concerned with the overall price level. Access services do not typically demonstrate great diversity, while other areas that are more heterogeneous, e.g. DSL bit-stream access, tend to apply a different, more precise form of access price regulation (cost-based pricing, retail minus pricing).

addition to network services provided directly to customers. In this case price regulation could replace the price cap.

    - Functional separation (mandatory separation of retail and wholesale activities where applicable, in terms of accounting as well);

- Solutions regarding externalities.

Indirect tools:

7. Demand stimulation:
    - Subsidies in IT-related product groups16; tax credits based on such purchases
    - Training programs to increase digital literacy:
        - at the basic school level,
        - in adult education;
    - creation of public access points, implementation of a help desk system;
    - Emergence of the government as consumer in the market.
8. Establishing conditions promoting economies of scale:
    - Standardization:
        - End-user devices, e.g. set-top boxes– to allow clients to switch freely from one provider or network to another,
        - Advocating the adoption of uniform regional or global systems, e.g. GSM, TETRA;
    - Construction/liberalization of regional markets for cross-border developments.

[16] In Hungary a number of government programs were implemented in this field, too, for example the Sulinet ('School Net') program within the framework of the eLearning initiative of the European Union between 2004 and 2006.

I.4. The dissertation in relation to the scientific discipline

This dissertation explores the framework, results and effects of government measures aimed at the development of digital broadband telecommunications. Based on an analysis of actual implemented programs, I offer suggestions as to what government intervention tools would be most beneficial in the future to maximize the outcome. Little has been published on the subject in Hungary[17], and the majority of the literature focuses on regulatory issues. This is due to the fact that quantitative studies geared towards the production of basic data have been rare in the field, and a significant percentage of the data remains unpublished.

My research is only partially related to regulatory economics, and it is not the goal of this study to elaborate on the above listed regulatory tools (see section 6), either, as this has been undertaken by several outstanding Hungarian experts (Ferenc László Kiss, Iván Major, Pál Valentiny), who also reviewed the works of foreign authors relevant to the subject (Kiss, et al., 2000). In terms of potential tools, this study focuses primarily on intervention strategies which could be effective in ensuring universal high-speed Internet access, therefore other topics will be discussed only minimally, for example within the topic of spectrum management the present study deals only with frequency allocation in terms of its relevance for the core and aggregation network and for providing broadband Internet services in the access network.

My early interest in the subject matter was sparked by my own Internet access at home. By the late 90s I was spending several hours a day on the Internet, but in our home in central Budapest Internet service was offered by a single provider, and the subscription fee was extremely high compared with our household income. The situation has improved since then; I can now choose from several service providers offering increasing bandwidth via various technologies. However, in October 2008, I

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[17] These appeared primarily in *Híradástechnika*, a journal of the Scientific Association for Infocommunications Hungary, and also in academic media pertaining to competition regulation (e.g. in the series *Verseny és szabályozás* and in materials published by Akadémiai Kiadó), as well as in documents distributed by government institutions in the field. I made every effort to extensively refer to these publications in my literature review.

participated in the 16th Annual Telecommunications Seminar of the Scientific Association for Infocommunications in Zalakaros as a lecturer, where I was stunned that broadband Internet was not available in one of Hungary's major resort towns. Many Internet users report in online forums that outside the largest cities of Hungary, but sometimes even in big cities, they have no options in choosing service providers, if broadband connection is available at all. In an effort to outline the background of the scenario, I was compelled to examine a number of factors, including the ownership structure of the basic broadband infrastructure in Hungary, the regulations pertaining to different regions, as well as the driving forces behind the ever-growing demand for more and more bandwidth. Since 2005 I have been involved via GKIeNET Internet Research and Consulting Ltd. in the performance assessment of earlier proposals aimed at basic broadband infrastructure development, and also in the preparation of subsequent proposals. During the process, I had the opportunity to familiarize myself with the perspectives of implementation related to the proposals, as well, given that GKIeNET also provided project management services[18]. In addition, I participated in or supervised several projects that explored the status and ownership structure of the broadband infrastructure in Hungary. This dissertation is also a summary of my experiences in that field.

I.5. Research methodology

The topic and methodology of this research study deviate from the mainstream of the Doctoral School of Management and Business Administration at Corvinus University, Budapest. Owing to the complex nature of the topic, I applied a different organizational principle instead of the traditional structure generally used at the Doctoral School[19]. I introduced the research question in the introduction, and I

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[18] At GKIeNET, the project management tasks related to broadband infrastructure development projects were supervised by my colleague András Gál, whose observations and insight, thanks to his former position at IHM as well as well as his project management responsibilities, have been of tremendous help during the writing of my dissertation.

[19] A typical dissertation written at the Doctoral School has the following structure: a survey of relevant theoretical literature, formulation of a research question and hypotheses, presentation of the methodology and the research, and finally hypothesis testing.

dedicate separate chapters to the individual hypotheses. The relevant literature is presented prior to the discussion of each hypothesis in several chapters rather than as a separate unit in the initial half of the study. In the case of (desk) research on several topics, I rely mainly on material published by regulatory authorities and international organizations in the domain of digital telecommunications, due to the fact that the analysis of a number of hypotheses required the examination of primary literature, to which academic resources[20] can provide guidelines only.

Each hypothesis is based on an individual research project, of which there is a total of six. I used both quantitative and qualitative research methodologies to test the hypotheses, always applying the relevant tools for the actual topic under study. The research methods, along with explanations to justify their application, are also discussed prior to each individual research.

Given the nature of the study, technical terminology and abbreviations were used extensively, which are listed in the *Glossary* along with definitions for easier interpretation.[21] I would like to point out that the definitions of the terminology used in this dissertation are of crucial importance. When discussing network layers, for example, I use the term Wide Area Network (WAN) throughout the analysis, consistently avoiding expressions such as core and backbone network applied extensively in the telecommunication industry for the same concept (because they had been based on the structure of the primary local area network rather than the optical network). In the case of the access network I also avoid the term 'local network,' because an access network can reach several municipalities, while a local network is restricted to one municipality.

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[20] E.g. Information Economics and Policy, Telecommunications Policy.

[21] Given that the present study is an economic analysis focusing on a technical field, the precise use of the specialized terminology is crucial.

I.6. A note on the practical recommendations evoked by the research

In the course of the research for hypothesis testing I formulated practical recommendations for development policy in the field of digital telecommunication networks. These are included in section X.4 (final section); addressing them in the initial part of the dissertation would be meaningless without the individual hypothesis tests. Therefore I am indicating in the final (present) section of the introduction that conclusions will be presented following the evaluation of the central research question.

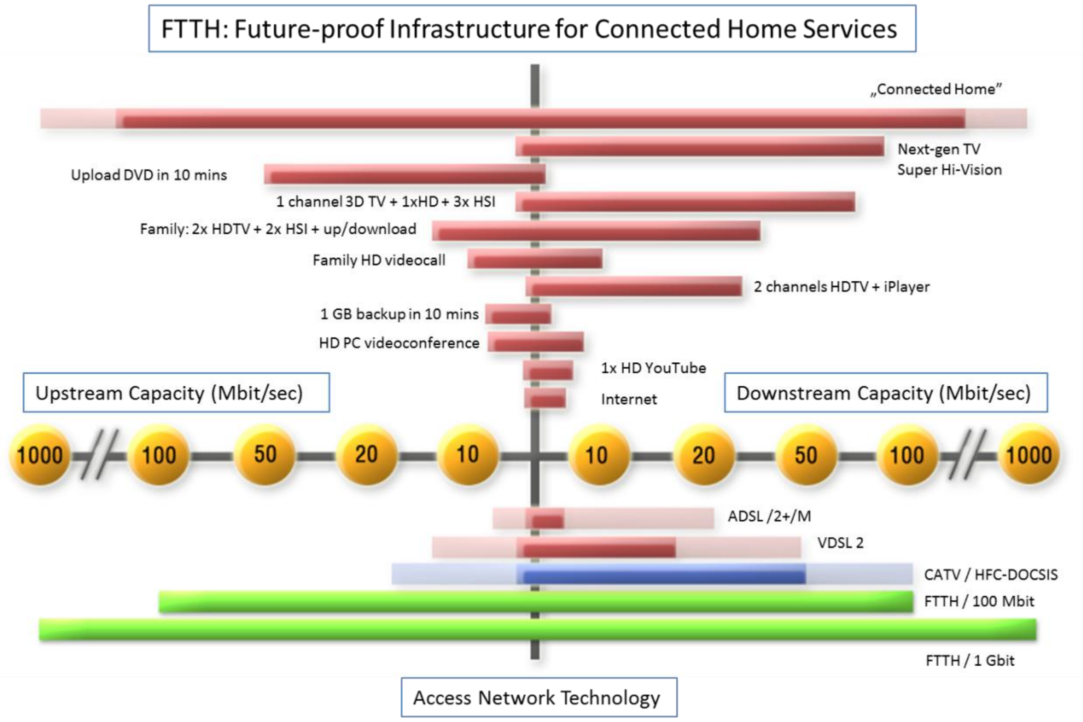
II. EFFECTS OF BROADBAND INFRASTRUCTURE AND BROADBAND SERVICES ON THE NATIONAL ECONOMY

Regardless of economic philosophies, it is a generally accepted view in developing and developed countries of the world that the development of the digital telecommunication network and the growth of broadband infrastructure generate primarily positive externalities[22] and provide a boost to the development of national economies. In their book published in 1998, Carl Shapiro and Hal R. Varian present an example from economic history about the evolution of the book market in England (see Appendix 1), in which the major issues correspond to current dilemmas associated with Internet access.

A comprehensive U.S. study on broadband issues published in 2002 (Committee on Broadband Last Mile Technology, Comp. Sci. and Tel. Board, 2002) compares the central problem of broadband infrastructure development to the chicken-egg question: the development of applications relying on increasing access speeds is senseless if infrastructure is poor, while users need high-speed connection to access the services available through the applications – creating the demand essential for business investments. Figure 1 illustrates the types of service that can potentially be offered by increasing bandwidth (using available compression methods) and the corresponding access technologies. The illustration also reveals the limits of the individual access technologies, projecting the need for fiber to the home (FTTH) in the fixed line network and 4th Generation Long Term Evolution (LTE) standard in the wireless industry.

[22] Literature on externalities is somewhat confusing due to variations in the use of terminology and vague definitions. This is probably one of the reasons why externalities are generally referred to with the modifier 'positive' when it comes to digital telecommunication networks. Within the concept of this study, positive externalities refer to the external benefits (network effects), reflecting the benefits to consumers. Internal economies, on the other hand, are related to the costs of producers, which, in the case of digital telecommunication network development, are less likely to be positive, given that service providers are facing increasing investment costs, and recovery periods have also been rising consistently since the 90s.

FIGURE 1. DIGITAL SERVICES AS A FUNCTION OF BANDWIDTH AND ACCESS TECHNOLOGIES (ON A LOGARITHMIC SCALE)



Source: Gergely Kis, Ph.D. dissertation, 2010, on the basis of data published by the FTTH Council (http://www.ftthcouncil.eu/)

In order to justify costly basic infrastructure developments, infrastructure owners have to prove to investors that investments promise quick returns and convince government officials that, in addition to the regulatory framework[23], community resources have to be provided to foster investment, which in turn contributes to economic progress. None of these tasks are easily justifiable; however, given the topic of this dissertation, I am focusing only on the second component, namely the rationale for government intervention.

The first conceptual plan for broadband infrastructure in Hungary, the National Broadband Strategy 2005, claims that "the development of the ICT sector had numerous macroeconomic impacts in developed and medium-income countries. Improvements in the ICT sector primarily affect the rate and structure of economic growth, but they also impact employment, capital formation and the restructuring

[23] However, as Ferenc Kiss notes, regulation is "necessary only as far as it enhances the social effectiveness of markets." (Kiss, 2008).

of the economy" (Informatikai és Hírközlési Minisztérium, 2005). The designers of the National Broadband Strategy 2005 applied the 'traditional' neo-classical growth model widely used in economics to empirically measure the impact of the ICT sector on overall economic development, dividing capital into two categories, ICT and non-ICT. According to their model, positive externalities (external economies) are obvious in the ICT tier. To underline their claim, they referred to additional countries (South Korea, Japan, United States) where advancements in the ICT sector were irrefutably generated by broadband infrastructure developments. Two common traits can be determined among these countries regarding the increasing contribution of the ICT sector to the overall growth. First, in all instances the administration had an industrial policy which highlighted the development of the ICT sector, even though the tools they chose were different.[24] Second, the supporters of the industrial policy and the ICT development endeavored to make their country a world leader in a certain segment of the market.[25]

In addition to a direct impact, the ICT sector can have an indirect effect on growth, as well. It is not the production but the use and application of ICT products and services that shapes the growth of the economy. Many studies explore the importance of ICT applications (Jorgenson, et al., 2000); (McKinsey Corp., 2001); (McGuckin, et al., 2001). Van Ark and his co-authors (van Ark, et al., 2003) compared productivity growth in the United States with European countries, revealing how the growth in ICT-intensive sectors gave a boost to the entire US economy. On the other hand, Nordhaus and Bailey, the prominent American economists behind the concept of the new economy, believe that the difference in the rates of growth between the United States and Europe is attributable to the sectors utilizing ICT products and services, primarily the retail, wholesale and

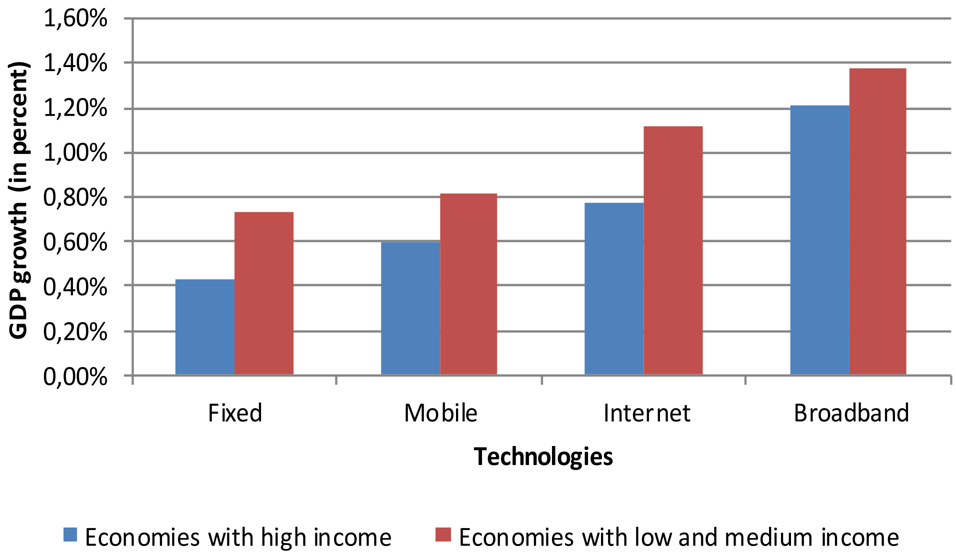
[24] While South Korea focused clearly on the stimulation of broadband access development and government-owned basic infrastructure, the United States boosted investments by government orders. The US even applied government intervention to solve the chicken-egg dilemma: offering appealing content, by listing profitable homeland security procurement opportunities online and accepting bids solely over the Internet.

[25] The intense government intervention in South Korea is unique in all aspects among the methods used to stimulate investments, and it is considered extremely effective.

financial sectors, rather than to the effectiveness of the sectors producing them (Nordhaus, 2001); (Bailey, 2003), given that they grew at a much faster rate in the United States than in Europe.

No matter which theory gives a more precise account of indirect impacts, a report published in 2010 by the World Bank and the IFC points out that in economies where average income is in the low-to-medium range, every 10 percentage point increase in the number of broadband subscribers per 100 people contributes to a 1.3 percentage point rise in GDP (World Bank & IFC, 2010). Another study published in 2009 as part of the same series (Quiang, et al., 2009) demonstrates that growth in the availability of different telecommunications services affects the performance of a national economy at various rates. Of the services below, broadband availability has the most marked effect on GDP growth.

FIGURE 2. GROWTH EFFECTS OF ICT TECHNOLOGIES



Source: World Bank (Quiang, et al., 2009)

The development of the ICT sector as a whole clearly has a positive effect on economic growth, thanks to the goods it creates.

TABLE 1. POSITIVE EFFECTS OF ICT OUTPUT AND ICT ABSORPTION ON ECONOMIC GROWTH

	ICT output	**ICT absorption**
Investment growth	X	X
Productivity growth	X	X
Short-term employment growth	X	
Creation of high value-added jobs	X	X
Growth of R&D intensity	X	X
Improvement in public sector effectiveness		X
Creation of more flexible factor markets		X
Micro-economic advantages	X	X

Source: Ministry of Informatics and Communications (Informatikai és Hírközlési Minisztérium, 2005)

The direct and indirect impacts of ICT use need to be expressed quantitatively in order to assess the positive externalities in terms of external economies of scale, which could then rationalize the use of public resources for basic infrastructure development. First, we need to have a clear answer to this question: What are the direct impacts of the development of basic infrastructure on the growth of the economy? Or, in other words, to what extent is the improvement of basic infrastructure responsible for ICT-generated growth?

Few studies or computations have been published to date to calculate the direct effects of broadband infrastructure developments. A key requirement is that externalities be observable and evident. It is difficult to compute the correlation through quantitative techniques, and no study has been conducted so far in Hungary with this objective.[26] Due to the time-intensive and costly nature of these studies, only a small number were conducted altogether worldwide, of which two examples will be presented below.

[26] A study like this could make up a doctoral dissertation in itself, however, I am not concerned with the exact computation of externalities generated by broadband infrastructure developments. At the same time, communities that either did or did not receive subsidies within the framework of infrastructure grants offer an outstanding opportunity to evaluate these impacts by keeping track of the economic development of a number of reference communities through the assessment of their ICT application methods.

The first example comes form two counties, Brisbane and Moreton, in the state of Queensland in Australia, where calculations were made regarding potential returns prior to the construction of broadband infrastructure, considering both the open access and the closed option (The Allen Consulting Group, 2003). The total cost of the network construction over a four-year-span, based entirely on optical fiber, amounted to approximately 850 million Australian dollars over a four-year-span (this includes the wide area network construction necessary for FTTH service as well as hardware, software and installation costs). The net present value (NPV) was calculated for 15 years and totaled 2,640 million Australian dollars (3,160 in the case of an open access network) in extra revenues for the two counties. In addition, the project creates 1,500 new jobs over the period of 15 years by stimulating services based on the investment. The GSP (Gross State Product) growth of Queensland as a whole reflects a revenue of 4,180 million Australian dollars over the 15-year NPV analysis (4,900 million Australian dollars in the case of an open access network), along with a growth in the number of jobs and in annual aggregate consumption (2,835 million Australian dollars in terms of the 15-year NPV, and 3,414 million Australian dollars in the case of an open access network). The investment provides a significant boost to the development of Queensland’s industry, generating an extra +0.5% growth in manufacturing, agriculture, mining; +0.46% in communication services, and +0.14-0.38% in other industrial segments, including the government sector. Based on the calculations, the authors argue that an open access infrastructure would be beneficial to all sectors.

The second example is based on actual quantitative analyses, not just a model calculation. Studies in the United States focused on the development of two adjoining municipalities, Cedar Falls and Waterloo in the state of Iowa (Kelley, 2003), as well as on Lake County and ten additional counties in Florida (Ford, et al., 2005). The construction of the local government-owned broadband infrastructure was completed in 1997 in Cedar Falls and in 2001 in Lake County. In Lake County, the wide area network owned by the local government was opened to hospitals, economic actors and 44 schools. Compared with neighboring counties where the network was closed, economic growth was twice as fast over the period of three years. After verifying the calculations, the Bureau of Economic Advisors concluded that every dollar invested in broadband infrastructure yielded 3 dollars to the economy. Broadband infrastructure development was clearly an engine of local economic growth in Cedar Falls, as well.

In light of the impacts discussed above, the data presented by the World Bank are instrumental in calculating the potential effects of a large-scale investment in digital communication network upgrade with FTTH access in Hungary, assuming that it would involve the actual use of the services:

- At a development cost of 1500 euros per household,[27] increasing broadband penetration from 20% to 30% (1 million new FTTH connections) would involve approximately 1.5 billion euros.
- Calculated on the basis of the 2008 GDP at 105.95 billion euros,[28] in the year after the ten-percentage-point increase in broadband penetration (or realistically in the year following that due to the lagging effect), GDP increase attributable to the rise in the number of broadband subscribers will also amount to approximately 1.5 billion euros, equal to the estimated total investment cost. This goes to show that funds spent on community development projects such as this provide guaranteed returns to the community.
- While broadband infrastructure developments promise returns to investors with a 5-10-year horizon in the best-case scenario, these investments yield returns to the national economy within a year due to the impact of external economies (externalities).
- Funds spent on a ten-percentage-point increase in the number of subscribers can by themselves generate a GDP growth of 10% compared with the base as

[27] The total NGA investment cost per household is a high-end estimate, using GPON technology and assuming a take rate of 20%., which includes resources for developments at higher network layers, as well (Kulkarni, et al., 2010).

[28] Source: based on data published by the Hungarian Central Statistical Office (the 2009 GDP totaled 26,094.8 billion forints, which translates into the above value at the year-end exchange rate of 246.9 forints).

early as seven years following the investment, contributing an additional 10.6 billion euros to GDP in the 7th year following the investment.

As I indicated earlier, the above arguments cannot be used separately to justify a publicly funded large-scale infrastructure project, because economic growth accompanied by the increase in the number of broadband subscribers does not necessarily prove that the use of public funds guarantees steady organic development. The added value comes from services built around the digital telecommunication network, in other words, from the actual use of the infrastructure.

The discussed cases and calculations allow us to conclude that it is the expansion of broadband infrastructure that drives economic growth and not vice versa, with economic growth creating demand for broadband.[29] No matter how limited the number of studies, arguments supporting the role of ICT within the economy make it clear that the availability or absence of broadband infrastructure determines the feasibility of information and communication services, which fundamentally shapes the development of the entire economy. Every basic – and therefore critical – infrastructure is the essential basis for production via its system. In this sense, broadband is a fundamental engine of economic growth. Consequently, all my suggestions and reasonings in the following chapters will be based on the argument that the development of the digital telecommunication network is desirable and promotes both economic growth and social progress.[30]

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[29] Basic broadband infrastructure development has similar impact on the progress of certain areas as high-quality roads, particularly expressways or freeways: they generate economic growth through the services established around them. "The Internet embodies a new force in the sector that uproots everything and cuts our main source of revenue: advertising." (Gálik, 1999).

[30] I am making this statement despite the fact that the Internet, which operates through the digital telecommunication network, often has a negative impact on a number of sectors. Regarding the media industry, Mihály Gálik expressed the following thought: "A new force emerged in the sector in the form of the Internet, uprooting everything and pulling the plug on our most crucial resources: advertisement revenues." (Gálik, 1999).

At the same time, investments aimed at offering increasing bandwidth are extremely costly, and it is questionable whether the interests of users are best served by infrastructure-based competition in terms of access to basic infrastructure. In Hungary, or in any country of this size, it is important to consider whether the domestic broadband infrastructure is sufficient for a competitive market with multiple service providers and for a regionally balanced development. It should be noted prior to any further analysis that it is practically impossible to answer this question precisely. Arguments can be made for and against individual statements, possibly proven by model studies. Nevertheless, in all developing and developed countries of the world, the issue is of key interest to policy makers, researchers and regulators in the digital communication arena, including myself.

As a first step to any type of evaluation regarding government intervention, we need to take a deeper look at the development and ownership structure of broadband infrastructure, which forms the core of the analysis. This determines the nature of government participation in the development of basic broadband infrastructure: it is crucial to identify underserved areas in critical need of development.

III. DEVELOPMENT OF THE DIGITAL TELECOMMUNICATION NETWORK IN HUNGARY BETWEEN 2003 AND 2008

In Hungary "broadband coverage is likely to be limited in a large percentage of municipalities, and the expansion or modernization of the broadband access network is crucial," points out a study I referred to earlier, written by prominent Hungarian experts in the telecommunications field and published in March 2009 (Sallai, et al., 2009). In order to correctly assess the government's role in broadband infrastructure developments in Hungary, it is necessary to prove that the development of the infrastructure that provides the basis for ICT services has not been regionally balanced over the past few years, in other words, there is a digital divide in terms of access to the infrastructure.

H_1: The development of the digital telecommunication network in Hungary was geographically unbalanced in terms of subregions between 2003 and 2008.

It is obviously a plausible argument regarding this hypothesis that no country in the world has seen a regionally balanced pattern in the expansion of its digital telecommunication network. In the United States, analysts at ID Insight published a study with remarkable revelations in 2010: the number of broadband connections is higher in states with lower average household income than in states with higher average household income (ID Insight, 2010). This implies that the lower income status of a region does not necessarily mean that the area is underdeveloped in terms of broadband infrastructure.

The purpose of my first hypothesis test is to justify government participation, or intervention, given that regional imbalances are undesirable in the development of digital telecommunication networks. A further advantage of this analysis is that it reveals which subregions of Hungary could benefit from the use of more 'powerful' development policy tools.

Before the hypothesis can be accepted or rejected, it is necessary to investigate the ICT-related development of individual subregions. This involves a complex ICT development index which demonstrates the different development rates. In setting up the index, I used the most feasible method rather than the theoretically soundest approach.

III.1. Investigation of hypothesis H_1

III.1.1. Methodology

An accurate account of the development of the digital telecommunication network in Hungary over the period between 2003-2008[31] would only be possible if comprehensive data sets had been collected on network infrastructure investments on an annual basis. However, creating databases that contain data like this is a costly endeavor, and it would not always be a reasonable expectation towards surveyees (this rules out the theoretically best possible analysis). There are indices, though, that provide a good overview of the development of the ICT infrastructure over the period under investigation:

A. Number of Internet subscriptions per 100 residents;

B. Number of cable TV subscriptions per 100 residents;

C. Number of mobile phone subscriptions per 100 residents;

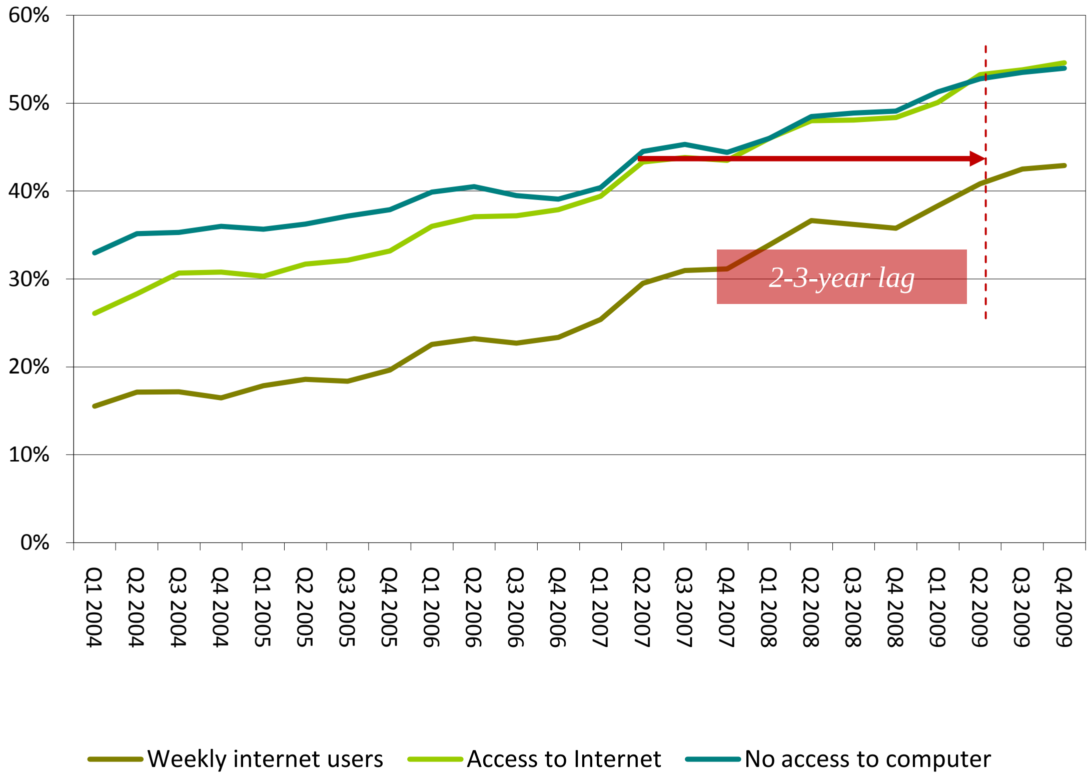
D. Number of PCs per 100 residents.

The indices themselves do not represent the development level of the infrastructure, but they are indicative of the volume of consumer demand for selected elements of the infrastructure (the number of PCs is particularly significant in this respect). However, it is a key question whether the demand can be met on the side of the telecommunication infrastructure. This is particularly true in the case of Internet and cable TV subscriptions (the latter always involves modernization of the basic infrastructure for the 'last mile'). Basic infrastructure developments are

[31] There are no data sets available for the period prior to 2003 that could be used to derive the data necessary for the investigation at least at the level of subregions.

also necessary to meet the demand for mobile service subscriptions (increasing bandwidth to cell towers). PC use does not require broadband infrastructure, but computer and Internet use are closely related in the household segment: the rate of households with computers projects the changes in the rate of residential Internet subscriptions. As a rule of thumb, it is generally true of the domestic Internet penetration that the rate of regular Internet users (weekly or more) mirrors the rate of PC access with a two-to-three-year lag.

FIGURE 3. CORRELATION BETWEEN PC PENETRATION AND INTERNET USE



Source: GKIeNET, 2010

Over the past three years (2007-2009) the percentage of people with Internet access has been approximately equal to the percentage of those who have access to a computer, which can be attributed to the fact that computer use at work or at school increased the demand at home, too. As a result, as low as 1-2% of all computer users are without Internet access.

By synthesizing the individual sets of precise data, we can create an indicator which reflects the development of the domestic ICT infrastructure. Ideally, indices should be available to represent the development level of micro-regions, however, neither the Hungarian research institutes nor the Central Statistical Office collected detailed data during that time period. GKIeNET, on the other hand, has relevant data on the regions under study, which, with the help of model estimates, can be used to generate data sets for subregions or even municipalities with a relatively low error rate. Data from 2003, 2005, 2007, 2008 should be sufficient to study the development, because, provided that the assumption is correct, they clearly demonstrate the regional imbalances. A detailed description of the model estimate is included in Appendix 2. The complex ICT development indicator – ICT availability index – is an appropriate tool to indicate differences in development patterns.

For comparison purposes, I determined the values of all four indices on the basis of 100 people, where the population means the total number of residents in a given subregion. I examined data between 2003 and 2008 to explore the differences in development rates among subregions (while data sets created for 2005 and 2007 served as control). The study period was determined on the basis of the following considerations:

- 2008 is the final year for which comprehensive databases are available with respect to all four indices (by the time of the study, the Hungarian Central Statistical Office had not published data relevant for the model estimate past 2008);
- this time frame covers the entire period when broadband-related government-subsidized grants were awarded and (with the exception of GOP 3.1.1) implemented.

In light of the above considerations, it is important to examine the four indices separately. Although there is a close link between computer access and Internet access, changes in one factor cannot fully be attributed to the other. By integrating the four indices, I created an index which shows ICT availability per 100 people. Changes in the compound index indicate the rates of change (increase) in ICT availability against the base value by subregions.

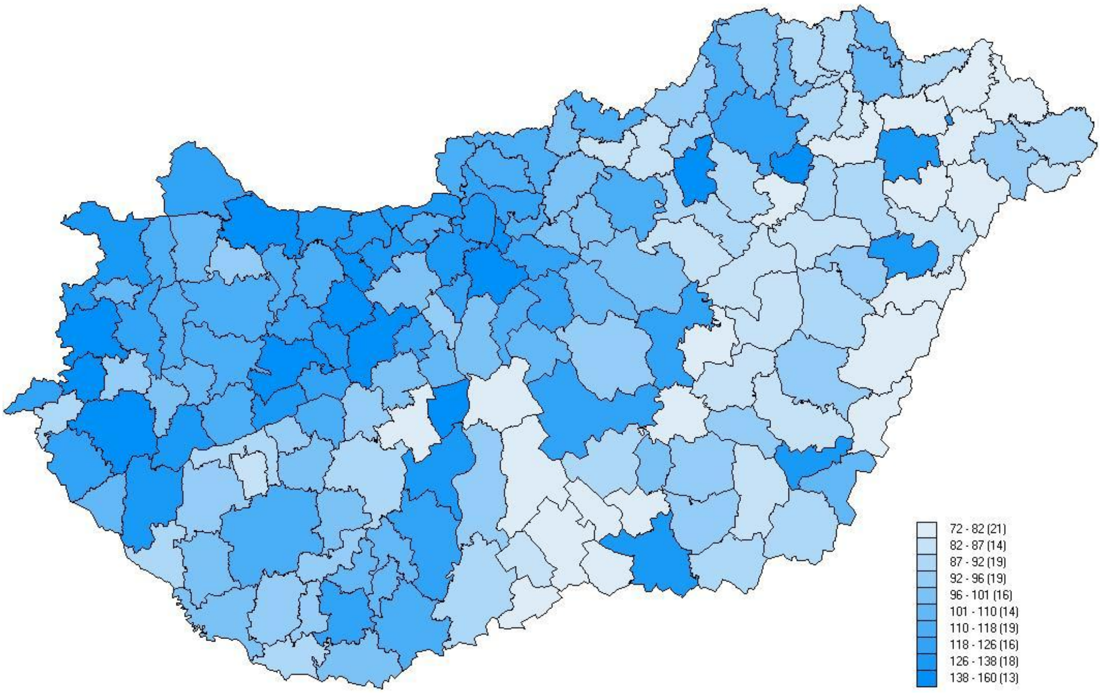
III.1.2. Results of the study

The analysis demonstrates the development level of subregions in 2003 and 2008 based on the index[32]. In addition, this investigation will provide input to map out a possible correlation between the geographic location of government programs in effect – presented in a later chapter – and the rate of development.

Development indices of subregions

For easier comparison, I divided the subregions into ten deciles with equal number of elements. Due to the discreet values, the categorization resulted in groups with some differences in the number of elements, but the discrepancies in development levels are still obvious.

FIGURE 4. DEVELOPMENT LEVEL OF SUBREGIONS BASED ON THE ICT AVAILABILITY INDEX (2003)



Source: Gergely Kis, Ph.D. dissertation, 2010

The following table summarizes the nationwide averages based on the analysis of the four indices. In terms of the four devices, ICT availability increased 60% per 100

[32] There were major changes over the five-year period between 2003 and 2008 in the way Hungary was divided into subregions: for comparison purposes, I am using the division structure that was in effect in 2008, which includes 168 subregions.

people on average. Internet availability rose at the fastest rate: Internet access surged from 6.6 subscriptions per 100 people in 2003 to 22.7 subscriptions per 100 people in 2008. The choice of 2008 is favorable for another reason: it does not yet include the distorting effects of statistics reflecting the boom of mobile Internet.

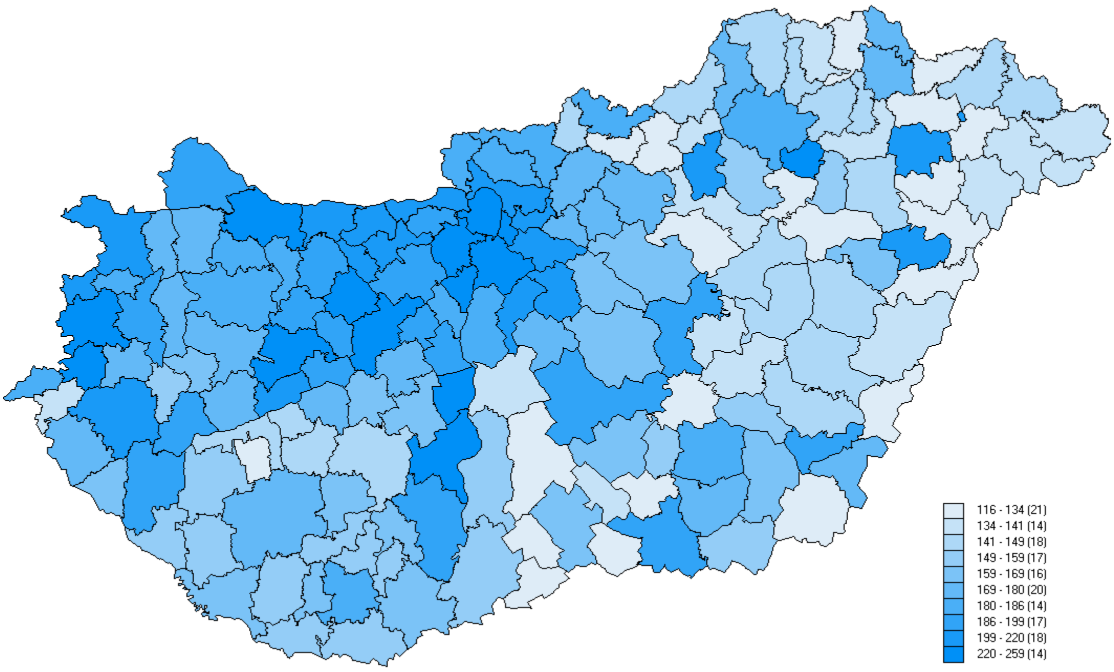
It should be noted that values reflecting the national average were in the 7th decile in 2003 and in the 8th decile in 2008, indicating that subregions with higher population have a higher ICT availability index, raising the average value. Changes in the national average ranking also indicate that although access to technological devices expanded significantly across the board, smaller, less developed subregions fell behind in terms of ICT availability. This fact alone suggests that the implementation of government-funded development programs is indispensable in this field.

TABLE 2. CHANGES IN THE ICT AVAILABILITY INDEX

	2003	**2008**
Number of Internet subscriptions per 100 residents	6.6	22.7
Number of PCs per 100 residents	14.0	25.8
Number of mobile phone subscriptions 100 per 100 residents	78.0	120.1
Number of cable TV subscriptions per 100 residents	18.7	20.9
Total	**117.3**	**189.4**

Source: Gergely Kis, Ph.D. dissertation, 2010

FIGURE 5. DEVELOPMENT LEVEL OF SUBREGIONS BASED ON THE ICT AVAILABILITY INDEX (2008)



Source: Gergely Kis, Ph.D. dissertation, 2010

Relative developmental differences

During the five years under investigation, the rankings based on decile positions have not changed significantly. More than 40% of all subregions were in the same decile in both 2003 and 2008. If we consider that the percentage of subregions that remained in the same category or moved no more than one step totaled 80%, it is easy to conclude that the regional characteristics regarding the prevalence of ICT devices and services remained relatively constant. Only 33 out of the 168 subregions saw a change of two or more steps in their rankings, with twelve regions moving down and 21 moving up.

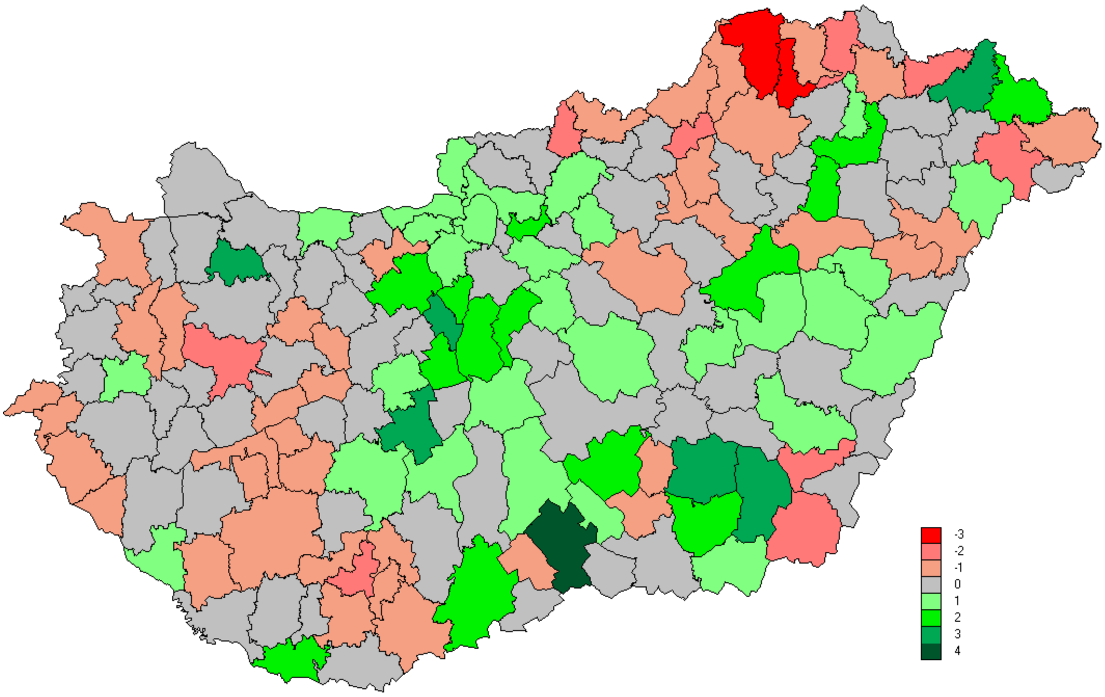
TABLE 3. CHANGES IN RANKINGS BASED ON THE DECILE POSITION (2003-2008)

Degree of change in rankings	Number of subregions	As a percentage of all subregions
-3	2	1%
-2	10	6%
-1	38	23%
0	69	41%
1	28	17%
2	14	8%
3	6	4%
4	1	1%

Source: Gergely Kis, Ph.D. dissertation, 2010

The following map illustrates the geographic location of subregions that moved 'downward' and 'upward'.

FIGURE 6. CHANGES IN THE RANKINGS OF SUBREGIONS BY DECILE POSITION BASED ON ICT AVAILABILITY BETWEEN 2003 AND 2008



Source: Gergely Kis, Ph.D. dissertation, 2010

Shades of green on the map show subregions that developed at above-average rates, while shades of red indicate slower-than average development, clearly demonstrating which subregions are facing the problem of digital divide in terms of ICT availability.

The next table includes a summary of subregions that had the fastest and slowest development rates during the five years under study compared with the average.

TABLE 4. FASTEST AND SLOWEST GROWING SUBREGIONS IN TERMS OF ICT ACCESS

Subregion	Change in rankings
Adony	+2
Baja	+2
Bicske	+2
Budaörs	+2
Gyál	+2
Hódmezővásárhely	+2
Kiskunfélegyháza	+2
Polgár	+2
Ráckeve	+2
Sellye	+2
Tiszafüred	+2
Tiszavasvár	+2
Vásárosnamény	+2
Veresegyház	+2
Ercs	+3
Kisvárda	+3
Orosháza	+3
Sárbogárd	+3
Szentes	+3
Tét	+3
Kiskunhalas	+4

Subregion	Change in rankings
Edelény	-3
Szikszó	-3
Abaúj–Hegyköz	-2
Ajka	-2
Békéscsaba	-2
Bélapátfalva	-2
Bodrogköz	-2
Komló	-2
Mátészalka	-2
Mezőkovácsháza	-2
Pacsa	-2
Szécsény	-2

Source: Gergely Kis, Ph.D. dissertation, 2010

Subregions that grew faster than the average in terms of the compound ICT availability index are generally located in the Great Plains region and in Central Hungary, while slower-growing micro-regions are typically in Northern Hungary and in Southern Transdanubia. As mentioned earlier, the data will be particularly interesting once we add the information on the locations of government-funded infrastructure development projects (this will be undertaken during the analysis of hypothesis H_5). Given that the results of the investigation verify the H_1 hypothesis, hence the hypothesis can be accepted.

Although not directly addressing the time period or the focus of the present study, the National Communications Authority's report "Broadband Internet Access in Hungary" (published annually between 2004 and 2010) includes interesting facts relevant to the topic. László Horváth, the coordinator of the study, points out a phenomenon with respect to Budapest and the rest of the country: "There was a shift from Q2 2008 to Q2 2009. The 'positive' trend of the earlier period turned into negative (growth in broadband subscriptions in regions outside Budapest outpaced the capital by almost 2 subscribers per 100 people), which lead to a narrowing of the broadband gap" (Horváth, 2010). This is promising news, considering that basically following the investigation period of the H_1 hypothesis (with an overlap of six months) the extent of the digital divide between Budapest and the rest of the country seemed to have diminished slightly.

As indicated in the introduction of this chapter, the ownership structure of the digital telecommunication network is an equally important factor in the evaluation of government intervention tools. The purpose of the next section is to portray the ownership structure within the field.

IV. OWNERSHIP STRUCTURE OF THE DIGITAL TELECOMMUNICATION NETWORK IN HUNGARY

Giving a comprehensive account of the ownership structure of a business sector is a daunting task, but it is particularly difficult in the field of the digital telecommunication network of Hungary, due to multiple layers of leveraging. "Who owns a company?" is a subject often discussed in corporate economy (Yoshimori, 1996) (Chikán, 2003), and the bottom line is that even at the corporate level it is difficult to determine who owns a company.[33]

In the present study I am not concentrating on shedding light on investment chains; instead, I focus on issues relevant to the analysis, without precisely identifying the owners.

Prior to presenting the ownership relations, it should be noted that the NMHH[34] database (compiled by the National Media and Communications Authority) that can be accessed publicly is less useful for this purpose (it was not created for this purpose): it contains the service data of active and registered service providers as well as postal and courier service providers (updated on a regular basis), in other words companies that provide services in this field. By reducing the list to active providers of telecommunication services based on data from 08/27/2010 and omitting items recurring multiple times, the number of businesses or entrepreneurs providing services in the field totaled 666.

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[33] For example, in June 2010 the majority owner of the largest Hungarian telecommunication service provider, Magyar Telekom, was MagyarCom Holding GmbH, which is exclusively owned by Deutsche Telekom AG (DTAG). 31,7 percent of DTAG is owned by the German federal government (14,8 percent directly and 16,9 percent through the state-owned development bank KfW). Hence, in addition to private and institutional investors, government – or community – property also plays a crucial role.

[34] Available from http://www.nhh.hu/hir_szolg/app/index.jsp. Retrieved on August 27, 2010.

Several of these businesses, however, belong to the same corporate group[35], hence, it is safe to say that approximately 440 companies or entrepreneurs provided telecommunication services to corporate or residential subscribers at August 2010. The sheer number of companies obviously does not reveal any ownership details, and companies' clients data allow for vague estimates only.[36]

In an effort to unfold the ownership structure pertaining to wide area networks (WANs), I am using a database compiled by GKIeNET in 2009, which contains ownership details about fixed and to some extent wireless wide area networks as well as access networks. Within the framework of the research project commissioned by the Prime Minister's Office, my colleagues and I collected and summarized companies' registries over a period of several months. However, I have to point out that currently there are no comprehensive data available to keep track of the assets in the digital telecommunications system, which, as later chapters will show, can result in numerous problems. The GKIeNET database has shortcomings, too, but I am not focusing on them, given that my goal is to describe the ownership structure from a macro perspective. The ownership structure of the Hungarian digital telecommunication network(s) had the following features until Summer 2009.

Wide area networks

Five service providers (Antenna Hungária Zrt., Invitel Távközlési Zrt., GTS-Datanet Távközlési Kft., Magyar Telekom Távközlési Nyrt., Magyar Villamos Művek Zrt.) have nationwide or almost nationwide infrastructure, which does not necessarily mean nationwide broadband coverage. As far as ownership is concerned, Antenna Hungária and GTS-Datanet do not have significant wide area network capacity.

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[35] For example Opticon Holding Group Zrt. including several firms: Opticon Telekommunikációs Hálózati Szolgáltató Kft., Optanet Kft, Hírös-Net Kft., which can be considered as one entity in terms of service portfolio and ownership in the digital telecommunication network infrastructure.

[36] For example, a new access network may reach the boundary of the building with no subscribers using it. Data would be even more distorted due to the fact that almost 100 companies lease, rather than own, the infrastructure. Leasing is becoming prevalent among large providers as well, for example since 2009 Magyar Telekom has preferred to lease infrastructure if given the opportunity or in areas where it has no coverage. As a result, ownership details are not transparent based on the number of subscribers.

