ANALYSIS OF BROADBAND DEVELOPMENT IN BULGARIA

Master Thesis

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Abstract

One of the recognized basic instruments for enabling major improvements in social and economic wellbeing is broadband connectivity. Widespread access can deliver significant increases GDP, employment and international competitiveness and improve quality of life in the country. The European Union (EU) has recognised the importance of ICT by making broadband connectivity and adoption main portion of the EU Digital Agenda. As a Member State of the European Union, Bulgaria develops national strategic goals that intend to consist with the strategic objectives and priorities lay out by the EU.

One of the leading objective of the Digital Agenda for Europe is to achieve accelerated development of high-speed Internet access, creating it possible to enlarge the benefits from the presence of a digital single market. Bulgarian government put great focus on that objective in their programing documents, which are the updated National Strategy for the Development of Broadband Access and particularly the National Broadband Infrastructure Plan for Next Generation Access in 2014.

The main purpose of this thesis is to analyse the broadband market and policy developments in Bulgaria and specifically how the country has adopted the EU regulatory framework. Secondly, it goals to indorse possible broadband measures and policies, which need to be implemented, for the nation to accomplish its goals on broadband adoption and high speed broadband access.

The discoveries have shown that, in respect to the main aim of the thesis, Bulgarian policy makers must encourage and give more emphasis, not only the broadband infrastructure and access, which is the current situation, but also should support and put more focus on the demand side of broadband policy, which deals with broadband adoption and the applications and content.

Keywords: broadband policy, broadband development, Bulgaria, Digital Agenda for Europe, Bulgarian broadband strategy

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List of Acronyms

3G, 4G, 5G	Third, fourth, fifth - generation
3GPP	3G Partnership Project
ADSL	Asymmetric digital subscriber line
AN	Access nodes
AON	Active Optical Network
BPL	Broadband over powerline
BTC	Bulgarian Telecommunication Company
CATV	Community antenna television
CCI	Connected Communities Initiative
CIS	Commonwealth of Independent States
CM	Council of Ministers
CoCOM	Communications Committee of the European Commission
CRC	Communication Regulation Commission
CTC	Community Technology Centre
DAE	Digital Agenda for Europe
DESI	Digital Economy and Society Index
DNA	The Digital National Alliance
DOCSIS	Data over Cable Service Interface Specification
DSL	Digital Subscriber line
DSM	Digital Single Market
EA ECNIS	Executive Agency “Electronic Communication Networks and Information Systems”
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EDPR	European Digital Progress Report
EFSI	European Fund for Strategic Investments
EU	European Union
FCC	Federal Communications Commission
FDD	Frequency division duplex
FTP	Foiled twisted pair
FTTB	Fiber to the Building
FTTC	Fiber to the Curb
FTTD	Fiber to the Desk
FTTH	Fiber to the Home

FTTN	Fiber to the Node
FTTP	Fiber to the Premises
GDP	Gross domestic product
HSPA	High speed packet access technology
ICT	Information and communications technology
IMT	International Mobile Telecommunications (Advanced)
ISOC	Internet Society
ISP	Internet service provider
IT	Information Technology
ITU	International telecommunications Union
LAN	Local area network
LE	Local exchange
LEC	Law on Electronic Communications
LoI	Ladder of investment
LTE	Long-term Evolution
MITI	Ministry of Trade and Industry
MTITC	Minister of Transport, Information Technologies and Communications
MTITC	Ministry of Transport, Information Technology and Communications
NGA	Next Generation Access
NGN	Next Generation Network
OECD	Organization for Economic Cooperation and Development
PAL	Phase Alternating Line
PON	Passive Optical Network
PPP	Public-private partnership
PSTN	Public Switched Telephone Network
SC-FDMA	Single Carrier-Frequency Division Multiple Access
SME	Small and medium-sized enterprises
STEM	Science, technology, engineering, and mathematics
SWOT	Strength, Weaknesses, Opportunity, and Threats.
TDD	Time division duplex
UNDP	United Nations Development Programme
US	Universal Service
USO	Universal service obligation
UTP	Unshielded twisted pair
VDSL	Very high-speed digital subscriber line
VoIP	Voice over Internet Protocol

VPN	Virtual private networks
W-CDMA	Wideband-Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access

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Chapter 1

1. Introduction

The continuous technological progress, development of innovative technologies, broadband access and advance in telecommunications bring constant change of the world we live in. The result of this development in online environment brings a new world – a converge digital ecosystem, creating countless new business, social, personal, and political uses.