Following a number of purchases (e.g. Monortel), UPC obtained a few hundred kilometers of wide area network capacity, but this is not an integral part of the company's profile, given that their main focus is on the development of the access network. In addition to the service providers mentioned above, other companies also carried out considerable wide area network developments, including Tarr Kft. (a key player in Tolna County in Hungary), Optikon Zrt., FiberNet Kommunikációs Zrt., PR Telcom Zrt. and Novotron Zrt., mostly within the framework of the GVOP 4.4.1 and GVOP 4.4.2 grant programs.

Access networks

As revealed by the NMHH database discussed above, approximately 440 companies provided any type of telecommunication services. Almost 100 of them did not own but leased infrastructure. If we narrow down the list to include only carriers that offer broadband services, we get a group of 250 companies (some of which also operate on leased infrastructure). Nevertheless, it is obvious that the ownership of access networks is significantly more extensive that than of wide area networks (which is not surprising, as this is a typical feature of the ownership structure in all decentralized communication markets). Based on the number of subscribers and revenues, the largest access service providers include Magyar Telekom, Invitel, UPC, DIGI (also TvNetWork), GTS-Datanet, FiberNet, PR Telekom, ViDaNet, Parisat, Tarr (also Zelka), RubiCom, Antenna Hungária, Enternet (also Actel) and Opticon.

In terms of network coverage, 59% of municipalities with broadband connectivity had more than one access network option, while 1,692 municipalities had access to a wide area network in Summer 2009. Aggregation network connectivity is available via different media and technologies as needed by service providers to support their access networks. In the majority of municipalities (85%) a single network medium is utilized, which does not necessarily indicate that there is only one network (Horváth, 2010). The ownership structure of networks will be elaborated in more detail later (when testing hypothesis H_4) with respect to municipalities with fiber optic coverage.

Overall (including both wide area networks and access networks), only a few of the companies controlling the HCP network infrastructure are in 100% Hungarian ownership (e.g. Tarr, Opticon, PR Telekom), however, all except Tarr use considerable bank loans. The largest owners of network infrastructure in Hungary (Magyar Telekom, Invitel, UPC, etc.) are in majority foreign ownership.

Details of broadband infrastructure ownership should be investigated from various perspectives, not just in terms of the companies providing the services. The location of the essential infrastructure is also important: cable channels along expressways have significant – currently unused – optical capacities, and, in the case of aerial cable solutions, the owners of utility poles also play a central role (e.g. MÁV Hungarian Railways). Community-owned digital telecommunication network assets are significant in the infrastructure of Magyar Villamos Művek (MVM), and also at local governments through the GVOP 4.4.2 (Economic Competitiveness Operative Program) programs. The community's 'property' in the digital telecommunication network appears at every infrastructure level (cable channels, aerial cables, passive and active network elements), indicating that the government's development policy employed several concepts when it came to investments.

In my introduction to broadband infrastructure development and ownership structure, I pointed out that the processes of the multi-agent competitive market are of great interest to researchers in the field. Analyzing the status of the Hungarian infrastructure based on the 2009 conditions, we might assume that the Hungarian broadband infrastructure is sufficient for a multi-agent competitive market and for a regionally balanced development across the country. However, this is not the 'ideal' case. An effective monopoly could probably better meet the infrastructure demand, however, we had seen earlier that in a monopolistic market many people waited 30 years in vain for a phone line. Apparently, competition is desirable in terms of the infrastructure as well; we 'simply' need to decide how the government can stimulate investments most effectively while keeping in mind the interest of the public.

Before evaluating the government's role, I will elaborate on the issues hampering the identification of development policy goals, which fundamentally limits the room for maneuver when concepts need to be formed.

V. THE EFFECT OF THE DEFINITION OF BROADBAND AND THE PRINCIPLE OF TECHNOLOGY NEUTRALITY ON BASIC INFRASTRUCTURE DEVELOPMENT

V.1. The definition of broadband

The term ‘broadband,’ a marketing buzzword created by Internet service providers, is a widely used expression to this day referring to the ‘cutting-edge’ infrastructure of the digital telecommunication network, but it has also been a subject of numerous debates. “The term ‘broadband’ cannot be defined with a fixed value mainly because it involves dynamic increase in terms of demand,” according to a document published in 2004 by the Ministry of Informatics and Communication summarizing technology-related terms and definitions, providing little guidance in the interpretation of concepts. The figure representing the ‘number of broadband connections as a percentage of all households’ is the most frequently used country-specific indicator in political arguments or even in assessments evaluating the status of the ICT infrastructure in a given country, which can be a confusing or often (deliberately) misleading tool.

The concept of broadband changes in time, too, in line with the bandwidth requirements of services consumers tend utilize. As a result, the definition of broadband is inconsistent in the international arena, as well. Early on in the domestic broadband market (in the early 2000s), the difference between narrowband and broadband from the perspective of consumers was in the pricing: while narrowband services involved a significant per-minute rate similar to phone services (with a temporary flat rate night-and weekend option), broadband providers adopted a flat rate pricing regardless of usage.

The characteristics of digital services have also changed significantly since then. Even though broadband services are still primarily used for Internet access, web browsing and emailing, there is an increasing interest in video content and high-speed data transfer solutions; in other words, there is growing demand for broadband connectivity enabling multimedia services. The typical bandwidth requirements of web pages have changed, too; there are more and more dynamic pages, and ordinary web pages frequently contain embedded contents that have high bandwidth requirements (for example short clips or picture galleries). In addition to Internet browsing, the most common usage, IPTV has emerged, requiring bandwidth[37] that is more than one step up from the definition currently used in statistical classifications for functional and reliable service.

There is no uniform definition for 'broadband;' the term is defined in various ways depending on countries or interest groups. To ensure statistical measurability, EuroStat specified a download speed of 144 Kb/s and an upload speed of 64 Kb/s to be the minimum criteria for broadband. OECD defined slightly higher values in 2004[38], 256 Kb/s and 64 Kb/s for download and upload speeds, respectively, which were still being used in 2009. These definitions are increasingly lagging behind the actual bandwidth demand of users. This has been evident in the fact that plans featuring such low speeds were not even offered by service providers in Hungary in 2008 (as a matter of fact, even service plans providing 1 Mb/s download speed were starting to disappear from the list of fixed-line broadband packages in 2009). In reality, services precisely meeting the exact requirements are rare; the significance of the defined speed is to distinguish it from dial-up connections, which cannot reach the specified speed (144 Kb/s is the total capacity of the 2B+D channels via ISDN2). This approach is represented in Newton Telecom Dictionary (Newton, 2005), too, describing broadband as an umbrella term for all data transfer services allowing download speeds that exceed the speed of dial-up connections. In addition, the 'always on' feature distinguishes all types of broadband Internet access from dial-up connections.

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[37] IPTV subscription requires a 4 Mb/s download speed at the current compression techniques.

[38] A few random examples are indicative of this phenomenon: In 2004 EuroStat defined broadband as an asymmetrical connection with a download speed of 144/s. In the same year, FCC and OECD set the minimum requirement at 200 Kb/s and 256 Kb/s, respectively (also in an asymmetrical structure). A year later (in 2005) the IT Commission in Sweden interpreted broadband as a symmetric access at 5 Mb/s, the Swedish government defined broadband as a symmetrical connection at 2 Mb/s, while Telia, the largest Swedish telecommunications carrier, adopted a 500/s standard (also symmetrical).

The Federal Communications Commission (FCC), an independent government agency in the United States, was the first in the world to publish a new set of categories defining broadband connectivity (Federal Communications Commission, 2008). This classification can be considered the first official document that categorizes the concept of 'broadband,' paving the way for comparison measurements as well. According to the FCC standard:

- First generation connection: 200-768 Kb/s
- Basic broadband: 768 Kb/s – 1,5 Mb/s, followed by additional categories (above basic broadband)

  1.5 Mb/s – 3.0 Mb/s

  3.0 Mb/s – 6.0 Mb/s

  6.0 Mb/s – 10.0 Mb/s

  10.0 Mb/s – 25.0 Mb/s

  25.0 Mb/s – 100.0 Mb/s

  100.0 Mb/s and above.

It is an open question whether the FCC's categorization system will become standard or will have to be modified before being adopted by various authorities that oversee statistical classifications. A key factor that needs to be taken into consideration when defining broadband is what the minimally required speed will be in case broadband is adopted as a universal service in a country. As of 2010, Finland guaranteed legal right to a 1Mbps broadband connection, as did Germany, while the United Kingdom is officially proposing 2Mb/s for minimum bandwidth starting in 2012 under the universal service commitment. A reformulation of the outdated 'broadband' classifications of Eurostat or the OECD would cause more marked transition problems in political and marketing communication than among statisticians.[39]

[39] If, for example, a new category system were created before 2011, the 2010 eEurope objective of the European Union, which aims to guarantee universal access to broadband Internet services to all EU citizens, would not be met.

Broadband services allow fast transmission of large amounts of data to ensure widespread access to various digital services, and based on the above factors, we can safely say that these services have to provide always-on access, and that they are definitely 'broad' compared with the maximum bandwidth provided by an analog modem.

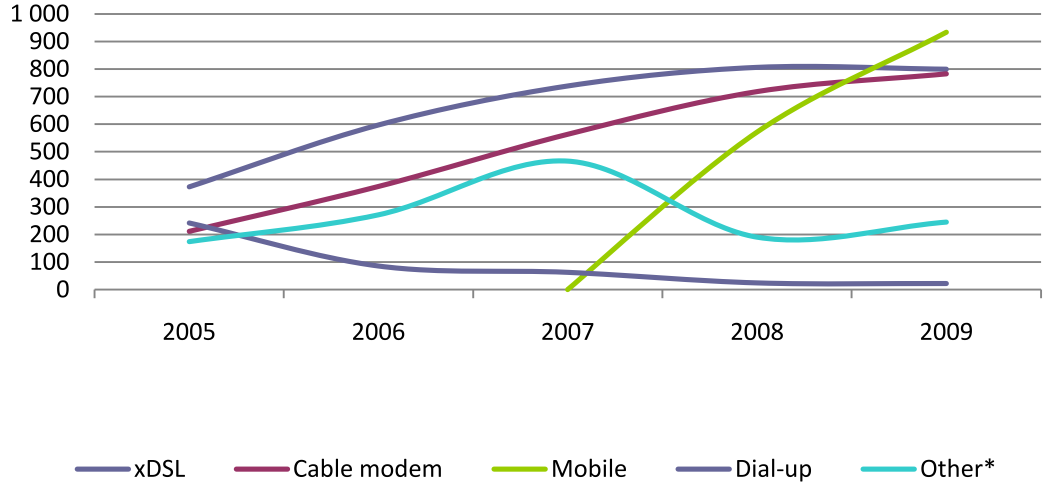
V.2. Development of broadband services in Hungary

In order to set the stage for further analysis regarding the question of definition and for the description of the wholesale market as well as the technological competition in the access network, it is necessary to present a brief review of the market of broadband services in Hungary, particularly because its development significantly differs from the general trends seen in Europe. In Hungary broadband Internet access as a mass consumer product was offered over cable networks retrofitted for two-way communications or newly built that way than before it was launched as a copper-based xDSL service of the legacy providers. Up until the end of 2002 the number of termination points in broadband cable networks exceeded the number of xDSL – particularly ADSL – endpoints. The low computer penetration rate and the high cost of service also stood in the way of the spread of technology during this time.

In addition to the two fixed-line infrastructure determining the development of the broadband market, wireless solutions have also been having a substantial impact on the market. Fixed wireless broadband services that utilize the available 2.4 Hz frequency range[40] provide broadband access to users in many locations that have no wired coverage. The main use of this technology is to fill in a gap, while dedicated Wi-Fi hotspots also using this frequency provide complementary services (nomadic Internet access) supplementing the fixed access networks.

[40] Fixed Wireless Access (FWA).

FIGURE 7. NUMBER OF INTERNET SUBSCRIPTIONS IN HUNGARY BY TECHNOLOGIES, 2005-2009 (IN THOUSANDS)



**Other category: fixed wireless access technologies (2,4Ghz, 5Ghz, microwave) and other types of fixed access (e.g. FTTH)*[41]

Source: Gergely Kis, Ph.D. dissertation, 2010, based on data from the National (Media and Info)communications Authority (broadband) and the Hungarian Central Statistical Office within the framework of the National Statistical Data Collection Program (narrowband.)

During the time this dissertation was being written, several data collection projects were conducted exploring the number of Internet subscriptions, which are often confusing. On the one hand, service providers are required to report quarterly data to the Hungarian Central Statistical Office within the framework of the National Statistical Data Collection Program, however, these are not always accurate due to inadequate assessment practices applied prior to 2010, and also not comprehensive

[41] Carriers offer an increasing variety of technologies to allow Internet access to users. The graph includes only the larger 'groups.' In details, the following technologies are employed by operators in access networks:

- *Wired and fixed wireless access technologies*: xDSL (ADSL, ADSL2; VDSL, VDSL2; other DSL), cable net (DOCSIS 1.0, 2.0, 3.0; LAN City), Ethernet (ETTH EoC; twisted pair or coax cable Ethernet; FTTH active Ethernet; FTTH P2P Ethernet), FTTH PON (e.g.. GPON), WLAN (WLAN+Ethernet, FastEthernet; WLAN 2,4 GHz; WLAN 5 GHz), Licensed Microwave, PLC, and other wired or fixed wireless access technologies.

- *Non-fixed wireless access technologies:* on GSM network („2,5G" GPRS); on UMTS network („3G" UMTS; „3,5G" UMTS+HSxPA); on LTE network („4G"); WiMAX standards (also WiBro); and a number of miscellaneous technologies whose main feature is to provide mobile access.

(but this is the only source of information about narrowband Internet access, which is why the above graph includes these data.) In addition, the National (Media and Info)communications Authority collects data on broadband Internet access, publishing them in two monthly briefings:

1. *a survey conducted with the participation of the seven (leading) service providers exploring the number of broadband subscribers (this approach does not portray the entire market, and service providers usually correct the data subsequently),*
2. *and an Internet briefing on the number of mobile Internet users. This is a comprehensive compilation, however, it includes all mobile Internet users not only those using broadband mobile services.*

In addition to these data sets, the National (Media and Info)communications Authority prepares an annual comprehensive survey assessing broadband connectivity, and service providers are required to provide precise data in a breakdown by types of access. The above graph and data sheet incorporate these data, presumably reflecting the most accurate statistics available regarding the number of broadband subscriptions in Hungary. Data on mobile Internet users, on the other hand, are not accurate in the annual report, either, due to the problem of imprecise definitions, given that data on broadband and non-broadband mobile Internet users were not distinguished prior to 2008.[42]

3G mobile broadband connectivity is already significantly more widespread than fixed wireless access services, and based on its recent development trajectory, it is likely that its market share will be comparable to that of fixed broadband services by 2011 (comparability will still be somewhat difficult since mobile technology provides individual access while wired connectivity typically provides Internet access to households).

Considering the access technologies prevalent in the Hungarian market, it is obvious that wired access technologies – owing primarily to the development projects currently underway (DOCSIS 3.0, NGA: FTTx) – will support services allowing download speeds that are an order of a magnitude faster than wireless

[42] This can be attributed primarily to the attitude of Pannon Zrt. (currently Telenor), a carrier that did not support the publication of 3G data by the National Communications Authority, given that the standard they preferred, EDGE, was not an actual mobile Internet connection except by the standards of the OECD. As a matter of fact, they doubted for a long time that the number of 3G users could potentially be extracted from the providers' systems. This 'practice' was challenged by the COCOM quarterly data collection, to which Pannon has provided separate data on the number of 3G subscribers since early 2009.

technologies.[43] As a result, it is questionable whether these services can be considered as parts of the same market as services provided by other (past-generation) technologies. If we assume that currently users are able to access multimedia contents via an approximately 4Mb/s bandwidth, then the answer is yes, they are in the same market. If, however, we consider the aspect of 'future proofness,' then LTE will likely be the only mobile technology that can be put in the same market category as the most up-to-date wired access technologies. For the time being, the majority of European telecommunication authorities[44] do not distinguish between these markets, though (this is probably justified by the current restrictions on data volume in mobile Internet services); I am therefore applying the same approach with respect to substitutability.

Regarding wide area network development, it is essential that the upgrades referred to earlier (DOCSIS 3.0, NGA: FTTx) – currently affecting the wired infrastructure – are regionally concentrated, which means that there is no clear change in broadband coverage in statistical terms, but the difference among various regions is likely increasing in terms of the actual usage value (depending on coverage). This also means that the broadband divide recreates itself at a higher level.

V.3. Basic and multimedia-capable access services

For an analysis of the government's involvement in broadband infrastructure development in Hungary, it has become clear that it is essential to distinguish between:

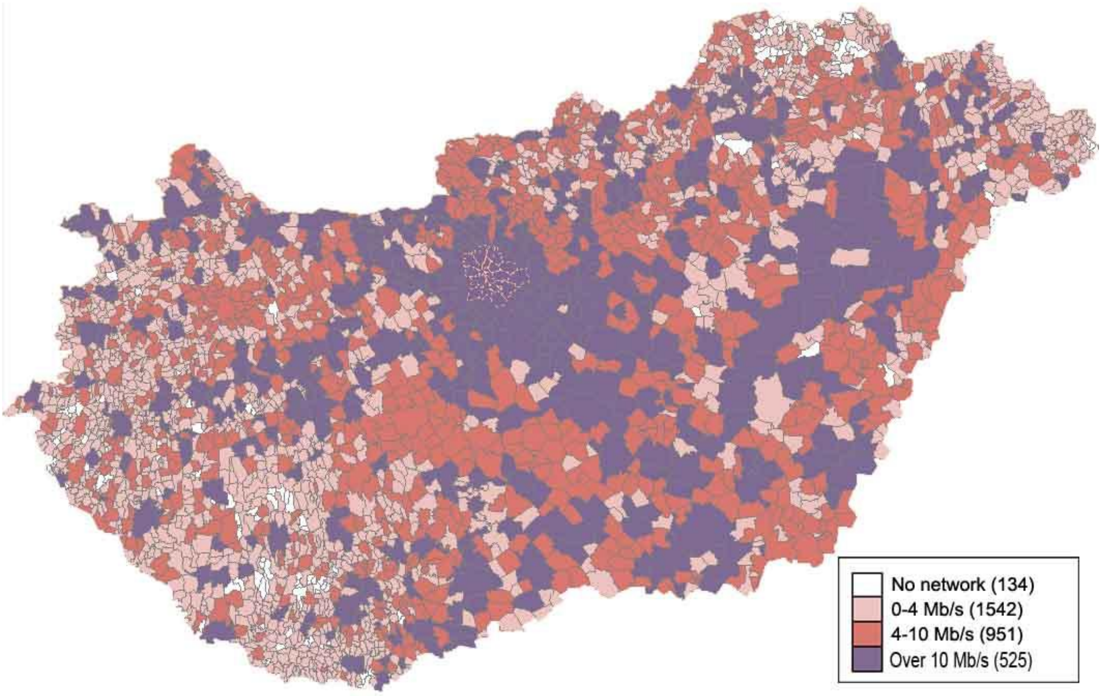
- basic and
- multimedia-capable

[43] This statement has been generally valid 'dynamically' throughout the technological evolution with respect to the wired and wireless infrastructure. The download speed promised by the next, fourth generation mobile technology, Long Term Evolution (LTE), could narrow this gap.

[44] The Commission sent a Comment Letter to the telecommunications authority of Austria for identifying the mobile broadband market as a substitute for fixed broadband services. This was the first case when based on the professional opinion of ERG, the Commission adopted this view "only with respect to Austria."

access services. The distinction is important, since the bandwidth requirements, service quality and service accessibility of the two levels are markedly different depending on municipalities. This is clearly demonstrated by the figure below, which shows that 53% of all Hungarian municipalities failed to meet the comprehensive criteria system including multimedia transmission capability in late 2009, which is also reflected in the data published by the National Communications Authority (Horváth, 2010).

FIGURE 8. BROADBAND ACCESS NETWORKS PROVIDING A MINIMUM OF 4MB/S SPEED AT THE END OF 2009



Source: GKIeNET

In the present dissertation I do not intend to raise and professionally validate a suggestion in an effort to advocate a Europe-wide redefinition of the concept of 'broadband,' [45] however, I do indicate that the expected change will fundamentally affect the nature of the government's involvement. For example, the bandwidth specification of basic access services defines the range when it comes to universal

[45] The category system of FCC should preferably be adopted by all countries: this would allow comparisons in terms of the development level of various counties' digital telecommunication networks from this point of view.

Internet access requirements; and a difference of a few hundred Kb/s in bandwidth could involve tens or hundreds of billions of forints in government expenses annually at the national level.

Based on current user expectations, basic broadband service is minimally required – with reasonable adjustments for wireless access – to provide an average speed of 512/128 Kb/s in the peak hours of any day (as indicated earlier, an even higher level was proposed in Finland and Germany, for example). It is not a requirement in the case of basic services to provide 'triple play' services, i.e. the three following features simultaneously:

1. phone service,
2. Internet access,
3. and non-stop transmission of standard definition television (SDTV),

while multimedia package subscribers must be provided access to all three services at the same time (Sallai, et al., 2009). If this approach were adopted in Europe, as well, it would create a classification system equal or similar to the above discussed broadband categories put forth by the FCC. In the FCC specifications basic broadband refers to the range between 768Kb/s and 1,5Mb/s in download speed, which, as long as the three services are not utilized simultaneously, is by and large acceptable from the perspective of users, albeit with some compromise[46].

High quality voice and video transmission, however, is impossible without a guaranteed minimum bandwidth as well as additional quality features.[47] Consequently, services like these can only be offered via multimedia-capable networks. A network like this has to be capable of constantly adapting service

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[46] Newer generation video compression techniques are available in the market, which allow almost SD quality signal transmission at a significantly lower bandwidth compared with MPEG (at a download speed of a few hundred Kb/s). Research and development activity in the area of still and moving image compression focuses on high efficiency compression algorithms that can be applied in (mostly wireless) systems with limited bandwidth. This is a development thread that can primarily affect the 3.5-4G shift, as long as it provides an alternative to ease the CAPEX burdens of carriers within the multimedia segment.

[47] Packet loss, packet delay, packet delay variation, short term service disruption.

delivery to changing user needs within a service area without jeopardizing the subjective satisfaction that users receive form the service (i.e. without having to resort to access management procedures such as admission control, prioritizing or traffic shaping, causing inconvenience to users).

V.4. Difference between broadband Internet and broadband infrastructure

Another definition problem similar to the issue of the term ‘broadband’ involves the frequent erroneous use of the concepts of ‘broadband infrastructure’ and ‘broadband Internet’ in broadband infrastructure development action plans formulated by governments throughout the European Union. In discussion materials and theoretical expert studies related to ‘broadband Internet,’ occasionally topics are included that do not involve the Internet, and have little to do with the access of the global IP address range (the global Internet cloud) by a fixed or mobile subscriber. A typical example is triple play (a bundle including Internet, TV/IPTV and VoIP phone service), in which ‘Internet’[48] is only one element. “Broadband Internet” is a product consisting of the following “elements” (so-called OSI layers):

- passive infrastructure (L0) – options: twisted pair, coax cable, wireless communication frequencies, optical fiber, and other passive instruments;
- active data communication infrastructure (L1+L2) – access network and wide area network, managing the actual data flow;
- IP communication (L3) – services, domestic peering, international peering.

Given that the essential digital telecommunication network infrastructure is the basis of all existing and future signal transmission and data interchange functions of ICT services, it is assessed according to these criteria. Technically, Internet access is only one of the many ICT services, which does not contradict the claim that in terms of relevance, Internet access probably needs to be currently considered as the

[48] From a service management and business perspective, the other two elements are associated with the phone network and cable TV broadcasting, and are largely independent from the global IP address range. This, however, will likely change in the future as a result of new developments.

number one priority among ICT network services. As indicated in the introduction, the focus of my investigation is the accessibility of this service, because there is growing evidence that services used over the digital communication network are increasingly based on Internet Protocol (IP).

Addressing the definition problems described above is crucial in terms of development policy; however, if the European Union does not provide guidance in this respect, it is the responsibility of the domestic development policy to give unequivocal responses to broadband-related issues prior to the design of development strategies to be applied in Hungary.

V.5. The principle of technology neutrality

Regardless of the actual development policy concept, the regulations of the European Union mandate adherence to the principle of technology neutrality. In regards to the government's involvement and regulatory role, some experts argue for a more widespread application of the principle: "We believe that […] the guidelines of technology neutral regulation should also be adhered to in situations where it is not mandated by the Union or by member state norms" (Csáki, 2010). As Balázs Gyula Csáki also admits, despite the fact that "in the realm of digital public administration certain – perhaps revolutionary – solutions inherently limit the possibility to apply various technologies […], it is advisable to strive for a flexible regulatory framework which does not stand in the way of development in the long run" (Csáki, 2010).

Based on technical considerations, on the other hand, the principle of technology neutrality is extremely questionable. Nevertheless, organizations requesting proposals have to respect the validity of the principle. Consequently, EU and domestic authorities making ICT-related decisions do not have to deal with the technical details of the communication industry when identifying the destination of resources: details of the implementation are up to market competition. This means, however, that the EU's ICT program typically has no serious industrial policy significance, as opposed to similar programs in the Far East (for example in Japan, South Korea, and China) [49]

In practice, 'tricky' solutions are often necessary in community-funded projects to ensure the construction of 'future-proof' (i.e. optical) networks in areas that had no prior broadband coverage. This, however, requires commitment and expertise on the part of the institutions requesting the proposals.

An increasing number of studies published within the EU express criticism that the majority of the EU member states lag behind the developed Asian countries and the United States in terms of fiber optic upgrades. The European subsidy system relies rigidly on the requirement (dogma) of technology neutrality, and no member state is willing to dedicate government funds as extensively as Japan or South Korea to improve the essential broadband infrastructure. The EU's current approach to fund allocation favors service providers directly or indirectly, since it delegates them the power to decide about the precise technical details and the features of the architecture when rolling out 'broadband Internet,' [50] provided the Quality of Service (QoS) meets the minimum requirement. At the same time, it considerably complicates the efforts of those who are trying to convince policy makers of the plausibility of community-funded[51] telecommunication development and services. As a result, the definition of broadband and the principle of technology neutrality have a direct impact on broadband infrastructure development and on the services that can be offered via the network given the narrow widths. This forms the basis of my second hypothesis:

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[49] This is precisely the difference in the use of devices, which was addressed in the introduction with respect to the various economic philosophies.

[50] The term refers to the definition problem discussed earlier.

[51] The community character can be attributed to the relevant requirements and regulatory frameworks rather than to the ownership structure. For example, a basic requirement for utilities considered as 'public' is the provision of open access for eligible parties.

H_2: The definition of broadband varies from country to country, and the principle of technology neutrality applied mandatorily in EU regulatory processes complicates government-funded infrastructure projects by counteracting the push for the universal use of fiber optic technology, the optimal long-term choice for WAN projects. This would jeopardize the interests of consumers.

The hypothesis assumes that the lack of a uniform definition for broadband as well as the principle of technology neutrality impair conditions for broadband infrastructure and/or services-based competition.

V.6. Testing of the H_2 hypothesis

V.6.1. Methodology

Prior to testing the hypothesis, it is important to discuss how the technology requirements have appeared in broadband infrastructure development proposals in Hungary. The use of qualitative methods is helpful in this respect:

- On the one hand, it was necessary to conduct interviews with two former heads of the Senior State Secretariat for Infocommunication[52] managing the field and supervising the proposal request process. I conducted structured deep interviews using protocols that can be viewed in Appendix 3 along with the responses.
- On the other hand, requests for proposals had to be reviewed. During the period until the summer of 2010, the first two of the total of five programs (HHÁT 2 and HHÁT 3) were carried out without EU co-financing, but the three

[52] All programs (subject of discussion in a later section) financed by the EU in Hungary were managed by the Senior State Secretariat for Infocommunication, an institution supervised by three different government bodies over a six-year period (until mid-2010) – including in order: Ministry of Informatics and Telecommunications, Ministry of Economy and Transport, and the Prime Minister's Office. During this time two persons managed the operations of the Senior State Secretariat, it was therefore essential for me to contact them (during a transition period, there was a third person temporarily in charge for six months, however, he made no decisions with respect to the proposals).

subsequent programs, GVOP 4.4.1, GVOP 4.4.2., and GOP 3.1.1, were subsidized by the EU.

The outcome of these programs will be presented in a later chapter; this section is dedicated only to the analysis of how the principle of technology neutrality surfaced in these grant programs.

V.6.2. Outcome of the investigation

The emergence of the principle of technology neutrality in the following programs: GVOP 4.4.1, GVOP 4.4.2, and GOP 3.1.1

All three programs are based on the theory that winning bidders are required to establish termination points providing Internet service to households. In GVOP 4.4.2, the agency requesting proposals defines the eligibility conditions (on page 8 of the request):

"[…] an infrastructure development project is eligible for subsidies if it is deployed

1. *between the nationwide digital telecommunication network / Internet backbone access point and the future distribution point(s) to be located within the administrative boundaries of a municipality,*
2. *between existing or planned distribution points within the administrative boundaries of to or more adjacent municipalities,*
3. *between the existing or planned distribution point(s) within the administrative boundary of a municipality and subscribers' service points.*

If a bidder does not own a backbone network, it is required to attach a statement from a backbone owner declaring that the bidder will have access to the Internet network in the bandwidth it requests."

The first specification refers to the wide area network (if it needs to be rolled out). However, regarding the expected quality parameters, only the following criteria are formulated:

"An infrastructure development project is considered completed if it is able to provide broadband communication service that is in line with the recommendations

of the International Telecommunication Union (ITU) and meets the following requirements.

For eligibility for subsidy, the Internet service has to meet the following minimum conditions:

Regarding specifications 1 and 2:

- *The availability of the service is at least 99.5 percent per individual subscriber on a monthly basis,*
- *no time limits in the connection,*
- *Packet loss is under 0.5% in 24 hours (if it is measured on a network at maximum of 65% capacity) […]"*

Even though the GVOP 4.4.1 program is geared towards different types of bidders, it involves the same parameters in terms of the service quality requirements at terminal points. At the same time, the concept of WAN infrastructure development was not addressed separately from the access network in the request for proposals.

The following also surfaced in the GOP 3.1.1 (on the seventh page of the request) among the conditions of subsidy eligibility:

- *"Deployment of distribution network and connection to nationwide backbone networks (distribution point within the administrative boundaries);*
- *Connection between distribution points within the administrative boundaries of two or more adjacent municipalities;"*

in other words, the potential to roll out a wide area network. However, these are the only quality parameters specified (on page 17 of the RFP):

"The completed infrastructure or the services available via the infrastructure must satisfy the following requirements:

- *[…] The digital subscriber line and access point allowing the service have to be able to ensure data transmission at a minimum speed of 2 Mbps/512 kbps, but preference is given to bidders offering a symmetrical 2Mbps speed."*

This demonstrates that, even in best case scenarios, the only way authorities could ‘apply pressure’ on bidders was by specifying the conditions regarding terminal distribution points: if the number of terminal access points in a municipality is high, an optical aggregation network is necessary. This did not always materialize.

The way the requests for proposals were formulated reveals that there were no specifications regarding data transfer capacity in wide area networks. The interviews will give an account of the reasons.

Interview findings

The interviews with the two former heads of the Senior State Secretariat for Infocommunication (Appendix 3) revealed that the expectation to abide by the principle of technology neutrality was one of the reasons they had to use ‘tricks’ to increase the chances of bidders creating ‘future-proof’ infrastructure. When establishing the guidelines of the programs GVOP 4.4.1, GVOP 4.4.2, GOP 3.1.1 in 2004-2005, the principle of technology neutrality was not a prevalent concept. In the requests for proposals, a couple of specifications determined the expectations regarding termination points, which was basically a de facto infringement of the principle of technology neutrality. At the same time, they tried to “leave the doors wide open to invite as many good solutions at as many locations as possible.”

In many cases, proposals adopted non-future-proof technical solutions; however, the vague definition of the principle of open access caused an even greater problem than the principle of technology neutrality. Due to the lack of clear definitions, the requests for proposals failed to include precise requirements, and the coordinating ministry was unable to exercise control.

One of the conversations revealed an important issue. As a result of the successes of the GVOP 4.4.1 and particularly the GVOP 4.4.2 programs, significant EU resources have been allocated, which was thrilling, as the money "was used for great purposes, given that the ultimate goal was to increase the coverage of households and to implement state-of-the-art technological investments. The aim of the program was to overextend and to bring as much money into the country as possible.”

As indicated in the course of the document analysis and also reinforced by the interviewees, due to the conceptualization of the proposals it was impossible to allocate funds specifically for WAN developments. GVOP 4.4.2 was the first program that actually identified the term 'wide area network;' it had not come up in grant earlier programs. However, requests for proposals did not include any criteria regarding bandwidth provided by aggregation network sections. As a result, wireless connections were frequently used when linking municipalities, even though, as one of the respondents commented, "optical fiber […] is the only right direction in wide area network development." To avoid infringements on the principle, termination point speed requirements were specified in a way that they could be satisfied by several technologies in addition to fiber optics. According to one of the respondents this was a common technique in other EU countries as well, for example in Ireland, where minimal bandwidth requirements were specified for various sections of the network.

The conversations brought attention to another issue which is only partially related to the topic but is nevertheless extremely important: the 'interesting' business practice regarding development tax benefits. This type of tax benefit had been used only by Magyar Telekom until 2005. In 2005, however, mobile providers emerged and "realized that this was a great opportunity for them to save money in the course of 3G development." Policy makers were intent on keeping the opportunity available, but the lobbyists of the affected firms also protected their interests, and the debate gave a highlight to "the definition of broadband as one of the central factors in terms of the assessment of the quality of development projects. Ultimately, the soft definition was adopted, but with regards to the development tax benefit the regulation included a technological condition which ensured that only Magyar Telekom was able to take advantage of it."

All the above evidence implies that the principle of technology neutrality has been infringed in other areas as well. The hypothesis proved to be valid, but it needs to be added that the vague definition of 'broadband' and the inappropriate interpretation of the principle of technology neutrality were significantly less relevant in the course of the implementation of the proposals five years ago than presently, at the time of this dissertation. There have been other problems due to vague definitions – e.g. related to the principle of open access – that caused at least as many difficulties to bidders as the two areas of my hypothesis. Still, the interviews with the two former leaders as well as the requests for proposals clearly show that the lack of precise definitions regarding bandwidth categories and the interpretation of the principle of technology neutrality have caused problems and conflicted with the interests of consumers in subsidized locations. Based on the investigation, I conclude that the hypothesis is verified.

Although optical fiber cannot be considered technology neutral, it is the only "future-proof"[53] technology for aggregation network upgrades. In certain categories and keeping proportionality in mind, projects for well-defined public purposes should be exempt from the principle of technology neutrality, for example to maintain public safety, to promote social or regional cohesion, or to foster competition, protecting the long-term interests of consumers.

[53] By 'future-proofness' I mean satisfying the long-distance data transmission demand expected in the next 15-20 years, and based on our current knowledge, optical fiber is the only technology that can meet this requirement.

VI. UTILIZATION OF COMMUNITY RESOURCES TO STIMULATE BASIC INFRASTRUCTURE DEVELOPMENT

The previous chapters have demonstrated that some form of utilization of community resources is necessary for the development of the digital telecommunication network, but the lack of definitions essential for identifying development policy goals significantly hampers the conceptualization process.

These days the ultimate infrastructure-related goal of telecommunication policy must be the fastest possible comprehensive broadband coverage (universal access to the digital telecommunication network) at minimal social-economic expense. Logically, this could also mean that infrastructure-based competition is only desirable in cases when it considerably improves the continuity of access when it comes to catastrophe situations.[54] Unfinished digital telecommunication infrastructure involves extra costs at the societal level owing to the delays, while extra costs at the economic level can be attributed to unreasonable infrastructure-related expenses. This perspective does not necessarily contradict the liberal economic policy approach. Railway construction is a good example, where basic infrastructure construction involves significant costs, but it makes no sense to build two tracks in order to stimulate market competition unless the goal is to separate the two directions of traffic. Nevertheless, competition is possible in the railway sector, too, by sharing the basic infrastructure: trains owned by various companies could use the tracks under equal conditions.

We can look at the digital telecommunication network infrastructure in the same way – sharing the facilities or network sections (e.g. local loop unbundling, active network elements for lease) indicate that the owners and users of the infrastructure are able to cooperate to some degree[55], whether motivated by cost reduction or regulation, i.e. to meet community interests. The question is: In which areas is it sufficient to

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[54] This involves significant costs, which are justifiable only if the competing networks are not deployed parallel to each other, or if they are significantly different in terms of technical features (e.g. wired and wireless technologies competing with each other).

[55] Divergent technologies (with different standards and/or technical features) are impeding factors.

apply regulatory tools to ensure that the facilities are shared, and if it does not promise results, where is it necessary to utilize community resources?

VI.1. Investments driven by demand, risk, and government intervention

The development of various technologies and the resulting rise in the roll-out costs of new generation networks (NGN) does not necessarily mean that the market value of the network as a whole is increasing.[56] The use of state-of-the-art technologies in fixed-line networks (e.g. the deployment of optical fiber to the home) involves tremendous investments (Begonha, et al., 2010), therefore, areas that are less attractive for businesses see little or no digital telecommunication network development unless community resources are made available.

The lower the population density and income level per household in an area, the higher the average per-households costs associated with the deployment of digital telecommunication networks in the case of state-of-the-art (wired or wireless) access technologies.[57] With access to relevant data, the emergence of private capital in these investment projects is therefore easily predictable based on a region's population density and income figures. [58] In light of these considerations, I set up three categories of investment types to demonstrate why investments

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[56] It is becoming increasingly difficult to assess the value of a digital telecommunication network owned by a company by using 'traditional' methodologies (e.g. discounted cash-flow calculation). Assessment methodology could also be the subject of a separate doctoral dissertation, because it is necessary to consider an increasing number of parameters, whether the company competes in the field of infrastructure or services.

[57] In addition, a number of other factors influence investments, for example digital literacy, regulatory environment, administrative burdens, etc, but the two factors mentioned above are the key aspects, and several other factors can actually be derived from them.

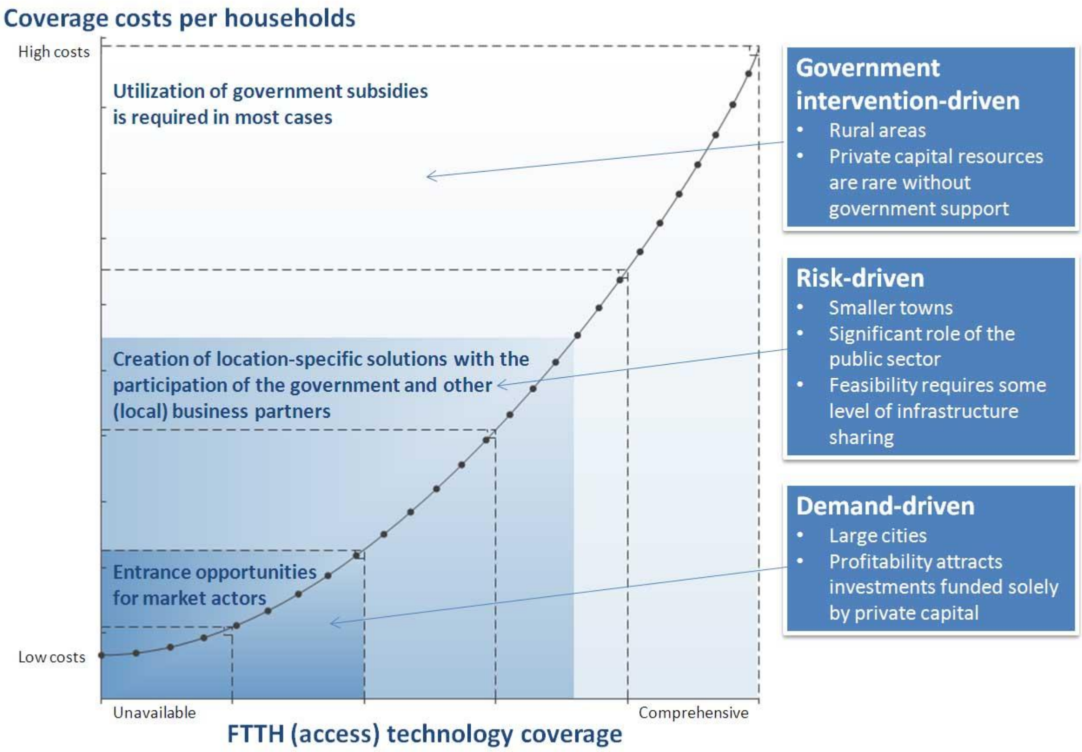
[58] Disposable income is the most relevant of all household income data, because this is what sets a limit to growth potentials when investors try to sell new products or services to households within the area following the initial investment.

slowed down or disappeared with time in state-of-the-art technology upgrades[59] in access network development:

- *Investment driven by demand* – materializes in areas that attract businesses without government intervention, which does not mean that an active government involvement could not stimulate further competition or improve the efficiency of investments to a great extent (e.g. service providers could cut their costs significantly by using mandated cable manholes owned by local governments).
- *Investment driven by risk* – in areas that are less attractive from a business perspective investors are more cautious, and investments do not materialize without active community participation.
- *Investment driven by government intervention* – in areas where there is no business case for investments and where little or no investment can be seen.

[59] Obviously, investments may focus on WAN development in addition to the access network. This issue will be discussed later; however, the logic behind investments can be perfectly illustrated by analyzing the deployment of the access network, given that it involves considerably higher investment costs than WAN development.

FIGURE 9. MODERN ACCESS TECHNOLOGY COVERAGE AS A FUNCTION OF COSTS PER HOUSEHOLDS



Source: Gergely Kis, Ph.D. dissertation, 2010

The above areas indicate that in order to foster regionally balanced growth in a country, community resources have to be utilized even under competitive market conditions, except in demand-driven regions, but even there they should not be ruled out.

The following task arises: telecommunication policy makers have to reckon with the inherent monopoly-building capacity of broadband infrastructure involving significant investments, where land occupancy itself goes against the concept of competition and impairs progress if infrastructure sharing is not enforced. If the infrastructure owner is unable or – due to a sustainable monopolistic position – not motivated to upgrade the infrastructure it owns, a solution has to be developed to turn it into a – possibly FTTx-type – open access system. The community is an active participant in creating the new infrastructure, by contributing capital or other support[60] – a

[60] Via the local or central government or the European Union, but there are numerous positive examples showing that in response to local interests communities participate directly in the deployment of infrastructure (e.g. by trenching).

satisfactory degree of participation would be recognizing the area's lagging broadband development and initiating a search for solutions in cooperation with business partners. This is important for another reason: given the EU regulations concerning the utilization of transferred funds, telecommunication infrastructure projects completed so far using EU resources basically guaranteed that the technology did not go beyond the level of satellite, DSL or DOCSIS. This causes a problem in all regions that had previously attracted businesses to deploy infrastructure utilizing private and public resources but would currently need a different investor to roll out a more up-to-date infrastructure to compete with the existing one. The new entrant, however, has no access to community resources, because the EU prohibits multiple uses of community resources in such cases[61], while private investors are more cautious in areas that are less attractive from a business point of view given that they have to face a competitor. If private-capital-based deployment is the only alternative, mandating access requirements also becomes more difficult with respect to the secondary infrastructure, and the monopoly can turn into duopoly.[62] The time to recoup their invested capital increases owing to the resulting competition, moreover, each carrier has only partial access to the market (it is rare that one household subscribes to the same services at two different operators). This inherently raises expectations to decrease investment and particularly operational costs, which inevitably results in deteriorating service quality.

This creates a paradox situation: in regions that are moderately attractive from a business perspective, initial investors settle down for the long term, while areas that have no business case for investment and do not have access to community resources until later due to the lack of private capital end up receiving significantly more modern infrastructure. In fact, the utilization of community resources fulfill

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[61] Another shortcoming is related to the fact that the EU prohibits the use of community resources until a market player commits itself to the development of a given area within three years – meaning that one promise, without any competition, is enough to occupy an area for a period of three years.

[62] In the case of two sets of parallel infrastructure, access requirements are not mandated unless one of the networks belongs to the incumbent carrier and the requirement affects its "legacy" network (or the new network built over it).

investors' profit expectations in these areas, as well (provided the company is not 100% state-owned).

The last step in determining the directions of development policy is to identify ways to overcome market failures by utilizing government resources as effectively as possible.

VI.2. Ownership structure created by the utilization of community funds

The inventory of potential intervention tools has already been addressed, but before actually applying them, it is essential to decide who the owner and operator of the newly created infrastructure should be.

Several options are available in terms of ownership structure, given that the active and passive elements of the infrastructure can be owned by different market actors. In a simplified framework,[63] investments utilizing community resources can theoretically belong to one of the following categories[64] in a competitive environment:

1. *Upgrades to existing infrastructure:*
    - The infrastructure is owned by the community, so publicly-funded upgrades are easy to implement (this scenario is rare in Europe, too, but there are a few examples – e.g. STOKAB in Sweden, which will be presented in a later section;
    - The infrastructure is not publicly owned – two cases are possible:
        - Upgrades are implemented following the purchase of the privately owned infrastructure to serve the interest of the public. The government acts, at least temporarily, as a strategic investor,

[63] Without separating the ownership relationships of the active and passive elements.

[64] Investments implemented by the utilization of private capital can be turned into public property by state expropriation and subsequently upgraded; however, this is out of the question in a liberalized environment and this option is therefore not included in the list.

meaning that it also functions as a competitive market actor. This works in accordance with a well-known principle in the European Union: the Market Economy Investor Principle (MEIP), i.e. the government acts as an investor under market conditions.

- Owing to capacity shortage, the private owner of the infrastructure is unable – or for some reason unwilling – to do upgrades to meet the demand of the community, therefore community resources support the construction of an alternative infrastructure. In the European Union, this falls into an intervention category along the lines of the Services of General Economic Interest (SGEI) principle, where the goal is to implement general community-oriented economic services.

2. *(Green field) investment in the case of non-completed infrastructure:*

   - Following the utilization of community resources the completed infrastructure remains the property of the community;
   - The infrastructure project is completed by utilizing private as well as community resources [via proposals, in Public Private Partnership (PPP) constructions, etc.], where the new infrastructure:
     - becomes the property of the investor with set operating conditions, or
     - becomes shared property.

The issue of management is relatively straightforward: the party with the most effective solution for the given network sections should be in charge of operating the infrastructure (this could also be a community participant or market actor).

There is one considerably problematic issue in the list in terms of ownership structure: the 'transformation' of community property to private property. The only justification acceptable for this case is that it serves the interest of the community and provides cheaper and/or better quality services compared with the community-owned structure. Showing proof is obviously not easy in the case of an unfinished investment project.

The pros and cons of joint infrastructure projects utilizing private and public funds have been discussed by many authors. Compared with a scenario in which a minimum service quality level is imposed, some experts believe that PPP constructions apply more cost-effective solutions and provide higher quality services (Hart, 2003), or could positively affect operating costs (Martimort, et al., 2008). At the same time, the ratio of private and public contributions easily shifts in the foreground if the contract was not precise as the PPP was created (Hart, 2003), or if it is desirable to turn community goods into community property (Besley, et al., 2001). In an environment prioritizing liberal economic policy concepts, PPP constructions are the primary means of tackling market failures by involving the private sector, as long as there are investors willing to participate, although it frequently results in misinterpretation (Hodge, et al., 2007). Despite the problems PPP constructions are increasingly becoming institutionalized in the countries of the EU in an effort to tackle unresolved issues (Koppenjan, et al., 2009), because there are some undoubtedly good examples [in Europe e.g. in the Netherlands and Italy (Alberto, et al., 2010), while the northern countries – Sweden, Finland and Norway – are considered leading models in the global arena]. In the United States projects implemented with strong community participation are playing an increasing role in the digital telecommunication network development of smaller municipalities (Angsana A., et al., 2010).[65]

PPPs have become prevalent in Hungary, as well, but, as a later section will show, only representatives who are extremely knowledgeable in the field are able to serve the interest of the community in the area of digital telecommunication network deployment and operation due to the complexity of the tasks, and their expertise has a high price. Otherwise, the interests of the community will be subdued by those of private capital investors.

[65] The authors present the positive outcome of broadband infrastructure development projects that were supported by community participation in Chaska, Minnesota; Hermosa Beach, California; as well as Fredericton in Canada.

There are two distinct approaches to 'broadband telecommunication infrastructure' development and to the subsidy system both at the national and greater regional (e.g. EU) level:

- Conceptual approach focusing on the perspective of service capability,
- Conceptual approach focusing on the task of infrastructure development.

Both approaches may be correct. Considering the potential objectives aimed at decreasing the regional and social broadband divides, both perspectives could be effective in battling the problem, as long as the right one is applied at the right time during the design of development concepts.

VI.3. Service capability vs. infrastructure development approach

VI.3.1. Conceptual approach focusing on the perspective of service capability

Advantages of the approach focusing on the perspective of service capability

- Could result in market conform solutions in every aspect;
- Allows for maximum technology neutrality[66], which theoretically contributes to cost optimization and could promote the smooth rollout of broadband infrastructure (companies do not need to give up their preferred technologies to compete);
- Could generate infrastructure investments, which inherently boosts the development of broadband basic infrastructure;

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[66] Certain 'services' are infrastructure-related (e. PSTN, the traditional telephony) and solely service-based (VoIP – Voice over Internet Protocol) at the same time. Supporting these 'services' may violate the principle of technology neutrality. Therefore I use the expression 'service potential' in this study.

- Easy to communicate (e.g. full broadband coverage[67] for a given municipality/subregion/region, etc.).

Disadvantages of the approach focusing on the perspective of service capability

- Does not directly address the elimination of regional broadband divides, i.e. does not insist on state-of-the-art technologies in basic infrastructure development;
- More often than not, implementation is motivated by the principle of 'broadband by any means' – important questions regarding the new infrastructure are often ignored, for example:
  - Who will be the owner?
  - Is infrastructure-based competition possible, i.e. can the infrastructure be shared (will there be local monopoly)?
  - If the infrastructure is built in an area where there is no business case for the deployment of an alternative infrastructure, will there be an opportunity for service-based competition?
- The approach does not guarantee 'future-proof' technical solutions due to the principle of technology neutrality.

VI.3.2. Conceptual approach focusing on infrastructure development

Advantages of the approach focusing on infrastructure development

- Directly addresses the elimination of regional broadband gaps (secondary market mechanisms aimed at service development are not necessary);
- Has a direct, predictable impact;
- Has a marked industrial policy feature;

[67] It is essential to provide a precise definition of coverage in this case, as well – this will be subject of further discussion. For the purposes of communication, however, simplification is/can be an option, often 'hiding' important details regarding the actual technical capabilities of the basic infrastructure.

- Creates an open access infrastructure by default, provided the requirements are well designed in the request for proposals and the authority insists on adhering to them in the course of the implementation process;
- Theoretically, a general feature of the model is technology neutrality and/or public utility-type implementation;
- Potential to achieve long-term technological value (currently this could accelerate migration to the FTTx fiber optic network); aimed at creating telecommunication infrastructure based largely on durable, state-of-the-art passive elements (new generation subconstruction networks and fiber optic cables).

Disadvantages of the approach focusing on infrastructure development

- Does not necessarily achieve market conform solutions;
- The principle of technology neutrality might suffer by being subordinate to the priority of 'future-proofness' in basic infrastructure construction;
- If the focus is exclusively on one element of the digital telecommunication network (e.g. WAN), it may not produce the expected results at the termination points (users may only perceive the advantages indirectly, because they are contingent on additional conditions);
- More difficult to communicate.

If the government's goal is to promote infrastructure-based competition and/or 'future-proof' broadband infrastructure development, the above factors imply that the infrastructure-based approach is more effective in most cases. This approach emphasizes the interest of the community in the ownership structure and management practices of the infrastructure more explicitly, thereby serving the long-term needs of users.

VI.4. Methods to involve community resources aimed at broadband basic infrastructure development

Based on the arguments above, the following hypothesis formulates guidelines for determining the techniques of community resource integration in an effort to shape the basic principles of government intervention:

H_3: In a liberalized communications market, the utilization of public resources allocated for digital telecommunication network infrastructure upgrades in the WAN segment are necessary only if the infrastructure to be constructed (1) is not an alternative system next to an existing network or (2) aims to alleviate the shortage of existing fiber capacities.[68] In all other cases the only role of the government is to apply regulatory tools in the WAN market to foster competition.

The hypothesis assumes that utilizing community resources could be necessary when new basic infrastructure needs to be built and when it is no longer possible and economical to share the existing infrastructure using current technical solutions. At the same time, the two conditions alone can justify government intervention. If, however, at least one infrastructure had been built under market conditions and it is suitable for shared use, regulatory tools have to be used to stimulate competition. If the hypothesis is validated, it attempts to address a significant shortcoming of the relevant EU recommendations: the separation of the access and wide area networks from the perspective of development policy.

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[68] In other words, aid is directed toward upgrading existing but insufficient infrastructure. In addition to upgrading network points enabling interconnection, the potential unbundling of closed infrastructure could be aimed at expanding fiber capacity in the wide area network. However, the WAN infrastructure to be upgraded has to provide open access in this case, as well.

VI.5. Testing of the H_3 hypothesis

VI.5.1. Methodology

To test the hypothesis, it is necessary to analyze EU regulatory documents related to digital telecommunications networks and to look at implemented projects, in order to assess what methods have been applied so far to promote the shared and competition-enhancing utilization of the existing infrastructure. The central question to be answered is whether and how the competition law and relevant provisions provide opportunities for community-funded basic infrastructure development.

This section of the study is based on qualitative research (analysis of documents and secondary data), consisting of the investigation of relevant regulations, directives of the European Parliament and the European Commission, as well as case studies and strategic documents.

VI.5.2. Outcome of the investigation

By regulating the digital telecommunication networks, the European Union has been employing several methods to promote the shared and competition-enhancing utilization of the existing infrastructure.

The shared and competition-enhancing utilization of the existing infrastructure

Sharing the existing infrastructure with competitors was mandated for the first time by the EU's regulatory package of 1988, featuring the Open Network Provision (ONP).[69] The ONP framework was fundamentally shaped by the Open Network Architecture (ONA) concept designed in 1986 by the FCC, the telecommunications regulatory authority of the United States. This fundamental principle was based on a norm-oriented, comprehensive redesign of the services and network facilities of AT&T (after it had been broken up), in an effort to ensure that all network users can interconnect to the network and its basic interfaces and functions under equal conditions.

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[69] Additional elements included guidelines associated with approval, data protection and terminal devices.

Like the ONA program of the US, the ONP aimed to allow open and efficient access to public telecommunication networks and services, and to provide harmonized conditions fostering their use. Harmonized conditions involve technical interfaces (including network termination points), network conditions, tariff guidelines, as well as access to frequencies/numbers/address/names. The system of ONP directives consists of the ONP Framework Directives, as well as directives and recommendations related to interconnection, leased lines and voice telephony. It is in line with the mission formulated in the present dissertation: It addresses the regulatory issues associated with open access; in other words, it discusses the details of the government's (regulatory) role in promoting infrastructure-based competition. The following section will primarily analyze two features of the system of ONP directives: regulations controlling interconnection and leased lines.

The open access provision is a basic principle defined in the ONP Framework Directive (European Parliament, 1990), and in the modifying directives (European Parliament, 1997), ensuring open and efficient access to public telecommunication networks and – where applicable – to public telecommunication services.

The regulatory parameters associated with linking networks, coordinating services and providing universal access were defined by the ONP Framework Directive (European Parliament, 1997), which calls for asymmetrical regulation. For the first time, the question whether a carrier has significant market power (SMP) was included as a regulatory criterion in telecommunication regulations, with the National Regulatory Authority being responsible for assessing it. As a basic rule, issues of interconnection and special access[70] should be decided in business negotiations between parties. The directive asserts that the operators and/or carriers of public (wired or wireless) telecommunication networks (including retail providers of leased lines) have the right to negotiate interconnection. If a service provider has significant market power, it is required to satisfy all reasonable demands for access to its network, including special access points. If a network operator and/or service provider is approached by a same-category

[70] Special network access refers to network access points that are different from the network termination points available to the majority of users.

operator/provider for interconnection, negotiation between the parties is mandatory. Another important regulation of the directive is that the national regulatory authority is allowed to grant temporary exemption from the negotiation requirement associated with interconnection on a case-by-case basis, as long as there is a reasonable alternative to the required interconnection both from a technical and business point of view, and the required interconnection is not completely feasible considering the available resources. According to the directive, service providers that are allowed or required to negotiate interconnectivity have to be reported to the Commission.

The assessment of the SMP criterion has been limited to four markets by the directive (as evident from the above description):

- public fixed-line telephone network operation and service,
- public mobile telephone network operation and service,
- leased line service,
- interconnection service.

According to the directive's definition of SMP, a service provider presumably has significant market power if it has a market share of over 25% in a given telecommunication market or within a given member state. [71] In addition, the following factors are to be considered: the service provider's potential market influence, its revenues compared with service area size, its power to control the tools for end user access, its opportunities to access financial resources, as well as experience in providing service.

The directive detailed the requirements that had to be imposed by member states on service providers with significant market power through legal regulations when gearing up for interconnection. These requirements include avoidance of

[71] One of the major shortcomings of the regulation was the lack of definition regarding the method of measuring the 25% market share, and it was possible to apply several methods that generated different results. This has been significantly revised by more recent EU regulatory materials, in particular by Guideline and New Recommendation on market analysis (both in terms of the 25% market share and the four markets). This also means that this directive was not considered relevant by the National Communications Authority, either.

discrimination, transparency, cost-based interconnection rates, and financial separation. In order to establish transparent and cost-based interconnectivity, the directive mandated that SMP providers prepare and publish a reference offer for connectivity approved by the National Regulatory Authority.

Leased line regulations are specified in a separate directive addressing leased lines (European Parliament, 1992). The goal of the directive is to create harmonized conditions for users in terms of the open and efficient access and use of leased lines provided through the public telecommunication network, and to define the minimum inventory of leased lines with harmonized technical parameters within a community. The directive required each member state to identify at least one organization that meets the specifications of the directive, while all requirements derived from the directive affect only SMP providers, unless there is no SMP provider in this market within a given member state.

The ONP directives were adopted in the Hungarian legislation in the Telecommunication Act XL of 2001 and its directives.

In an effort to review the completion, results and shortcomings of the ONP directives objectively without assessing them through the 'lens' of our current knowledge, I am relying on the EU Commission's reports evaluating the completion of the telecommunication regulation package. Some of the statements in the fifth report that are of central importance to this dissertation included: "Twenty-one months after the establishment of a competitive market in the telecommunications sector, the (ONP) regulatory framework directive is the driving force of telecommunication services. The relatively limited harmonization of regulatory measures is a major obstacle in creating a uniform market in the areas of permit processing and interconnection. The regulatory authorities of member states need to be much more active, particularly in the area of interconnection agreements" (European Parliament, 1999).

According to the report, many member states have not adopted a cost accounting method, which primarily created a significant price squeeze between retail and interconnection rates and resulted in excessive leased line fees.

The report reveals that the local access market sees no competition despite the fact that permits have been issued for wireless local loop solution, providing an alternative way for the 'last mile.' In addition, in some member states cable TV networks remained under the control of incumbent service providers. The current (ONP) framework directive does not address any special issues associated with Internet access or measures that could protect the competition from distortions created by the integration of voice/data and wired/wireless services.

In the ONP regulatory framework system a decree was issued about sharing the local loop in an effort to eliminate the bottlenecks that had hampered competition and to ensure access to the local loop (European Parliament, 2000). In light of the results and tasks, the Commission's report that pawed the way for the decree described the use of 'open network provision' in the ONP directives as follows: "The open network provision (ONP) framework directive refers to the open and efficient access to public telecommunication networks, and where applicable, to the harmonized conditions regarding the use of public telecommunication services." The ONP directives define the conditions under which certain types of networks and/or services can be accessed and used.

According to the definitions of the ONP directives, 'network access' refers to the capacity of accessing a few or more parts of an existing network, however, this does not affect the ownership structure. In the sector-specific directives, requirements for network operators (registered as SMS operators) do not specify that incumbents have an obligation to fully unbundle the local loop. At the same time, they are entitled to force a dominant service provider to ensure access by means of competition regulation. Only the leased line directive requires registered service providers to lease transmission capacity for exclusive use to third parties under harmonized conditions (European Commission, 2000).

The ONP principles are valid within the framework of the decree enforcing local loop unbundling and the directives of 2002, which are in effect as this dissertation is being written. At the same time, the 2002 system of directives was amended in 2010, and the modifications have to be implemented in sector-specific regulations by 2011 in Hungary. The most important amendments are outlined below.

Two definitions in section 2 of the framework directive (21/2002) are being adjusted:

- The definition of public telecommunication network in section d) has been changed to digital telecommunication network "containing inactive elements as well." (This could be relevant in optical networks, where inactive elements can be useful tools to separate wavelengths.)
- The definition of 'related facilities' in section e) was supplemented by "physical infrastructure, in particular substructures, poles, street cabinets and buildings."

The amendments specified in the 12th section of the access directive (19/2002) are also related to the second definition. The original title "Location and equipment sharing" received an addition: "for digital telecommunication service providers." The sentence "national regulatory authorities encourage the sharing of these facilities and properties" was modified to "national regulatory authorities are entitled to enforce the shared use of these devices and properties, particularly connections to buildings, poles, antenna stands, substructures, control manholes and street cabinets." It should be noted that the four-pillared broadband strategy of the Federal Republic of Germany specifies the utilization of synergies available through infrastructure building as its first pillar. The most relevant sections of the strategy are reviewed in Appendix 4.

A crucial change is that SMP functional separation can now be required from SMP operators provided the commission exercises a strong control. The market analysis guideline currently in effect acknowledges only financial separation as a potential requirement that can be imposed on SMP providers. (It should be noted that the ONP system of directives has already adopted the strictest requirement, structural separation, according to which the department of a vertically integrated company that is involved in issues of access must be spun off either to a different owner or in a public offering. The cable TV directive of 64/1999 required the dominant phone service provider to divide its telecommunication network operating division and its cable TV segment into two separate legal entities.) [72]

Functional separation means that all the bottleneck facilities of a vertically integrated company become the property of a division specializing in the field and owned by the parent company. In addition, the following areas are crucial to be separated (the relevant sections of the access directive are included in Appendix 5).

Separation of functions:

- Creating separate business units for the production and sales of the given products,
- Obligation to provide services under non-discriminatory conditions,
- Separation of operation support systems,
- Separation of brand names.

Separation of employees:

- Employees of one branch are not allowed to work for the other branch, not even part time,
- Restrictions on the movement of managers,
- The salaries of employees in the removed branch cannot depend on the revenues of the parent company.

Separation of information:

- Limitations on information flow between the two branches,
- Separation of information management systems.

It should be noted that British, Swedish and Italian authorities already required JPE service providers to apply functional separation (following a long period of negotiations), and the process is underway in Poland, as well. The 'Openreach'

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[72] Separation into two legal entities is not equal to structural separation as defined in the first part of the paragraph. There may be several individual legal entities associated with the same investor or owner. The significance of structural separation is to eliminate the interrelationship both structurally and in terms of ownership.

agreement based on the negotiations of OFCOM and BT has become well known, after 230 requirements had been satisfied (and monitored).

The above factors indicate that Open Network Provision (ONP) is a well-defined term in the legal system of the European Union. This, however, is not true of the terms Open Access (OA) and Open Network Access (ONA). These are applied most consistently by ITU (International Telecommunication Union) and 'infoDEV'[73], and in the following sections I follow these applications, as well. A precise definition of the terminology is essential for the topic: they define the areas where the government can get involved in order to ensure infrastructure-based competition.

One of the infoDEV publications[74] claims that Open Access was originally used in the narrow sense and it emerged during the debates around the role of Regional Bell Operating Companies (RBOCs) following the breakup of AT&T. During the debate, the key issue that emerged was why cable TV operators providing triple play services cannot be obligated to ensure on-demand transmission capacity to competitors for a charge when Bell companies have to meet this requirement (particularly in the local loops) (Spintrack AB., 2005)[75].

The term was interpreted in a broader sense in Europe, incorporating the issues of network access, financing and operation. Another related issue was the fact that certain OA initiatives (mostly of the local government) could not have been financed if alternative infrastructure (particularly access network) has been deployed. Nevertheless, they expected offers from several competing operators. If there is only one network, the conditions under which businesses can gain access are critical. Access networks are not the only field where this issue is relevant: some nationwide electricity providers launched wide-scale network construction projects in order to become indirect telecommunication service providers, and the definition

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73 InfoDev is an international development program funded by the World Bank, supporting information exchange related to ECT development applications.

74 Available from: http://www.infodev.org/en/Publication.10.html.

75 Lately the term has been used in a different debate, namely whether Internet content providers should be required to pay extra charges for gaining access to transmission networks that can ensure adequate service quality. Network neutrality, however, is not discussed in this analysis.

of OA was relevant in this process. The OA term was used in an even broader sense when issues of the separation of transmission infrastructure and services via the network were under discussion (Spintrack AB., 2005).

Referring to infoDEV, an ITU study[76] provides the following definition for OA: "Open Access means the creation of competition in all layers of the network allowing a wide variety of physical networks and applications to interact in an open architecture. Simply put, anyone can connect to anyone in a technology-neutral framework that encourages innovative, low-cost delivery to users. It encourages market entry from smaller, local companies and seeks to prevent any single entity from becoming dominant. Open access requires transparency to ensure fair trading within and between the layers based on clear, comparative information on market prices and services" (Cohen, et al., 2008).

According to the definition of ITU from an economic perspective, "open access allows multiple downstream competitors to share a bottleneck facility that is a critical input for the services that are provided. In most cases, the bottleneck facility is owned by one of the firms that also compete in the downstream market. Access is open if it is sufficiently non-discriminatory that all competitors can access the bottleneck facility at the same cost and level of quality. This ensures that if the bottleneck provider competes downstream, it cannot discriminate against its competitors and realize a significant competitive advantage by virtue of its ownership of the facility."

The above paragraphs imply that Open Network Provision (ONP) is a form of open (network) access – O(N)A– implemented on the basis of EU regulatory tools.

The ITU study investigates two models that are potential OA implementations for developing countries. In one of the models, the incumbent telecommunication service provider is required to separate its wholesale and retail functions, while in the other model, issues of greenfield investments are reviewed. During the analysis of the models a central thought is that OA is a tool that promotes infrastructure

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76 Available from http://www.itu.int/ITU-D/treg/Events/Seminars/GSR/GSR08/discussion_papers/Cohen_Southwood_session5.pdf. Retrieved on October 23, 2009.

investments, facilitates market entry for new entrants, and creates competition. At the same time, it is important to maintain a balance during the implementation of open access as a regulatory tool. If new entrants are willing to take significant risks when investing in the infrastructure – in other words, if they get access at a cost that does not reflect the cost of risk –, the result can be the same as with the exclusive use of the infrastructure: small-scale or no infrastructure investment. In the traditional framework, incumbent carriers were reserved exclusive access for a set period of time, during which the infrastructure had to be completed. According to the ITU study, this regulatory policy was a failure in almost all cases. The reason is that the other extreme, namely that access has to be ensured under unrealistically favorable conditions, also hampers investment. Regulatory policy has to be flexible and consider cost factors, technological innovations and the intensity of the competition at all levels of access. As a later chapter will point out, the EU puts special emphasis on creating sustainable competition to satisfy the interest of consumers.

With respect to the regulation of NGA access a European Commission draft paper (European Commission, 2008), formulated a recommendation regarding the regulation of the 4^{th} market (fixed wholesale physical access to network infrastructure). It encourages national regulatory authorities to urge the SMP provider to roll out fiber optic network in a way that allows it to offer dark fiber to third party providers (because this technology involves negligible costs). To illustrate the separation of wholesale and retail activity, the draft presents the Openreach solution mentioned earlier. Two important aspects have been pointed out: regulators are to strive for agreements obligating infrastructure owners to maintain their infrastructure and to ensure that these undertakings pay off. (It needs to be emphasized that the agreement is to be concluded between the operator and the national regulatory authority. This is particularly important in European law, where national regulatory bodies are entitled and required to make service providers with significant market power subject to certain obligations, e.g. mandated network unbundling). Obviously, a government ministry can be a national regulatory authority if the Commission is aware of it. Consequently, if a ministry makes an agreement with an operator with regards to network unbundling, it has to be investigated accordingly.)

Greenfield network deployment funded by the central or local governments is the other type of OA model analyzed in detail by the ITU study (Cohen, et al., 2008). The following section outlines a few examples.

Models: Sweden - Stokab (Stockholm)

Stokab was founded in 1994 by Stockholms Stadshus AB, which is owned by the city of Stockholm. Initially, Stokab filled a gap created by the fact that the incumbent refused to provide fiber optic capacity following the liberalization. The management of Stokab made a strategic decision to offer only optical dark fiber, the least substitutable asset, to the market. Services and innovation are up to the telecommunication companies.

The core tasks of Stokab include building, operating and maintaining fiber optic telecommunication networks around Stockholm, as well as leasing fiber optic connections. The company is competition-neutral, providing optical network under equal conditions. Currently (in 2010) a 5,600 km long cable network provides fiber optic access to 27 surrounding local governments. In addition, the city became a regional ICT hub through cooperation with the Nordic and Baltic neighbors.

Following the coverage of commercial areas, optical fiber extended into residential areas as well, initially to multi-unit buildings, where service providers installed routers in the basement. Then it extended into single family home neighborhoods, feeding wireless and other access networks. In one suburb with a population of 16 thousand people, a local electricity network added optical cable to provide open access to all households. Today all new buildings are equipped with fiber optic access, thanks to a cooperation with real estate developers.

Models: Ireland – SERPANT (South-East Regional Public Access Network of Telecommunications)[77]

Based on the national broadband strategy designed in 2004, the project aimed at providing broadband access initially to six cities (Waterford, Kilkenny, Carlow, Clonmel, Dungarvan and Wexford) and later to over 350,000 residents in 88 municipalities, in an effort to defend and improve the country's international competitiveness. The government ministry offered a 40% contribution to communities involved in broadband development. The majority of the allocated fund of 140 million euros over a three-year-period came from the European Union, as a contribution to Ireland's National Development Plan 2000-2006.

The fiber optic Metropolitan Area Network (MAN) was rolled out in a way that ensured that a most of the businesses as well as government and education institutions were reached in a ring network. Certain major users (e.g. hospitals) were connected via spur routes if a ring configuration was not an economical solution.

After a competitive bidding process, two companies were in charge of deploying the 4 PVC cable ducts of 100 mm (as well as the necessary manholes) to serve the fiber optic network (and potential expansion) at a total cost of 18 million euros. The local E-Net consortium, also selected in a competitive bidding process, (led by Tiernan Properties, a real estate development firm, with support from ACT Venture Capital, Anglo Irish Bank and the Bank of Ireland), was awarded a 15-year concession to operate and maintain the optical cable MANs owned by the state and to act as a wholesaler of transmission capacities and facilities to any service provider.

Models: United States (Virginia) – Mid-Atlantic Broadband Co-operative (MBC)

MBC was formed in 2000 in the southern, rural areas of the state of Virginia in response to the challenges caused by changes in the global economy. Entire sectors (tobacco, agriculture, textile, furniture) disappeared, forcing thousands out of their jobs. The work force had low education level, and there was no demand for old skills. Due to the geographical location there were no competing

[77] For further information see the website of the project: http://www.sera.ie/

telecommunication service providers, and services were expensive. Carriers had no plans to develop the broadband access.

In response to these circumstances an economic development strategy was designed, bringing together the local university (Virginia Tech), local business leaders as well as the Virginia Tobacco Commission. The strategy was based on four pillars: open access telecommunication infrastructure, human infrastructure, innovation, and local development capacity.

The network was designed to connect all businesses and technology parks. MBC serves solely as a wholesaler of aggregation network services, dark fiber and physical infrastructure, and operates over 1,100 km of fiber optic cables and 20 nodes. In exchange for rights-of-way, local governments receive two fiber strands each to be used for their own purposes. Telecommunication companies also joined MBC, providing open access to their networks and also sharing the profits of MBC.

Other models

Special consideration needs to be given to EU requirements that approve of the intervention of the public sector and the allocation of state aid under specific circumstances.

The European Community Treaty provides a precise definition of state aid. According to section (1) of Article 87 in the EC Treaty, [78] any type of government aid that distorts or jeopardizes competition by showing preference for certain businesses or the production of certain goods is incompatible with the common market if it affects trade among members.

According to section (2), the following shall be compatible with the common market:

a. aid having a social character, granted to individual consumers, provided that such aid is granted without discrimination related to the origin of the products concerned,

[78] Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12002E087:EN:HTML. Retrieved on February 13, 2010.

b. aid to make good the damage caused by natural disasters or exceptional occurrences,

c. aid granted to the economy of certain areas of the Federal Republic of Germany affected by the division of Germany, in so far as such aid is required in order to compensate for the economic disadvantages caused by that division.

According to section (3), the following may be considered to be compatible with the common market:

a. aid to promote the economic development of areas where the standard of living is abnormally low or where there is serious underemployment,

b. aid to promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State,

c. aid to facilitate the development of certain economic activities or of certain economic areas, where such aid does not adversely affect trading conditions to an extent contrary to the common interest,

d. aid to promote culture and heritage conservation where such aid does not affect trading conditions and competition in the Community to an extent that is contrary to the common interest,

e. such other categories of aid as may be specified by decision of the Council acting by a qualified majority on a proposal from the Commission.

Based on established European Court practices, the condition of influencing trade is met when the beneficiary company is engaged in economic activity that includes trade between member states.

General implications of the studies conducted earlier were reviewed by experts of the Commission (Hencsey, et al., 2005): In areas where demand for broadband services is not particularly high and the recovery of investment costs is uncertain, public intervention may accelerate network development and maintain competition in the future by adhering to the open access requirement. The potential competition distorting effect of public intervention is explored by the EU Directorate General for Competition on a case-to-case basis. The purpose is to determine whether government aid had been used.

Public sector intervention has two major forms:

1. First, public authorities support or undertake the deployment of local or regional infrastructure (e.g. cable ducts, dark fiber), and operation is tendered out to a service provider who offers wholesale services to additional operators. The infrastructure remains the property of the public authority (state).
2. Second, the operator selected in an open bidding process provides retail services. The selected provider builds the infrastructure with the support of the public authority, and the assets become the property of the service provider (Hencsey, et al., 2005).

Between 2003 and February 2009, the Commission's Directorate General for Competition assessed 44 broadband projects within the framework of a competition authority procedure[79] and approved all but one.

A study conducted by another group of experts of the Directorate General (Papadias, et al.) asserted that investigations had not identified unauthorized state aid (except in one case, in Appingedam in the Netherlands), therefore no objection was made. According to the decisions, public sector intervention was justified based on section (3)(c) of article 87 in the EC Treaty.

Although the investment project in Amsterdam, to be discussed in a later section, did not fall within the scope of the article, it was assessed whether the public sector (the local government of Amsterdam) adhered to the Market Economy Investor Principle (MEIP). The following aspects were considered:

1. Are the participants of the investment project actually market investors, and do the investments they are involved in have real market significance?

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[79] Available from http://ec.europa.eu/competition/sectors/telecommunications/broadband_decisions.pdf

(Investment share and investment value in comparison with financial situation).

2. Did the parties in question implement the investment simultaneously?
3. Were there equal terms and conditions for all investors?
4. Did the public sector investor have any connection with the beneficiary beyond the actual investment project, possibly putting the provision of equal terms and conditions in question (e.g. government backing)?

Local governments initiated many FTTH projects in Europe. The most significant case was the initiative of Amsterdam city, which lead to a formal investigation by the European Commission in 2006 owing to initial doubts about the feasibility of the business plans as well as preliminary investment activities carried out by the city. The Commission determined a year later that the city of Amsterdam participated in the project under the same conditions as any potential investor, and concluded that the case did not constitute state aid.

The city of Amsterdam, along with other shareholders, invested in a company to build an FTTH network providing state-of-the-art broadband access to 37 thousand households (at a total investment cost of 18 million euros). One-third of the shares was owned by the city of Amsterdam, one-third belonged to ING Real Estate and Reggefibre, and one-third was shared by five home construction firms. A wholesale carrier was selected in a bidding process to provide open, non-discriminatory access to retail service providers offering TV, broadband Internet and phone services.

According to EU regulations on state aid, a public authority's investment in a business enterprise does not fall within the scope of state aid regulations if the applicable terms are acceptable to an investor operating under market conditions. Although the European Commission tends to be more cautious with respect to urban investments, it had no objections to the investment project in Amsterdam, where retail services were available under competitive conditions. In 2006 there were 84 projects supported by energy service providers, including the city of Vienna, Reykjavik Energy (in Iceland), Almera in Holland, and Vasteras in Sweden.

As revealed by the infoDev study as well as the examples discussed above, open access can help the market transform digital telecommunication services into public good (with cautious support from the government), which could then become accessible to the broader public. Although open access puts particular emphasis on efficient market operations, it acknowledges that the market does not always provide a solution. It responds to the challenge of getting telecommunications to those who are at the bottom of the income pyramid by cutting back prices. In this scenario it is the responsibility of the government sector to create an optimal environment for open access (partly by providing funds for the infrastructure) and to promote the widespread use of services.

Based on court rulings, the EU Commission defined several conditions to make sure that the government sector carries out this responsibility in accordance with the EU principles:

- Most importantly, the service has to be in line with the principle of Services of General Economic Interest (SGEI).
- Clearly formulated obligations to reveal excess costs and compensations related to the completion of public services.
- Pre-established system and parameters of compensation in order to prevent over-compensation.
- Selection of the most effective service provider in order to minimize the costs of public services. The selection has to meet the principle of non-discrimination.

The above examples show that there are various ways in which the governments of different member states in the European Union get involved in an effort to promote broadband infrastructure development. The United Kingdom represents a strong market approach, with the government requesting tender offers from market players for the coverage of unserved areas, but the preservation of public property is becoming increasingly common when public financing is involved. In Lithuania, for example, local governments own publicly run regional networks, while in Germany they build and own cable ducts. In Sweden, often referred to as the land of thousand urban networks in the context of telecommunications, the regulatory authority soughed to invest public funds in 2010 to support the lowest possible layers of the digital telecommunication network (in other words, local governments were supposed to invest in passive infrastructure elements to be used by all service providers rather than operate networks). In Estonia, the government decided to regard regional networks as public services, and argued for EU funds (SGEI) accordingly, which served as a precedent. The decision had not been published by the time this dissertation was completed,[80] but it will likely come out by October 2010.

TABLE 5. EUROPEAN PRACTICES IN NGA INFRASTRUCTURE SHARING

Country	**Incum-bent NGA**	**Passive**				**Active**	
		In-building fiber	**Duct access**	**Dark fiber**	**Sub-loop unbundling – SLU**	**Wavelength**	**Ethernet Bitstream**
Belgium	FTTC		⍰ (MDF to Cabinet)	⍰ (MDF to Cabinet)	⍰		⍰
Denmark	FTTC DOCSIS 3.0		⍰ Industrial agreement	⍰ Commercial offer by TDC	⍰		⍰
France	FTTH GPON	⍰	⍰				
Germany	FTTC		⍰ MDF to Cabinet	⍰ MDF to Cabinet	⍰		
Italy	FTTC FTTH		⍰ (TI equal access)	⍰ (TI equal access)	⍰		⍰
Holland	FTTC FTTH P2P		⍰	⍰ (ODF access for P2P)	⍰ (no business case)		FTTC: ⍰ FTTH: ⍰
Spain	FTTH GPON	⍰	⍰	⍰	⍰		⍰ (up to 30 Mbps)
United Kingdom	FTTC FTTH GPON				⍰		⍰

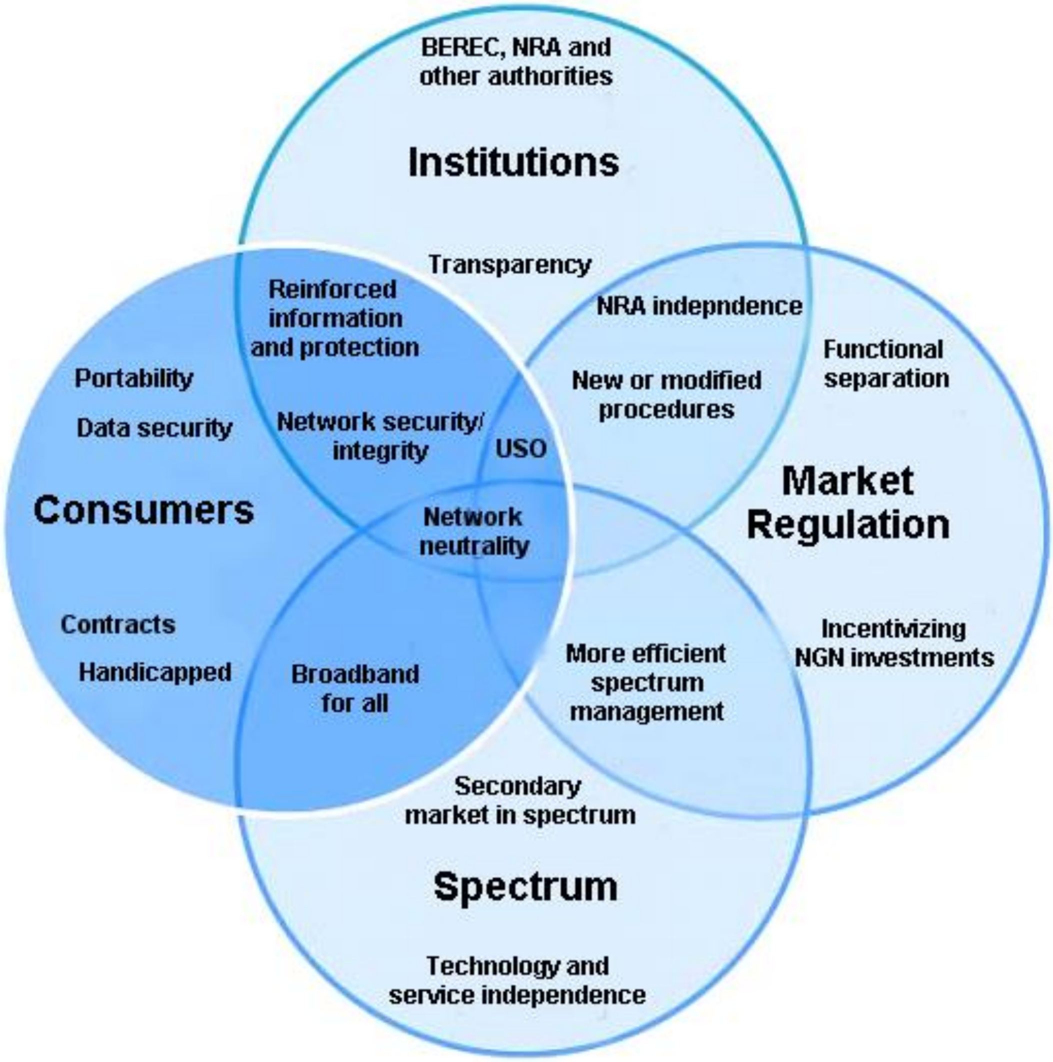
Source: Cullen International (Scaramuzzi, 2009)

[80] Available from http://ec.europa.eu/competition/state_aid/register/ii/by_case_nr_n2010_0180.html#196

Converting telecommunications into public good

The arguments so far – as well as the infoDev study – allow us to conclude that open access (along with cautious government support) helps gradually convert telecommunications into public good, which then becomes available to the broader public. Although the principle of open access focuses on the efficiency of the market, it has been proven that the market does not always present the optimal solution for the community. Adapting the new EU directive allows Hungary to make digital telecommunications available to the lowest layers of the income pyramid by reducing the costs of services. The program approved in November 2009 involves changes in four key areas.

FIGURE 10. ADAPTATION OF THE NEW REGULATORY FRAMEWORK



Source: Presentation by László Tóth (Tóth, July 1, 2010)

In this situation the government sector has a responsibility to create a favorable environment for open access (by financially contributing to the infrastructure) and to promote the widespread use of services.

This chapter described how the digital telecommunication regulations of the European Union have intended to promote the shared and competition-oriented use of existing basic broadband infrastructure, which would be impossible without providing open network access in some way. In EU recommendations currently in effect (e.g. NGA recommendation), government intervention methods tend to focus on access networks, and intervention is considered justified if the following conditions apply in the geographical area in question:

1. Basic broadband is not yet available, and no broadband construction is planned by private investors for the near future[81].
2. A next generation access network is not available and not planned to be built or launched in the near future.
3. A broadband access network is available but certain user groups fail to receive appropriate service, or the cost is not affordable due to the lack of competition, or the quality of the service is poor, with no improvement in sight.

The above prerequisites are indisputable, however, WANs are not systematically classified in a separate category, which is a big mistake in my opinion. EU directives provide no specific rules (or decisions) regarding the infrastructure- versus service-based competition among digital telecommunication networks; consequently, Hungarian policy makers are in charge of establishing the basic guidelines aimed at fostering competition and creating an appropriate regulatory environment in line with the directives of the EU. The thesis I formulated provides a framework for this process in the field of wide area networks.

Based on the evidence presented in this chapter I adopt the H_3 hypothesis.

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[81] The term 'near future' refers to a three-year period.

The provision of open access as a fundamental precondition of infrastructure-based competition has been mentioned multiple times in this study. The term ‘open access’ has been used in various meanings, but insufficient knowledge of the details could lead to inadequate regulations, which occurred in several parts of the world. The next chapter will present some critical issues in this respect.

VII. PROMOTING INFRASTRUCTURE-BASED COMPETITION BY ENSURING NETWORK ACCESS

In the competition of telecommunication service providers for end-users, open access means unrestricted access to limited resources that are basic prerequisites for providing the service. In the case of the optical network infrastructure, limited resources may include the optical fiber, the conduit, the manholes and any other physical structures, but they also include other resources defined in the OSI 2 layer, such as the Fast Ethernet Link or the Gigabit Ethernet Link. Access to the former represents passive access, while access to the Ethernet-based resources is active access. An excellent justification for Ethernet-based access is found in the appropriate documents of OFCOM (OFCOM, 2009).

The European Union unequivocally requires open access[82] in order to avoid public funds being used for creating telecommunication networks that are then used exclusively, creating a monopoly (European Commission, 2006). The entity disbursing funds must, therefore, consider the following:

1. Freedom of technology choice means that any technology can be chosen as long as it is able to satisfy the conditions set forth in the request for proposals (RFP);
2. Irrespective of open access, the RFP itself defines certain limits to the choice of technology;
3. Open access is a basic requirement that, together with the other requirements, will determine the kinds of technologies that are in play;

[82] To quote the document COM(2006) 129 final (Brussels, 20.3.2006): "State aids and competition policy: public intervention may distort competition, and state-aid law provides an important set of rules to safeguard it. When the granting of state aid is envisaged, the project must be notified to the European Commission. The Commission will then assess its compatibility with the Treaty rules. There have already been a number of decisions regarding publicly funded broadband projects in rural and remote areas in which the Commission did not raise objections. A summary of those decisions can be found in Chapter 3 and Annex 3 of the Digital Divide Forum report. Deployment of open access infrastructure, defined according to technological neutrality and managed by an independent entity, appears to be the solution most conducive to effective competition."

4. Technology neutrality cannot be a tool for circumventing open access (Horváth, et al., 2009).

Every signal[83] indicates that platform-independent migration to broadband infrastructure will take place on an IP basis (NGN itself is, by definition, platform-independent and IP-based). A missed or delayed implementation is a serious risk factor for any country, given that it impacts the development of the entire national economy through the services based on the infrastructure.

VII.1. Competition on the access network and the wide area network

A thorough separation of access networks from WANs is important in the study of development projects and the related government intervention. In the "fiber age" subscriber access is also built primarily on optical networks, creating a Next Generation Access (NGA) network. The relevant draft recommendation of the European Union (European Commission, 2009) states that "NGAs can be defined as access networks which consist wholly or in part of optical elements, and which are capable of delivering broadband access services with enhanced characteristics (such as higher throughput), when compared to those provided over already existing copper-based networks."

Since NGA development is one of the key directions in digital telecommunication development, it seems appropriate, at this point, to discuss the definition of the concept in more detail in order to be able to analyze the locus of competition.

In most cases, next generation networks represent the results of improvements to existing copper- or coaxial cable-based networks. NGA analyses started in the European Union in 2009 include maps distinguishing NGA implementation zones using white, grey and black colors. (The same colors are typically used in towns with optical coverage, as it will be seen in detail during the analysis of the Hungarian

[83] Prices of subscriber services over optical access networks were first published in early 2009 in Hungary, launching the commercial utilization of fiber optic access. Of course, the overwhelming majority of the telecommunication wealth of a country is not in its wide area network but in the local access infrastructure; this is why fiber optics approaching and eventually reaching the subscriber's home/business location is such an epochal event.

situation later on.) At the same time, neither the EU's recommendation on state aid to broadband (European Commission, 2010) nor its latest NGA draft recommendation (European Commission, 2009) provides a precise NGA definition, causing the color-coding of NGA coverage to have an uncertain basis. [84] At the same time, the English language Wikipedia (however controversial it is as a source of scholarly information) has well-defined NGA criteria.[85] These can be augmented to outline the meaning of NGA in terms of next generation broadband networks:

- In a fiber-to-the-cabinet scenario, minimum download speeds of 40 Mb/s and minimum upload speeds of 15 Mb/s (compared with 8 and 24 Mb/s download speeds of ADSL and ADSL2+ access technologies, respectively);
- Improving existing cable TV networks using the new DOCSIS 3.0 technology to achieve a maximum throughput of 50 Mb/s and beyond, instead of the current 20 Mb/s;
- Connecting newly built homes and offices using optical connections capable of delivering services at speed in excess of 100 Mb/s.

In commercial practice:

- New generation access networks can come into being not just through improvements to existing access networks having more limited capabilities, but also by replacing them, involving the reasonable re-use of network elements (such as conduit channels or manholes) that can be recycled from the previous generation of access networks;
- The bandwidth of new generation networks is considered unlimited in theory and very widely expandable in practice (within limits defined by cost), so that access bandwidth does not limit services available over the network;

[84] The previous, 2008 draft NGA recommendation (European Commission, 2008) had a comprehensible, although contradictory and technology-dependent set of NGA criteria, but that was excluded from the latest version.

[85] Retrieved from: http://en.wikipedia.org/wiki/Next_Generation_Access on September 3, 2010.

- New generation networks must have sufficient upload speeds, in addition to having high download speeds, if they are to satisfy the new service requirements. Upload speeds do not necessarily need to match download speeds, as long as this does not limit the freedom of developing services. However, access networks with symmetric access speeds tend to have optimal service capabilities;
- Available bandwidth must be independent of the length of the subscriber segment within a large access radius;

The above considerations, however, pose the following questions for state development policy concerning NGA projects:

- What upload speed criteria should be defined for CATV DOCSIS 3.0 technology applications?
- What nominal and guaranteed speeds should be set as minimum goals? (This is particularly critical for DOCSIS.)
- What is the best way to enforce guaranteed speeds?

While some questions are still open, we can clearly state that the main feature of the new era (NGA) is that access bandwidth will increase significantly, opening up opportunities for new services and new business models. In order for the multitudes of users to be able to take advantage of true broadband technologies (such as video streaming) and to be able to enjoy content and applications that make use of broadband, these services, content and applications must be able to reach the local access networks, meaning that the new generation access networks require new generation wide area networks and new generation networks connecting the access network nodes. The two (or three, if we consider the wide area network separately) only make sense together. These resources form a value chain in moving signals to the subscribers, and only their coordinated development can result in an optimal return on investments. New generation access networks represent one of the biggest problems, owing to their huge capital requirements. This is partly because of the gigantic investment costs, but also because of the natural monopoly-generating power of the access infrastructure. While in the case of the wide area network, the owner of the second optical cable reaching a city has a reasonable expectation to capture a portion of the city's telecommunication market (as long as his long-distance wholesale broadband prices are competitive), the owner of the second optical line reaching a household can hope to satisfy the telecommunication and other fiber-related needs of that household only – if he can entice the client to switch to the new technology at all. This means that the revenue from one subscriber must cover the cost of developing two networks, which is unrealistic, except under very limited circumstances.

In an earlier chapter concerning the impact of broadband services on the national economy, the question was raised whether Hungary's broadband infrastructure was sufficient for operating a competitive market with multiple participants and for the geographically balanced development of the country. The question may be divided into two parts from the point of view of creating a broadband infrastructure:

1. Is any broadband infrastructure being built in the given area (town section, town, group of towns) showing at least a minimum amount of market potential?
2. If so, is there going to be any infrastructure-based competition there?

Clearly, if a region is showing a low expected return per customer and/or the ROI in an area of high investment need is not there, the broadband infrastructure will not be built. In contrast, areas where investments are likely to be recouped within a reasonable timeframe will see broadband infrastructure constructed, but it is questionable whether true infrastructure-based competition is possible: will a secondary infrastructure be built as well (whether we are talking about a wide area network or an access network), or is the market going to be monopolized by the first builder.

This is where we arrive at a characteristic feature of infrastructure-based competition: while the competitive return of the secondary infrastructure creating the infrastructure-based competition is obvious and accepted in terms of increased competition: decreasing prices, increased penetration, overall consumer benefits measured in terms of improved consumer position and aggregate consumer savings, it is important to remember that the combined societal yield of infrastructure-based competition is close to zero, according to some research, and it may even be negative (Höffler, 2005). As unit revenue drops due to competition while required investments remain high, the disadvantages to the service provider are so large that the societal yield (measured as the aggregate of benefits to the consumer and to the provider) vanishes or even becomes negative. In order to see the positive overall impact of investments in broadband infrastructure on society, we must consider positive externalities in addition to benefits restricted to those directly impacted by telecommunication. However, investors in network projects will not be interested in these externalities unless and until they can share them (for example, by receiving public funds disbursed through state aid). It has become clear that the liberal economic policy dogma of "the market solves everything" does not hold in broadband infrastructure development: the socially required level of access cannot be attained on a purely business basis, restricting the state's involvement to regulatory tasks alone. As long as the yield of competition in broadband infrastructure is negative from the network proprietor's point of view, investments in a secondary broadband infrastructure will not materialize.

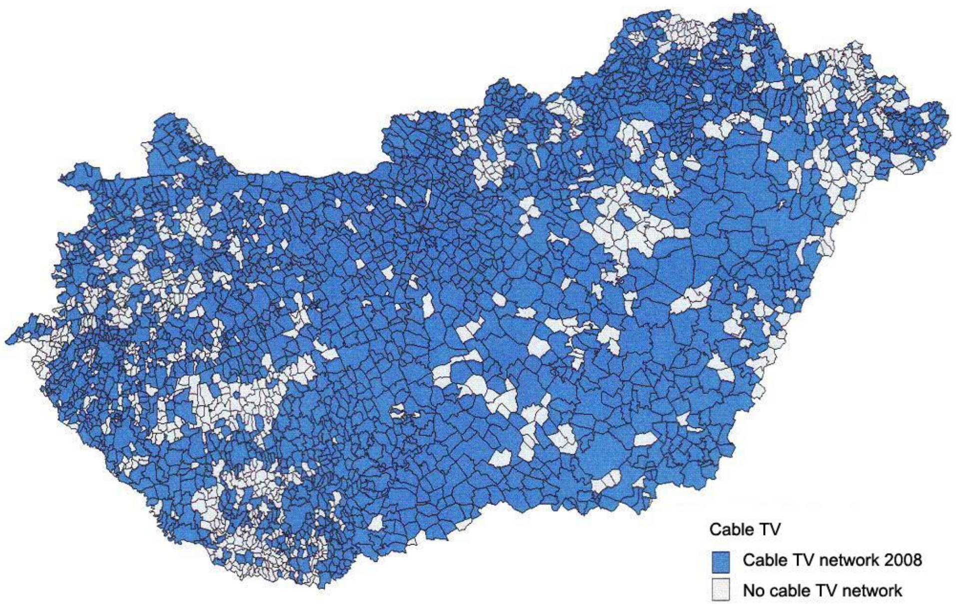
At the access network level, in countries with high cable TV penetration (Hungary among them) competition among various types of broadband infrastructure means competition between modern CATV networks and competing modes of newly built or repurposed broadband telecommunication infrastructure.[86] Consequently, Hungary's current end user demand and average expected subscription revenue[87]

[86] Here the meaning of telecommunication infrastructure is restricted to infrastructure typically built and operated by actors in the telecommunication services market (telecommunication providers). Clearly CATV infrastructure also provides telecommunication services, and in this sense it is a type of telecommunication infrastructure itself.

[87] Average revenue per subscriber is fundamentally determined – limited – by disposable household income. Household statistics of the Central Statistical Office regarding the per-capita telecommunication expenditures of the Hungarian population indicate that in the period since the year 2000, mobile phone service has been the only telecommunication service capable of significantly reshaping the household consumption basket. In 2006 Internet access appeared to be the next such service, but its extent falls far short of mobile phone usage, not the least because of the number of users.

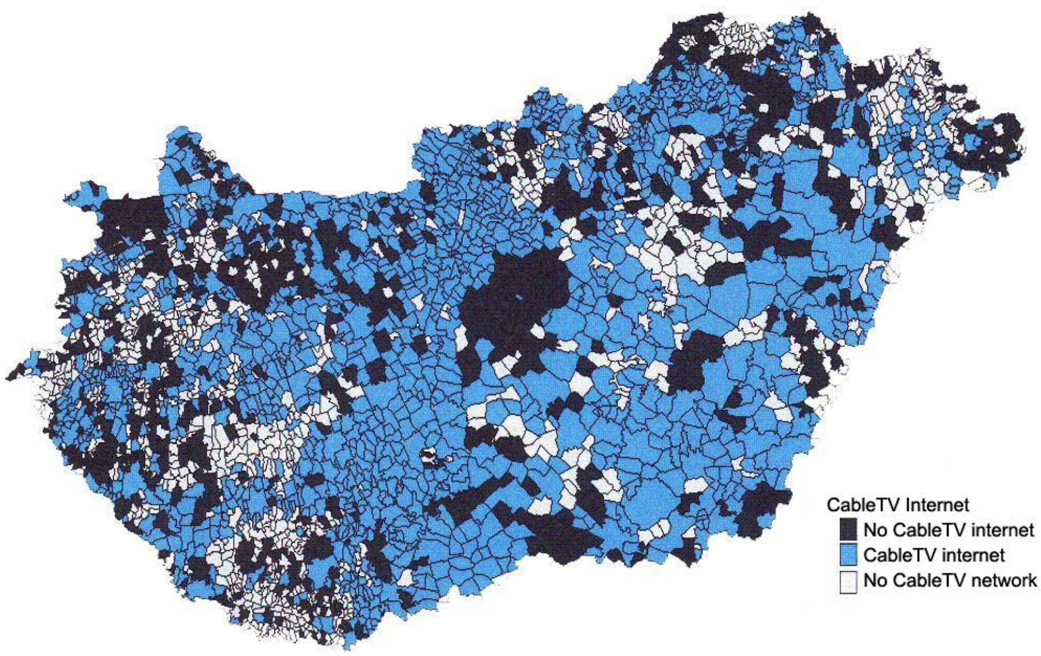
make it almost impossible to build primary broadband infrastructure in lucrative markets, since CATV has already taken that role.

FIGURE 11. CATV NETWORK COVERAGE IN HUNGARY AT THE END OF 2008



Source: National Communications Authority, 2009

FIGURE 12. CATV INTERNET SERVICE COVERAGE IN HUNGARY AT THE END OF 2008



Source: National Communications Authority, 2009

In order for an intense infrastructure-based competition to arise, the penetration rates of the two infrastructures must be close to each other. The national regulatory authorities scrutinize coverage, in addition to penetration, when considering the intensity of competition from an ex-ante regulatory point of view. Experience so far has indicated that there must be at least three competing parallel infrastructures in order for sustainable competition to have a chance. In a theoretical approach, Eli M. Noam has posited that the borderline is somewhere around 2.5 parallel infrastructures; above this level sustainable infrastructure-based competition will likely occur, but as few as two providers may be sufficient to create a competitive environment (Noam, 2001).

As a consequence, in most Hungarian regions the new generation telecommunication infrastructure will be created as a second broadband infrastructure (if it is created at all). Obviously, this will create a number of consumer benefits on the short run, but it also represents increased risk to investors, given that the aggregate investor benefit (the revenue increase less the development cost) may easily end up being negative. Therefore in Hungary broadband infrastructure based competition in the access networks will typically arise not between new generation telecommunication networks but between a modernized CATV infrastructure upgraded to a DOCSIS 2.0, and eventually DOCSIS 3.0 level, and a new generation broadband infrastructure built out in the CATV coverage area by the incumbent service providers.

A peculiar regulatory problem may arise if the CATV operator dominating the broadband market in a region refuses to open its network, while there is no interest in building a second broadband network, owing to profitability reasons. In such instances either the CATV network must be opened using regulatory powers or the creation of a second infrastructure must be subsidized to the extent of the "profitability gap" in order to create a competitive environment.[88] Any infrastructure built from public funds must necessarily offer open access (in which case the SGEI principle allows for a second, parallel infrastructure to be built using public monies).

A broadband duopoly may form unless regulatory instruments are used to create further competition-enhancing conditions in the market. Competition amongst

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[88] The problem will be analyzed in detail when the regulation of the wholesale market is discussed.

service providers creates considerable benefits to consumers: it increases consumer welfare by lowering prices; however it barely impacts penetration, because it does not create a compelling interest for the network owner to increase the number of subscriber connections: penetration is increased to the limits set by existing capacities only. It is necessary, therefore, to find some regulatory middle ground which does not eliminate investor interest and the market entry of further providers while creating a nearly infrastructure-based competitive environment at the lowest possible level of capital injections. The solution will be found in a "well-tuned" system of passive and active access (from the vantage points of both the network owner and the new market entrant) that will sustain the motivation of the network owner as an investor. At the same time it will set the threshold for market entry by new actors reasonably low, offering them opportunities for provider creativity and differentiability that are equal or close to those available to providers using their own infrastructure.

VII.2. Implementing the principle of open access

Implementing the principle of open access is a practical way of resolving the problem indicated above: it allows for nearly infrastructure-based competition and service-based competition to take place on the basis of a single infrastructure. In order for competition to ensue and be sustained, it is important that as much basic infrastructure be available as reasonably possible, but in cases where state aid is needed for even a single infrastructure to be built (for example, in our case, when a town has no broadband WAN or access network coverage), it is a duty of the state to make the operator's default SMP status market conform by mandating that wholesale service be provided. The operator must be compelled to open up its network and to offer to all market participants passive and active access equivalent to the kind offered to its affiliate partners. As mentioned earlier, an approach centered on the ability to provide services can result in a situation where there is no open access even to infrastructure built with public funds, simply because the disburser of those funds nominally asks for it in the RFP but ends up not enforcing that requirement during implementation.

Of course, it is not easy to define and enforce the requirements of true "openness" in each case involving telecommunication infrastructure development projects, even though this is in fact the basis of providing wholesale-level access. In theory it is possible to offer open network access at various points of the network, assuming technological feasibility (i.e., that "points of interconnect" allowing unbundling have been established), bit in practice it is also possible that these points of interconnect have not even been built. In the event that these unbundling locations do not exist, the regulator can only implement the unbundling of the infrastructure if

- it compels the owner of the infrastructure to construct these interconnect points, which has significant cost associated with it. In a liberalized market the state has an obligation to assume a significant portion (or the entirety) of the costs arising from actions compelled through its regulatory powers;
- the access points already exist. In this case regulations must clearly spell out the conditions under which unbundling can take place, making sure that everybody is governed by the same competitive rules.

Unbundling can be compelled in the wide area network as well as in the access network. The question is, which solutions are the most practical. In a liberalized telecommunication market it cannot be the intention of the state to put investors in an untenable position, and consequently it can only offer subsidies for basic infrastructure development in areas that are not sufficiently attractive for investors, and where the failure to build out the infrastructure would sustain the digital gap.

To maintain "pure competition," the desirable scenario would be one where the owner or operator of the limited resource would not even be a participant in the downstream market. In such a scenario it is substantially simpler to provide equal conditions to the participants of the downstream market, and it is also easier to show to the market that the solution is correct. [89] All of this is justified by the fact that the users of the limited resource will unavoidably see fixed costs, even if they

[89] At the same time it must be considered that this conceptual easing is not always feasible, nor is it necessarily useful, as investor interest may easily become a victim of the principle of straightforward regulation. This is why it is important to analyze the conditions under which the owner of the limited resource can participate in the downstream market.

do not have to build the limited resource; at the same time the fixed costs of the service providers will differ from each other, but particularly from those of the owner of the limited resource. The difference between the fixed costs determines the competitive chances and the number of competitors, and also the smallest market size for which it is still worth competing.

So far in the analysis of open network access the only substantial differentiation was made between the access network (which includes the last mile) and the wide area network. This is not nearly sufficient, if we wish to locate all the possible interconnect points over the entire network. Over the last mile (within municipal boundaries), for example, it is possible to identify significant "microstructures" where xDSL built on the metropolitan area network offers quite different opportunities for unbundling than hybrid fiber-coax (HFC) networks, while there are network types with marked differences in terms of open network access within pure telco tree structures. And if the investigation extends to wireless "last mile" network types, the picture becomes even more complex.

This dissertation will not identify every "unbundling-ready" point. The aim is much more to focus on a critical network component that deserves special attention in the case of networks built with community resources as well. This element is the Point of Presence (PoP)[90] with InterConnect functionality, or interconnect location.

VII.3. PoPs as key elements of open network access

The role of PoPs is to provide a business with access to instruments and/or services that in turn offer a service under defined circumstances, whether on an exclusive or non-exclusive basis, in order to allow it to offer an electronic communication service (European Commission, 2009). It includes, among others:

a) *access* to network elements or devices that may have a role in connecting equipment, whether in wired or wireless form (this includes access to the

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[90] PoP: Point of Presence – a location where access to the network resources of a service provider is offered to its wholesale clients.

local loop, as well as access to devices and services that are necessary for provisioning services via the local loop);

- access to the physical infrastructure, including buildings, sub- and superstructures;
- access to relevant software systems, including access to operational support systems, resolution systems or equivalent systems;
- access to landline and mobile systems, particularly with respect to roaming;
- access to the conditional access systems of digital television services;
- access to virtual network services.

b) *interconnection,* i.e., the physical and logical connection of state/community owned (public) networks (regardless whether or not operated by the same entity) in order for users of one business to be able to communicate with users of the same business or of another one, or in order to access electronic services offered by another business. The services may be offered by the parties involved, or by others with access to the network.

Providers owning the PoPs typically have great fiber capacity: in addition to dark fiber, lambda (DWDM) and Gigabit Ethernet capabilities are available at a minimum, and PoPs operated by larger companies have the active elements of legacy technologies (like PDH, SDH and ATM).

Constructing/operating PoPs with Interconnect functionality under controlled circumstances is a key condition of providing open access to interlocational network infrastructure. Future programs focused on developing wide area networks (among others) should also be evaluated on this basis: optimally, the default for small and medium-sized providers requiring IP-VPN bandwidth should be WAN Interconnects at the subregional level, at subregional centers. Large service providers, on the other hand, may opt for "strong" Interconnect PoPs with leased transparent lambda circuits or extra wide bandwidth Gigabit Ethernet or IPV-VPN service.

At the WAN level, two categories of Interconnect PoP can be distinguished by default:

1. One that offers a full range of services to the various investors (at all significant levels of the investment ladder), i.e., one that can offer all service types, up to and including dark fiber leasing.
2. One that does not offer a full range of services, only IP-VPN.

At the same time, interlocational networks can be classified into one of at least three individual types:

- public road based network,
- railroad based network,
- regional electric power provider based network.

Distinguishing between these three types is also very important in preparing RFPs, in order to secure open access. After all, the entity requesting the proposals must be clear about the "facts on the ground" in order to be able to formulate the requirements for the critically important PoP with Interconnect functionality.

Based on the above it is clear that a PoP infrastructure with Interconnect functionality that provides a channel (access) from a lower-level network operated on an open access basis to a higher level network

- should allow access to the services of as many WAN service providers with available capacities on the higher level network as possible;
- must provide the access in a structured way, at each level of investment, making sure that resources are available to the lower level network at every level offered by the network environment of the PoP and allowed by the technological capabilities of the service providers present at the PoP.

The above can be applied to any kind of Interconnect PoP scenario, including:

- last mile/access network;
- access network /wide area network.

VII.4. Open access to wide area networks

So far it has been shown that PoPs with InterConnect functionality are the key element of open network access. In order to define state participation, it is necessary to define clearly what priorities should govern aiding access to PoPs and – in the absence of PoPs – the creation thereof. The basic conditions also need to be clearly defined.

The following hypothesis will aid in investigating the problem:

H_4: If the goal of the state is to incentivize infrastructure-based competition, in order to enhance the ICT infrastructure, its primary task is to ensure regulated access to wide area networks, which are part of the basic infrastructure.

The hypothesis assumes that in the case of interlocational networks connecting municipalities, the high construction costs and the extremely long repayment times make it pointless to build alternative infrastructures in most Hungarian municipalities. Instead, owing to economic reasons, they must be given the type of network access that puts the rest of the market participants in a competitive position. In my proposal, open network access is the access principle that fulfills the competitive requirement.

Of course, the following is a fair question: if the cost of building access networks is much higher – and they have been shown to be just as important in the value chain – then why should the expansion/development of the wide area network be enjoying primacy in infrastructure developments financed from community resources?

To answer the question, let me refer back to the analysis of the definition of broadband, in particular to the provisioning of basic and multimedia-capable broadband. Essentially, if only basic broadband is provided, then the transmission of video content or any other high-bandwidth data transfer will be unavailable to users, and this capability may not be essential. In my opinion, however, it is: in an

Internet-based environment the availability of this information transmission capability is just as important as access to e-mail.[91]

The currently used third generation mobile network (UMTS) – wherever it is available – typically makes multimedia-capable broadband service possible.[92] The access points of the UMTS network, according to our current understanding of technology, are capable of covering circles of a 5-10 km radius, depending on the terrain, offering Internet access at the same time. Mobile access is essentially the "last mile" in wireless terms, meaning that it can now be substituted for a lower-quality wired access network. As a result, the UMTS mobile network, and especially LTE,[93] destined to replace it, are capable of being multimedia-enabled. An additional advantage of mobile technology is that they enable portability, the continuous connectedness of ubiquitous devices.

As a result, mobile networks represent a competitive technology in the access network. Bandwidth offered through them depends on the data transfer capabilities of the frequency in use and the bandwidth of the connections feeding the mobile access points themselves. Consequently, the competition between technologies is increasingly stronger in the access networks, however the actual bandwidth they carry to the customer is fundamentally determined by the capacity of the wide area network. The only exception is when Internet access is provided using satellite (VSAT) technology. Unfortunately, however, VSAT is beset by

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[91] I have no intention of entering the semi-religious dispute about the kind of content Internet users are consuming. My assumption is the e-learning solutions already require the display of video content (for example, this is how www.ted.com, dedicated to demonstrating human creativity, is available). Remote access and web-based applications are gaining importance in business Internet usage, and they also require high-speed access. I could go on.

[92] While the data traffic of current mobile Internet access packages is limited, the limitation is explained by the lack of basic infrastructure capacity (and spectrum). Unlimited mobile Internet packages will not happen until the mobile network is capable of meeting the constantly rising demand for data throughput, and that requires building a fiber-optic network that reaches almost every mobile access point.

[93] LTE (Long Term Evolution). This is a collective name for fourth generation mobile network technology. It has a data throughput capacity significantly exceeding that of UMTS networks (with current research indicating a sustained throughput of 50-60 Mb/s).

extremely poor service quality, and to make things worse, its operation is very expensive, making it suitable only as a temporary, stopgap role where the basic wired infrastructure is of a very poor quality, or has not even been built yet.

VII.5. Investigation of the H_4 hypothesis

VII.5.1. Methodology

As shown above, to investigate the hypothesis, one must analyze the ownership structure of Hungary's wide area networks and the competition between the technologies employed in the interlocational broadband connections. Collecting basic data (which, as mentioned in the first chapter, had not even been taking place in a regular fashion earlier) was made possible by the 2009 project I led at GKIeNET, aimed at surveying the Hungarian wide area networks for the Prime Minister's Office. The results of that research are suitable for the analysis alluded to above. There was no database available to me regarding the investigation of network capacity. This is partly due to the fact that optical network capacity is fundamentally limited by the capacities of the active devices, while the transmission medium itself (the optical fiber) represents no realistic limit to bandwidth. Therefore I investigated the data of PublicNet (made available to me by the Prime Minister's Office for analysis), to get an approximate impression of the prevailing conditions. I have even augmented the latter analysis with an addendum regarding the prices of Internet services, which, although not necessary for confirming the hypothesis, will help provide a more rounded picture by illustrating retail prices, a factor of key importance from the consumer's point of view.

From a methodological vantage point, the analysis involved collecting the primary data and quantitatively analyzing them, allowing for the confirmation or rejection of the hypothesis.

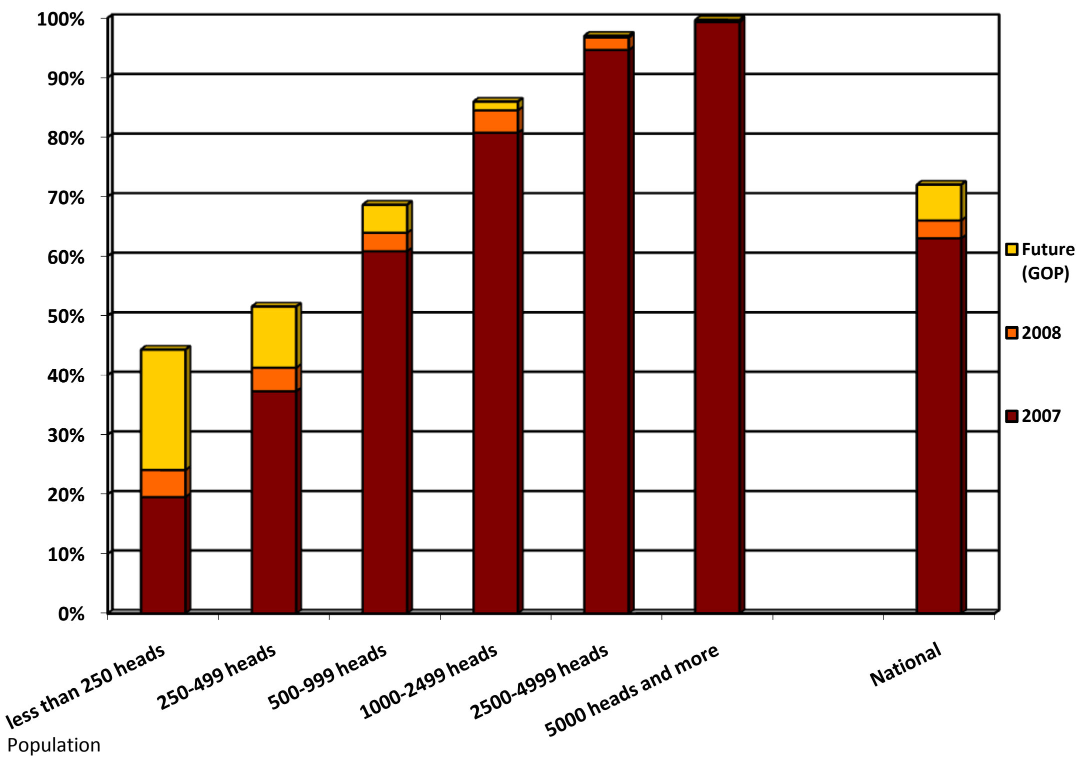
VII.5.2. Results of the investigation

Coverage

Of the 3,152 Hungarian municipalities, 1,987 had optical wide area network access in 2007, representing a coverage of 63%. The National Communications Authority's

2008 data indicate that the number of municipalities with at least one optical connection to the wide area network was 2,090, representing a 3.3 percentage point improvement in coverage. In addition, the GOP broadband infrastructure development program involves the ongoing optical connection of another 194 municipalities to the wide area network, although it is worth mentioning that a number of earlier winners of this program ended up not completing the contract, meaning that the impact of the program on optical WAN coverage will diminish. (The extent of this discrepancy cannot be assessed exactly, because there are no appropriate statistics available, and so I have based my analysis on the original proposals of the winners throughout.

FIGURE 13. OPTICAL NETWORK COVERAGE BASED ON MUNICIPALITY SIZE



Population (thousand heads)	66	215	494	1320	1126	6956	10178

Source: Author's calculations based on National Communications Authority and GKIeNET data

18% of the municipalities without optical coverage can be connected to the nationwide optical WAN under the GOP. Of the minor municipalities (under 250 inhabitants), 27% can get fiber, and the rate is 17% for those with populations of 250-499. Still, there are 868 municipalities that, to the best of my knowledge, are not subject to any plans for business-oriented fiber optic development (and the actual number is most likely higher, due to the reasons listed above).

In terms of coverage, I am considering a municipality "white" if it has no optical WAN connection, "grey" if it is served by the optical WAN of only one provider and "black" if the optical WANs of at least two providers are present. Coverage in itself does not mean that the optical wide area network reaching the municipality actually provides service. In fact, there are 425 municipalities in Hungary that are reached by an optical network, but for some reason there is no service (either because the price is prohibitive to the owner of the access network or because while the optical cable is there, it is not operational as the active devices are missing), or there is no interconnect location (a PoP, as discussed above, involving an engineering building, container or climate controlled outside cabinet) for placing the active devices.

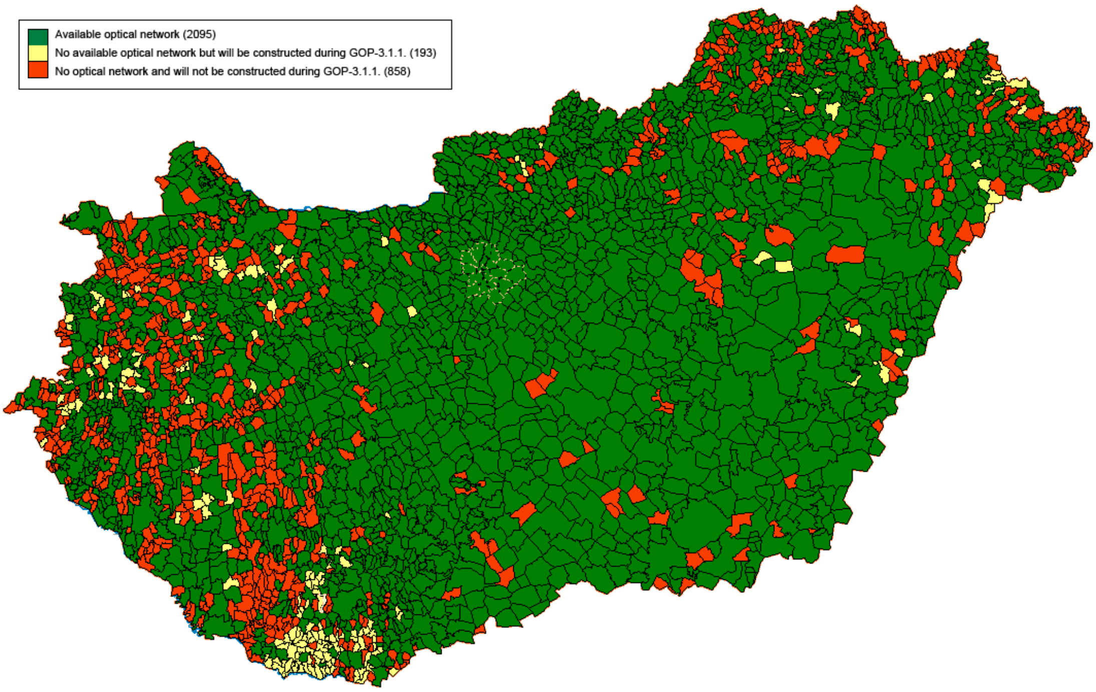
TABLE 6. OPTICAL NETWORK COVERAGE OF MUNICIPALITIES BY POPULATION SIZE

	Number of munici-palities	Total population	Fiber optics status					
			Fiber optics present	... only one*	...more than one	No fiber optics present	... but under construc-tion	... not under construc-tion
Under 250	440	66 thousand	106	80	26	334	89	245
250-499	584	215 thousand	241	175	66	343	60	283
500-999	679	494 thousand	434	275	159	245	32	213
1000-2499	825	1 320 thousand	697	416	281	128	12	116
2500-4999	334	1 126 thousand	323	182	141	11	1	10
5000 or more	290	6 956 thousand	289	67	222	1	0	1
Total	**3152**	**10 178 thousand**	**2090**	**1195**	**895**	**1062**	**194**	**868**

Source: Author's calculations based on National Communications Authority and GKIeNET data

**There are five municipalities where the number of networks is not clear. These locations are likely to have only one network, and they were included in the appropriate column.*

FIGURE 14. OPTICAL NETWORK COVERAGE OF MUNICIPALITIES (WITH MUNICIPAL BOUNDARIES)



Source: Based on National Communications Authority and GKIeNET data

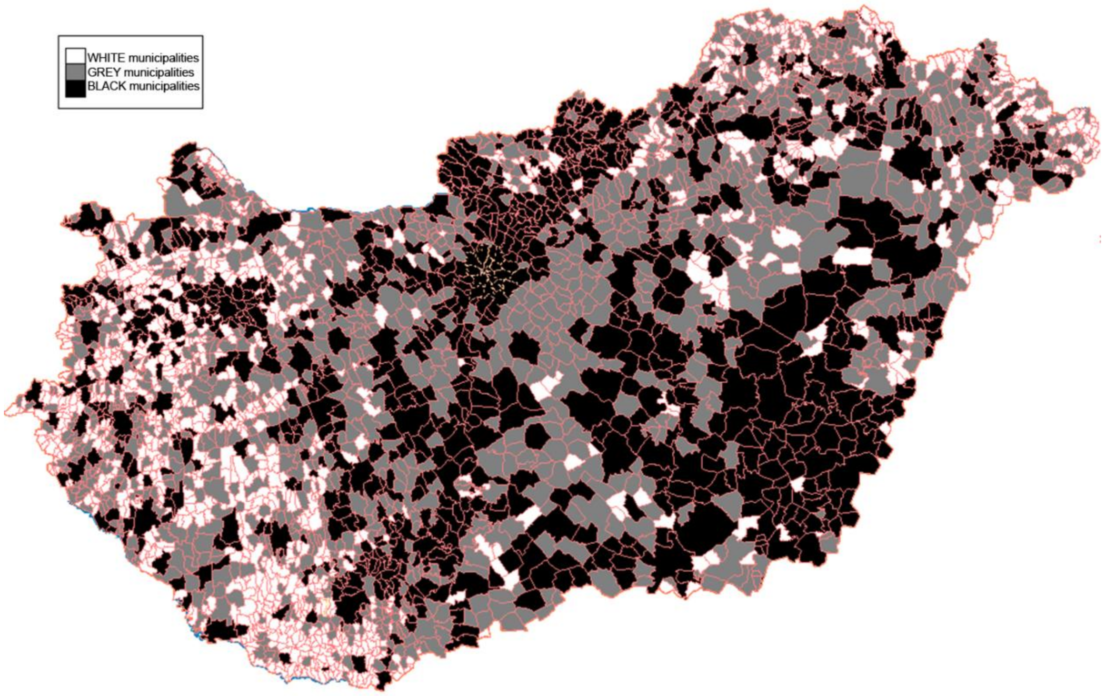
Of the "gray" municipalities with only one optical WAN connection, 36% (425 municipalities) have no fiber-optic service, meaning that the optical network is unused in those locations. In spite of this, only 44 of the grey networks have no Internet service. Unused optical lines are mostly found in smaller municipalities, but there are grey municipalities with over 5,000 inhabitants that still do not utilize the available capacity.

TABLE 7. FIBER OPTICS COVERAGE OF GREY MUNICIPALITIES

	Number of municipalities	Fiber optics status of grey municipalities		
		Number of grey municipalities	**Fiber optics coverage unused**	**No Internet service**
Under 250	440	80	65	16
250-499	584	175	121	19
500-999	679	275	124	9
1000-2499	825	416	96	0
2500-4999	334	182	18	0
5000 or more	290	67	1	0
Total	**3152**	**1190**	**425**	**44**

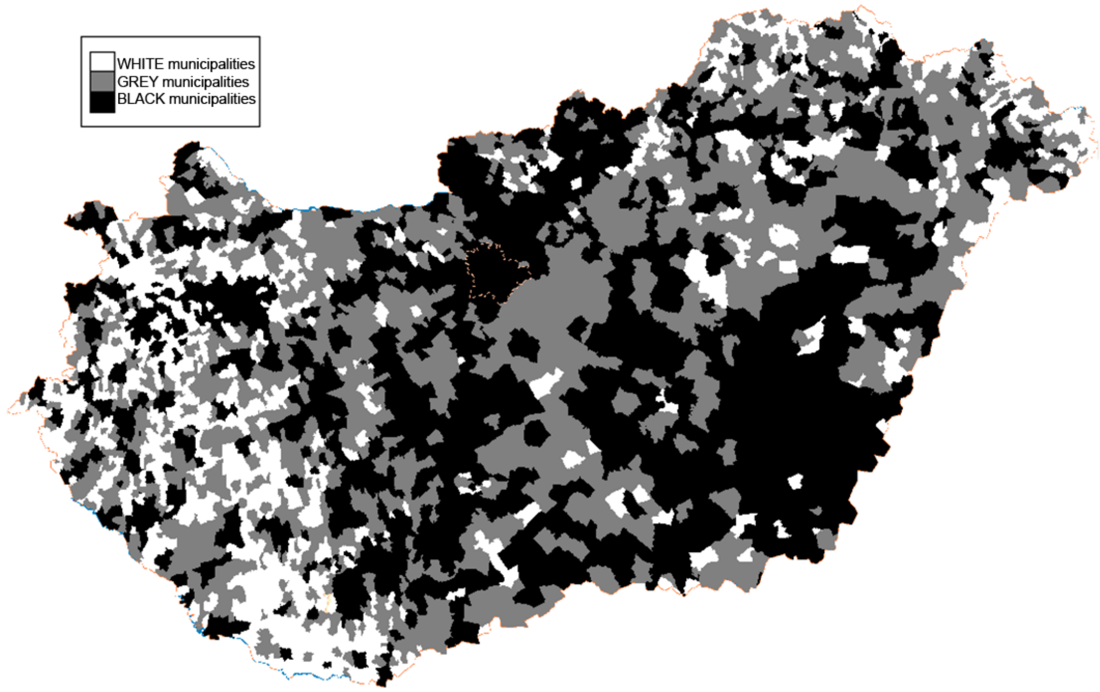
Source: Author's calculations based on National Communications Authority and GKIeNET data

FIGURE 15. "WHITE," "GREY," AND "BLACK" MUNICIPALITIES IN TERMS OF FIBER OPTIC COVERAGE, WITH MUNICIPAL BOUNDARIES



Source: Based on National Communications Authority and GKIeNET data

FIGURE 16. "WHITE," "GREY," AND "BLACK" MUNICIPALITIES IN TERMS OF FIBER OPTIC COVERAGE, WITHOUT MUNICIPAL BOUNDARIES



Source: Based on National Communications Authority and GKIeNET data

In addition to fiber optic coverage at the WAN level, the database also contains data on which municipalities received public funds for building their access networks. Of the grey municipalities, 28% had access networks built using state aid (under the HHÁT-2, HHÁT-3, as well as the GVOP-4.4.1 and 4.4.2. programs). At grey municipalities, where the existing fiber optic connection is not in use or provides no service (i.e., the capacity is unutilized) – a total of 425 municipalities – 39% were awarded state funds for access network construction.

Of the 868 municipalities lacking fiber optic wide area network access but not awarded public funds under GOP 3.1.1, 4.8% (a total of 42 municipalities) had access networks built using state aid. Although the operative programs supporting the construction of access networks also allow proposals for connections to the wide area network, this was not required, nor was it mandatory to build a fiber optic network, given the principle of technology neutrality.

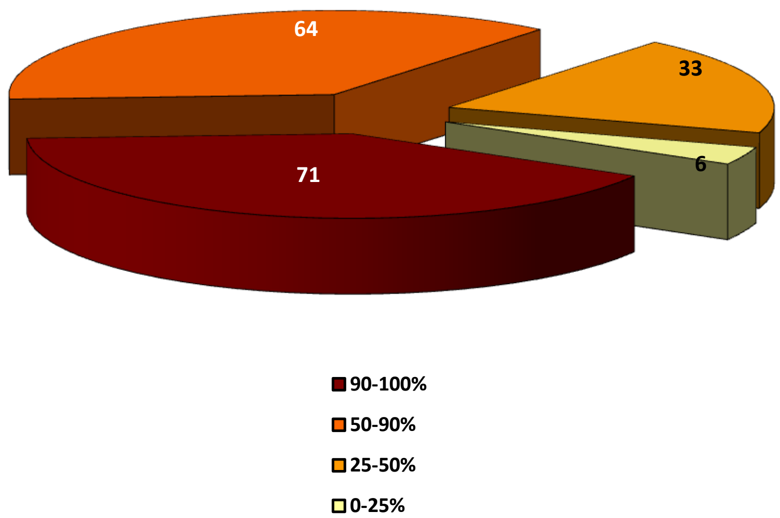
TABLE 8. STATE AID FOR ACCESS NETWORKS AT WHITE AND GREY MUNICIPALITIES

		Grey municipalities				White municipalities			
	Number of municip-alities	Total	Access network const-ructed	Net-work unu-sed	Access network const-ructed	Fiber optics being const-ructed (GOP 311)	Acces s net-work const-ructed	Fiber optics not const-ructed	Acces s net-work const-ructed
Under 250	440	80	80	65	65	89	89	245	244
250-499	584	175	168	121	115	60	59	283	280
500-999	679	275	247	124	110	32	29	213	198
1000-2499	825	416	352	96	83	12	10	116	102
2500-4999	334	182	117	18	12	1	1	10	10
5000 or more	290	67	46	1	1	0	0	1	1
Total	**3152**	**1190**	**1011**	**425**	**386**	**194**	**188**	**868**	**835**

Source: Author's calculations based on National Communications Authority and GKIeNET data

There is no subregion in Hungary without any fiber optic network, and every subregion has at least two municipalities connected to this network. As for the intensity of coverage, there were 71 subregions in 2009 with optical cable reaching at least 90% of the municipalities. In 64 subregions at least half but no more than 90% of the municipalities are covered by fiber optic network. There are six subregions in the least covered category: Lengyeltóti (20%), Őriszentpéter (23%), Sellye (11%), Siklós (17%), Szigetvár (17%) and Tét (21%).

FIGURE 17. SUBREGIONS BY PERCENTAGE OF MUNICIPALITIES WITH FIBER OPTIC COVERAGE

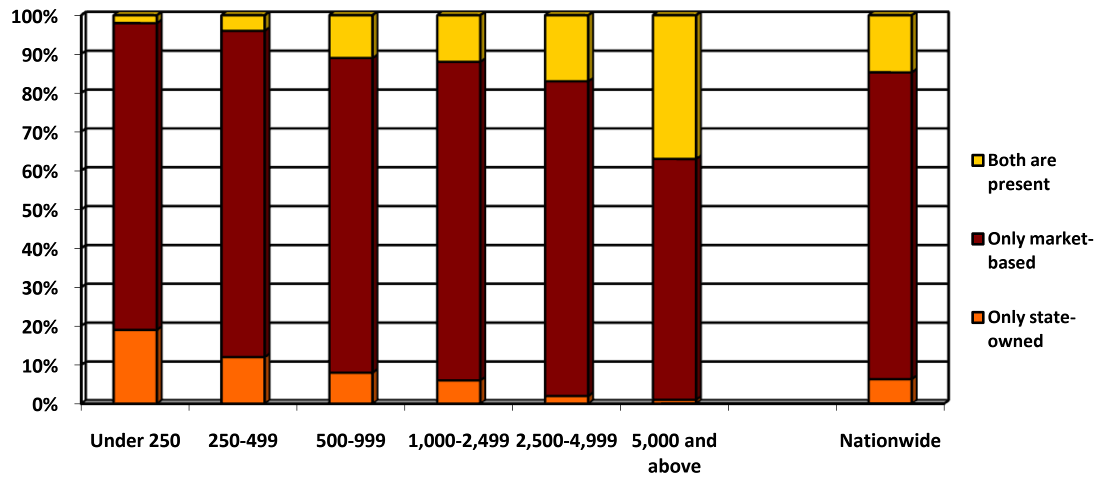


Source: Author's calculations based on National Communications Authority and GKIeNET data

Network ownership

Among municipalities with fiber optic network connections, 132 (6%) have state- or community-owned optical networks. I included MVM's network to be state-owned (community-owned), even though it is not 100% state-owned, as well as the fiber optic networks created under the GVOP-4.2.2 program, because the latter are still mandatorily owned by the local governments or the subregion. Almost one-fifth (15%) of the municipalities have state-owned or state-supported access in addition to the networks built by market participants. Another six municipalities with networks whose ownership is unclear (the data only indicates that the municipality is connected to a fiber optic WAN, but the connection is presumably privately owned).

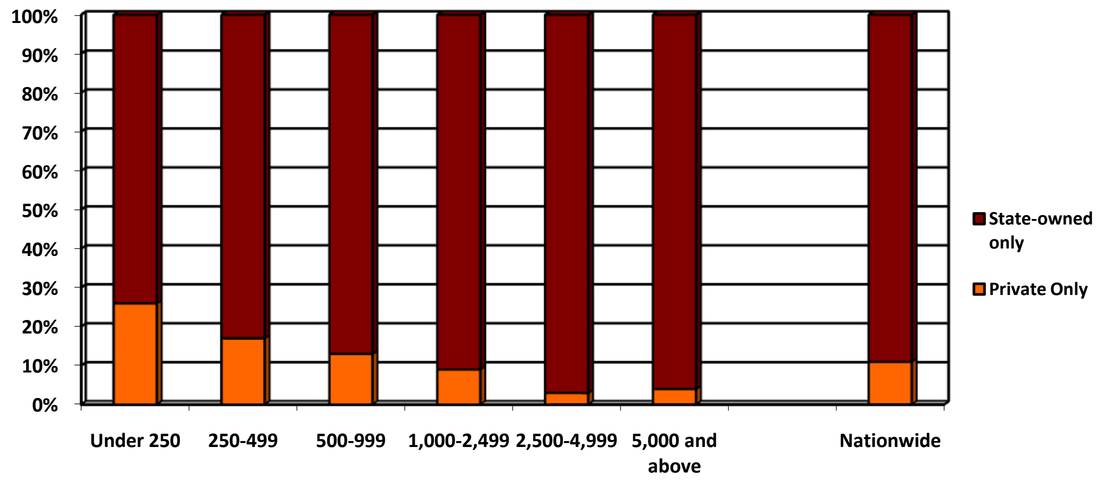
FIGURE 18. OWNERSHIP OF THE OPTICAL NETWORK BY MUNICIPALITY SIZE



Source: Author's calculations based on National Communications Authority and GKIeNET data

Grey municipalities with a single fiber optic WAN connection are serviced by private providers 89% of the time, while state-owned networks make up the remaining 11%.

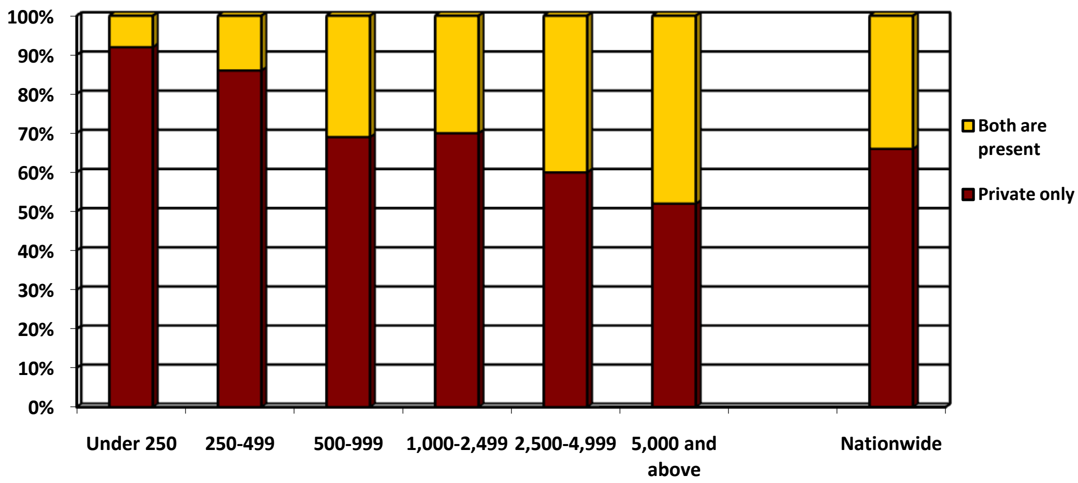
FIGURE 19. NETWORK OWNERSHIP OF GREY MUNICIPALITIES



Source: Author's calculations based on National Communications Authority and GKIeNET data

No municipalities with multiple fiber optic WAN connections have all their networks in state ownership. State network development happened mainly in larger municipalities so far, while smaller municipalities do not typically have a state presence.

FIGURE 20. NETWORK OWNERSHIP IN BLACK MUNICIPALITIES

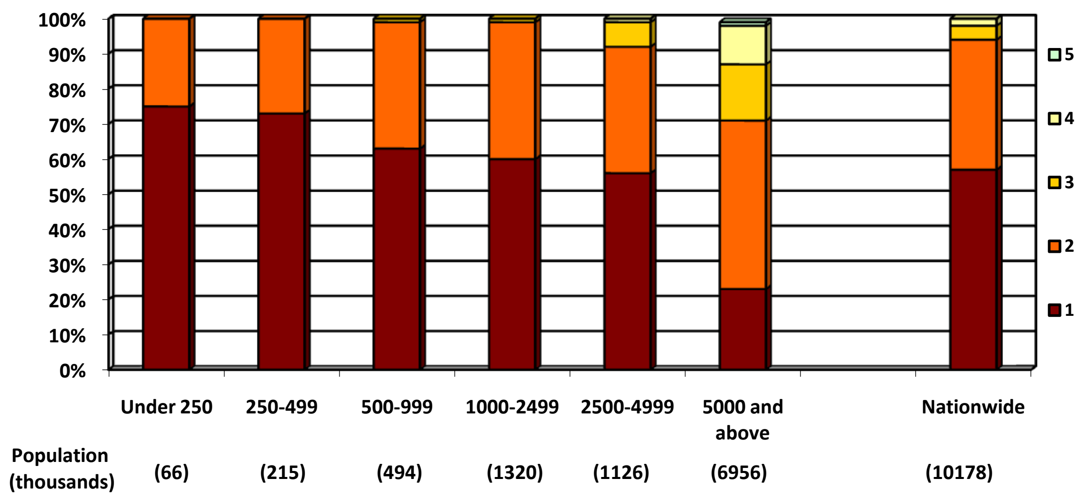


Source: Author's calculations based on National Communications Authority and GKIeNET data

Alternative networks

Alternative fiber optic networks have been constructed in about 43% of the municipalities with fiber optic access. Alternative fiber optic networks are typical for municipalities with larger populations, but about a quarter of the municipalities with fiber optic access having fewer than 250 inhabitants also have at least fiber optic network connections.

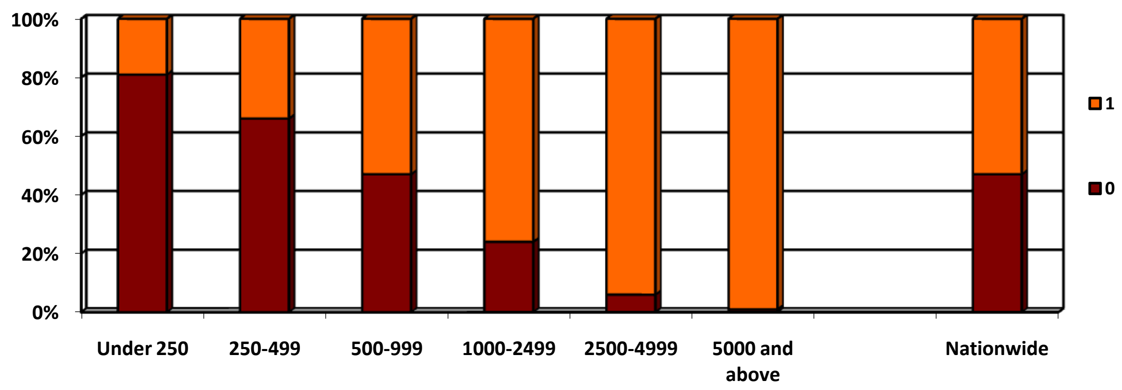
FIGURE 21. ALTERNATIVE FIBER OPTIC INFRASTRUCTURE IN MUNICIPALITIES WITH FIBER OPTIC CONNECTIVITY BY MUNICIPALITY SIZE



Source: Author's calculations based on National Communications Authority and GKIeNET data

The percentage of white and grey municipalities is shown by the next figure. As population size increases, white municipalities become more rare. As shown before, it is mostly the coverage of smaller municipalities that is spotty; the private sector's leadership in their development is less likely here.

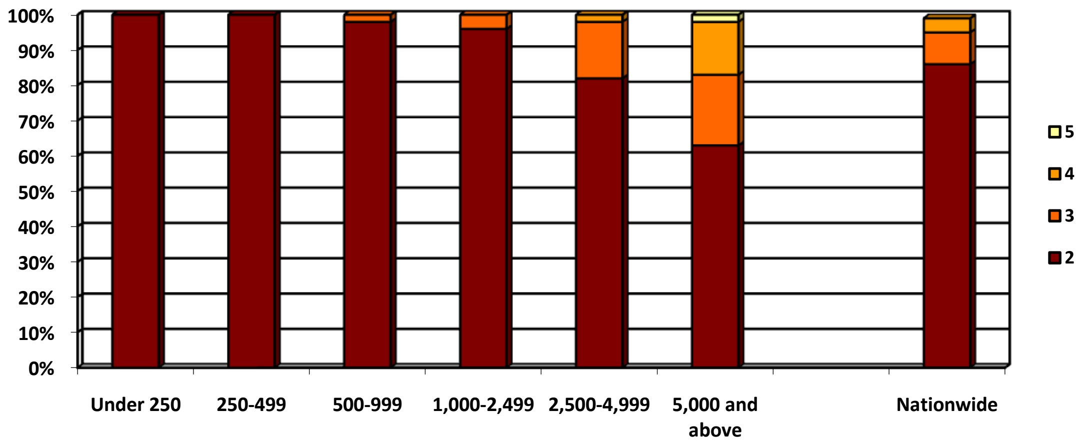
FIGURE 22. NUMBER OF FIBER OPTIC INFRASTRUCTURE IN "WHITE" AND "GREY" MUNICIPALITIES BY POPULATION SIZE



Source: Author's calculations based on National Communications Authority and GKIeNET data

Among municipalities with at least two fiber optic WAN connections, redundant fiber optic connections are typical for larger municipalities. This phenomenon is completely missing in municipalities with fewer than 500 inhabitants, and it is very rare (2-4%) in municipalities with 500 to 2,500 inhabitants. There are some municipalities with 2,500+ inhabitants and 4 alternative fiber optic connections, and some municipalities with 5,000+ inhabitants have as many as 5 alternative fiber optic WAN connections.

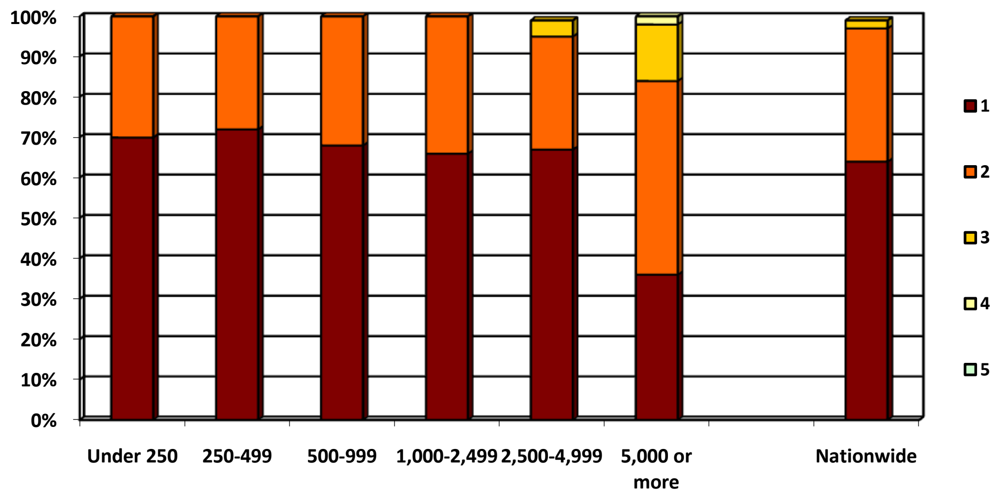
FIGURE 23. NUMBER OF FIBER OPTIC INFRASTRUCTURE IN "BLACK" MUNICIPALITIES BY POPULATION SIZE



Source: Author's calculations based on National Communication Authority and GKIeNET data

In the majority of municipalities with network access built on an exclusively market basis the given private provider has a monopolistic position. In about two thirds of the municipalities with fewer than 2,500 inhabitants only one company built a fiber optic line. Some municipalities with over 2,500 inhabitants have 3-4 alternative optical connections. Among municipalities with more than 5,000 inhabitants, 36% have only one fiber optic WAN connections.

FIGURE 24. PERCENTAGE OF ALTERNATIVE OPTICAL INFRASTRUCTURE AMONG MUNICIPALITIES SERVED BY PRIVATE PROVIDERS ONLY, BY POPULATION SIZE

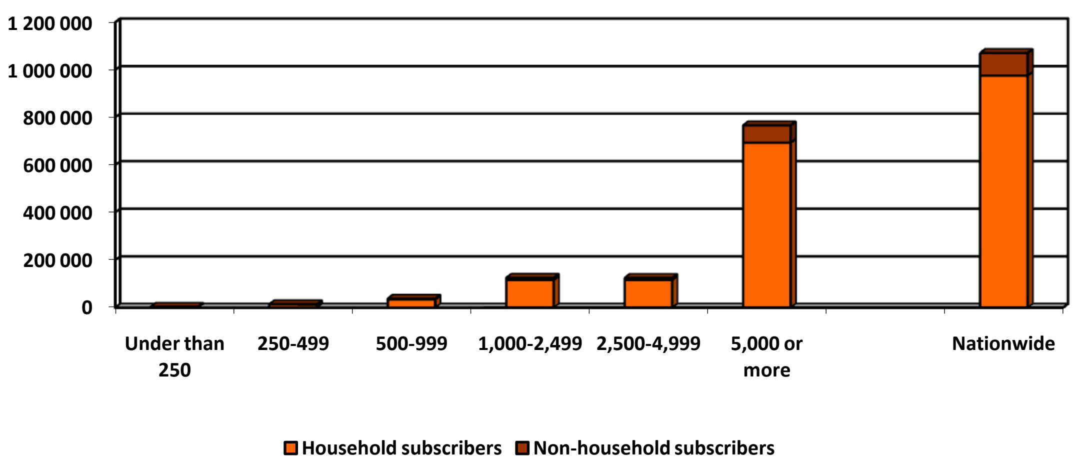


Source: Author's calculations based on National Communications Authority and GKIeNET data

Number of subscribers

The municipality-level database of the National Communications Authority registered 1,071,000 fixed broadband Internet subscriptions as of the second quarter of 2008, outside of Budapest (based on the OECD's definition of broadband, also adopted by Hungary, of a minimum upload speed of 256 Kb/s and a download speed of 64 Kb/s). The number of household subscribers was 976,000.

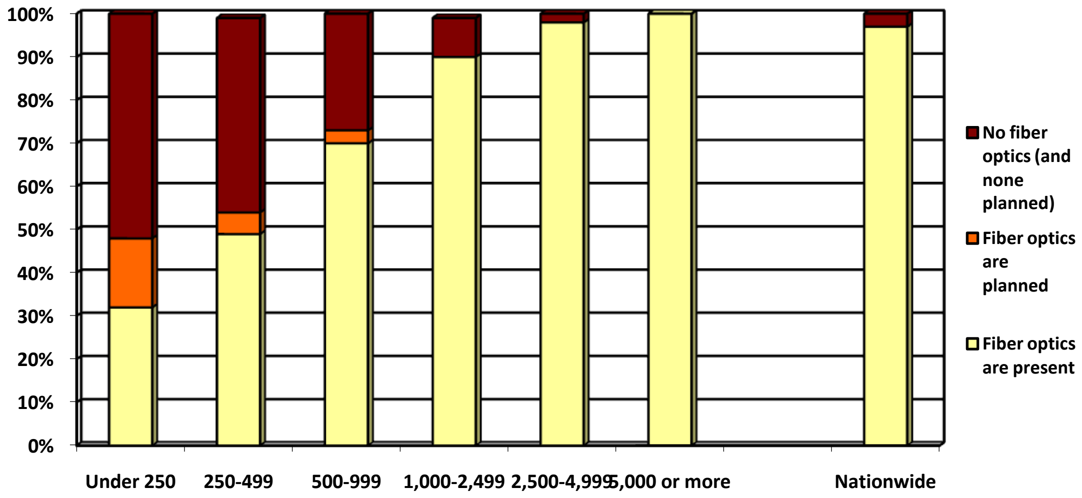
FIGURE 25. NUMBER OF BROADBAND INTERNET SUBSCRIBERS BY MUNICIPALITY SIZE



Source: Author's calculations based on National Communications Authority and GKIeNET data

Some 3% of all subscribers live or use fixed Internet service in a municipality that has no direct interlocational fiber optic network. In municipalities with fewer than 250 inhabitants, 68% are not connected to a fiber optic WAN. In municipalities with 250-500 inhabitants, half of the subscribers access via a non-optical access network.

FIGURE 26. FIBER OPTIC NETWORK COVERAGE AS A PERCENTAGE OF BROADBAND SUBSCRIBERS, BY MUNICIPALITY SIZE



Source: Author's calculations based on National Communications Authority and GKIeNET data

The ratios are roughly similar for households. Some 5% of the people live in a municipality where fiber optic development projects are not yet planned, and 1% live in a municipality where the construction of a fiber optic WAN connection is expected under the GOP program. Among municipalities with over 5,000 inhabitants, there is only one (Egyek) where there is no fiber optic WAN connection. There are 5,800 people living there.[94] There are 66 thousand people in the group of the smallest municipalities, and more than half of those people live in a place where no optical network development is being planned.

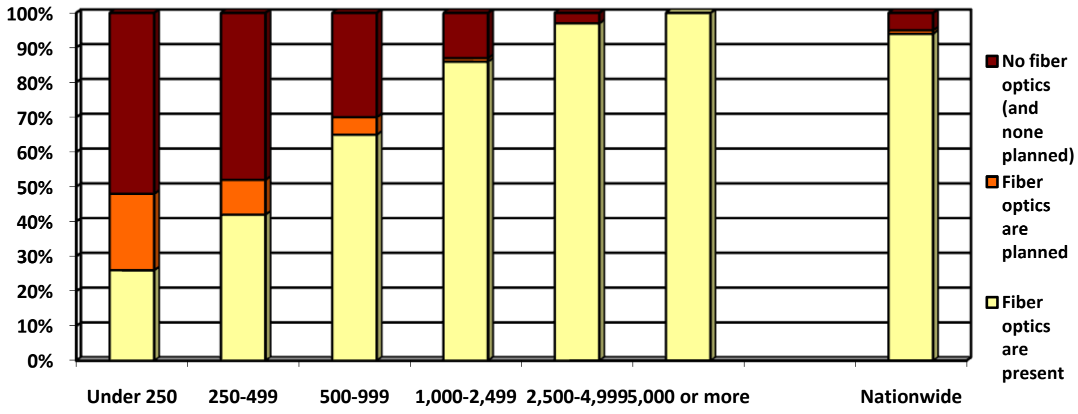
[94] According to the website of the municipality, there are in fact 5,900 inhabitants as those born in 2008/2009 and those who moved to Egyek during this period do not appear in the population survey of the Hungarian Central Statistical Office.

TABLE 9. POPULATION OF "WHITE," "GREY" AND "BLACK" MUNICIPALITIES

	Population	White municipalities	By fiber optic status Grey municipalities	Black municipalities
Under 250	66 116	48 965	12 556	4 595
250-499	215 105	123 808	66 775	24 522
500-999	494 093	172 961	201 865	119 267
1000-2499	1 320 249	181 079	682 229	456 941
2500-4999	1 126 392	32 254	615 874	478 264
5000 or more	6 956 450	5 844	607 897	6 342 709
Total	**10 178 405**	**564 911**	**2 187 196**	**7 426 298**

Source: Author's calculations based on National Communications Authority and GKIeNET data

FIGURE 27. FIBER OPTIC NETWORK COVERAGE AS A PERCENTAGE OF POPULATION, BY MUNICIPALITY SIZE



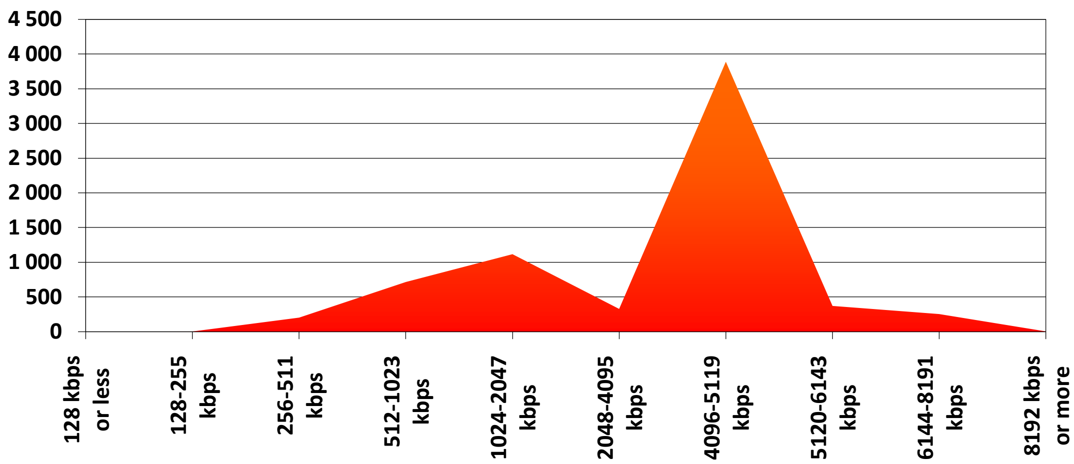
Source: Author's calculations based on National Communications Authority and GKIeNET data

Capacity / maximum subscriber bandwidth

No database regarding network capacity was available to me, in part because the capacity of optical networks is fundamentally limited by the capacity of the active devices, while the actual transmission medium (the optical fiber) poses no real bandwidth limit (being capable of potential n*Terabit/sec magnitude bandwidths). Therefore I examined the data of PublicNet in order to get an approximate idea about the status. Service providers are mandated by law to provide PublicNet users with the maximum bandwidth available in the area, on an SLA (Service Level Agreement) basis, with a CIR (Committed Information Rate) guarantee. Since the institutions using PublicNet (Mayor's Office, schools, etc.) are usually in the center of the municipality, the capacity available to them is a good approximation of the maximum bandwidth available in the given municipality.[95] The database of institutions using PublicNet has made it possible for me to determine the highest available subscriber bandwidth in 2,436 municipalities.

Based on the above, the mean highest available municipal subscriber bandwidth was 2.6 Mb/s in the download direction in 2009. In municipalities with 5,000 or more inhabitants this figure is nearly 4 Mb/s, while at municipalities with fewer than 250 inhabitants the typical value is 1.3 Mb/s.

FIGURE 28. NUMBER OF INSTITUTIONS USING PUBLICNET BY DOWNLOAD BANDWIDTH



Source: Based on KEKKH data

Average retail bandwidth in municipalities with fiber optic coverage at the WAN level is 2.9 Mb/s, and "grey" municipalities do not lag far behind (2.8 Mb/s). "White" municipalities, having no fiber optic WAN connection, typically have a 1.5 Mb/s maximum bandwidth at subscriber terminals. These values are not lower for the white municipalities left out of fiber optic development projects for the time

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95 This statement can be debated in individual instances, but statistically it is clearly true. The data might be distorted by the fact that the capacity of an access point may depend on the local/access network topology and technology, and not just on the distance from the PoP. In addition, the network owner probably will not make available to the end users the maximum uplink capacity available at the local PoP, particularly if it is used as a multi-service link. (These days bandwidth tends to be divided into video + voice + data (Internet) + reserve capacities.) Still, the aggregate numbers are telling, with the added benefit of being recorded officially at the Public Network access points.

being, suggesting that in these municipalities, or at some of them, broadband access to the Internet is not a problem – at least for public institutions.

10. TABLE HIGHEST RETAIL BANDWIDTHS *ON AVERAGE* (KB/S)

				Grey municipalities			White municipalities		
	Number of municipalities	**Total**	**With fiber optics**	**Total**	**State aid for access network**	**No state aid for access network**	**Total**	**State aid for access network**	**No state aid for access network**
Under 250	440	1279	1621	1564	1564	-	1150	1150	-
250-499	584	1690	1919	1929	1954	768	1510	1522	512
500-999	679	2004	2236	2446	2533	1562	1580	1657	666
1000-2499	825	2739	2887	2996	3038	2766	1924	1946	1755
2500-4999	334	3291	3342	3266	3580	2702	1815	1815	-
5000 or more	290	3989	4001	3712	3857	3395	512	512	-
Total	**3152**	**2563**	**2914**	**2815**	**2848**	**2654**	**1543**	**1563**	**1148**

Source: Author's calculations based on National Communications Authority and GKIeNET data

In the wake of intensive network development efforts there have been FTTx (Fiber To The Home, …Building, …Cabinet, …Node) offers with speeds of 25-50Mb/s, meaning that the 8 Mb/s guaranteed bandwidth is a more future-proof parameter. Offering the population of municipalities with no current coverage connections of such speeds would require municipality-level connections with average bandwidths of 1.5 Gb/s. However, this number varies widely, depending on the size of the municipality. The detailed calculation is summarized in the table below. The data were estimated based on the population of the "white municipalities." Lacking other data, I based my calculations on an average household size of 2.7 people. The table shows the necessary fiber capacity needed for guaranteed broadband service to these households, disregarding "overbooking."[96] The calculations used the following formula (and the resulting figures are summarized in the table below):

[96] The expression "overbooking" has been adopted from the tourism and logistics sectors into telecommunications. Its meaning: the telecommunication service provider sells more capacity (e.g., bandwidth) to its users than what it can actually provide, should all users decide to utilize all the services to the maximum extent simultaneously. The phenomenon exists in many other economic areas (for example, no bank could immediately provide in cash all the funds due to all its customers, should they all close their accounts at the same time); many sectors "overbook" by selling more than what they have. The magnitude of the phenomenon can be partially tracked in BIX statistics, although it is important to note that not every Internet service provider relies exclusively on the Hungarian Internet exchange (DIGI, for example, uses the one in Romania as well).

$$\text{value} = \frac{\frac{people}{2{,}7} \times capacity}{municipalities}$$

where the variables in the formula mean the following:

"people" = the number of people living in a municipality without coverage;

"capacity" = average bandwidth targeted;

"municipalities" = number of municipalities without coverage.

TABLE 11. AVERAGE MUNICIPALITY-LEVEL FIBER OPTIC CAPACITY NEEDED TO SERVICE HOUSEHOLDS IN MUNICIPALITIES WITH NO FIBER OPTIC COVERAGE (MB/S)

	Number of municipalities without coverage	Dedicated bandwidth per household			
		0,25 Mb/s	**0,5 Mb/s**	**1 Mb/s**	**8 Mb/s**
Under 250	334	14	28	54	434
250-499	343	34	68	134	1070
500-999	245	67	134	261	2092
1000-2499	128	134	268	524	4192
2500-4999	11	278	556	1086	8688
5000 or more	1	554	1108	2164	17316
Total	**1062**	**50**	**101**	**197**	**1576**

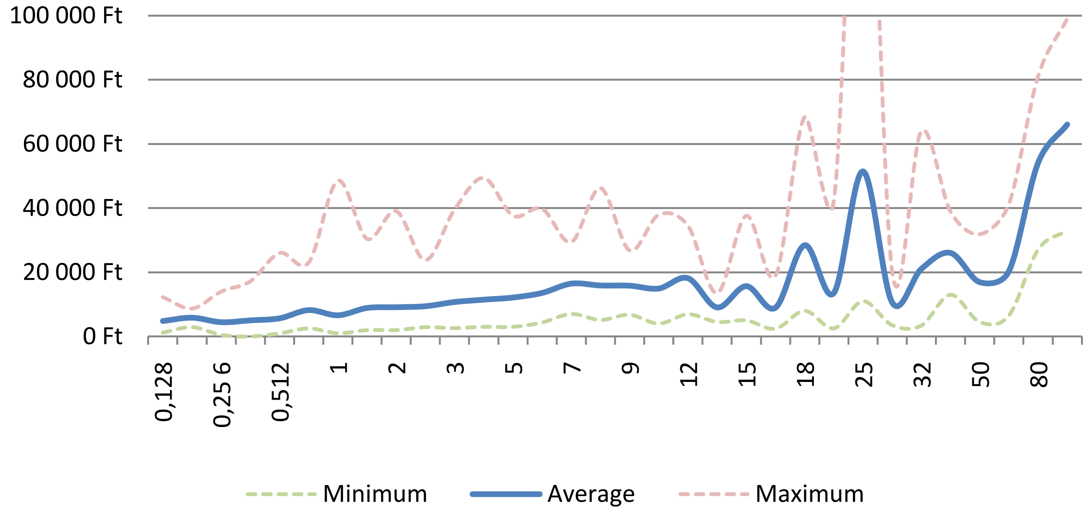
Source: GKIeNET, based on National Communications Authority and GKIeNET data

Addendum: retail pricing of Internet packages

The preceding sub-chapter has illustrated what Hungarian Internet users are facing in terms of bandwidth – but the price at which that bandwidth is available is just as important (even if this information is not needed for the investigation of the hypothesis). In order to identify market failures in this respect, I have considered prices advertised by the service providers – the ones that take affect once the various promotions expire. With that aim, wherever possible, I recorded the prices offered by the service providers in their General Terms and Conditions (GTCs) as shown on their websites. I looked for the prices included in one-year retail contracts offering unlimited non-fiber optic access to households, wherever possible, and when that was not possible, I considered the closest alternative. However, I did not collect data for Magyar Telekom and its resellers or Invitel (these show no clear signs of market failure). The General Terms and Conditions of the remaining 323 service providers included 1,295 Internet plans. The average prices of the Internet plans ranged from

2,500 forints to 40,000 forints. The most expensive plan cost 144 thousand forints, offering a nominal bandwidth of 25 Mb/s.

FIGURE 29. AVERAGE PRICE OF INTERNET PACKAGES (WITH THE EXCEPTION OF MAGYAR TELEKOM, ITS RESELLERS AND INVITEL)



Source: Contract conditions by service providers as of December 2009 (bandwidths are, of course, discrete values, and they are shown here as a continuous line only for illustration purposes).

There are two events that I consider signs of a market failure. First, if the service provider is unable to offer, even in theory, a bandwidth of at least 1 Mb/s to its subscribers. Second, if the service provider is charging at least 50% over the average price of similar plans. Service providers that find it suitable to offer their services under such conditions are presumably in a monopolistic position in a certain area, and are abusing that position. From the vantage point of the information society, such abuse can cause a region to fall behind the rest of the country very quickly. Eighteen of the Internet service providers exclusively offer plans that provide access speeds under 1 Mb/s.

Not every service provider specified its service at a municipality-level detail. In county-level listings Veszprém county was mentioned often, but the following other counties were also featured in the coverage maps of the 18 service providers: Békés, Fejér, Jász-Nagykun-Szolnok, Komárom-Esztergom.

As for pricing, I have identified 69 providers that had packages priced at least 50% above the average for the given category. Of the 18 service providers mentioned above, 11 were included in this list as well.

In addition to the full selection of plans, I will also focus on the pricing problems of the slower packages. The inappropriate pricing of the faster Internet plans may hinder the development of the information society, yet I see the resolution of the pricing problems of the slower Internet connections (e.g., those with a theoretical maximum bandwidth of 2Mb/s or less) as more urgent. It is the pricing of the slower, relatively more inexpensive plans that decides whether someone becomes an Internet subscriber. Of the 69 providers just mentioned, 50 exceed the average price for the category by more than 50% even for their narrower bandwidth plans. These providers impact more than 500 municipalities. It is imperative for any nationwide broadband infrastructure-promotion program to help these areas catch up with the rest of the country.

Summary of the investigation of hypothesis H_4

From the results of the investigation we can see that over 900 Hungarian municipalities (868 + the ones that did not end up signing a contract under GOP 3.1.1.) have no fiber optic network coverage, while another 1,195 are reached by only one fiber optic connection. In chapter V. I already presented an analysis of why, based on the interests of the entire community, it is not worth building an alternative infrastructure for the wide area network, and in the course of investigating the H_4 hypothesis it became clear that in terms of the fiber optic coverage of Hungary's wide area network, two thirds of the municipalities offer no opportunity for fiber optic network competition (while the chances of alternative network paths are minimal). Needless to say, infrastructure-based competition is possible, and it does happen (e.g., using wireless solutions). But as I have indicated earlier, the lack of "futureproof" non-fiber optic solutions and the inferior service quality caused by weather and other factors make these solutions less desirable. The analysis of the Internet service plans makes it apparent that the existence of a local monopoly negatively impacts the price of Internet service, as reflected by the GTCs.

The regulatory toolkit of the EU does not recognize the principle of open access as a principle that the authorities can mandate (sanction). According to the EU's current regulatory framework, the only thing authorities have the power to do is the ex ante regulation of the wholesale prices of leased lines or trunk segments. The

National Communications Authority has not identified any SMP actors in the trunk segment, while in the leased line terminal segment the SMP actor (Magyar Telekom) was mandated to have a "retail minus" type arrangement, which does not substantially improve the market position of the other participants. In contrast to the current regulatory practice, it would be at least as important for the wholesale peer companies to have regulation of the other services on the trunk network and of infrastructure unbundling (the dark fiber market). If the wide area network infrastructure reaching the municipalities has not been constructed on a business basis, the use of community resources is justified in order to create basic infrastructure, and in this case open access is mandatory according to EU regulatory principles. This will likely be changed by the new recommendation of the European Commission regarding regulated access to new generation access networks (NGA) to be released in September 2010. This will provide an opportunity for Hungary to take a new approach.

In light of the above, it appears that if the goal of the state is to promote infrastructure-based competition, then its primary task in the service of developing ICT infrastructure is to secure regulated access to the wide area network as a basic infrastructure. Therefore I consider the H_4 hypothesis proven and accepted.

VIII. ANALYSIS OF HUNGARIAN PROGRAMS FOR BROADBAND INFRASTRUCTURE DEVELOPMENT

There were a total of 62 decisions regarding competition law disputes in the member states of the European Union with respect to broadband infrastructure development projects funded by the EU between December 2003 and May 2010 (European Commission, 2010). This does not only reflect that the member states took advantage of the available broadband infrastructure development funds, but also that in Europe's liberalized telecommunication market there was some kind of competition law hurdle in the course of utilizing community resources in nearly every member country.

The Ministry of Informatics and Telecommunications (whose department overseeing infrastructure development proposals was incorporated into the Ministry of Economy and Transport in 2006 and into the Office of the Prime Minister in 2008, only to be transferred to the Ministry of National Development in 2010) defined as its primary objective catching up with the European Union and increasing competitiveness by providing state aid to the ICT sector as early as in the 2003 Hungarian Information Society Strategy already cited, but particularly in its continuation, the 2005 National Broadband Strategy. The development tax incentive that was already available before 2003, the HHÁT 2 and HHÁT 3 programs were the first domestically funded initiatives supporting infrastructure development for which companies could submit proposals. In order for broadband Internet service to be available throughout the country, another three programs were initiated: GVOP 4.4.1, GVOP 4.4.2 and GOP 3.3.1, however, these were already funded by the European Union. Some content aspects of these three programs were already analyzed in the investigation of the H_2 hypothesis, while details of the implementation and the results will be discussed here.

TABLE 12. BROADBAND INFRASTRUCTURE DEVELOPMENT PROGRAMS IN HUNGARY

Program	Year initiated	Number of projects	Total amount disbursed (EUR~HUF)*	Total project value (EUR~HUF)*
HHÁT 2	**2003**	**27**	2,810,674 EUR 737,043,000 HUF	
HHÁT 3	**2003**	**6**	939,455 EUR 246,353,250 HUF	
GVOP 4.4.1	**2004**	**28**	8,215,284EUR 2,020,384,678HUF	17,955,863EUR 4,415,885,493HUF
GVOP 4.4.2	**2005**	**59**	42,435,027EUR 10,724,604,270HUF	58,038,876EUR 14,668,165,038HUF
GOP 3.1.1	**2007**	**37**	11,911,908EUR 3,017,881,784HUF	25,040,458EUR 6,344,000,000HUF

Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

* 2003 – 1EUR ≈ 262,23HUF (end-of-year exchange rate)

2004 – 1EUR ≈ 245,93HUF (end-of-year exchange rate)

2005 – 1EUR ≈ 252,73HUF (end-of-year exchange rate)

2007 – 1EUR ≈ 253,35HUF (end-of-year exchange rate)

Red figures: the GOP 3.1.1 program is ongoing; the proposals have been adjudicated but the implementation is not complete in every case.

The primary aim of initiating these programs is to bridge the digital divide (as also identified by the EU Commission), which includes mitigating the differences between areas, regions and within regions. Broadband Internet access for rural and low population density areas is a high-priority issue. State aid in these areas is justified by high costs due to large geographical distances and by low demand (low population density, poor financial conditions).

Broadband infrastructure development took place along two directions with separate timeframes and separate sets of recipients:

- Increasing the availability of broadband Internet access at smaller, currently less well served and less lucrative municipalities where, in the absence of state aid, broadband infrastructure would not be built at all, or at least not until later.

The construction of broadband networks is to be aided through subsidizing the telecommunication service provider, with the network becoming the telecommunication service provider's property.

- Providing state aid for the construction of broadband networks by local governments in Hungary's less lucrative municipalities, with the local governments selecting the service providers in open competition, and the network remaining in local government (community) ownership.

In addition to the programs listed above, the PublicNet program was also aimed at providing access points; this, however, required relatively limited investment by the service providers.

Due to the unavailability of best practices, the utilization of community resources was largely a trial-and-error process. The entities inviting the proposals initially were limited to learning from their own mistakes in formulating new policies, given the scarcity of international examples to be learned from.

I have used the following hypothesis in evaluating the government’s role in Hungarian broadband infrastructure development programs so far:

H_5: In the course of the five government-funded infrastructure development programs implemented in Hungary by 2009, economic policymakers relegated community-based or community-owned digital telecommunication infrastructure to a heavily limited, stopgap role in terms of impact and extent.

The hypothesis assumes that in the period up to 2009, economic policy makers did not spend community resources in the digital telecommunication market they considered fundamentally liberalized unless they perceived a lack of broadband Internet access in a municipality enumerated under NUTS5 (later LAU2). To fill the gaps in coverage, the community-funded investment projects aimed at providing broadband Internet access at municipalities where the necessary infrastructure had not been built on a business basis. However, they had no separate policy goals for expanding wide area networks and access networks, and accordingly, they did not focus on what portions of the digital telecommunication network would be better off being operated on a community basis.[97]

VIII.1. Analysis of the H_5 hypothesis

VIII.1.1. Methodology

The basis of my investigation consisted of the RFPs for all of the five programs, as well as the data series showing the results of the projects already completed or yet to be finished under them. By analyzing them, it was possible to investigate the hypothesis.

VIII.1.2. The results of the investigation

HHÁT-2 and HHÁT-3

The differences in the names of the two programs reflect differences in content: the original concept behind HHÁT-2 was the implementation of broadband Internet access, while the HHÁT-3 program was the same, but by aiding innovative solutions only. The aim was to bring broadband infrastructure to areas where service providers would be unlikely to build it using their own resources for a long time (Gál, 2008).

Seeing the success of the HHÁT-2 program, decision makers in the Information and Telecommunications Ministry regrouped further funds to this area, creating the HHÁT-3 program, which had not been part of the original concept. At the same time, the accepted proposals were at the same technological level as the earlier ones.

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[97] In the course of the investigation the necessity of analyzing the PublicNet program also arose. However, the program, including the Sulinet sub-program serving schools, primarily provides IP-based connectivity for public institutions, the foremost application of which is Internet access. In organizing PublicNet, the government primarily rents IP-based connections. At the same time, the whole system is service-based, i.e., the Hungarian government, as a client, ensures the operation of PublicNet by purchasing packages of various services, without building an infrastructure of its own. Active terminal devices (routers, switches) are the only hardware components owned by the client, but client-side terminal devices such as xDSL modems are also provided by the service provider. Consequently, since the focus of this dissertation is the basic infrastructure, I will not analyze the details of the PublicNet program.

There were several problems with the proposals. Firstly, the Ministry had no database describing which areas of Hungary had access to broadband Internet service, and it lacked basic data on the network infrastructure throughout the country. As a consequence, it was possible to submit proposals to build coverage in municipalities where coverage had already been provided by private businesses, and such proposals were in fact submitted. To make things worse, it was possible to submit proposals involving cherry-picked groups of municipalities, defeating the initial purpose of state aid being spent only on areas where service providers would not build broadband infrastructure for the foreseeable future by their own volition. At the same time, there was no methodology for comparing proposals, and the RFP was inaccurate in many respects, which led to instances of multiple winners for a single municipality (for example, Apostag).

TABLE 13. HHÁT-2 PROGRAM RESULTS

	Number of proposals	**Amount**
Proposals	41	
Approved	36*	905 043 000 Ft
Not approved	7	178 000 000 Ft
Total proposal amount		1 083 043 000 Ft
Actual funds spent		737 043 000 Ft
Administrative costs		40 000 000 Ft
Funds/covered households	31 403**	23 470 Ft

**In the end, only 27 proposals were processed completely. **Number of covered households*
Source: Ministry of Informatics and Telecommunications, 2004

TABLE 14. HHÁT-3 PROGRAM RESULTS

	Number of proposals	**Amount**
Proposals	8	
Approved	6	246 353 250 Ft
Not approved	2	142 066 750 Ft
Administrative costs		40 000 000 Ft
Total		428 420 000 Ft

Source: Ministry of Informatics and Telecommunications, 2004

Under the HHÁT 2 and HHÁT 3 programs, 458 NUTS5-level municipalities received some sort of broadband Internet access, and if municipality levels below NUTS5 (sub-municipalities) are also considered, the tally increases by 16 (to a total of 474).

GVOP-4.4.1

The GVOP 4.4.1 program for expanding broadband infrastructure is the continuation of the HHÁT-2 ("State aid for building broadband Internet infrastructure and initiating service in less lucrative municipalities of Hungary") and HHÁT-3 ("State aid supporting the expansion of broadband Internet access through innovative and technology-intensive infrastructure developments and service models") programs of the Ministry of Informatics and Telecommunications from 2003. The HHÁT-2 and HHÁT-3 programs aimed at attracting a wide range of proposals with relatively small individual grant amounts.

The GVOP program simply declared as its aim to promote the construction of broadband networks while defining who the potential grantees are, and prescribing the way the projects were to be implemented. It clarified the way the project was to be completed without detailing the goals.

The program showed that its target group of 400-500 small and medium-sized telecommunication enterprises (mainly cable TV service providers) are incapable of implementing large-volume broadband infrastructure development projects.

Despite the low propensity and ability to submit proposals, the GVOP 4.4.1 program basically coincided with the requirements of the target group, while improving the competitiveness of the development-oriented but undercapitalized small and medium-sized enterprises active in the gap market. At the same time, the broadband infrastructure thus created has contributed to alleviating the regional differences in competitiveness as well, but larger volumes of broadband development cannot be implemented on the basis of this vehicle in the future. This is part of the reason why the form of state aid offered by GVOP 4.4.2 was moved to the forefront, and the bulk of the funding was channeled here as well.

GVOP-4.4.2

The project in preparation for the GVOP 4.4.2 program examined the international examples and the practice of Hungarian local governments, and formulated the initial assumption that the Hungarian local governments would be unable to undertake independently another task that is new and largely outside of their core competencies, if they are left to their own devices, particularly if they have to finance the initial (preparatory) phase of the activity. Local governments typically lack the appropriate project management capacity to handle projects under market-driven conditions. This statement is particularly true of disadvantaged local governments that are short on funds through no fault of their own, and which form the most important target group for the project from the vantage point of broadband digital communication. Consequently, the theoretical key to a state aid program is forming and forcing a partnership system in order to secure the appropriate professional and financial background for:

- preparing for projects,
- implementing development plans,
- operating the infrastructure and
- providing appropriate services.

The model of the 4.4.2 program allows the local government to involve a partner in planning, building and maintaining a broadband network. The goal, not unlike in 4.4.1, was to provide broadband service in areas where profitable market-based service is not feasible.

The first approximation for a target group of the 4.4.2 program consists of municipal governments and consortia of municipal governments formed voluntarily and under section 10 of act XXI of 1996 about area development and zoning (i.e., consortia that are incorporated legal entities and operate as budgetary organizations). As reflected by the goals of the state aid, the main objective is providing coverage in underdeveloped areas, meaning that the municipalities and consortia of municipalities (regardless of their population size) that are eligible for state aid are the ones lying in statistical/planning regions and subregions defined in section 30, subsection (1) a) of Government Decree 85/2004. (IV.19.). That 4.4.2 program was more successful is shown by the fact that it attracted three times as many proposals as the 4.4.1 program. (The attention of service providers was focused on 4.4.2 by the higher cofinancing ratio and the higher absolute amount to be disbursed.)

TABLE 15. RESULTS OF THE 4.4.2 PROGRAM

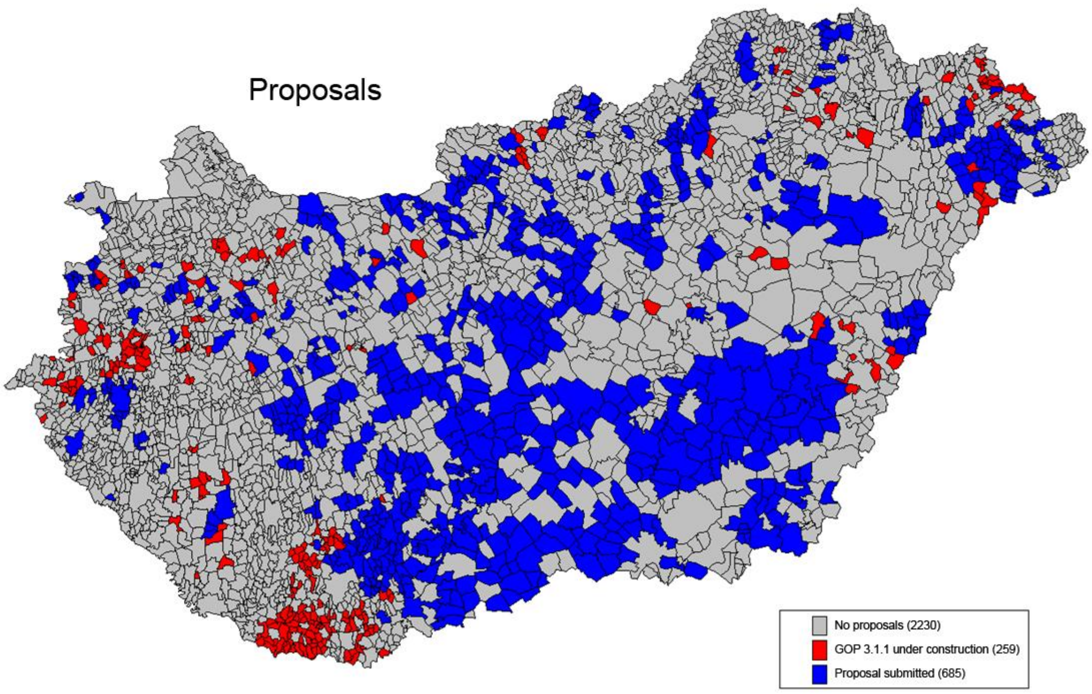
	Not approved	Approved	Total
Municipalities covered	458	378	836
Households covered	224 317	241 409	465 726
Population covered	581 884	636 078	1 217 962
Amount requested (millions of forints)	9 667	10 541	20 208
Amount awarded (millions of forints)	-	10 040	10 040

Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

Monitoring coverage data

The following map, showing municipality boundaries, clearly indicates the location within Hungary of municipalities with networks constructed (or modernized) under the program. At the same time, differences between regions are not shown clearly owing to the differences in municipality sizes (larger and fewer municipalities in the Great Plains region, and smaller but more numerous ones in the mountain areas).

FIGURE 30. GEOGRAPHICAL LOCATION OF THE MUNICIPALITIES INVOLVED IN THE PROGRAMS

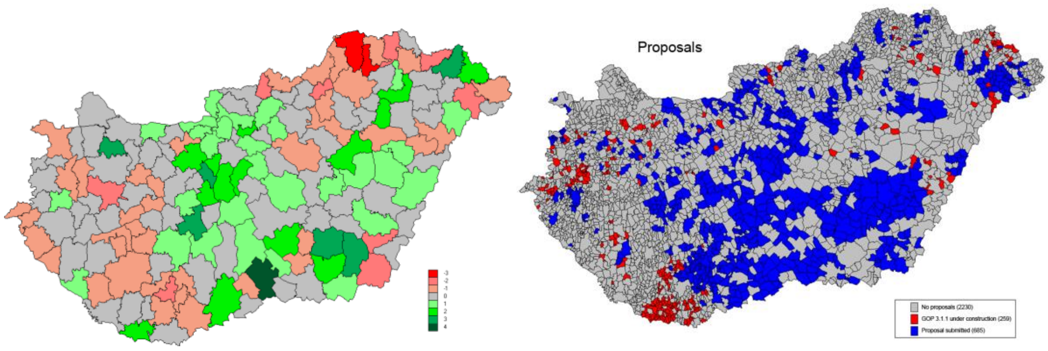


Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

In terms of coverage (independently of the area of the municipalities), the southern part of the Great Plains region is very highly impacted. The numerical data (see graph below) show that the 62% area coverage ratio of the Southern Great Plains region is extremely high.

Municipalities of the Southern Great Plains region also had the most successful proposals in terms of municipality structure (number of municipalities – population). The low participation of the Western Hungary region is perhaps expected, while in Northern Hungary, where penetration values are low, there is a danger of falling behind. As I have already mentioned in the course of investigating the H_1 hypothesis, it makes sense to compare the municipalities impacted by the program with the comprehensive ICT availability index.

FIGURE 31. COMPARISON BETWEEN CHANGES IN THE POSITION OF SUBREGIONS IN DECILE GROUPS BY THE ICT AVAILABILITY INDEX IN 2003-2008 AND THE GEOGRAPHICAL LOCATION OF MUNICIPALITIES IMPACTED BY THE PROGRAMS



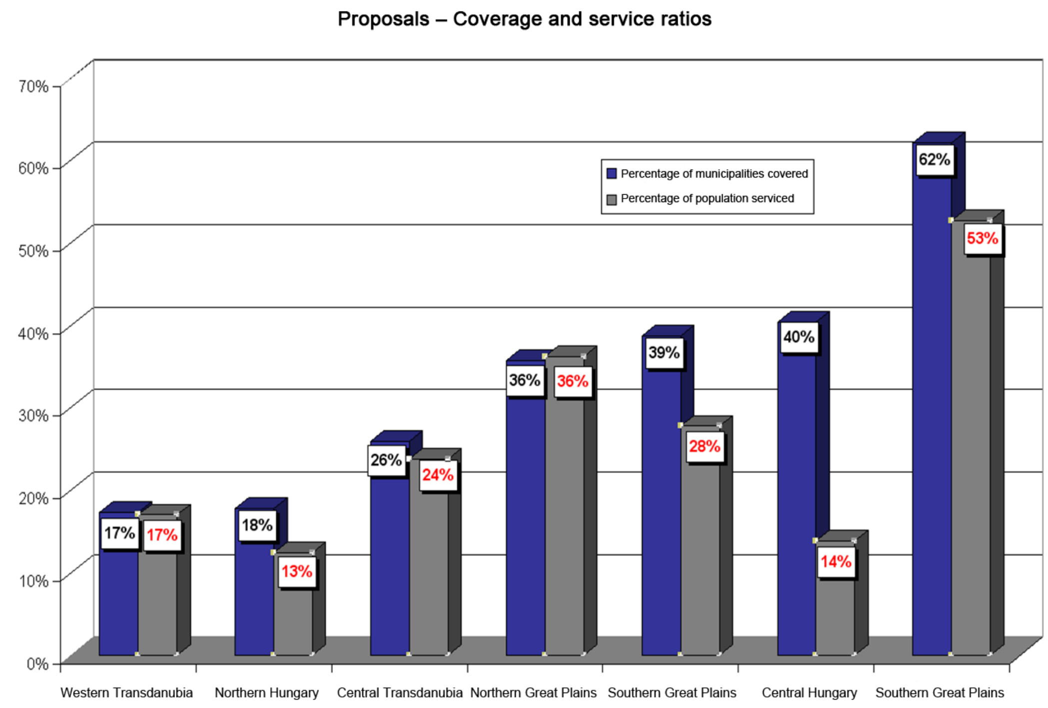
Source: Gergely Kis, Ph.D. dissertation, 2010

As explained earlier, the map on the left could not yet reflect the impact of the GOP 3.1.1 projects shown in red on the right-hand-side map. The subregions marked in blue, however, have a clearly visible overlap with the gray and green subregions on the left-side map. What this shows is that the state-aided basic infrastructure investments are not only able to counteract the slower development in the ICT availability in the relatively more slowly developing subregions (and their utilization) but they can even catalyze them, resulting in faster development than the rest.

However, there is another vantage point from which the locations where these proposals are implemented deserve a look. If we superimposed a terrain layer over the two maps above, it would be readily apparent that the proposals are mostly implemented in flat areas, where the terrain is easy. In these locations implementation was possible in a more economical way (in wooded, hilly areas construction is more difficult and hence costlier). For example, areas in the Zala hill country, where the basic ICT infrastructure is quite poor, have remained underserved precisely for this reason.

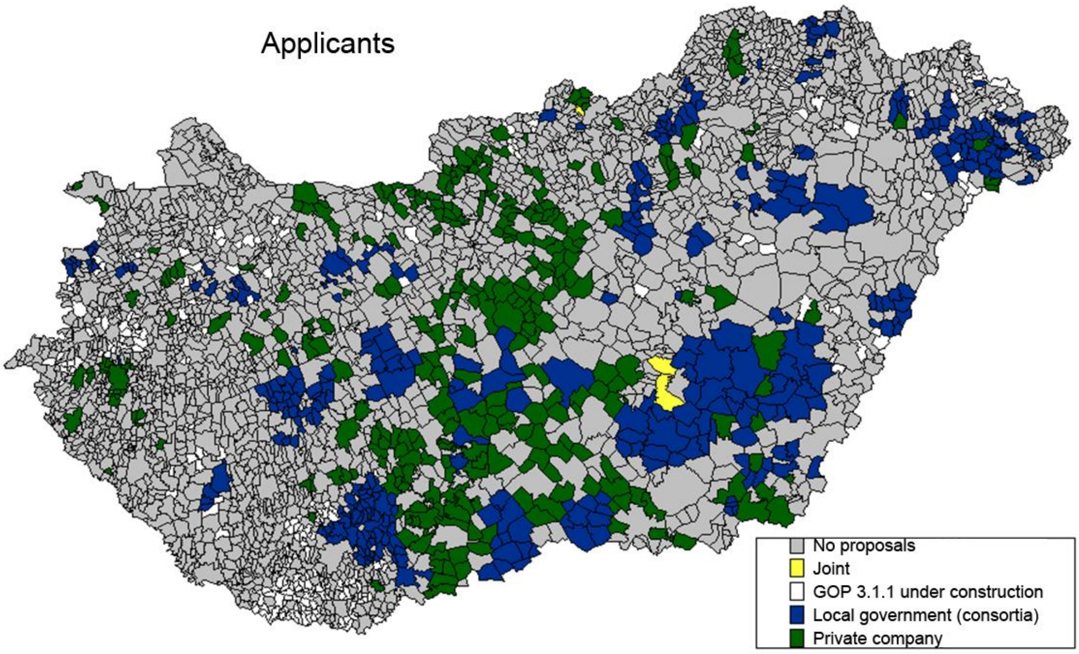
The coverage and service ratios in the proposals also reflect conspicuous differences between various parts of the country.

FIGURE 32. PROPOSALS – COVERAGE AND SERVICE RATIOS



Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

FIGURE 33. GEOGRAPHICAL LOCATION BASED ON APPLICANT TYPES



Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

The only aspect of the original RFP that is clearly reflected in the network development (modernization) efforts of the business sector is the increase in the number of households serviced. The intent of increasing coverage by lowering the number of underdeveloped, less lucrative municipalities was not part of the main focus. Most of the development projects are clustered along the Danube in the central part of Hungary, an area of the country that is not underdeveloped.

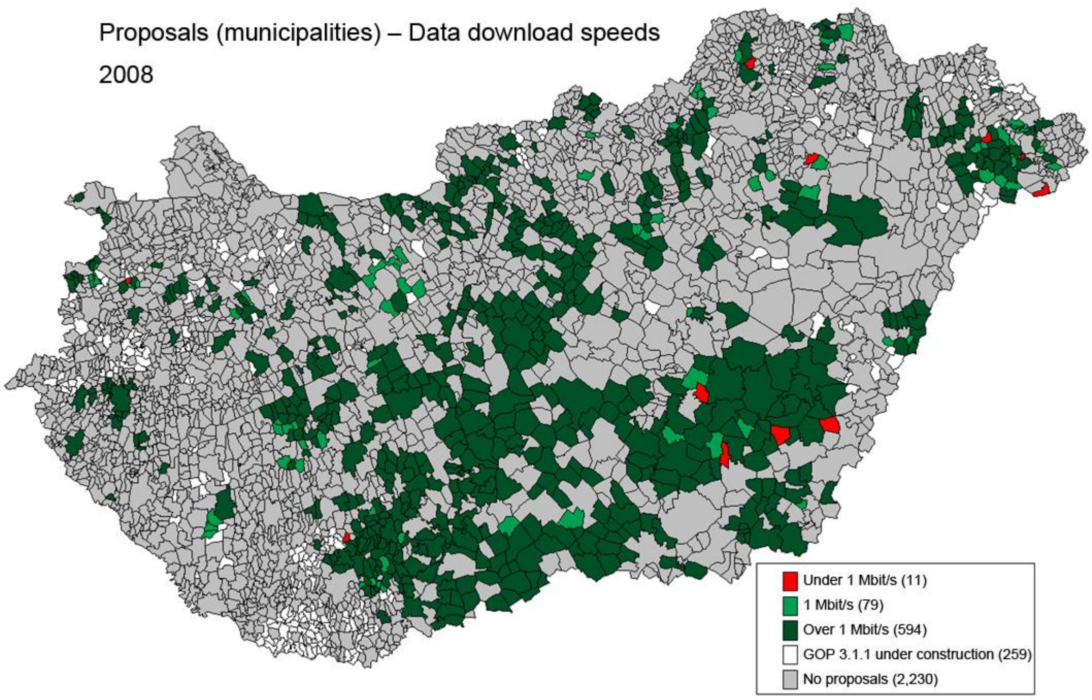
Local governments (and their consortia), including the municipalities in the scope of the GOP 3.1.1 program under construction, however, are clearly targeting municipalities or clusters thereof which fulfill the requirements of the program's RFP.

Data download speed

In the majority of the networks built or modernized under the programs (594), the nominal data download speed reflects an actual service level of over 1 Mb/s. Only 11 municipalities have access speeds under 1 Mb/s. The broadband access speeds under 1 Mb/s are features of networks in local government ownership, with one exception.

The majority of local government-owned networks are examples of wired broadband (HFC or purely coaxial) infrastructure. The network no longer limits data transfer speeds, but the capacity of the wide area network can be a significant limiting factor. This fact underscores the conclusion I described in chapter V.1. as a paradoxical situation.

FIGURE 34. PROPOSALS (MUNICIPALITIES) – DATA DOWNLOAD SPEEDS (2008)

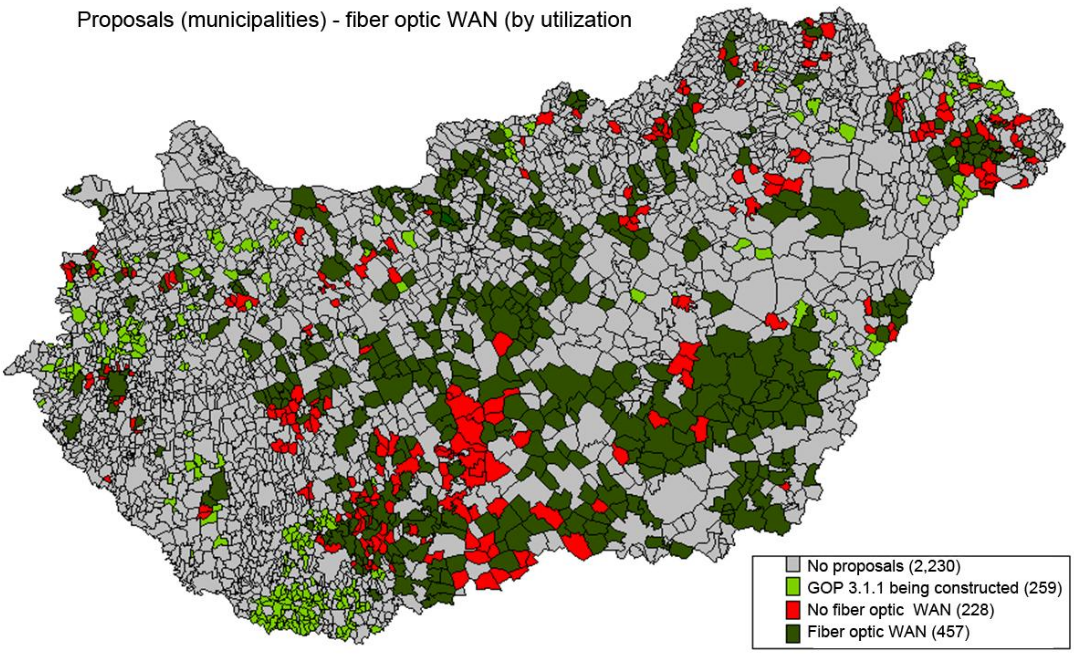


Source: *Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister*

Wide area network on a fiber optic medium

The subject of the next map is not fiber optic coverage, but the geographic location of fiber optic connections aggregating the traffic of access networks and used for broadband Internet access. The map does not reflect network connections that have access points at the given municipality, but are not used for broadband access (not purposed for telecommunication). In addition, fiber optic connective capacities accessed through coaxial connections in HFC (broadband CATV) networks are also excluded. In these areas fiber optic coverage may be somewhat more favorable as fiber optics are not necessary between municipalities within switch network distance (quality service is still possible). Needless to say, demand for higher bandwidth dictated by technological development (e.g., VOD services) may force the restructuring of the networks sooner or later, meaning that the fiber optic cable will have to get closer to the subscriber. But in this sense the map is a good indicator of the municipalities where a next step of development is unavoidable. In the absence of a high-bandwidth, high-capacity wide area network, the access networks built under the programs can easily end up becoming isolated. Conversely, the utilization of the existing capacities can be limited by the high prices of aggregated access.

FIGURE 35. PROPOSALS (MUNICIPALITIES) – FIBER OPTIC WIDE AREA NETWORK



Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

Based on the above (as of May 2009) 48% of Hungary's municipalities has access to a fiber optic wide area network. (As GOP 3.1.1 is completed, another 150-200 municipalities are expected to be connected.)

Technology-based competition between service providers

Technology-based competition between service providers expresses the relationship in a given municipality among service providers with a network infrastructure of their own (and/or network owners). In Hungary, technology-based competition is led by xDSL, which has nearly 100% PSTN network coverage but only 82% broadband coverage, at 85% (which exceeds the national average).

Some 50% of all municipalities have cable modem and WLAN access, while 28.6% offer all three technologies (May 2009).

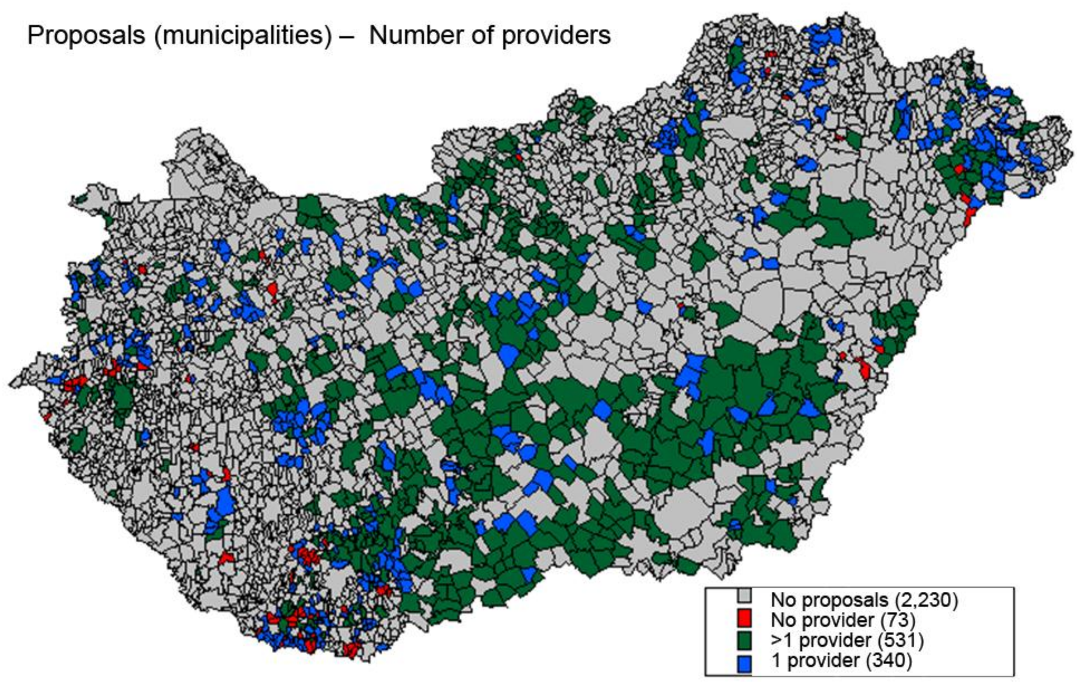
TABLE 16. USED TECHNOLOGIES IN ACCESS NETWORKS

Technology	**xDSL**	**Cable modem**	**WLAN**	**Cable modem+WLAN+xDSL**
Municipalities	740	432	441	249
Percentage	85.0%	49.6%	50.6%	28.6%

Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

This ratio is reflected by the following map, which shows the competition between service providers on a territorial level. There is actual competition in more than half (56%) of all municipalities (including those with ongoing GOP 3.1.1 development projects).

FIGURE 36. PROPOSALS (MUNICIPALITIES) – NUMBER OF PROVIDERS



Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

However, I must point out one aspect of infrastructure-based competition in the analysis: unfortunately, the HFC networks of the GVOP programs will not really be suitable to be used by other service providers, should this demand be raised in the wake of eventual new regulations aimed at boosting competition. This is because the new fiber optic networks are laid in 12-fiber layouts. Most of the time, the signal carried by the fibers is analogous (i.e., radio frequency signals are modulated with light – which is not compatible on an IP basis), and typically one pair of fiber strands is used in each municipality. That means that even if 12 optical fiber strands enter a municipality (and this is the least unfavorable situation), then a pair of fibers is separated in the internal network, with the remaining 10 continuing on to the next municipality, and so on. This is clearly a tree structure, meaning that if the fiber optics laid down were to be used for other purposes as well, then a significant technological shift would also be necessary. As a consequence, although the affected municipalities have seen a high quality access network constructed using community resources, when unbundled, this network is unsuitable for the one purpose it was constructed for: broadband Internet access. The prices of aggregate access are high, and the local governments are finding it hard to find providers willing to provide services in the financially unattractive areas.

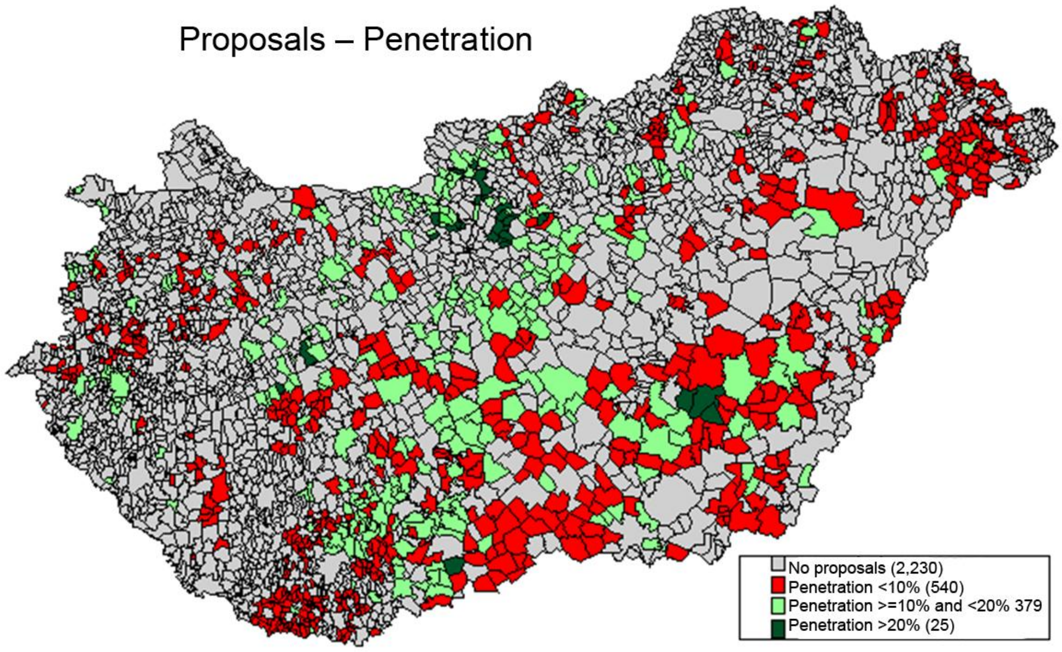
Of course, the HFC networks have been developed since 2007 (using their own funds), and most are now two-way, and therefore capable of offering Internet service, but the problem illustrates how the original community program meant to boost broadband Internet access has morphed into a privately owned cable television network development project.

Penetration (meeting commitments)

The most obvious difference between winning and losing proposals is in the penetration commitment data. Proposals forecast average penetration rates of 14% and 37% in one and five years, respectively. Rejected proposals planned to have 10% penetration within a year on average, while accepted ones averaged 18%. In a five-year timeframe, rejected proposals projected 34% penetration while approved ones showed 39%. Considering domestic and international data, it seems difficult to meet even the more modest 10% penetration rate proposed for the first year by those rejected. From an analytical perspective, the 18% average penetration target of the winning bids appears *ambitious*. The available data show that the more successful proposals were those which projected higher penetration indicators both in the short and the medium term. This is a clear consequence of the point system used to evaluate proposals. At the same time, there was no mechanism to check unrealistically high commitments (e.g., by looking at effective demand or existing service provider experience). Successful proposals made commitments between 18% and 39%.

The data clearly indicate that the penetration commitments in the winning bids were not based on realistic calculations. Given that the majority of municipalities have not just one, but two or three competing broadband technologies, as few as 25 municipalities registered penetration rates above 20% in 2008. This would reflect a meager 3.6% fulfillment rate for the commitments made in the proposals.

FIGURE 37. PROPOSALS – PENETRATION



Source: Based on data from the Ministry of Informatics and Telecommunications, the Ministry of Economy and Transport and the Office of the Prime Minister

A number of shortcomings were unearthed during the follow-up evaluation of the proposals. I have alluded to this earlier, but I will emphasize it again: there were no exact data about Hungary's broadband infrastructure for the programs prior to GOP

3.1.1, and no best practices were available regarding the way to introduce state aid. The first such survey[98] was completed just before the GOP 3.1.1 program was launched. It targeted terminal points (purposely forgoing reports by service providers) in order to see which of the 3,152 NUTS5-level municipalities had available broadband access (defined as 256 Kb/s in the download direction and 64 Kb/s for upload). The survey provided a good background for setting up the GOP 3.1.1 program, but it became clear that providing broadband coverage and maintaining competition would likely be hampered by a very significant problem: the substantial shortcomings of the wide area network will substantially limit future infrastructure development projects. This research result was the first to lead to preparations for the planned, but ultimately unrealized GOP 3.1.2 program, and the birth of the National Digital Utility concept, whose implementation was also beyond the reach of the political leadership at the time. At the same time, resolving the problem is also a task for the new government formed in 2010, which will likely attempt to manage it in the framework of a program called National Network.

Summary of the investigations of the H_5 hypothesis

The results of the government interventions indicate that the programs failed to separate efforts to develop wide area networks and access networks, instead mostly attempting to answer political calls for "finally, broadband Internet access for all." The infrastructure development program with the greatest impact was GVOP 4.4.2. It led to broadband coverage in some form for 378 municipalities, and this was the only program where the infrastructure created theoretically remained in community ownership. However, vendors employed tricks under this program as well: sections constructed with public funds were connected to privately owned segments (rendering them inoperable on their own), and in many cases the local governments have made secret agreements with the vendors ensuring that the network would become the property of the operator in some form, once the maintenance period mandated by the state aid program expires.

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[98] Done by GKIeNET, with me as a participant in the research.

GVOP 4.4.2 was the only program with the objective of keeping network segments built with community funds in community ownership, but owing to the reasons above, most of them can practically be considered privately owned networks as well. Considering the number of municipalities in Hungary, all publicly funded programs had a small impact on the entirety of Hungary's digital telecommunication network. At the same time, some Hungarian-owned businesses (such as PR Telekom, Tarr, Opticon) were able to increase their customer base and expand their infrastructure substantially.

Based on the above I consider it proven that in the course of the five state-aided infrastructure development programs implemented in Hungary by 2009, economic policymakers relegated community-based or community-owned digital telecommunication infrastructure to a heavily limited, stopgap role in impact and extent– and consequently I declare the H_5 hypothesis proven and accepted.

In the final part of the dissertation I will be examining wholesale activity in Hungary in order to explore and evaluate the effects of wholesale regulation in the current liberalized telecommunication market environment. In this part of the analysis I have been driven not by a desire to criticize the work of the regulators but by a wish to record events and showcase critical areas.

IX. ANALYSIS OF HUNGARY'S WHOLESALE BROADBAND MARKET

IX.1. Wholesale broadband services and the regulatory framework

Technologies suitable for broadband services vary greatly in terms of the wholesale services they are capable of supporting and in their regulatory patterns. There are well-known and viable wholesale models in the realm of fixed-line infrastructure based on network sharing and unbundling. No such models surfaced in the practice of wireless infrastructure, even though the technical conditions theoretically allow for network sharing[99] at higher levels of the network hierarchy (feasibility at lower levels is currently questionable from a business point of view).

From a regulatory standpoint the goal of wholesale regulation is to achieve sustainable competition. Sustainable competition means that ensuring competition does not require additional specific regulatory intervention. In practice, competition among services is currently considered sustainable if it is infrastructure-based. In this case, services provided through various networks create perfect (even if not micro-economically 'sterile') competition.

Competition among networks can be fostered by a system of mandated service provisions called for by the regulatory framework. This is associated with the investment ladder theory[100] in the regulatory framework, which entails that the provision of various access services involving different investment levels is beneficial for new market entrants. 'Higher-level' access services involving lower investment costs basically support new market entrants and help them acquire new clients.

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[99] Technically, wireless infrastructure can be shared almost the same way as fixed-line infrastructure. To achieve this, active devices need to be made capable of sharing, just like in the case of the fixed-line network, where the capacities of active devices form the basis of bitstream access sharing. The physical medium (Layer 0) cannot be shared, therefore access in the form of loop unbundling (or equivalent thereto) is impossible, because it is not supported by RF technologies.

[100] The investment ladder theory will be presented in more detail in the description of the domestic wholesale broadband market.

The construction of alternative infrastructure can be fostered by migration from higher-level access points to access services at lower-level access points closer to subscribers.[101] Utilization of the latter, lower-level access services requires a more considerable network (owned or leased) on the side of the new market entrant (in order to reach lower-level access points), requiring service providers to reproduce, build, or at least obtain a (long-term) lease for network infrastructure elements necessary for managing the service value chain.

This reasoning, i.e. the provision of wholesale services based on network access (rather that solely resale activity) makes particular sense with respect to fixed-line networks, as the construction of alternative network sections is ruled out in the case of wireless networks due to frequency constraints.

In analyzing the wholesale market, it is important to see its development in the past, because this is what defines the interpretation and reference of the term 'market.'

IX.1.1. Development of the wholesale broadband market

Hungary's wholesale broadband market developed parallel to the retail xDSL market – in 2001 the Communication Authority, exercising its right to license services based on the Communication Act, approved the service license of the largest fixed-line operator Matáv Rt. (currently Magyar Telekom Nyrt.) on the condition that it would implement xDSL services in the form of wholesale services as well.

It should be noted with respect to the development leading to this decision that independent Internet service providers (ISPs) played a key role in the growth of Internet services, in particular dial-up services (provided via the 'traditional' telephone exchange network). First, Internet services were not launched by phone service providers (but by an independent ISP), and second, the prices of Internet

[101] Needless to say, whether service providers entering the market are interested in migrating from a "higher" access level service to a "lower" access level service depends on the conditions under which wholesale services built upon one another are offered, price being the foremost concern. Another key condition of migration is for the service provider entering the market by utilizing higher-level services to accumulate a critical mass of customers which then makes it a rational decision to make the investment in network construction needed to utilize the lower access level.

connectivity declined gradually in response to the constant pressure from these independent service providers in the second half of the 90s, with operators continuously offering new discounts. The regulatory decision of 2001 regarding the mandatory provision of wholesale ADSL services was not independent of these prior developments; had it not been for wholesale DSL services, these independent Internet service providers would have easily been driven out of the Internet market.

At the same time, cable service providers were not required by either the Communications Authority or its successor, the National Communications Authority (so far) to provide wholesale services. The decision of the Communications Authority, which seems relatively one-sided in retrospect, could be attributed to the fact that cable networks at that time were less developed than today (linear bus networks, old cables with different resistance, duplexing in rudimentary stages), and there was no dominant operator among cable service providers that was potentially capable of achieving wide-scale coverage for providing broadband services in the way Magyar Telekom was in the case of traditional copper-based networks.

The National Communications Authority was established at the same time when the European regulatory framework was adopted (2004). The strict obligations dictated to what was then Matáv by the Communication Authority, based on the EU guidelines in effect at the time, were only applicable to service providers with Significant Market Power (SMP) identified within the framework of a market analysis process.

Based on the 'Market analysis recommendation' as part of the European regulatory framework mentioned earlier, the so-called ex ante regulation is applicable to the wholesale market of broadband services, as it is included in the lit of digital communication markets recommended for market analysis (Nemzeti Hírközlési Hatóság, 2005). In practice this means that the regulator is required to complete a market analyses procedure in case of these services, consisting of three major parts:

- On the one hand, it has to decide (based largely on micro-economic principles, particularly on substitution considerations) which services belong to the market in question, and

- it has to state whether there is a service provider with significant market power (SMP) in that market (a provider that can perform its business activities more or less independently from its buyers.
- In case there is an SMP provider in the market, the regulator has to make a decision whether the competition law is sufficient to handle to identified competition problem, and if the answer is no, it has to determine what kind of potential competition problems are caused by the SMP status, and which ex ante (i.e. preliminary) requirements should be enforced with respect to the service provider in question in an effort to promote competition.

Broadband services via cable networks (CATV/HFC) were not included in the affected market by either the market analysis of the National Communications Authority, or other EU member state authorities or the market analysis declaration approved ("notified") by the EU Commission. According to the Commission,

- the fact that wholesale broadband services (bitstream access services[102]) are never offered over cable networks,
- and the assumption that even if the bitstream access service is theoretically viable it may not be justifiable from the standpoint of competition law as a reasonable substitution for users[103]

indicates that the two services are not interchangeable, therefore cable-based broadband services cannot be considered parts of the market in question. This explanation was sufficient for the EU Commission, but we can hardly agree with it.

In addition, substitution cannot be justified due to the technical and economic conditions of the switch between the two types of bitstream access services (as assumed by the Commission). Even though a large number of member state

102 Definition of bitstream access: a two-way, digital high-speed network service, in the course of which the mandated service provider ensures for the entitled service provider full or shared access to the transmission capacity of its active network facilities.

103 For instance, in case of a 5-10 percent permanent increase in the prices of DSL bitstream access service in a hypothetical monopolistic test, entitled service providers using DSL bitstream access would switch to cable-based bitstream access services.

authorities, particularly where cable penetration is significant (e.g. Holland and the United Kingdom), identified cable modem-based broadband networks as parts of the wholesale market, the EU Commission did not approve of it based on two sets of arguments: the effect of the indirect pricing constraint on the wholesale market resulting from the competition between retail services provided over the two different networks (CRA International, 2006), and the documents analyzing the technical feasibility of bitstream access services available via cable networks.

Basically, based on the approach of the EU Commission, opening up a cable network to competitors in line with the ex ante regulation had been out of the question up until very recently; furthermore, the authorities of member states had practically no say in this matter. During the course of the market analysis, the EU Commission consistently refused to allow national regulators to include cable modem services in their definition of wholesale market.

Hungary's regulations followed the European regulatory framework and legislation practices; broadband services via cable networks at the wholesale level were not parts of the market in question in either the first or the second market analysis procedure of the National Communications Authority. At the same time, the regulator took the cable-based broadband connections into consideration when assessing significant market power, primarily due to the substitutability by the retail market.

IX.1.2. First case of mandating cable bitstream access services

In a surprising step in light of the prior developments, NITA, the Danish regulatory authority, imposed mandatory bitstream access provision on a cable service provider owned by the incumbent phone operator in a decision approved by the EU Commission as well in 2008. However, even in this case the Commission refused to identify the bitstream access services to be implemented on cable networks as part of the affected market due to issues of substitutability. At the same time, it called the mandate proportional, and approved the guidelines of NITA, which claims that if mandatory access provision did not apply to cable networks owned by the incumbent, the incumbent would have an interest in developing cable networks, making it impossible for entitled service providers to take advantage of competitive access services.

At the same time, the Commission left the question open in numerous comment letters whether cable connections can be substituted at the wholesale level. In addition, it pointed out to the Danish authority that the pricing of cable bitstream access services required attention: does it really allow entitled service providers to provide retail services with a viable business model? The Commission accepted (for the first time in this decision) the technical feasibility of the provision of cable bitstream access services.

The decision, and particularly the approval of the Commission will likely have a strong impact on future market analyses in Europe. On the one hand, the theoretical perspective is considerable: considering the harmonization of obligations within the ERG, a framework in which cable networks are exempt from any obligations (especially cable service providers owned by the incumbents) is not acceptable unless there is further explanation (i.e. detailed analyses). On the other hand, if cable-based wholesale bitstream access services prove to be viable in the Danish market following this decision and entitled providers take advantage of them, it may shed light on the actual substitutability of this technology for the bitstream access services of DSL networks from the perspective of entitled service providers. Consequently, this may (or based on my expectations should) question the rather empty argument that the Commission used to refuse the wholesale substitutability of services provided via cable networks, therefore cable networks would be included in the market subject to regulations. As a result of the market analysis it is possible[104] that there will be cable networks whose operators will be obliged to share their infrastructure. When using access services, it is important for entitled providers to have access to wide area network, because making access services available over cable networks will give a further boost to competition.

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[104] The worst 'possible' was used intentionally instead of 'likely.' Just because cable service providers are parts of a market does not mean that they are owned by a SMP providers.

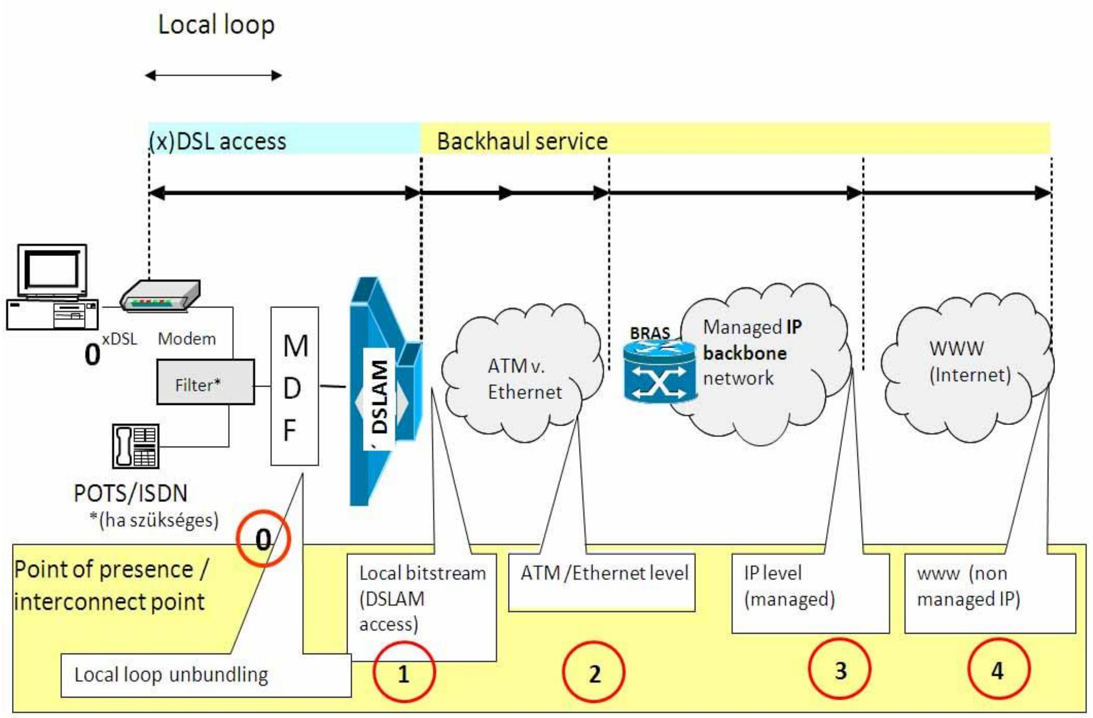
IX.2. The domestic wholesale broadband market

The domestic wholesale broadband market currently refers to network access services provided on the DSL value chain. An entitled competitor can enter the market at three levels of the DSL value chain in Hungary, and these three levels reflect three different access services:

1. unbundled access to the local loop,
2. local bitstream access, and
3. nationwide IP bitstream access.

The figure below illustrates the three types of access levels within the value chain of DSL broadband services and in the network hierarchy.

FIGURE 38. BROADBAND INVESTMENT STEPS – TECHNICAL FEASIBILITY IN DSL NETWORKS



Source: On the basis of ERG and the National Communications Authority's decision DH-23398-31/2007 (see page 85 of the decision)

The positive numbers in red circles indicate the levels of bitstream access. '0' refers to the unbundling access to the local loop, which is the lowest level of the value chain, in which case the owner of the network provides no network-related services except infrastructure leasing. In the domestic regulatory framework, levels ’0,’ ’1,’ and ’3’ are available and regulated; levels ’0’ and ’1’ are subject to cost-based price control, while retail minus pricing applies to level ’3’ (wholesale pricing derived from retail prices).

It is important to note that, as set forth in appendix 2. of the already mentioned decision on SMPs in the wholesale market (DH-23398-31/2007)[105], similar network sharing can also be implemented in cable modem networks. There is a way of sharing networks that allows access to those entitled at the "end"[106] of the access portion of the network, and there exist two additional, higher level network access points that may be considered wholesale services that follow the logic of the investment ladder and are based on one another.

The relationship between the access levels and the investment levels needed by the entitled service provider in order to be able to take advantage of the given service can be seen from the diagram above, but the one below shows it even more clearly. The most important lesson from the diagram is that while taking advantage of nationwide IP bitstream access does not require the ownership (or at least long-term leasing) of an extensive proprietary network, the other products may.

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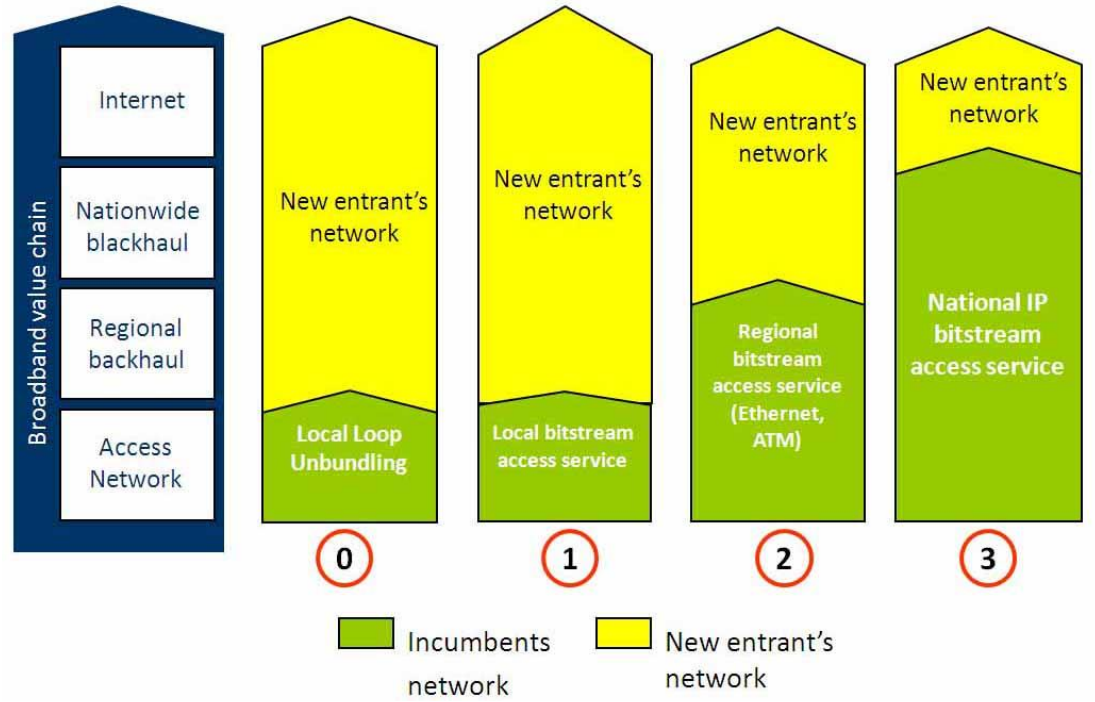
[105] See p. 102 of the decision.

[106] Cable modem termination system access – or CMTS access.

FIGURE 39. INVESTMENT LADDER FOR BROADBAND DSL SERVICE, NETWORK SHARING



Source: on the basis of ERG and the National Communications Authority's decision DH-23398-31/2007

In Hungary, access to the market of DSL services was possible at levels 0, 1 and 3 as of mid-2010.

Based on the regulatory environment surveyed above, I am formulating my last hypothesis based on my investigations of the wholesale market:

H_6: In Hungary's wholesale-level broadband market the existing regulatory instruments in themselves (and so far) have not created the opportunity for entitled service providers to acquire a significant retail-level subscriber base of their own by taking advantage of wholesale-level services (such as local loop unbundling), which are significant for sustainable competition but presuppose a more extensive network than the ones the entitled subscribers have.

There could be three reasons behind the statement in the hypothesis:

1. existing regulation has not forced it,

2. under the existing rules it did not arise,
3. existing regulation prevented it from happening.

In order to investigate the hypothesis, the Hungarian wholesale-level broadband market must be compared with those in the other member states of the European Union, showing the differences and revealing the reasons behind the differences (discrepancies).

IX.3. Investigation of the H_6 hypothesis

IX.3.1. Methodology

In the first part of the analysis I will show which investment levels are operational in the case of the DSL market, and I will compare the xDSL subscription data collected by the National Communications Authority for COCOM with the corresponding international data series. Next, I will investigate in detail the markets of the individual wholesale services, with special emphasis on the markets for local loop unbundling and local bitstream access. In this case the methodology requires the analysis of secondary data. Most often the data reflect the status at the end of 2008, because that was the latest I was able to collect for the purposes of the research, but this is not a problem for the research: the xDSL market clearly started stagnating in the summer of 2008, indicating that the wholesale market conditions have been largely unchanged.

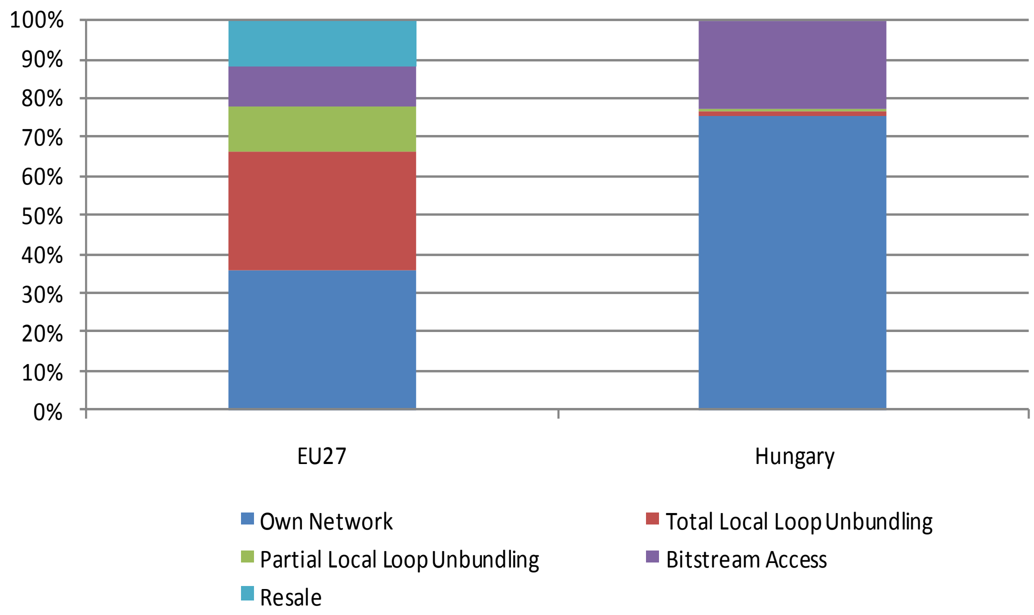
In the second half of the investigation I prepared 10 in-depth interviews with executives of Internet service providers, in order to learn about their wholesale prices. Currently there is no public information or statistical database about these prices in Hungary, and it was important to find out about the market conditions, with the buyers of these services being the primary source of information. In this case, therefore, I chose the qualitative research method (in the form of non-structured in-depth interviews).

IX.3.2. Results of the investigation

Based on the investment ladder, only Level 3 works in Hungary, even though local loop unbundling (a part of the RUO) has also occurred. In a later section, however, I will make it clear that even this has taken place in a geographically highly concentrated manner.

Among regulated access services, it is basically the least infrastructure-intensive bitstream access that the peer providers use. The utilization of local loop unbundling products by wholesale partners, which would be more important for sustainable competition, is conspicuously low in international comparison.

FIGURE 40. TYPES OF DSL SUBSCRIPTIONS AT THE END OF Q2 2008



Source: National Communications Authority (COCOM)

All of this also indicates that the regulatory instruments in themselves failed (until the middle of 2008) to create the opportunity for entitled service providers to acquire a significant retail-level subscriber base of their own by taking advantage of wholesale-level services (such as local loop unbundling), which are significant for sustainable competition but presuppose a more extensive network than the ones the entitled subscribers have.

One possible, but probably just apparent reason behind this is the high cable broadband penetration in Hungary, which makes market entry less attractive. At the same time, the latter statement is contradicted by the fact that independent ISPs have acquired a significant retail customer base through nationwide IP-level bitstream access, which indicates that market entry is nonetheless attractive to several dozen independent Internet service providers.

Until the economic recession hit in 2008, the service providers have mentioned at several consultations held by the National Telecommunication Authority that as Internet service providers having attained a critical mass of subscribers, they would be happy to take over local loops, but they were unable to reach the vast majority of access points, and that they did not encounter competing providers in the market for the necessary infrastructure. As a result, they were unable to lease, at a competitive price, network segments that would have enabled them to reach the desired location and establish points of presence.

Analysis of the nationwide IP bitstream access market

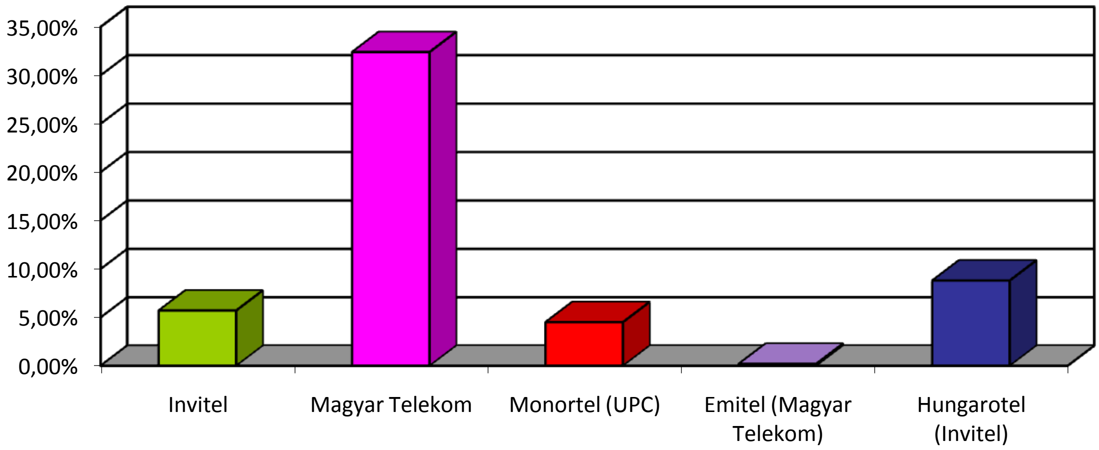
Of all the access services, this one assumes the least extensive network infrastructure being at the disposal of the entitled providers, and as such, it is much more an instrument promoting service-based competition than a wholesale entry point encouraging infrastructure-based competition.

Of course, in an indirect way, this access service can also promote infrastructure-based competition, because the only service providers that can seriously be expected to take over large volumes of local loops are the ones that have already acquired a significant subscriber base by taking advantage of the higher-level access services.

Although there are no significant barriers to market entry in the course of using this service, the data still show extremely great variance in the utilization of this service by entitled providers in the service areas[107] of the five providers identified as SMPs in the first and second rounds of market analysis by the regulators.

[107] These five service areas are five distinct geographical markets coinciding with the service areas for which the five providers had landline telephone service concessions.

FIGURE 41. IP BITSTREAM ACCESS SHARE OF ENTITLED PROVIDERS WITHIN THE DSL MARKETS IN THE FORMER CONCESSION AREAS OF THE SMP SERVICE PROVIDERS AT THE END OF 2007



Source: Based on National Communications Authority data

The data indicate that regulation had significant successes in service-based competition in the largest part of the country (making up some 80% of the total area) that used to be subject to concessions, but that there is essentially only token competition in the service areas of the smaller providers. These conclusions are supported not just by the static data collected at the end of 2007, but also by the dynamics of the market shares. In several cases among the smaller providers, the shares of the entitled ISPs have been stagnating or continuously declining.

The underlying reasons often have to do with economies of scale. It is generally not cost effective for the Internet service providers to develop a separate product for the smaller areas, even though this is what the varying wholesale prices of the individual geographic markets require. There are fewer entitled ISPs in the smaller geographic markets (the geographic market with the fewest service providers is the smallest one: the Monor area, with two ISPs in addition to the incumbent, but with Magyar Telekom being practically the only one providing services). Often the only reason a provider is present in a small geographic market is one of prestige: to be able to claim full nationwide service.

Regional bitstream access services

In many European countries regional bitstream access is required by regulators. In the already discussed diagram displaying the investment ladder of broadband services and its technical implementation, Level 2 (ATM, Ethernet or equivalent access) and Level 3 (IP level) are the access levels where regional access points can be defined.

In the current Hungarian regulatory framework there is no regional bitstream access service. In the course of the national-level consultations accompanying the market analysis of the wholesale market there were no requests by the entitled service providers for this type of service in either the first or the second round of market analysis. Accordingly, we do not even really know where exactly in the networks of the Hungarian providers the access points for such a service could be established, nor is it clear what the appropriate price would be, or indeed whether in the Hungarian environment such a price would allow a sufficient price differential for the entitled providers, if only economic considerations were allowed. The situation is further exacerbated by the significant differences between the network sizes and structures and service portfolios of the three providers with significant market power: Magyar Telekom, Invitel and UPC (Monortel).

As next generation networks (NGN) and particularly next generation access networks (NGA) are spreading, the availability of currently regulated access services or equivalent access services become uncertain, and in some cases their technical feasibility comes into question. Accordingly, bitstream access services become are expected to become even more important as NGN and NGA continue spreading. As I have shown in the investigation of the H_3 hypothesis, various legal frameworks have been established throughout Europe in order to regulate sharing the NGA infrastructure but, for instance, the type of local access on the NGN/NGA networks is still unclear. At the end of 2008 the main points of the proposed regulation (the recommendations) were summarized by Márton Illyés of the National Telecommunication Authority as follows:

1. **Substructure sharing**

Recommendation:

- If the Level 4 market has an SMP, then the following must/should be mandated;
- A regulated reference offer similar to the LLU needs to be prepared (within 6 months after the mandate is issued);
- Price regulations are needed. Concrete details of the price regulations should also be defined;
- Incentives for shared construction of new network components (using cost sharing).

Directives:

- Separately enumerated among the symmetrical requirements (Framework directive, article 12).

Practice[108]*:*

- France, Spain (2008), Germany (2007): SPM mandate;
- Portugal: legal mandate;
- Denmark: industry agreement;
- Italy: business agreement with action by the competition authority.

2. **New access products**

For FTTH (fiber to the home):

- The regulator must find the point where access to the local fiber is possible (ODF – optical distribution frame);
- LLU reference offer must be extended to fiber optics as well;
- Mandatory access to indoor wiring (if owned by the telecommunication provider).

[108] This was contained in the table presented in the investigation of the H_3 hypothesis.

FTTN (fiber to the node)

- sub loop unbundling (SLU) at the street cabinets;
- point of presence at the street cabinets;
- wholesale-level products in the access network (dark fiber, leased line, etc.).

Bitstream access

- In this respect, NGN does not equal a "new" market per definition. It must make it possible to reproduce new types of services;
- Geographic segmentation (at the level of market definition or mandates) is possible (Illyés, 2008).

Demand for bitstream access services that are higher than local level (which means some type of regional level) may also be boosted by the spread of IPTV services. Given the current access services and network infrastructure, entitled providers cannot provide IPTV service under technologically and economically appropriate conditions. Using local access services (local loop unbundling, local bitstream access) it would be technically possible to provide IPTV service, but the sufficiently numerous and geographically concentrated subscriber base, with the underlying local loop unbundling is not available to any entitled service provider. Technologically, there is the theoretical possibility of providing IPTV service through nationwide IP bitstream access, but if we assume that there is a single nationwide interconnect point, as is the case with the current service, it is not clear that the project would be financially reasonable and technologically efficient.[109]

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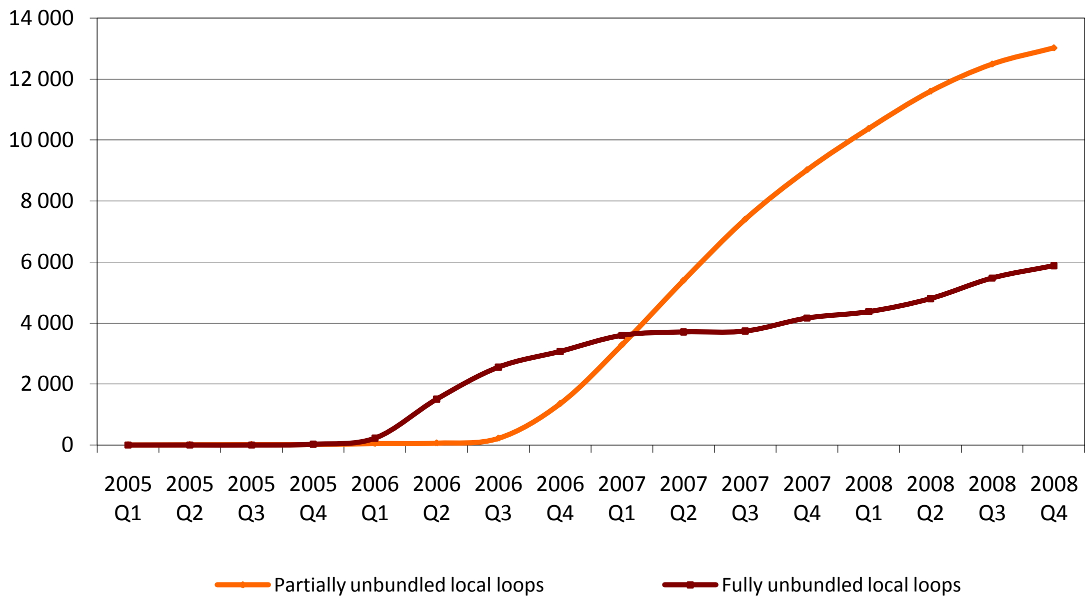
[109] IPTV multicast assumes IP capability. An incumbent with multicast IP capability, or, given an IP "cloud," a wholesale client at the national interconnect points (an ISP with IPTV service capability) takes up only as much MPEG stream bandwidth on the wholesale service provider's network as is proportional to the number of total channels it offers. At the same time, in the current Hungarian "environment" it is not economically reasonable to offer IPTV service over nationwide bitstream access (whose basic demand on the incumbent is to provide the technical background for moving "traditional," non-multicast IP traffic, and is priced accordingly). Accordingly, it would be unfair to mandate the SMP providers to do that. Nowhere in the world is there an IPTV over bitstream mandate for the time being, particularly not on a nationwide basis, with a single interconnect point. Accordingly, a more realistic regulatory scenario would be to introduce a re-sale mandate, but even that is in dispute currently.

Consequently we can say that there will be future demand for bitstream access service that is at a higher-than-local level and enables IPTV service among others.

Local loop unbundling and local bitstream access market

The domestic local loop unbundling market is at a nascent stage currently, and this does not necessarily mean that it has a future of development in front of it. In fact, as I have mentioned before, the earlier development essentially stopped in 2008 and gave way to massive stagnation. HFC and FTTH developments as well as fast-spreading mobile Internet services are hindering local loop unbundling.

FIGURE 42. KEY DATA ABOUT HUNGARY'S LOCAL LOOP UNBUNDLING MARKET (2005-2008, UNITS)



Source: Based on National Communications Authority data

Unbundled local loops are very heavily concentrated geographically. An analysis of the three service providers that are offering local loop unbundling (Magyar Telekom, UPC (Monortel), Invitel) shows that the only provider actually providing the service to an appreciable degree is Magyar Telekom. In Invitel's area there were only a few dozen full unbundling transactions, and the number of unbundled loops varied, meaning there were loops whose unbundling was reverted (either because the client canceled the service or because the entitled service provider returned it to the mandated one). UPC (Monortel) had no (fully or partially) unbundled loops as of the end of Q1 2009.

TABLE 17. NUMBER OF UNBUNDLED LOCAL LOOPS AT MANDATED SERVICE PROVIDERS, 2006-2009

	2006 Q1	2007 Q1	2008 Q1	2009 Q1
Magyar Telekom full	39	3 215	10 340	13 229
Magyar Telekom partial	226	3 596	4 372	6 377
Invitel full	8	66	37	29
Invitel partial	0	0	0	0
UPC (Monortel) full	0	0	0	0
UPC (Monortel) partial	0	0	0	0

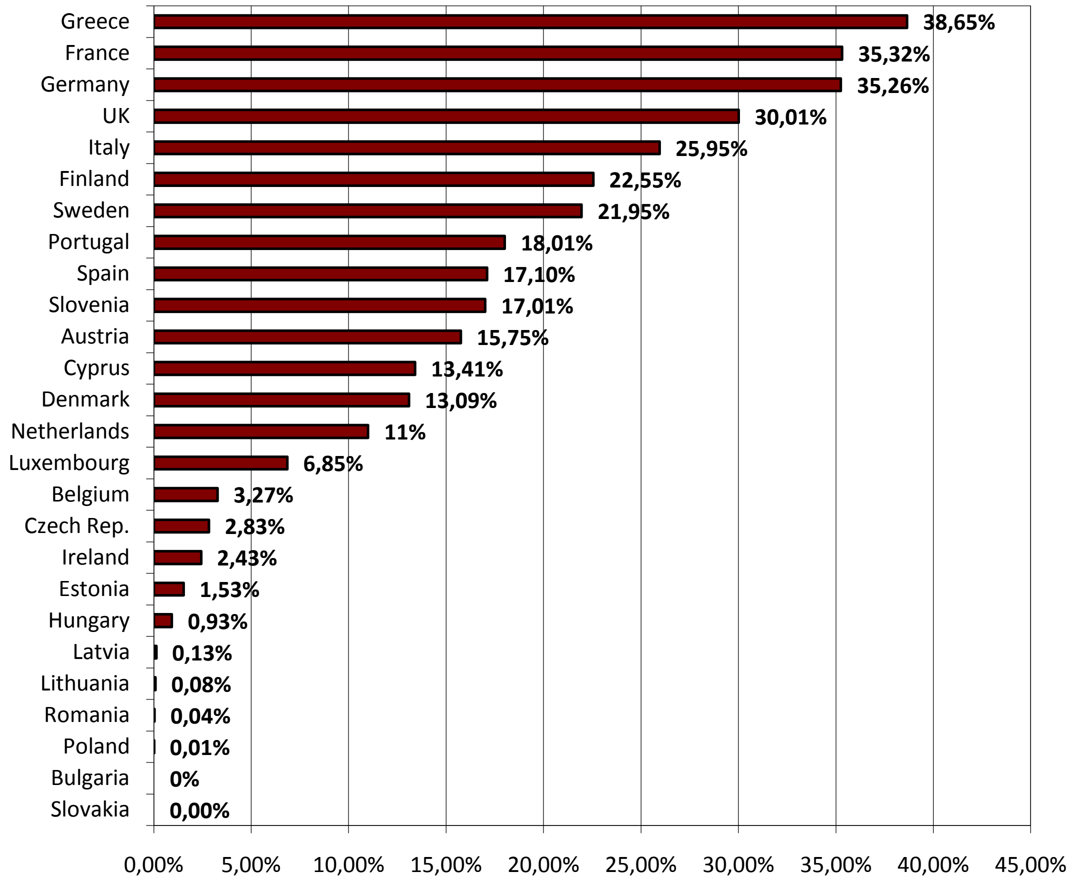
Source: National Communications Authority

Consequently, local loop unbundling can be considered the least successful regulatory instrument in the Hungarian regulatory framework, although from the point of view of sustainable competition, it is still the most important regulatory instrument.

The percentage of unbundled local loops among all broadband subscriptions is below one percent in Hungary, similarly to other East European countries. The September, 2008 ECTA Broadband Scorecard indicates that similarly low – or even lower – rates were measured in only six EU member states.[110]

[110] Note: No local loop unbundling data were available for Malta, so that country is not part of this analysis as a point of reference.

FIGURE 43. LOOP UNBUNDLING COMPARED WITH THE NUMBER OF SUBSCRIBER TERMINALS (SEPTEMBER 2008)



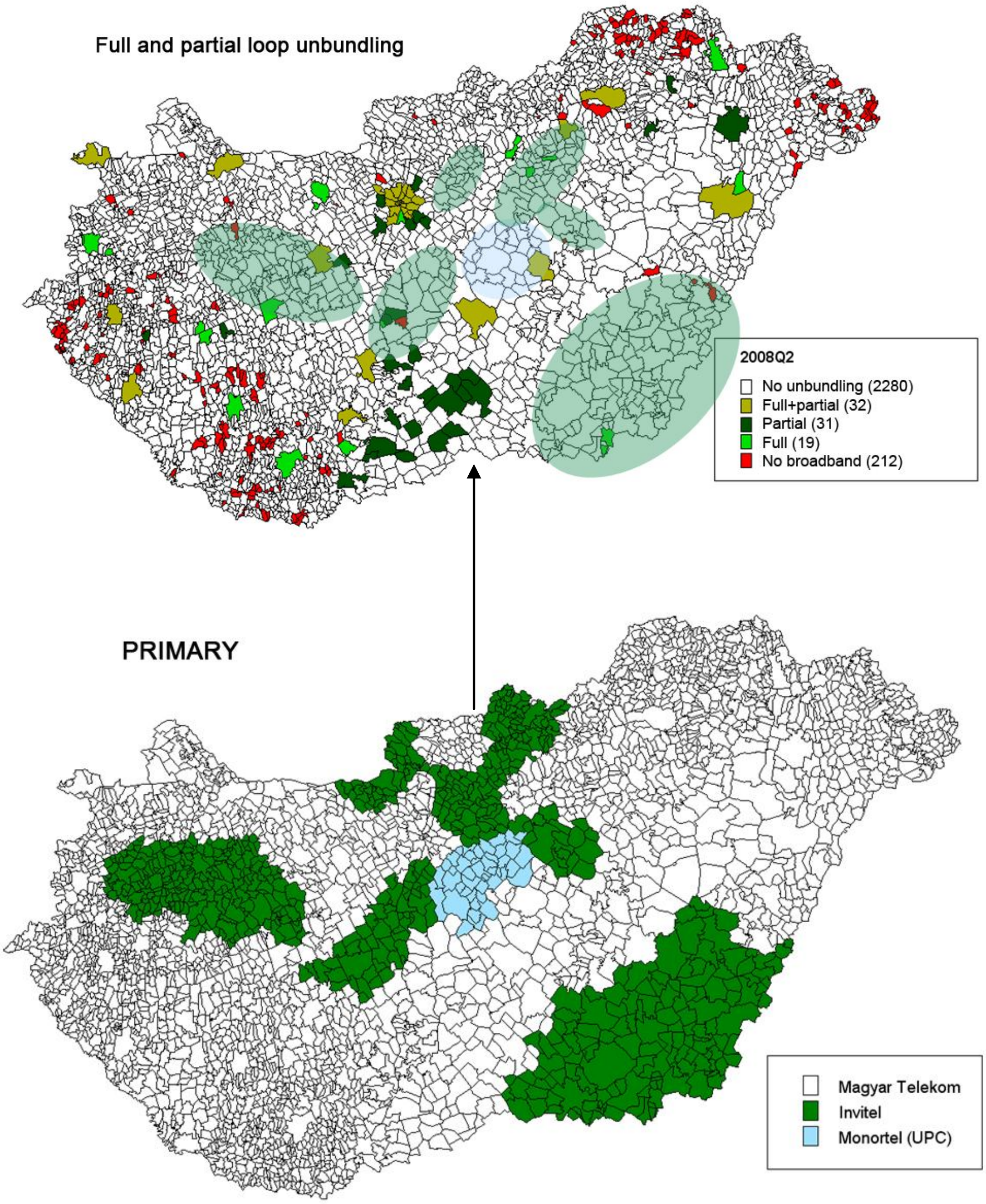
Source: ECTA Broadband Scorecard, 2008 Q3

The conspicuously low percentage is partially due to the history of regulation so far, which will be discussed further in a later section analyzing the reference unbundling offer (RUO). It bears mentioning again that, owing to the extensive broadband cable coverage, local loop unbundling is far from being the only competition-generating factor in Hungary's broadband market.

The above diagram lists a number of countries where cable penetration is also high (Austria, Netherlands, Portugal), but where local loop unbundling is nonetheless significant, compared to the number of service termination points (respectively 15.7%, 11% and 18%). What this shows is that high cable penetration does not, in itself, discourage investors from spending on local loop unbundling.

In Hungary there was no partial local loop unbundling at all in the service areas of Invitel and UPC (Monortel) as of 2008 Q2, total local loop unbundling was practically unnoticeable as well: entitled service providers did not take over any local loops in the area serviced by UPC (Monortel), while the number of fully unbundled local loops with Magyar Telekom and Invitel was low (34 at the end of the first half of 2008).

FIGURE 44. FULL AND PARTIAL LOOP UNBUNDLING



Source: Based on National Communications Authority and GKIeNET data

Investors in the local loop unbundling market face a significant risk because the largest incumbent service provider, Magyar Telekom, has started new generation network development. As NGN/NGA developments gain ground, the system of current network access points will likely change, which will probably impact most sharply the service providers involved in "traditional" local loop unbundling.

The role of MDFs[111] (main distribution frames) aggregating traditional copper pair based local access sections will lose importance in new generation networks. To be more precise, there will be a device with a similar logical function (as I have suggested, ODF – optical distribution frame – may be one such device, depending on the actual realization of the network), but its location and quantity will not necessarily (or probably) be the same as those of MDFs. This implies two things:

1. Service providers that have become part of more than one MDF (accepting the significant setup costs) may find themselves in a situations where NGN/NGA development has gone ahead and the incumbent service provider has migrated potential customers accessible from the given point of presence to an access network with a much more advanced technology. As a result, these service providers are forced to compete against the incumbent's advanced services with services that can be rendered using traditional copper pairs (basically by taking over abandoned local loops).
2. In addition, and not independently of the first point, their one-time investments in order to establish a point of presence in the course of local loop unbundling may lose their value. This is reinforced by the fact that the NGA development target area of the incumbent is essentially the same as the range of customers targeted by entitled providers in the course of local loop unbundling: due to economies of scale, both market actors will focus on the more densely populated, more affluent areas of large cities, where the population has good purchasing power.

[111] See the diagram showing the investment ladder for broadband networks and its technical feasibility.

Consequently, when it comes to regulating competition in the broadband market, it is far from inconsequential how (and how effectively) mandated access is implemented on the freshly constructed new generation networks.

Magyar Telecom's NGN/NGA development plans that are in the implementation stage involve GPON (Gigabit Passive Optical Network) technology. GPON is probably cheaper than point-to-point Ethernet, the other widespread NGA technology, but the cost difference is under 10%. Point-to-point Ethernet is easier to develop and it is easier to make it capable of offering higher-bandwidth services than GPON, meaning it is more "futureproof."

If a service provider opts for GPON in its next generation network development strategy, then either it believes that medium-term demand for bandwidth will only grow to the extent that this technology will be able to satisfy it, or (and) the motivation (in part) is that with GPON opportunities to share network resources are very limited, and in fact the equivalent of the current local loop unbundling is not even feasible with GPON networks.

That said, many incumbent providers around the world believe that bandwidth requirements for as far ahead as the next ten years can be fulfilled with GPON technology, and so the lower costs in themselves justify the use of GPON in developments. It is particularly in Europe and North America that service providers are opting for GPON. In this environment the role of networks independent of the incumbent is becoming more important for ensuring broadband competition.

Analysis of the reference unbundling offer RUO for local loop unbundling

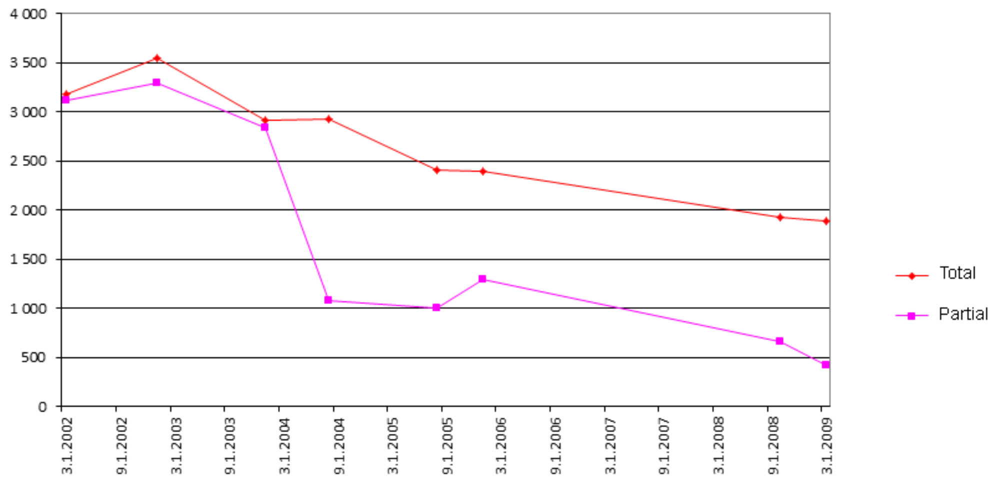
As I have mentioned, local loop unbundling is probably the most important (active) regulatory instrument in ex ante regulation for infrastructure-based competition that is sustainable on the long term. On the other hand, this also means that it is precisely this regulatory mandate, and its implementation that is the most detrimental to the SMP service providers. Accordingly, the conditions under which this mandate is implemented have a huge impact on whether the regulation is successful. It appears that the incumbent providers have long been successful in protecting their interests through the application of these details.

I have also shown that the local loop unbundling mandate in Hungary has been perhaps the least successful regulatory instrument so far. In this sub-chapter I will briefly analyze the reasons for this lack of success, and I will also look into the role of wide area networks in local loop unbundling.

Prices

Hungary's local loop unbundling mandate for incumbent phone service providers has been in place since 2002. This is when the first reference unbundling offers were made. For a long time the monthly fee for partial loop unbundling was almost the same as the fee for total unbundling (which is strange in comparison to today's cost calculation methodology). When the entitled providers opt for partial unbundling, they can offer broadband services, while the landline phone service is still provided by the incumbent provider.

FIGURE 45. PARTIAL AND TOTAL LOOP UNBUNDLING FEES OF MAGYAR TELEKOM 2002-2009

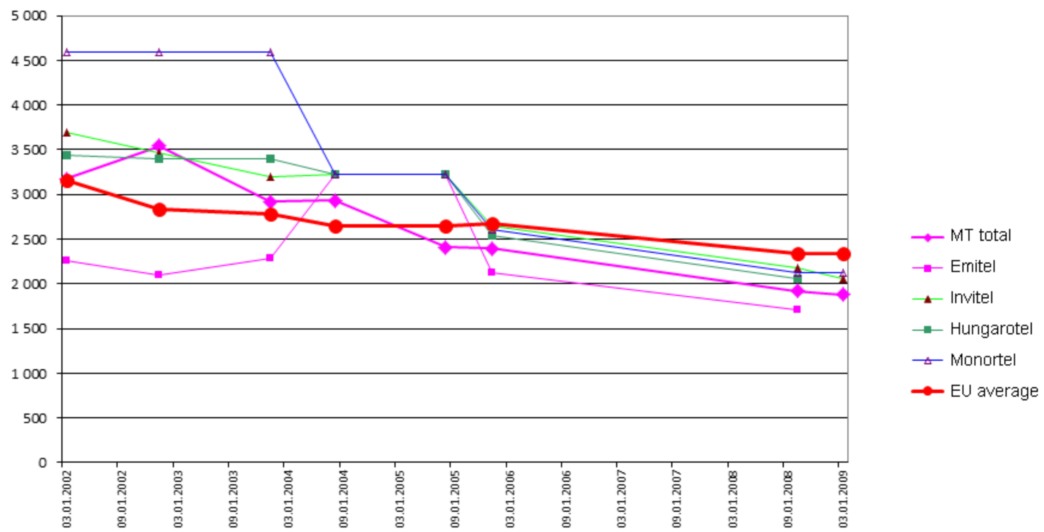


Source: National Communication Authority (COCOM)

As seen in the diagram above, displaying the wholesale prices for local loop unbundling by the biggest mandated provider, Magyar Telekom, the prices of partial and total local loop unbundling were nearly identical until the fourth reference unbundling offer was approved in August 2004. Entitled Internet service providers (ISPs) that wanted to compete only in the broadband market found that the monthly fee for wholesale-level input and its extent relative to other relevant wholesale services (total unbundling, IP bitstream access) made any business model based on partial unbundling outright unviable, even though the prices charged for broadband service were much higher in that period than they are now.

Until August 2004 there were significant differences between the monthly fees for local loop unbundling charged by different former holders of concessions. The highest local loop unbundling fees occurred at the smallest former incumbent provider, Monortel. The monthly fees of this provider were more than twice as high as the wholesale prices of Emitel, the SMP provider with the lowest fees. (In 2008 Emitel no longer existed, not even in name. The name of the owner Magyar Telekom superceded the brand as well.)

FIGURE 46. LOCAL LOOP UNBUNDLING FEES (TOTAL UNBUNDLING) 2002-2009



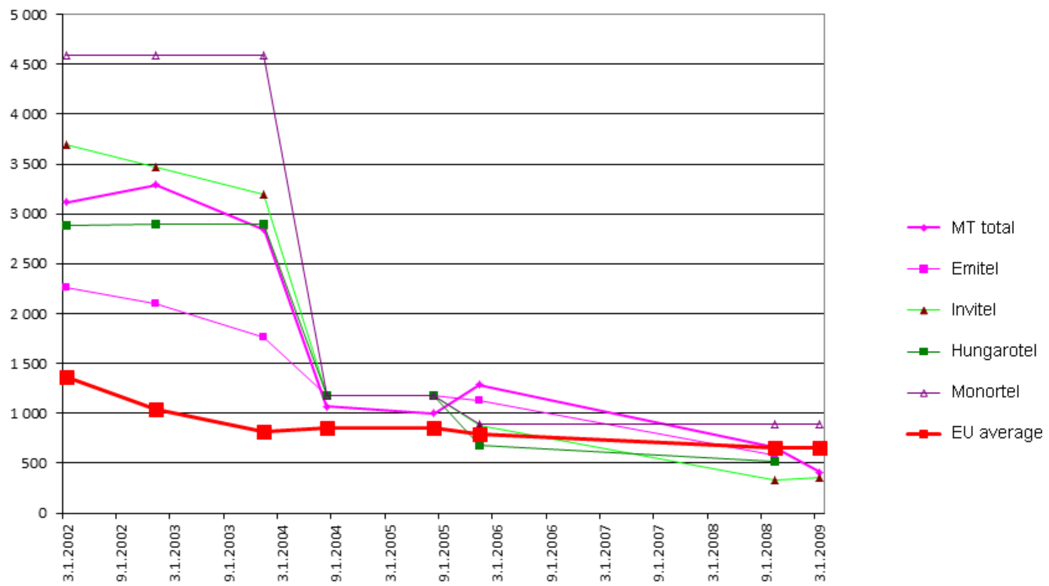
Source: National Communication Authority (COCOM)

This geographical difference is particularly interesting given that in the service area of UPC (Monortel) the utilization of nationwide bitstream access service, analyzed in section 3, is also very low, and there is practically no cable Internet service provider. Based on these, it is clear that competition is the least intense in the service area of UPC (Monortel): there is practically no competition.

The difference between local loop unbundling prices was quite significant among SMP service providers until August 2004, meaning that the conditions of unbundling services varied greatly geographically. At the same time, the diagram above also indicates that, starting in mid-2004, Hungarian monthly regulated prices did not meaningfully exceed average regulated prices in the EU[112], and from 2006 onward, the domestic regulated prices have been below the EU average, while the significant geographical differences have disappeared as well.

Similar statements can be made about the prices of partial local loop unbundling services.

FIGURE 47. LOCAL LOOP UNBUNDLING FEES (PARTIAL UNBUNDLING) 2002-2009



Source: National Communication Authority (COCOM)

In the period up to August 2004 there were very significant differences between the various service providers in the monthly fees for partial unbundling services. Domestic regulated prices also significantly exceeded the EU average. From 2004 onward, the difference between the monthly fees of SMP service providers diminished, but the monthly fees still exceeded the EU average until 2006. Starting

112 The sources for fees charged in the member states of the European Union are the so-called Implementation Reports, which monitor (typically with a once-a-year frequency) the implementation of the New Regulatory Framework introduced in the Union. The reports are available at http://ec.europa.eu/information_society/policy/ecomm/library/communications_reports/index_en.htm (retrieved January 3, 2010)

in 2008, as the LRIC[113] cost accounting model was adopted, prices fell further, however the monthly fee charged by UPC (Monortel) was still more than twice as high as those of both Invitel and Magyar Telecom as recently as in 2009.

The history of Hungarian local loop unbundling services shows that the significant price differences prevailing until August 2004 did not lead to geographic inequalities: there was no actual total or partial local loop unbundling until mid-2005. At the same time, a comparison with average European prices reveals that (at least in the past five years) the reason behind the dearth of local loop unbundlings was not the high price of these services.

In addition to the monthly fees, there were also a number of price components in the domestic regulatory framework that made it practically impossible to base a working business model on local loop unbundling.

Among the auxiliary services, perhaps the most significant, and for a long time mandatory, service price component was the loop assessment fee, which was 37,644 forints for Magyar Telekom customers. Auxiliary services are different from one country to the next, and so are their prices, but there is probably no price component of comparable magnitude, representing such a large additional cost to entitled service providers in the regulatory practices of the more developed countries.

Non-price conditions

In analyzing the prices I have mentioned that the failure of the Hungarian local loop unbundling market was probably not, or not entirely caused by the price-type conditions in the reference unbundling offer.

Practical conditions for taking advantage of the unbundling service

The practical conditions of local loop unbundling, of the unbundling process, have often made it effectively impossible for the entitled providers to take over local loops. These conditions mostly pertain to the actual timing of the unbundling, damages payable by the mandated provider in the event of a failure to meet deadlines, quality standards to be met by the entitled providers, expected technical

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[113] Long-Run Incremental Costing.

conditions and to a ban on reselling the unbundled services.[114] What made it particularly cumbersome to fix these practical problems in Hungary's regulatory framework was that for a long time in the prevailing interpretation of the law the entitled providers were not considered clients, and so their objections did not need to be taken into account formally.

The European Regulators Group (ERG) published an ERG Report in 2007 on regulatory best practices regarding local loop unbundling. The report emphasized several non-price regulatory instruments that had not been part of the Hungarian regulatory practice, such as:

- stipulations requiring that migration between various wholesale access products be allowed,
- key performance indicators for the wholesale service provided by the mandated party,
- implementing service level agreements (ERG, 2008).

Several of the requirements listed in the ERG Report were adopted into the text of the mandate during the second market analysis. Their practical implementation, enforcement and inspection could have influenced the development of the local loop unbundling service.

Network access to the points of presence

As I have indicated earlier, the prices and non-price factors in the Hungarian regulatory framework of local loop unbundling services have made it practically impossible for the market to function. There were much more favorable conditions in the reference unbundling offers approved in 2006, but particularly in the mandate contained in the second market analysis decision and in the subsequent new reference unbundling offers approved in 2008 and revised in 2009 in the wake of the mergers among the mandated providers (Magyar Telekom-Emitel, Invitel-

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[114] Entitled service providers can significantly cut their unit costs by reselling the unbundled service, as this makes it possible to split the initial setup costs among several entitled providers.

Hungarotel). The market was resurrected, but it is still very underdeveloped in comparison to the rest of Europe, as I have shown earlier.

In addition to the new regulations primarily applied to the SMP providers of the local loop unbundling market, the functioning of the market is also hampered by another factor, which is not strictly part of regulating the given wholesale market. Specifically, network access to PoPs needed for the unbundling of the local loops poses a significant practical problem to the entitled providers outside the capital and perhaps some major county seats. The problem is that the points of presence shown in the reference offer are typically only reachable through the mandated provider's own network, and the other providers' networks need substantial development efforts in order to create a realistic alternative. Needless to say, there are exceptions, particularly the local exchanges in Budapest, but this problem is a real one even in major cities outside the capital. Accordingly the entitled providers are forced to obtain network access from the mandated provider, typically through some leased line. Entitled providers report that they are typically charged a high price for this, and the transaction is generally unregulated. Given this price, setting up a PoP (and thereby unbundling the local loop) is not a viable option, even if the entitled provider already has a fair number of broadband subscribers in the affected service area (the area covered by the given MDF), typically through nationwide bitstream access provided by the mandated provider. [115]

The dismantling of the access networks based on local loop unbundling is already underway. Theoretically, the problem could have been handled using regulatory instruments as well, particularly through the more detailed (geographically based) segmentation of the trunk segment of the leased line market,[116] or more generally,

[115] In other words, the entitled provider can't migrate its customers from the higher access level of IP bitstream access to the lower, wholesale access level through local loop unbundling. The importance of standard procedures in the context of this migration has already been mentioned.

[116] As I have mentioned in the discussion of the H_4 hypothesis, ex ante regulation of this area (at least in the European practice) tends to focus on leased lines, and even there, SMP designations only exist in the wholesale-level leased line termination segment, even though wholesale provider peers find other services through the trunk network (such as infrastructure unbundling, dark fiber market) at least as important.

through the inclusion of the trunk network segments in ex ante regulation and the further rationalization of the rules governing PoPs, thereby radically lowering the cost of establishing them.

The market analysis decision about the leased line trunk segment market still in effect in 2010 declares the market to be nationwide and finds that there are no providers with significant market power. The data collection that preceded the analysis did not involve collecting data much beyond the "macro level." It is clear that the market probably has a significant number of trunk segments where there is only one market actor capable of providing service, and therefore is sure to be dominant. If the ex ante regulation were to identify the incumbent provider as having significant market power in these geographic submarkets of the trunk segment market then the appropriate mandates (such as cost-based pricing) could improve the situation of the entitled providers, which in turn could theoretically have a positive effect on the local loop unbundling market as well.

At the same time leased line services are very heterogenous, and so it is much more difficult to put geographically-based segmentation into practice and to justify the segmentation of the markets than in other markets (like broadband, for example). (Strictly speaking, in theory individual leased line destinations could be treated as separate markets.)

On the basis of the recommendation of the European Commission regarding markets where ex ante regulation is applicable,[117] the leased line trunk segment market is not among the markets requiring (automatic) analysis. The practical consequence (according to the text of the directive implementing the recommendation in Hungary) is that the Hungarian regulator does not have to perform a new market analysis procedure if previously it did not identify significant market powers in the given market earlier.

[117] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:344:0065:01:HU:HTML. Retrieved October 28, 2009.

At the same time, the Explanatory Note[118] for the recommendation emphasizes, with respect to the leased line trunk segment market, that this market may have a large number of low capacity segments where only one provider has a network, and new market entrants cannot be expected to generate the appropriate amount of competition against the incumbent over the entire service are, even in the medium term. In discussing these situations, the document points out that in cases like that, the national regulators must make a decision on whether or not the leased line trunk segment market, or at least one portion thereof (as described above) should be considered an impacted market. The decision must be based on the three criteria[119] determining the applicability of ex ante regulation. The text of the document suggests that if the number of leased line trunk segments in the country is high, then the given dominant position probably cannot be addressed using ex post instruments of competition law, and so ex ante regulation may be warranted.

The conclusion is that the introduction of ex ante regulation in this market would probably be justified in some (likely numerous) trunk segments, but there is little chance of it actually happening. Today, in municipalities with modem cable TV network access, xDSL-based broadband access, and consequently, local loop unbundling have lost a lot of its significance in the market, and so the actual impact of the (otherwise desirable) regulatory reform is difficult to calculate.

The development of wide area networks also deserves special attention because it allows the offering of substitutable services competing against the incumbent's network service and thereby increasing the supply of services on the trunk network segments so important for providers interested in local loop unbundling. In this case, wide area network development may count as a "gray zone" (from a state aid

[118] http://ec.europa.eu/information_society/policy/ecomm/doc/implementation_enforcement/article_7/sec_2007_1483_2.pdf. Retrieved October 28, 2009

[119] The three criteria for applicability: 1. the given market has high and non-transitory barriers to entry, 2. the given market does not tend towards effective competition, 3. the possible dominance of the market by an actor cannot be addressed by ex post instruments of competition law.

point of view), since network segments overlapping the incumbent's wide area network may (also) be built.

Wholesale prices of interlocational connections

In theory, the way to collect data from service providers in the wholesale sector is by making a trial purchase, an option that was not open to me, owing to my background.[120] Theoretical alternatives included asking cable and Internet service providers over the phone or to collect data in interviews. After the first few phone calls it became clear that without personal connections, essentially cold calling, I was not going to get anyone to talk to me openly about the pricing of wholesale offers received or accepted. The one remaining option was networking through "acquaintances"[121] who would then recommend me to their own acquaintances (snowball method). These recommendations allowed me to interview a total of four people, while another six were my own acquaintances. I assured the interviewees that that they would remain anonymous (several of them made it clear that they were divulging information that they did not want to appear with their names in any kind of summary). Based on the interviews, I have made the following determinations with a great deal of confidence, regarding the wholesale prices of interlocational networks in Hungary[122]:

- In 2009, between large cities, from PoP to PoP (trunk segment), Magyar Telekom typically offered leased lines with 100 Mb/s capacities at 110,000-140,000 Ft/month. The price, of course, could get relatively lower if the utilized bandwidth was increased, and it heavily depended on the location.

[120] Before they make an offer, companies want to identify the firm requesting a proposal and they want to know where they wish to take advantage of the service. The offer is tailored to the requestor, based on negotiations, considering individual aspects. For research purposes, involving a "friendly" service provider and using that firm's name may be a viable solution, but that was not appropriate for my dissertation.

[121] The field research did not involve structured in-depth interviews, given that all I wanted to find out was the market prices. Of the total of ten conversations that were meaningful for my research, eight took place on the phone, while another two involved in-person meetings.

[122] Since ten conversations are not statistically significant, I have accepted a statement if at least two interviewees mentioned it and no one of those asked later refuted it.

Invitel was mentioned as having prices that were 10-15% higher than MT's when large cities were involved, but again, the wholesalers' offer was highly dependent on the location.

- MVM typically offers 100 Mb/s leased lines at prices in the 100,000-300,000 forint range. At the same time, the company has a customer paying 250,000 Ft/month for 2 Mb/s, because the contract was made eight years ago, and nobody has bothered to renegotiate it since.
- Invitel does not even offer dark fiber leasing, practically (or if they do, do it at such a price that no business can pay). Typical West European dark fiber leasing prices are at 40 euros/fiber pair-kilometer; the minimum in Hungary is 30-40 thousand Ft/fiber pair-kilometer/month, but it can be double that, depending on the location.
- The typical range mentioned was 180,000-700,000 Ft/month for 100 Mb/s access, but the packages depend on the form in which the bandwidth is utilized at the retail level. Cable TV providers have their on PoPs, but if a retailer needs to rent a point of presence (about $4m^2$ of space to house the rack enclosures), the price is at least 100,000 forints, just for rent.
- The most expensive access, aside from the MVM case mentioned above, was quoted by one of the interviewees, who told about a cable provider in Sárvár, where the user leases 90 Mb/s at 700,000 Ft/month based on a 2008 contract.
- Each of the interviewees agreed that, given the current retail prices, it was not worth purchasing trunk capacity unless 100 Mb/s bandwidth was available at 100,000 forints, with the price of the PoP already included. There was some disagreement on prices among the interviewees: wholesalers claimed that even 200,000 forints was a reasonable price for 100 Mb/s, provided it was able to "hook up" a large number of subscribers relatively quickly. If it is necessary to rent space or to contribute to the price of installing the rack boxes, then the investment is no longer worth it. Claiming the latter (a scenario where the owner tells the provider seeking to establish a point of presence that there is

not enough room in the rack box and that the client should contribute to the cost of expansion) is one of the most typical ways of skirting wholesale regulations. The problem is basically an instance of information asymmetry, the central problem of principal-agent theory. This "is a result of the fact that the regulator knows less about the market than the regulated party" (Kiss, 2008).

Based on what the interviewees have said, the operator, itself a service provider, often exhausts the shared capacities of the infrastructure it possesses, or at least uses that statement as an excuse when called upon by a potential competitor.

Summary of the investigation of the H_6 hypothesis

In the investigation of the hypothesis it became clear that, in the period up to 2008, existing regulations have not created the opportunity for entitled service providers to acquire a significant retail-level subscriber base of their own by taking advantage of wholesale-level services (such as local loop unbundling), which are significant for sustainable competition but presuppose a more extensive network than the ones the entitled subscribers have. Incumbent providers circumvented the local loop unbundling requirements by using clever tricks (for example, by claiming that there was insufficient room in the rack boxes at the interconnection location, and therefore the party requesting the unbundling should contribute to the expansion costs[123]). The National Communications Authority, having faced a number of complaints, amended its regulations in 2009, but by that time the development of the xDSL market had basically ground to a halt. The authority likely set extremely high monthly fees in the pre-2008 versions of the MARUOs, thereby making business models untenable. The 2008 price correction was partly too late, and partly lacking a regulation of space sharing and the dark fiber market, contributing to the continued lack of attractiveness of the business model.

As a result of the investigation, I consider the H_6 hypothesis proven and I accept it.

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[123] This can cost as much as 1.5 million forints because the service providers insist on developing for at least ADSL2+ level services once they make an investment. Under these circumstances, however, air conditioning is necessary, which itself adds to the development costs.

X. SUMMARY – THE SIGNIFICANCE OF THE GOVERNMENT'S INVOLVEMENT IN BROADBAND INFRASTRUCTURE DEVELOPMENT IN HUNGARY

The central research question of my doctoral dissertation was to assess the status of community-funded broadband infrastructure investments in Hungary and the impact of government intervention in digital telecommunication network upgrades. In an effort to ensure a geographically more balanced digital telecommunication network development, I formulated six hypotheses, which proved to be correct in the course of the investigation. These theses could provide guidance for the design of pertinent government development concepts.

X.1. Summary of the results of the hypothesis testing

The ***first thesis*** revealed that geographical differentiation continued to intensify among subregions in the development of the Hungarian digital telecommunication network over the period between 2003 and 2008. Subregions developing at an above-average rate in terms of the comprehensive ICT availability index established for this study are generally in the Great Plains area as well as in Central Hungary, while those growing more slowly than the average tend to be in Northern Hungary and in Southern Transdanubia. Overall, the gap increased between the most and least developed subregions in terms of ICT availability. This regional imbalance should be tackled by a targeted ICT development policy aimed at boosting subregions that lag behind the average.

The ***second thesis*** demonstrated that the definition of broadband varies from country to country, and revealed that the principle of technology neutrality applied mandatorily in EU regulatory processes complicates government-funded infrastructure projects by counteracting the push for the universal use of fiber optic technology, the optimal long-term choice for WAN projects. It is primarily up to the EU policy makers to solve this problem, however, by keeping access network and wide area network upgrades apart, it is possible to define quality parameters that ensure that WANs are deployed using exclusively fiber optic technologies in the future. Although optical fiber cannot be considered technology neutral, it is the only up-to-date technology for aggregation network upgrades, and also the least subject to constraints due to limited financial resources. In certain categories and keeping proportionality in mind, projects for well-defined public purposes should be exempt from the principle of technology neutrality, for example to maintain public safety, to promote social or regional cohesion, or to foster competition, protecting the long-term interests of consumers. The research designed to test the second hypothesis also revealed that the conflict between the definition I applied and the principle was not the only source of controversy, as in many cases proposals resulted in technical solutions that would not stand the test of time: the lack of precise definitions regarding the principle of universal access and its mandatory adoption, which impedes legal enforcement[124], caused a bigger problem than the principle of neutrality itself. Contrary to the intended political objectives, public resources were used primarily for the construction of private networks.

The ***third thesis*** provides guidelines for development policy: in a liberalized communications market public resources allocated for digital telecommunication network infrastructure upgrades should only be used for WAN networks provided that the infrastructure to be constructed (1) is not an alternative system next to an existing network or (2) aims to alleviate the shortage of existing fiber capacities. In all other cases the only role of the government is to apply regulatory tools in the WAN market to foster competition. In the current EU recommendations (e.g. NGA) government intervention tools focus on the access network. Therefore, government intervention is considered desirable only in certain geographic areas under the following conditions:

1. Basic broadband is not yet available, and no broadband construction is planned by private investors for the near future[125].
2. A next generation access network is not available and not planned to be built or scheduled for operation in the near future.

[124] There had been no legal precedent for the enforcement of open access regulations by the time this dissertation was completed (September 2010).

[125] The term 'near future' refers to a three-year period.

3. A broadband access network is available but certain user groups fail to receive appropriate service, or the cost is not affordable due to the lack of competition, or the quality of the service is poor, with no improvement in sight.

The above prerequisites are indisputable, however, WANs are not systematically classified in a separate category, which is a big mistake in my opinion. EU directives provide no specific rules regarding the infrastructure- versus service-based competition among digital telecommunication networks; consequently, Hungarian policy makers are in charge of establishing the basic guidelines aimed at fostering competition and to create an appropriate regulatory environment in line with the directives of the EU. The thesis I formulate provides a framework for this process in the field of wide area networks.

a) Does the intervention have a well-defined objective of common interest, i.e., is the proposed aid aimed at alleviating market failure or is it aimed at achieving another objective?

b) Is the aid well designed to serve the objective of common interest? Do the following issues receive adequate consideration:

   i. Is government aid an appropriate policy instrument, or are there other, more efficient tools?

   ii. Does the aid have a stimulating effect, i.e. does it alter the behavior of businesses?

   iii. Is the subsidy measure proportional, i.e. could the same effect be achieved with less aid?

c) Are the distortions of competition and their effects on trade limited, ensuring an overall positive balance?

Currently there are no EU guidelines pertaining to government aid to support the construction of wide area networks, however, the European Union's aid approval practices include regional development programs simultaneously addressing WAN and access network investments. The analysis points out the key elements of the mandatory (functional) separation of the wholesale and retail segments relevant for regulatory authorities.

The ***fourth thesis*** underlines that if the government aims to stimulate infrastructure-based competition, its primary task is to ensure regulated access to wide area networks, which are essential infrastructure, in an effort to promote the development of ICT infrastructure. Given the high costs and extremely slow returns on investments, it makes no sense to augment the wide area network connecting municipalities by an alternative infrastructure: due to economic considerations, it is desirable to ensure that by providing access, WANs create competition among market participants. In my proposed plan I suggest that open access is a principle which allows the competition requirement to be met. The EU framework of regulatory instruments did not adopt the principle of open access as a standard that can be required by authorities. In line with the EU regulatory framework currently in effect, an authority can impose ex ante price control only on the wholesale prices of operators with significant market power in the market of terminating and trunk segments of leased lines. The National Communications Authority (NHH) has not identified any operators with significant market power (SMP) within the trunk segment, and with respect to a service provider identified as an SMP operator (Magyar Telecom), a 'retail minus' price control was implemented, which has not significantly facilitated the participation of other market players. In contrast to the prevalent regulatory practices in Hungary, the regulation of infrastructure leasing and other miscellaneous services provided through the trunk network, i.e. the dark fiber market, would be equally important for wholesale service partners. Unless market-driven wide area network deployment did reach all locations, public resources need to be used to roll out the basic infrastructure – in this case, ensuring open access is mandatory according to the regulatory principles of the EU. This framework will likely change as a result of the publication of the commission recommendation on regulated access to Next Generation Access Networks (NGA) in September, 2010, which opens the door to potential innovations in Hungary, as well.

The analysis supporting the ***fifth thesis*** proved that while approving a total of five government-funded broadband infrastructure development projects, economic policy makers envisioned a publicly operated digital telecommunication infrastructure that is extremely limited in both scope and effect, serving as a make-do solution. Up until 2009, economic policy makers refused to spend public resources on broadband infrastructure upgrades in a deregulated digital telecommunication market unless they assumed the lack of broadband Internet access in municipalities based on the NUTS5 (later LAU2) classification. Investments funded from public resources in an effort to make up for the shortage were aimed at providing broadband Internet access in municipalities where there was no private sector business case to deploy the necessary infrastructure. WAN and access network developments were not addressed separately in terms of development policy, consequently, policy makers tended to ignore the issue whether community-based operation would be desirable in certain areas of the digital telecommunication network. The study revealed that government-funded basic infrastructure investments can not only offset the slower growth of lagging subregions in terms of ICT availability (and usage), but they are able to even accelerate them, generating a faster growth compared with other subregions. However, upon completion, the newly deployed publicly funded access network in the locations under investigation was not suitable for the very purpose it was built for: broadband Internet access. The prices of aggregate access are high and unregulated owing to insufficient control by authorities; local governments struggle to find operators that are willing to provide services in less profitable areas. Cable television (HFC) networks built previously with community resources have been bootstrapped and advanced since 2007 (the majority of them became bi-directional, i.e. suitable for Internet services, as well); nevertheless, the problem demonstrates how a community program promoting broadband Internet access turned into a private cable network development project. We cannot afford this to happen again in the future.

Finally, the ***sixth thesis*** provided evidence that in Hungary's wholesale broadband market the regulatory tools alone have (so far) been insufficient to ensure that by taking advantage of wholesale services that require more extensive networks (e.g. by local loop unbundling), an essential factor for sustainable competition, local exchange carriers can build a significant retail subscriber base of their own. It is a major problem that the co-locations determined in the reference offers of incumbent service providers can typically be accessed exclusively by the incumbent's own network, with the networks of other service providers requiring significant upgrades to potentially provide reasonable alternatives. There are a few exceptions, though, especially local exchanges in Budapest, but the problem is prevalent even in major cities across the country. For the purpose of interconnection, alternative providers are required to request network access from incumbents, generally in the form of leased lines. Access seekers claim that the prices are set very high, and, as discussed earlier, price regulation is poor. Interconnecting – and taking advantage of the existing local loop – is generally not profitable at such a high price level, even if an operator already has a relatively large clientele of subscribers (basically by using the nationwide IP bitstream provided by the incumbent) in an exchange area serviced by a given MDF. Access networks built for loop sharing are currently being dismantled in Hungary. Theoretically, the problem could have also been addressed by regulatory tools, primarily by a more detailed (geographically focused) segmentation of the leased line trunk segments market, or, more generally, by the ex ante regulation of trunk segments, by rationalizing the collocation process and significantly cutting collocation costs. By now, the prevalence of xDSL-based broadband access has declined in locations with up-to-date cable TV networks, along with the importance of local loop unbundling; consequently, it is difficult to project the actual market results of the otherwise desirable regulatory reform.

In my opinion, all these factors are in need of changes.

X.2. Recent achievements

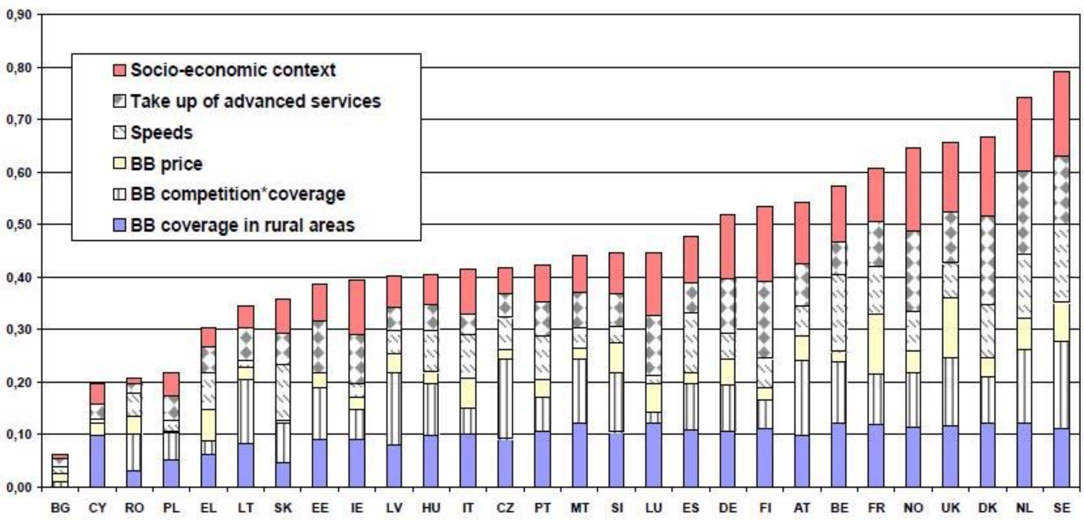
According to the Broadband Performance Index (BPI[126]), which presents comparative statistical data on all countries of the European Union, Hungary was ranked number 18 among the EU member states based on 2008 data (Commission of the European Communities, 2008).[127] The statistics also indicate that compared

[126] BPI is a comprehensive indicator assessing various factors, including the speed of Internet service, the coverage of rural areas, the affordability of prices, competition intensity, education level, as well as social and economic readiness.

[127] The survey is not conducted every year, therefore this was the most recent publication in September, 2010, as well.

with other countries Hungary was ranked low in two areas in particular: the price of broadband at Purchasing Power Parity (PPP), as well as the socio-economic dimensions of Internet use (Sallai, et al., 2009).

FIGURE 48. BROADBAND PERFORMANCE INDICES OF EU MEMBER STATES, 2008 (BPI)



Source: European Commission

A comparison between the Hungarian and other European broadband markets also reveals that one of the reasons Hungary’s aggregated data fall below the average of the EU-27 is the deficiency of basic infrastructure, including outdated wide area networks and the continuing dominance of copper networks at the level of access network. It should be kept in mind when assessing the situation that fifteen years ago there was no competition in the realm of digital telecommunication infrastructure in Hungary (Bartolits, et al., 2002). On the other hand, the transition period following the political reform resulted in special corporate strategies (Balaton, 2005a), (Balaton, 2005b), (Balaton, 2007), for example the pursuit of short-term speculative profit during the process of privatization.

The majority of the owners of Hungarian telecommunication companies are just as prone to excessive speculation as owners in other sectors, however, this clearly goes against public interest in an area like basic infrastructure, which is used by everyone in some form. Symptoms of speculation are common in other countries, as well, however, ETSA, an international organization aimed at promoting competition, revealed in an analysis of 18 EU member states and Norway that

Hungary was ranked last in 2007 for per-capita telecommunications investments. The broadband market participation of domestic incumbents also increased compared with other EU member states (+7%), indicating a decline in competition. According to ECTA there is a close correlation between the quality of the regulatory framework[128] and the level of investments.

Several companies that based their business plans on competitive opportunities on the (copper-based) telecommunication infrastructure that were theoretically ensured by regulations moved out of Hungary over the recent years (for example Tele2, which acquired half a million clients, or Actel, a service provider in and around Budapest. In the meantime, cable TV companies have been successful in urban areas and in smaller municipalities, after deploying their own access network infrastructure to municipalities or city districts (partly financed by community resources). Rapid yields were based on television services, their core business activities, with Internet and landline phone services gradually added to offerings. During the course of these developments, they created local monopolies on infrastructure that they are not even required to share at this point due to regulatory conditions discussed earlier. In areas that are less attractive from a business standpoint (if infrastructure is available at all), it will be a challenge to get local monopolies work under competitive conditions.

Broadband coverage and mobile Internet bandwidth in rural areas could improve if the grant programs for the 410-470 MHz frequency range and the 900 MHz channel blocks are actually established in 2010 as planned and if they prove to be successful. Requests for proposals have already been issued for some of the available frequencies in 2008, but the tender fell through, and the government ended up leaving the limited resources unused for a period of two years. This could be (partly) attributed to the fact that the government gave preference to license fee revenues rather than slow-yielding digital telecommunication investments.

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[128] There are several approaches to assess the quality and effectiveness of regulations. Pál Valentiny investigated the individual concepts within this topic. (Valentiny, 2008)

These developments are warning signs indicating that the Hungarian public administration needs to play a more active and more attractive role in the development and regulation of the Hungarian digital telecommunication network. The task clearly requires the regulatory authority (National Media and Infocommunications Authority) and the government ministries in charge of the sector (In particular the Ministry of National Development) to intervene proactively in order to promote telecommunication infrastructure investments rather than respond passively.

Obviously, it is easy to spot problems with the government's involvement in a sector that develops at such a rapid pace, but finding the right direction(s) for the future is quite a challenge. Mihály Gálik gave a description of this problem, although he referred to media regulation, a similarly soaring area, precisely due to the sudden boom in digital telecommunications:

- "we are not going to find special bullet-proof technologies and methodologies for the regulation of media concentration;
- the practical regulatory framework of a country is largely in line with the characteristics of its media system, or more broadly, with the democratic traditions of the country" (Gálik, 2008).

These statements are also true if we change the word *media* to *digital telecommunication network*.

The preliminary plans of the non-established GOP 3.1.2 program as well as the concept of the National Digital Public Utility Infrastructure announced in 2009 (both aimed at improving the wide area network infrastructure) indicate that experts were aware of the major shortcomings of the Hungarian basic infrastructure. It remains to be seen, however, how the government can get involved in digital telecommunication network development while using the fewest public resources possible within the new framework of the so-called National Network, in an effort to intensify competition, fill the gap in promoting community interests, and simultaneously complying with the newly formulated[129] EU guidelines.

A proactive government involvement in broadband development policy, including support and financing, calls for mapping and monitoring key developments in demand, coverage, technology and regional progress. This would allow for the elimination of unnecessary intervention in market activities and for the targeted and cost-effective response to the demand created by the government's development concepts. In this sense, demand aggregation is an important public policy tool boosting the efficiency of support measures, requiring serious coordination skills and sophisticated high-level organization background on the side of the government. One potential danger of a system relying on government orders is the excessive concentration of state-funded services, which can be avoided by appropriate practices during the proposal approval process.

The concept of "activist" government involvement in digital telecommunication network development is becoming prevalent among the approaches of EU politicians in the field, who started to work out the details of the implementation of open optical networks in 2009 and 2010. Their goal is to "prevent Deutsche Telecom or any other service provider from having a monopoly in the optical cable market. […] Operators will be required to provide all interested firms access to their optical cable networks, and there would be strict regulations regarding rates charged by operators," announced the Financial Times in September, 2010 (Pignal, 2010).

X.3. The role of an "activist' government

The Digital Agenda of the European Union requires all member states to present and implement their own broadband Internet strategies by 2012. The individual strategies have to demonstrate detailed action plans aimed at meeting the Internet coverage goals and determine the role of program (Key Action 8).

[129] Available from http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=6070. Retrieved on September 12, 2010.

Many countries all over the world commit themselves in various national broadband strategies to ensure Internet connectivity at a certain speed, for a certain percentage of the population within a certain time. Obviously, the due dates, the coverage areas and the technical parameters vary on a broad scale, just like the motivating force behind the programs. The differences can be attributed to country-specific geographic conditions, settlement structure, digital literacy of the population, as well as political power or the lack thereof. France, Germany, the United Kingdom, Sweden, Finland, Portugal, Estonia, etc. presented their area-specific programs in line with the Digital Agenda in late 2008 and early 2009 for the most part, and the implementation process is also underway in those countries.

In October, 2010 the parliament of Finland approved a legislation that regards Internet access as a basic right, just like access to water or electricity. Finnish Internet service providers are required by law to provide Internet access to all households at a speed of 1 Mbps or higher (universal broadband). Service providers managed to meet the surprisingly tight deadline (providers were expected to satisfy the requirement by July 2010), and from July 1 onward Internet access became a basic right of all citizens in Finland, both officially and practically. The next five years will continue to be a period of intensive development for Internet service providers in Finland, because the government is planning to raise the minimum download speed of the universally provided basic Internet package to 100 Mbps by 2015, to which the current bandwidth of 1 Mbps is considered a transitory step.

Great Britain set a similar goal. The creators of the Digital Britain strategy[130] claimed that more than one out of ten British households had no access to Internet at a minimum (download) speed of 2 Mbps, and they made a promise to solve the problem by 2012 at the latest. The French government strives to provide universal Internet access at 512 Kbps by the same deadline. In Germany, where 98% of all households have Internet access at a minimum speed of 384 Kbps, leaders are making an effort to deploy networks providing a minimum speed of 50 Mbps to three-fourth of all households by 2014.

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[130] Available from http://interactive.bis.gov.uk/digitalbritain/

In Australia, tenders aimed at building national broadband networks fell through, owing to the seemingly uninterested largest local service provider. In response, the Australian government decided to build its own FTTH network, which can be leased by service providers. The leadership in New Zealand also decided to support government investments, and networks will be deployed within a PPP framework. Singapore's grand plans are also aimed at Internet connections at or above 1,000 Mbps. Infrastructure roll-out, operation and leasing will be done by two firms.

In order for Hungary to progress, evidence presented in the study suggests that the country is in need of a (broad-spectrum) ICT strategy that takes into account, within reasonable limits, the expected trends in consumer demand over the next 10-15 years when envisioning community-funded digital telecommunication infrastructure upgrades and establishing the corresponding regulatory policy.

X.4. Recommendations for development policy makers

Section I.3 summarized the potential intervention tools that could be applied to develop the digital telecommunication network. As a final thought, I will now sum up the best practices and areas in need of improvement in development policy based on the results of my research and analysis.

X.4.1. Best practices

1. **Acknowledging the importance of government intervention in areas where there is no convincing business case for broadband infrastructure investments.** Despite the critical comments during the course of the analyses, it should not be ignored that the government has allocated resources for broadband infrastructure developments since 2003. In Poland, for example, there was no aid of any type available for such purposes during this time until 2008.

2. **Building a broadband coverage map**. In terms of the lack of a digital network infrastructure cadaster, the fact that the preparatory work for broadband infrastructure development proposals, including the Economic Development Operational Program GOP 3.1.1, was increasingly based on research revealing

actual data rather than providers' self-reported information was a major step in 2007. Obviously, the lack of such data in the prior period could be presented from a critical perspective, however, countries significantly more developed than Hungary did not have a precise inventory at that time, either (for example, Germany did not decide to create such a record until February, 2009, as part of its strategy design). Looking forward, it would be beneficial to create the most comprehensive and precise record possible to reflect the status of Hungary's digital telecommunication network infrastructure.

3. **Successful receipt of the allocated funds for proposals approved for EU funding**. It is true that funding was insufficient for nationwide broadband coverage reaching all locations in Hungary, however, those projects that were approved for funding did manage to receive payments, and none of them were required to return any financial aid.

X.4.2. Identification of areas in need of improvement

1. **Inappropriate management of investment (development) tax benefits.** Even though the utilization of this tool causes revenue loss to the government, the development of broadband infrastructure has a stimulating effect on the economy, which is likely to pay off generously as a result of indirect effects. Obviously, it is easier to look back and assess the situation ten years later, but it is clear that one of the major problems with domestic development policy is the fact that the investments that took place in response to investment tax benefits resulted in non-lasting infrastructure (the deployment of ADSL technologies was dominant, which means that tax benefits were used for the construction of copper-based access networks).
2. **Lack of cooperation between the ministry in charge of the field and the regulatory authority.** This problem surfaced during the preparation of broadband infrastructure development proposals, and, following the completion of the investment, in the insufficient monitoring of conditions specified in the proposal (which frequently precludes the implementation of

the principle of open access). In addition, confusion arising from vague definitions also need to be mentioned here, as it is up to the authorities to provide precise definitions of concepts relevant to the development policy makers. Collaboration between the two organizations is essential in the course of proactive and preventive regulatory interventions, as well. It is the duty of the political leadership to ensure an effective cooperation.

3. **Lack of distinction between wide area networks and access networks in terms of development strategies.** In the case of WAN deployment, it is clear that deviating from the deployment of optical fiber lines is allowed only under exceptional circumstances in order to optimize durability (e.g. when it is difficult to cross a river in the absence of a bridge). Nevertheless, technology-neutral designs specified for speed and optical, speed-independent models can equally be considered as far as the requirements are concerned. The increasing variety of competing wired and wireless technologies in the access network projects that the government's primary duty will be to meet their bandwidth demand with respect to the wide area network. This proves to be the case despite the fact that the costs involved in the building of the access network are significantly higher. Due to the capacity of the wide area network to create a monopoly, regulatory processes (market analysis) have to pay special attention to ensuring open access.

4. **Poor management of limited resources, including roads, sidewalks, poles and easements**. Spectrum management is the primary responsibility of the National Media and Infocommunications Authority, however, the organization has little say in determining the location of substructures and superstructures (except during the approval process, which basically involves the mere requirement of declaring the planned location). Competitive bidding processes or auctions to grant monopoly concessions should receive special attention. The majority of roads and sidewalks are owned by the central or local governments. Optimally, no roads should be built or upgraded without the construction of an open-access cable duct made available for digital telecommunication networks (owing to the mandatory regulation, they are currently being rolled out along

expressways, however, the utilization of the deployed optical cables is not satisfactory). It is important to keep in mind that appropriate local government mandates can gradually guarantee that developers in digital telecommunication networks use only publicly owned cable conduits to deploy communication lines. This would not only secure revenues for local governments, but it would also help to avoid the frequent breaking and patching of streets and sidewalks by various developers. At the same time, there needs to be some kind of regulation that prevents local governments from selling publicly owned telecommunication infrastructure to ease their financial problems. Considering that 70-90% of the infrastructure deployment costs (depending on geographic conditions) go toward the installation of cable ducts, the expenses of investors could also be reduced considerably, which would further stimulate competition. In the case of superstructures, on the other hand, owners of poles could be subject to regulations if excessively high rental rates hamper investments. Digital telecommunication network upgrades in multi-family buildings also require regulation, or, as demonstrated by the Swedish example, an industrial agreement with builders. Currently the chances of second, third or additional operators to enter multi-unit buildings are minimal, partly because the infrastructure within the building is not accessible, and partly because building superintendents tend not to support new entrants.

5. **Lack of comprehensive development programs.** The five broadband infrastructure development proposals carried out so far in Hungary have not been embedded in comprehensive development programs, and neither have the two planned but unexecuted development concepts (GOP 3.1.2 and the National Digital Public Utility Infrastructure). Developing the broadband infrastructure is a powerful driving force in itself, but if a program also focuses on the development of services related to the infrastructure with particular attention to their utilization, indicators measuring the outcome will likely show significantly more positive results. Certain demand boosters have been have been around for a while, (e.g. programs to fight digital illiteracy, or

creation of public access points, etc.), however, these do not address the comprehensive development of a region.

6. **Insufficient wholesale market regulations and failure to force carriers to offer wholesale services.** It is essential to mandate that a broader range of carriers allow wholesale access with price control, and to require functional separation (forcing operators to separate wholesale and retail activities, also in terms of accounting) where applicable. This was not incorporated in the NHH resolution DH-664-178/2005, however, resolution DH-26600-26/2007 published in 2007 calls for an almost functional separation, but the control function as well as compliance monitoring with respect to the fundamental details are yet to be taken up. In its recommendation on regulated access to Next Generation Access Networks, the European Union strongly supports joint investment agreements in the area of Next Generation Networks and allows operators to set lower prices for access to fiber optic subscriber loops in return for long-term contracts or quantitative considerations.

7. **Failure of the government to serve as a strategic investor**. The last time Hungary had a conscious industrial policy regarding telecommunications was in the 80s. Since then, none of the administrations have made an effort to promote Hungary to achieve a global leading position in at least one segment of the sector given the country's engagement in ICT development activity. R&D activities in the ICT field are conducted exclusively by multinational corporations in Hungary, and there is no government-initiated industrial policy that would coordinate these efforts.

My recommendations for development policy were formulated on the basis of hypothesis testing and professional experiences in the field. The conversion of the new European regulatory framework into Hungarian legislation will undoubtedly provide opportunities for modifications; however, these will affect only certain aspects of the issues discussed above. A supportive political, social and economic environment is necessary for broadband infrastructure developments to demonstrate their potential to be the engines of progress.

NGN/NGA issues have shown that regulations are worthless unless the infrastructure is or will be in place. However, there will likely be no business case for these types of developments at the current rollout costs except in major cities. As a result, the digital divide is expected to persist for an extended period of time considering the digital telecommunication infrastructure, and it is important to consider which types of services need to be supported by the government, keeping in mind that the changes will also have negative impacts on certain sectors. The government's participation needs to be constantly examined and reevaluated. In Ian E. Wilson's famous words: "No amount of sophistication is going to allay the fact that all your knowledge is about the past and all your decisions are about the future." With this in mind, I recommend my suggestions to development policy makers.

XI. APPENDIX

XI.1. Appendix – An example from economic history to illustrate the dilemmas of Internet access

“Libraries themselves are a wonderful example of an innovation that first appeared to threaten the publishing industry but ended up vastly expanding it. In the eighteenth century only the wealthy could afford to buy books.

A single book cost the equivalent of an average worker's weekly wage. And because books were expensive, there was little reason to invest in becoming literate. At the start of the nineteenth century, there were only 80,000 frequent readers in all of England.

The big breakthrough came in 1741 with the publication of Pamela. Instead of the usual dull theological treatise, the public was offered a racy and entertaining tale of a young girl's life. Pamela's success spawned many imitators, and a whole new genre, the English novel, was born. Pamela begat Moll Flanders and Moll begat Torn Jones and so it went. These classic novels were denounced by the literati such as Samuel Coleridge: "As to the devotees of these [novels], I dare not compliment their pass-time or rather kill-time with the name of reading. Call it rather a sort of beggarly day-dreaming, during which the mind of the dreamer furnishes for itself nothing but laziness and a little mawkish sensibility." Sounds almost as bad as television, doesn't it?

But the public paid little attention to the critics. People couldn't get enough of these lurid tales. English bookstores were unable to keep up with the demand for novels and romances, so they started renting them out. These circulating libraries, as they were called, were denounced by the literate classes as "slop shops of literature." What's more, they were also denounced by the publishers and booksellers for an entirely different reason: the publishers and booksellers were afraid that the circulating libraries would cut into their business: "[W]hen circulating libraries were first opened, the booksellers were much alarmed; and their rapid increase added to their fears, and led them to think that the sale of books would be much diminished by such libraries."

In the long-run, however, there is no doubt that the circulating libraries were much to the benefit of the publishing industry. The availability of low-cost entertainment motivated many to learn to read. According to Charles Knight, author of The Old Printer and the Modem Press, the 80,000 frequent readers in 1800 grew to over 5 million by 1850. The publishers who served the new mass market for books thrived, while those who sold only to the elite disappeared.

As the market grew, people started to buy rather than rent their books. The passage cited above continues: "But experience has proved that the sale of books, so far from being diminished by them, has been greatly promoted; as from these repositories many thousand families have been cheaply supplied with books, by which the taste of reading has become more general, and thousand of books are purchased each year by such as have first borrowed them at those libraries, and after reading, approving of them, have become purchasers."

Note carefully the causality: it was the presence of the circulating libraries that killed the old publishing model, but at the same time it created a new business model of mass-market books. The for-profit circulating libraries continued to survive well into the 1950s. What killed them off was not a lack of interest in reading but rather the paperback book—an even cheaper way of providing literature to the masses" (Shapriro, et al., 1998).

The growing demand for ICT services today provides a similar business opportunity for the owners of the basic infrastructure of the digital telecommunication network to the soaring demand for books in England's book market for booksellers and printers.

XI.2. Appendix – Description of the model estimate for investigating the first hypothesis

A. Number of Internet subscriptions per 1000 inhabitants (LAU2)

Indicators used in the model estimate:

1. Total income declared to the tax authorities;
2. Number of Internet subscriptions per municipality;
3. Age group indicators of Internet subscribers;
4. Infrastructure completeness:
    a) Fiber optic network coverage;
    b) RLL coverage;
    c) RUO utilization;
5. Dial-up and broadband subscriptions nationwide.

As a result of earlier works by GKIeNET, data on the number of household Internet subscriptions are available for many (1,000) municipalities. The first step was to create a model through iteration that uses the total number of Internet subscriptions in municipalities as well as the various demographic and geographic indicators while approximating the known data for the 1,000 municipalities as closely as possible. Accordingly, a subsistence minimum was subtracted from the per capita declared income for each municipality to arrive at an estimate of discretionary income. The (per capita) subsistence minimum was set at 25,000 forints per month. The discretionary income thus estimated was then used to establish a weight reflecting the propensity of people to obtain an Internet subscription. It was possible to scale the weight so that a gross per capita monthly discretionary income of 50,000 forints would yield a notional number of Internet subscriptions at the municipality that matches the nationwide average (a weight of 1), while a 10,000 forint discretionary income would correspond to half the national average (a weight of 0.5).

$$Weight\ I. = Discretionary\ income\ x\ 0.0000125 + 0.375$$
$$Discretionary\ income = \begin{cases} 0, & Inc. \leq Subsistence\ min. \\ Income - Subsistence\ min., & Inc. > Subsistence\ min. \end{cases}$$

A second weight can be obtained from the age composition of the residents of a municipality and the age breakdown of Internet users.

$$Weight\ II. = \sum_{All\ age\ groups} Number\ of\ people\ in\ age\ group \times Internet\ penetration\ in\ age\ group$$

Available infrastructure data make it possible to filter out places where there is no Internet service; obviously no subscriber data was assigned to these municipalities. Next, the nationwide number of subscribers was divided among the municipalities according to the weights determined earlier, based upon the availability of narrowband and broadband service.

The division will be done differently for the data of the four years. For 2007 and 2008 two parameters are available in the data: whether retail Internet service is available at the given municipality and whether broadband Internet service is available. Consequently, narrowband Internet service numbers can be divided up among municipalities where Internet service was available in the given year but broadband Internet service was not. The nationwide broadband subscriber figure can be divided up, using the weights explained above, among the municipalities where broadband Internet service was possible.

In the data series for the preceding years (2003, 2005), three parameters were available: the RLL (analog + GSM) coverage of the given municipality, data on whether or not RUO utilization was present in the given municipality and finally whether broadband Internet access was present. RLL coverage served as a basis for a new indicator:

$$P_{RLL} = (1 - RLL)^2$$

Whenever broadband Internet was available but the RLL parameter was below 0.1, or if there was no RUO utilization in the given area, then the weight of the number of broadband subscribers will be 1, while the weight of the number of narrowband subscribers will be 0.

If the possibility of narrowband Internet access can be assumed in addition to broadband Internet access, based on the RLL parameter and the RUO utilization data, then the weight of the broadband subscriber number will be 0.8 while the weight of the narrowband subscriber number will be 0.2 (these parameters provide the truest reflection of the actual available data).

If the data indicated that broadband Internet access was not possible at the given municipality, but the RLL parameter and the RUO utilization data made the presence of narrowband Internet access likely then the weight of the number of broadband Internet subscribers will be 0 while that of narrowband Internet subscribers will be 1.

In other cases the subscription types received a weight of 0 at the given municipality.

Using the weights thus calculated as well as the weights already explained, the numbers of nationwide broadband and narrowband Internet subscriptions can be divided among the municipalities, and then these can be aggregated at the municipality level. In the years 2003-2005, as narrowband access figures were divided up (assuming broadband and narrowband were both available) the number of broadband accesses were always assumed to have decreased.

B. Cable television subscriptions per 1,000 residents

The data were available from the T-STAR database of the Hungarian Central Statistical Office for the years being investigated.

C. Mobile phone subscriptions per 1,000 residents

Indicators and data series used for the model estimate:

1. Total income declared to the tax authorities;
2. Proprietary data collected from households:
    a) Number of people with mobile phone subscriptions by age groups;
    b) Number of people with mobile phone subscriptions by income groups;

3. Number of mobile subscriptions.

GKIeNET conducts at least four household surveys each year with sample sizes of 1,000 people. The resulting databases yield subregional-level indicators on mobile penetration (broken down by provider as well as by pre- and postpaid plans). In the annual series featuring inconsistent data (fluctuation), corrections can be made using moving averages.

D. Number of household PCs per 1,000 residents

Indicators and data series used for the model estimate:

1. Number of Internet subscriptions (LAU2);
2. Proprietary data collected from households:
    a) Number of people owning computers by municipality type;
    b) Number of computers by municipality type;
    c) Average number of computers per household;
3. Average number of people per household (government municipality statistics and proprietary databases).

The already mentioned databases resulting from GKIeNET's household surveys conducted at least four times annually with sample sizes of 1,000 yield subregional-level indicator on computer penetration.

The results were compared with the number of Internet subscriptions as well, in order to eliminate inconsistencies between the two data series.

XI.3. Appendix – Transcript of the in-depth interviews conducted to test the H_2 hypothesis

Interviewer: While working as a senior department chair in charge of broadband infrastructure development in Hungary, it was imperative that requests for proposals (RFPs) comply with the principle of technology neutrality, a mandatory requirement in the European Union (as long as they relied on EU transfers, including GVOP 4.4.1, GVOP 4.4.2, GOP 3.1.1.)

1. *Interviewer:* What is your opinion on the correctness of the principle of technology neutrality in light of the RFPs?

   Interviewee A: "This is a valid inquiry. The EU's regulations and policies regarding broadband infrastructure development have always been and still are adequately proficient and sophisticated. Complying with the principle of technology neutrality is essential in the case of government involvement; however, in the area of Internet networks, there is currently one level only where this plays a role, namely at the layer of access networks, where the more platforms compete, the better. In wide area networks, however, optical fiber is the only right way for development. In my opinion it would not be a huge challenge if EU policy makers gave a definition for wide area network."

   Interviewee B: "The principle of technology neutrality was not a significant factor when the GVOP 4.4.1, GVOP 4.4.2, GOP 3.1.1 grant programs were conceptualized. We have to keep in mind that in 2004-2005 when the GVOP programs were on the agenda, we had not had any prior experience in terms of broadband investments funded by the EU. We did apply a couple of specifics to define what we wanted to see, but there is a sense in which this was basically a de facto infringement of the principle of technology. We specified a number of parameters that we thought would steer the technological upgrades in the right direction. Obviously, we wanted to avoid creating conditions that benefited a specific producer. We tried to open the door wide enough to attract as many good solutions as possible in lots of locations."

2. *Interviewer:* Have you come across any distortions in the infrastructure investments of winning bidders that you think would not have surfaced if you hadn't had to strictly adhere to the principle of technology neutrality in every single case? If yes, where?

   Interviewee A: "Yes. When I arrived at the Ministry, the GOP 3.1.1 program was already set up. However, the misinterpretation of the principle of technology neutrality resulted in exactly these kinds of proposals – ones that focus on the termination points. All programs prior to that approached the issue from the direction of termination points."

   Interviewee B: "We typically started out from a different aspect, although it is obviously possible to arrive at this conclusion in retrospect. In many cases, winning proposals resulted in very cheap solutions that were not sufficiently durable. The question of how we can enforce the principle of open access caused a more significant problem to us. The vague definitions made it difficult for us, too, to specify precise requirements in the RFPs, and inspection was downright impossible – actually, this should have been fostered by the National Communications Authority, by analyzing the market. We conducted intensive consultations with the National Communications Authority, but they failed to provide sufficient guidance. It is impossible to promote open access if we cannot show investors the potential returns. The monitoring system of the entire structure was unaware of these problems. This goes to show that those in charge of development policy were unable to cooperate efficiently with the authority in charge of the field.

   Looking at it from our vantage point, we were happy about the fact that we were able to use GVOP 4.4.2 to reverse the failing path of the GVOP 4.4.1 (it had become obvious that they would not be able to receive the majority of the EU transfers). Politicians were glad that we were able to receive significant funds, they were spent on good causes, because the ultimate goal was to increase the coverage of households and to carry out state-of-the-art technological investments. We were focused on possibly overextending ourselves to pull in as much funding as possible. We liked to see conflicts among operators, because it finally reflected some competition. Obviously, we were not excited that parallel infrastructure systems were built, but that is a different issue.

GVOP 4.4.2. was the first program that clearly mentioned the category of wide area networks. This is due to the fact that the bottleneck problem came up in association with wide area networks, and we made every effort to support investments in a way that all essential elements of the network are eligible for funding (however, WANs were not separated from access networks, because we were focused on termination points.) We did not see distortions until we found out how the investment projects were actually implemented.”

3. *Interviewer:* Did you have difficulties owing to the fact that the definition of broadband varies from country to country?

   Interviewee A: “Yes. The definition of the concept of broadband cannot solve development policy issues in itself, but this is a major problem for authorities requesting proposals and for statisticians. The way I see it, life will gradually overcome this shortcoming and the problem will be solved, which, of course, is a challenge. The right direction would be to determine a universal bandwidth demand, which should currently defined at a ‘low’ level. For example at a download speed of 1 Mbps and an upload speed of 256 Kbps, which are sufficient to take advantage of e-government services in terms of current applications. All the other content that requires multimedia-enabling bandwidth falls into the category of business, which should be a matter of technological access.”

   *Interviewee B: “*Back then, OECD and ITU guidelines specified a minimum download speed of 256 Kbps and an upload speed of 64 Kbps for broadband; of course many countries had their own definitions, but these to institutions were what we could refer to. Considering today’s demands, 256 Kbps is an extremely slow rate, but five years ago Hungary could not afford to raise this level and spend the limited resources on higher bandwidth capacity. Initially it seemed more efficient to leave bandwidth at a lower level and instead expand coverage to more households. Those specifications still allowed broadband data flow relevant for the government given the conditions of the time. Solutions enabling multimedia content, on the other hand, needs to be regulated by policy makers, but there is still no framework for it in 2010.

4. *Interviewer:* Did you try using "tricks" in RFPs to promote more state-of-the-art technologies in new infrastructure construction? If yes, what techniques did you use?

   Interviewee A: "Yes. We tried to mandate speeds at termination points that could not be served unless by a WAN built solely with optical technology. This was of course a common technique in many EU countries; in fact, the Irish mandated minimum bandwidths for individual network sections, as well.

   Interviewee B: "We had very limited access to data at the time we set up the grant programs; we had some hunches, and we consulted with experts and conducted many in-depth interviews to have a better understanding of the actual situation. Needless to say, everybody represented a different opinion, depending on business interest.

   In less specific RFPs, bidders had more freedom, and decision-makers had greater responsibility. In previous RFPs bidders did not have the opportunity to deploy a wide area network only because everything was subordinated to indicators reflecting coverage in the household segment. There were no major debates in this respect. In GVOP 4.4.2 we did include local governments through an intricate process, which contributed to the return of public property, because we did not want public funds to boost private property. Despite the limited opportunities we took advantage of all possible tricks not only to achieve modern infrastructure but also to increase community property. Unfortunately, local governments often had under-the-table agreements with contractors prior to the construction to ensure that investors can buy the network following the required ownership period of five years. Sadly, the majority of local governments consider the digital telecommunication network infrastructure as assets that can be sold if money is tight at local governments.

Let me tell you a few things about the Development tax incentive, because I think it is even more interesting in terms of tricks. This type of tax incentive had to be approved by the EU already back then (we had things like this before 2004, as well). MT was the only one that took advantage of the development tax benefit, and to them it meant and still means a huge amount of money. In 2005, however, the new mobile phone companies realized that with 3G development they, too, could save a lot of money through this opportunity. In 2005 the Ministry of Finance decided to investigate the issue. Policy makers wanted to keep the incentive, but lobbyists also got to work, and, of course, the definition of broadband immediately came up as one of the most critical factors in the quality assessment of investments. They ended up going with the soft definition, but a special technological specification did make it into the decree which made sure that only MT qualified to take advantage of the tax benefit. This implies that there was no technology neutrality. I think the development tax incentive could have “implicitly” promoted optical development. This is certainly a different direction. Investigating the tax incentive never came up as a task at the ministry. In my opinion this is one of the tools we didn’t utilize properly in development policy, and the system is still in place.

5. *Interviewer:* Overall, do you think the interests of consumers were compromised due to the unclear definition of broadband and the mandatory adherence to the principle of technology neutrality?

   Interviewee A: “Yes. They ended up hurting the consumers – the EU member state where the investment took place suffered, because the way bidders reacted was to install cheap technology, especially where construction was expensive. I have to say that investments that were carried out this way will not stand the test of time.

Interviewee B: "Today we can interpret the issue this way, however, back then we did not think in such categories, and we had no data available to show whether the interests of consumers were being compromised. There were no surveys to evaluate consumers' opinions on investments. In regards to broadband, Hungary had its own definition, so we were not uncertain, and it was realistic at the time. We were *not de facto* technology neutral, but there was *de jure* technology neutrality. The goal was to provide Internet access to as many people as possible.

Internet service requires that all elements of the value chain be present, therefore we assumed that the market would take care of the missing pieces. We did not make a mistake, but time proved this assumption wrong. It is evident today that change is needed. And cost effectiveness analysis is very important."

XI.4. Appendix – Broadband Strategy in the Federal Republic of Germany (February 2009)

The starting point of broadband strategy in the Federal Republic of Germany is increasing coverage and speed. The initial status is that official statistics show 98% of all households as accessing at a download speed of 384 Kb/s. The goal is to raise the speed to 1 Mb/s, which is considered standard. This speed goal is met at 92% of German households, more than 70% access at 2 Mb/s and more than 20% have more than 50 Mb/s.

The objective is to have nationwide coverage (at 1Mb/s) by 2010, and to have 50 Mb/s access at 75% of households by 2014.

To meet this objective, the strategy outlines 15 action items, of which the following are the most important for the purposes of this dissertation:

1. Action item: Optimizing the shared use of existing infrastructure and assets.

   Germany's Federal authorities support the construction of broadband networks as much as they can, as long as this does not clash with their primary mission and taking security into account. This is particularly true for the partial shared use of available infrastructure under the supervision of the Federal Ministry of Transport, Construction and Urban Development (Bundesministerium für Verkehr, Bau und Stadtentwicklung, BMVBS), the Federal Ministry of Defense (Bundesministerium der Verteidigung, BMVg) and the Federal Ministry of the Interior (Bundesministerium des Innern, BMI) as long as those are not fiber optic cables or transmission equipment.

   The Federal government calls upon the states and municipalities to have their government offices similarly cooperate in the shared use of their existing assets and in opening their infrastructure.

2. Action item: Composing an infrastructure map.

   BNetzA (the Federal regulatory authority) and the Federal Ministry of Economy and Technology (Bundesministerium für Wirtschaft und Technologie) are combining their efforts in urgently composing an infrastructure map. As much as possible, they are taking into account the conceptual preparatory work of the states in economic and broadband initiatives. The preliminary plans called for the first version to be published in the fall of 2009.

Together with BnetzA, another high level Federal agency was also given the task of ensuring a high degree of reliability, and to make sure that only the infrastructures indeed capable of being used jointly be enumerated. In order to ensure the necessary degree of reliability, it is necessary to distinguish between information that is generally accessible from information accessible only to certain users, as well as information that only the actual operator of the information can relay.

3. Action item: Composing a databank of construction sites.

The Federal government is initiating talks with the Associations of Municipalities and Counties (Kommunale Spitzenverbände <Deutscher Landkreistag, Deutscher Städtetag und Deutscher Städte- und Gemeindebund>) and the states about an additional process to compose a databank of planned relevant road constructions. The databank and the infrastructure maps are to be used together.

The Federal Ministry of Transport, Construction and Urban Development regularly provides information about motorway construction areas in an effort to help develop the infrastructure map.

XI.5. Appendix – Changes in the relevant EU directive on access

Article 13a

XI.5.1. Functional separation

1. A national regulatory authority may, in accordance with the provisions of Article 8, and in particular the second subparagraph of Article 8(3), impose an obligation on vertically integrated undertakings to place activities related to the wholesale provision of access products in an independently operating business unit.

2. That business unit shall supply access products and services to all undertakings, including other business units within the parent company, on the same timescales, terms and conditions, including with regard to price and service levels, and by means of the same systems and processes.

3. When a national regulatory authority intends to impose an obligation for functional separation, it shall submit a request to the Commission that includes.

   a) evidence that the imposition of appropriate obligations amongst those identified in Articles 9-13 to achieve effective competition following a co-ordinated analysis of the relevant markets in accordance with the market analysis procedure set out in Article 16 of Directive 2002/21/EC (Framework Directive) has failed and would fail on a persistent basis to achieve effective competition and that there are important and persisting competition problems/market failures identified in several of these product markets.

   b) an analysis of the expected impact on the regulatory authority, on the undertaking, and on its incentives to invest in its network, and on other stakeholders including in particular the expected impact on infrastructure competition and any potential entailing effects on consumers;

   c) a draft of the measure being proposed.

4. The draft measure shall include the following elements:

a) the precise nature and level of separation, specifying in particular the legal status of the separate business entity;

b) identification of the assets of the separate business entity, and the products or services to be supplied by this entity;

c) the governance arrangements to ensure the independence of the staff employed by the separate business entity, and the corresponding incentive structure;

d) rules for ensuring compliance with the obligations;

e) rules for ensuring transparency of operational procedures, in particular towards other stakeholders;

f) a monitoring programme to ensure compliance, including publication of an annual report.

5. Following the Commission's decision on the draft measure taken in accordance with Article 8(3), the national regulatory authority shall conduct a coordinated analysis of the different markets related to the access network in accordance with the procedure set out in Article 16 of Directive 2002/21/EC (Framework Directive). On the basis of its assessment, the national regulatory authority shall impose, maintain, amend or withdraw obligations, in accordance with Articles 6 and 7 of Directive 2002/21/EC (Framework Directive).
6. An undertaking on which functional separation has been imposed may be subject to any of the obligations identified in Articles 9–13 in any specific market where it has been designated as having significant market power in accordance with Article 16 of Directive 2002/21/EC (Framework Directive), or any other obligations authorised by the Commission pursuant to paragraph 3 of Article 8.

Article 13b

XI.5.2. Voluntary separation by a vertically integrated undertaking

1. Undertakings which have been designated as having significant market power in one or several relevant markets in accordance with Article 16 of Directive 2002/21/EC (Framework Directive) shall inform the national regulatory authority in advance if they intend to transfer their local access network assets or a substantial part of them to a separate legal entity under different ownership, or to establish a separate business entity in order to provide to all retail providers, including its own retail divisions, fully equivalent access products.

2. The national regulatory authority shall assess the effect of the intended transaction on existing regulatory obligations under Directive 2002/21/EC (Framework Directive).

   For that purpose, the national regulatory authority shall conduct a coordinated analysis of the different markets related to the access network in accordance with the procedure set out in Article 16 of Directive 2002/21/EC (Framework Directive).

   On the basis of its assessment, the national regulatory authority shall impose, maintain, amend or withdraw obligations, in accordance with Articles 6 and 7 of Directive 2002/21/EC (Framework Directive).

7. The legally and/or operationally separate business entity may be subject to any of the obligations identified in Articles 9-13 in any specific market where it has been designated as having significant market power in accordance with Article 16 of Directive 2002/21/EC (Framework Directive), or any other obligations authorised by the Commission pursuant to paragraph 3 of Article 8.

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XIII. LIST OF TERMS

XIII.1. Technology-related expressions, abbreviations

Aggregation: converting (multiplexing) data streams from several subscribers, transmission media and technologies into a single, shared data stream.

Aggregation network: a network for transmitting aggregated (multiplexed, i.e., sharing a transmission channel) data streams between local network nodes within a municipality/metropolitan area (MAN) or between municipalities/metropolitan areas (WAN). **Core networks** are also aggregation networks (network backbones are networks organized into SDH rings, while area networks are, by definition, internal networks of the primary areas, connecting primary nodes with the service nodes of the local networks), but in this dissertation I have avoided the use of these two phrases, and I am using the wide area network concept, with the fiber optic upgrades in mind (**See wide area network**).

Base station: by transmitting and receiving radio waves, these units connect between mobile terminal equipment and the core network (or the fixed wired or wireless connections thereto). The base station is capable of providing this connection to the mobile devices situated in its service area.

Leased line: a dedicated line leased for exclusive use, providing two-way, permanent domestic or international connection.

Leased line interconnection service: half-circuit leased line interconnection service, double hop off leased line interconnection service.

Bitstream access: a two-way, digital high-speed network service, in the course of which the mandated service provider ensures for the entitled service provider full or shared access to the transmission capacity of its active network facilities.

Cellular systems mobile radiocommunications networks: mobile radiocommunications networks covering a large geographical area, in which the area of service is divided into a number of smaller cells each having its own transmitter/receiver equipment (base station). The use of cells allows for the same frequency to be re-used in non-contiguous cells, thereby increasing the maximum number of subscribers within a given network. As subscribers move from one cell to another, the cellular system automatically and seamlessly reroutes the call or "hands on" to the base station in the next cell, in order to enable continuous communications.

ECTA (European Competitive Telecommunications Association): international organization with a mandate to promote competition in European telecommunication – a lobbying organization of the alternative telecommunication service providers, similarly to **ETNO**, which is the lobbying organization of the incumbent providers.

Universal digital telecommunication service: the set of digital telecommunication services determined by Act C. of 2003, which must be provided anywhere in Hungary with a set quality at a price affordable to all users.

Digital telecommunication service: A service normally provided for remuneration which consists wholly or mainly in the conveyance of signals on digital communications networks (and routing them, where applicable), including telecommunications services and transmission services in networks used for broadcasting, but excluding services providing, or exercising editorial control over, content transmitted using digital communications networks and services; it does not include Information Society services, as defined in other legal directives, which do not consist wholly or mainly in the conveyance of signals on digital telecommunications networks.

Digital telecommunication network provider: the operator of a digital communications network or the provider of digital communications service, which is a natural person or legal entity or a business undertaking without legal entity.

Digital communications network / telecommunication network: Transmission systems and, where applicable, switching or routing equipment and other resources which permit the conveyance of signals by wire, by radio, by optical or by other electromagnetic means, including satellite networks, fixed and mobile terrestrial networks, and electricity cable systems, to the extent that they are used for the purpose of transmitting signals, networks used for radio and television broadcasting, and cable television networks, irrespective of the type of information conveyed.

Access network: various access network technologies connect subscribers to digital telecommunication networks through this. There is aggregation in the access network as well, and it can serve more than one municipality. Accordingly, I have avoided using the notion of a "local" network, because professional terminology uses it in reference to a single municipality (which, in turn, does not always necessarily mean an independent access network in terms of technological implementation).

Subscriber's termination point: a network termination point through which the subscriber can have access to network functions and services provided via the network through the physical and logical connection of the digital communications terminal equipment.

Relevant market: a product/service market determined setting out of markets listed in the Annex of Recommendation 2003/311/EC of the European Commission (in the Annex 1. of 16/2004. (IV.24.) IHM decree) whose characteristics may be such as to justify sector-specific regulation and on which the authority shall assess whether the competition is effective.

EuroStat: European Statistical Office.

FCC: Federal Communication Commission, a telecommunications authority operating as an independent agency of the Federal Government of the United States (subordinated to Congress only), while the regulatory agencies of the individual states are the Public Utilities Regulatory Committees (PURCs).

FTTB: Fiber To The Building – fiber optic access directly to the building serviced.

FTTH: Fiber To The Home – fiber optic access directly to the home serviced.

GPRS: Packet-oriented wireless data connection type with a maximum bandwidth of 115 Kb/s.

GSM: (Global System for Mobile Telecommunications) digital mobile phone standard.

Local loop unbundling: the provision of access to the loop or the local sub-loop owned by the mandated service provider for an entitled service provider. Full unbundled access to the local loop shall mean the provision of access to the loop or the local sub-loop, while shared access to the local loop shall mean the provision of access to the frequency spectrum above the frequency spectrum used by the mandated service provider.

Local loop: the physical circuit connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility.

Access services: according to the level of flexibility afforded to the user, there can be fixed termination point (permanent location), nomadic and mobile access services.

ICT: Information Communication technology (technologies).

Incumbent: public telephone service provider previously in a monopoly position, typically formerly owned by the state.

Internet subscription: a contractual relationship aimed at providing Internet service in return for a fee. The number of Internet subscriptions is not equal to the number of Internet users, since a single Internet subscription may cover more than one user.

Significant Market Power (SMP): 1. An economic situation which allows a company to conduct its business largely independently from competitors, customers and, in the end, consumers. 2. A business can be considered to have significant market power if, either alone or in conjunction with others, it enjoys a dominant economic position that makes it possible for it to conduct its business largely independently from competitors, customers and, in the end, consumers.

CSO: Hungarian Central Statistical Office.

Last mile: the last network segment accessing the customer in the access network.

MAN (Metropolitan Area Network): a network connecting local access network nodes within a municipality.

Number of mobile subscriptions: the number of active SIM cards. A SIM card is considered active if it is capable of receiving a call (at midnight on the last day of the period under consideration).

Mobile radio telephone network: a ground-based radio telecommunications network which facilitates two-way voice connections between users moving about freely within a wide area as well as between such users and public switched fixed telephone network subscribers, facilitating

- the initiation and maintaining of telephone voice connections,
- data transmissions at a minimum speed of 2400 bits/s.

Mobile radio telecommunication service: a mobile telephone service provided through a mobile telephone network using radio frequency electromagnetic waves to subscribers moving about within a wide area. Signal transmission may take place between mobile equipment in the network or between mobile equipment and subscribers to fixed telephone service. The called party can be selected by way of the selection procedure defined in the national or international numbering plan.

Mobile Internet subscription: starting in 2008, the number of mobile SIM cards for which an Internet service package with at least 10 Mbytes of data transfer and a monthly fee of more than 0 Ft was active on the last day of the calendar year (prepaid or postpaid). If a SIM card was active for several packages, the data service provider is still obligated to treat it as a single SIM.

NHH: National Communications Authority.

NMHH: National Media and Infocommunications Authority: the name of the new authority created in the 2010 fusion of the National Communications Authority and the National Radio and Television Commission; also the successor of the National Communications Authority.

NUTS5 – LAU2: Nomenclature of Territorial Units for Statistics. NUTS is a hierarchical system of classification augmented by the system of Local Administrative Units. Earlier LAU2 classifications were referred to as NUTS5. In Hungary it refers to municipalities (including central, inner, and outer areas).

PSTN: (Public Switched Telephone Network): publicly available "traditional" telephone network capable of providing local, long-distance and international phone calls (telephony typically with a copper pair on the subscriber end).

RIO: reference interconnection offer.

RLL: Radio in the Local Loop – a radio telephone with a fixed location.

RUO: reference unbundling offer.

Bandwidth: the information transmittal capacity of a communication network. For analogous networks it is typically measured in Hertz (cycles per second), while for digital networks it is usually measured in bits per second (bit/s).

Basic broadband infrastructure: the combination of the wide area network and the access network.

Broadband wide area network technologies: Broadband wide area network technologies include any network technology that transmits the concentrated traffic of the access networks to other networks. Our current understanding is that in the long term all WAN technologies will be fiber optic based. WANs may be augmented by point-to-point microwave or WiMax "backhaul" solutions to "extend" the optical networks. The following may serve as WAN technologies:

- **DWDM** – dense wavelength division multiplexing.
- **Optical Ethernet** – when large distances are needed to be bridged at very high throughput rates, WANs may use various versions of fiber optic Ethernet : Fast Ethernet (FE) at 100 Mb/s, Gigabit Ethernet (GbE) at 1 Gb/s and 10 Gigabit Ethernet (10GbE) at 10 Gb/s throughput rates. 10 Gigabit Ethernet was explicitly created for covering Metropolitan Area Networks (MANs).

- **SDH** – Synchronous Digital Hierarchy. The transmission medium for SDH is almost exclusively optical fiber, but it is also used in microwave connections. It's bandwidth range is between 155 Mb/s and 40 Gb/s.
- **Point-to-point microwave connection** – point-to-point microwave connections can be widely used in terrestrial communication.
- **VSAT** – (Very Small Aperture Terminal). In VSAT systems, which provide two-way satellite-based communication, the network is connected to a VSAT terminal, which in turn connects to the central server via a small satellite dish and a geostationary satellite. The advantage of the satellite technology is that it can be used immediately, anywhere, without needing terrestrial infrastructure, and that it provides broadband access. Until fiber optic networks reach a subregion, the aggregated traffic of the local subscribers may be channeled through satellites.

Telecommunication infrastructure: infrastructure constructed and operated by participants in the market of telecommunication services (telecommunication providers). (Cable TV infrastructure also offers telecommunication services, and in this sense it is part of the telecommunication infrastructure as well.)

Wide Area Network (WAN): a network (aggregation network) connecting the network nodes of the access networks of municipalities between different municipalities.

Triple play: Internet, TV/IPTV, and VoIP telephone service sold in a single package.

Trunk network: a trunk is a collection of connecting paths, or circuits connecting the nodes or switches of a switched network together or to the outside world. A trunk is typically a sheaf of circuits (a path); its constituent parts are called trunk lines or circuits. Trunks typically connect switching centers, but they are also used to connect special devices (such as voice mail) to the switching center.

Wireless broadband access network technologies (access network): nomadic and mobile technologies. They include:

- **2G** (GSM), 3G (UMTS), 3.5 (HSxPA) and 4G (LTE) mobile technology.
- **CDMA** 450 mobile technology.
- **FWA** (Fixed Wireless Access) technology, including LMDS (Local Multipoint Distribution System) and WiMAX (Worldwide Interoperability for Microwave Access) – the 802.16a standard.
- **Satellite** access technology – satellite-based access technologies may utilize satellites of the following types: LEO (Low Earth Orbit), MEO (Medium Earth Orbit), EEO (Elliptic Earth Orbit) and GEO (Geostationary Earth Orbit). One-way satellite connections are the most widely used, mainly for broadcasting, but there are examples of Internet service using this technology, where upstream requests are routed to the server using a modem, while downstream data are sent back via satellite. For telephony and data services the most widely used implementations are VSAT geostationary systems suitable for two-way communication. In satellite-based VSAT systems the network is connected to a VSAT terminal (Very Small Aperture Terminal), which in turn connects to the central server via a small satellite dish and a geostationary satellite.
- **WLAN** (Wireless Local Area Network) technology. Owing to their limited range, WLAN technologies are usually confined to be used as an extension of existing broadband connections over the so-called "last 100 meters." WLAN is also gaining acceptance as a technology for broadband connections in rural communities.
- A 802.11b (**Wi-Fi** – Wireless Fidelity) is currently the most widely used IEEE WLAN standard, operating at the 2.4 GHz frequency. Data exchange speeds are at 11 Mb/s maximum (although in practice it is closer to 5-6 Mb/s for each user) within a 100 meter range.

Wired broadband access network technologies (access network): these technologies are largely classified along the lines of physical media (twisted pair, cable, optical fiber), but Ethernet access may be based on twisted pair or optical fiber technologies alike. It includes:

- **DSL technology** – Digital subscriber line. According to ITU's description, digital subscriber lines (xDSL) are "an access technology utilizing the existing copper pair infrastructure originally laid down for traditional phone service." Practical experience shows that about 40% of the twisted pairs within a cable are capable of providing high speed access using DSL technologies. If a larger percentage of subscribers are to be provided with service, a combination of DSL technology and some optical technology are to be used (e.g., FTTC + VDSL2).

- **CATV** – cable modem technology. Defining cable modem technology itself can take an analysis in various directions. It may refer to a network building technology, a breakdown by medium, a broadband transmission technology, a CATV broadcasting technology. At the same time, if we are evaluating things from a broadband point of view, we need to treat the definition as one of standardized procedure (protocol), or we have to distinguish between DOCSIS 1-2 and DOCSIS 3 standards. The transmission route (especially if it involves optical fiber) may, therefore, involve several different technological processes in CATV networks. In my view the technology is fundamentally determined by the connective device plugged into the terminal socket at the CATV subscriber's premises. Whether the access network is purely coaxial or HFC, there is only one technology capable of transmitting broadband Internet: modulating the frequency with digital information content, and the various versions of the procedure are described in the DOCSIS 1…3…x series. Current CATV networks are mostly HFC (Hybrid Fiber Coax), meaning that they combine fiber optic and coaxial cable. The CATV system consists of a headend, a distribution network connected to home networks terminating in subscriber terminals. Data communication takes place over DOCSIS/Euro-DOCSIS standard cable modems, while the computer is connected to the cable modem via a 10/100 Mb/s Ethernet cable. CATV networks currently mean traditional high-frequency coaxial and HFC networks (together referred to as coaxial subscriber-end networks), but cable TV has gone beyond these networks, and their services have also become complex (Internet, telephone). Accordingly, regulatory agencies should rethink the definition.

- **FTTx** – Fiber optic technology. FTTx technologies may use purely optical solutions, or a combination of fiber optic and copper (DSL) solutions. Optical connections offer virtually unlimited bandwidth, and speed is only limited by the terminal equipment. As a result, this technology is widely viewed as the final solution in broadband. The disadvantage is that the associated investment has significant costs – this is what leads to the various combined FTTx solutions. Switched optical networks may be passive (PON – Passive Optical Network) or active (containing electrically powered devices).
- **Ethernet** access technologies – under the IEEE 802.3 standard, Ethernet has spread worldwide in the past decades. The real advantages of Ethernet first became apparent in local computer networks based on structured cabling. Ethernet can be realized in various physical media (such as twisted pair, fiber optics).

VoIP service: Voice over Internet Protocol – refers to the number and length of calls that are initiated through mobile phone service providers, and subsequently use IP-based network(s) in part or wholly.

XIV. List of the author's relevant publications

Journal articles

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