One of the recognized basic instruments for enabling major improvements in social and economic wellbeing is broadband connectivity. Widespread access can deliver significant increases in Gross domestic product (GDP), employment and busted international competitiveness and improve quality of life. Broadband connectivity may also improve community cohesion through enhanced and novel communications, likewise, create better choice and availability for individuals and families in work and other areas of lifestyle. Nevertheless, as the broadband to achieve its full potential, its range should be expanded in both developed and developing economies. Effective policies must be implemented by the government, in order to stimulate construction of broadband along to spur the uptake of broadband services in all areas of the economy.

There is an overarching concept of broadband to be seen as an ecosystem, consisting of demand and supply components. The concept is used to structure by what way policy makers can enlarge absorptive capacity and positively realize the promising impact of broadband on social, economic, and policy goals. Policies must be implemented, by the governments, that endure the supply of broadband services and networks, especially to economical attractive areas. (Kelly and Rossotto, 2012). That can be accomplished through a variety of instruments like appropriate market regulation, service and universal access policies, direct infrastructure investments, flexible licensing policies, and pro-market tax policies. Furthermore, governments must seek to stimulate demand of broadband, by means of creation of a permissive environment by addressing accessibility, awareness, and affordability of broadband services.

Republic of Bulgaria also applies increased focus on broadband development. As a Member State of the European Union (EU), Bulgaria develops national strategic goals that intend to consist with the strategic objectives and priorities lay out by the EU. In this field of information technologies, in 2009, Bulgaria approved National Strategy for the Development of Broadband Access and updated it in 2012, and in addition National Operational Plan, including strategies for broadband improvement in the country to 2015, with links to 2020, aiming to represent a unified approach to the development of the national broadband for the accomplishment of long-term sound strategic results. It is developed in accordance with the existing EU programming documents, published in 2010, Strategy for smart, sustainable, and inclusive growth ‘Europe 2020’, specially one of the leaded initiatives devised in it - Digital Agenda for Europe (DAE).

One of the leading objective of the Digital Agenda for Europe is to achieve accelerated development of high-speed Internet access, creating it possible to enlarge the benefits from the presence of a digital single market for businesses and households, with 2015 – 2020 as a period, (EC, 2010). Seven interconnecting priority pillars are identified in the program and will be discuss in the literature review.

Bulgarian government put to the fullest extent more focus on the fourth priority, associated with providing fast and ultra-fast Internet for all citizens the European Union, with the adopted by the Council of Ministers in 2014, National Broadband Infrastructure Plan for Next Generation Access. The national plan defines the methods, deadlines and means to achieve the objectives stated until 2020, in the Digital Agenda for Europe, the provision of fast and ultrafast internet to all European citizens by constructing Next generation access networks, so-called NGA.

The intention is to intensify the creation of NGA networks, which will contribute to the enhancement of all aspects of broadband services and broadband technology. NGA networks, in the future will have the capacity and speed to deliver content with ultrahigh resolution (television or video), to deliver a variety of advanced digital services at highly speed, to support speed demanding applications and deliver to enterprises and customers affordable symmetrical broadband connections.

By encouraging investment in building NGA broadband infrastructure, along with harmonization of radio frequency spectrum, the ambition of Bulgaria, as a part of EU, can turn into reality. The aim consists of needs for internet access at speeds more than 30 Mbps for all EU citizens and at least 50% of the European households to subscribe to broadband above 100 Mbps by 2020. And how that goals can be achieved by the overcome of the digital divide of the population in small and remote settlements, and give them the opportunity of accession high speed internet and the future use of e-government services.

2. Problem formulation

The intent of the paper is to analyse the policy and market developments in Bulgaria with respect to broadband. The country case study of Bulgaria is neither more interesting or less than all other cases concerning national broadband developments. The information taught from such a case study reveal to the interplay among the specifics of the exact national development and the general features. It is essential to analyse the specificities of the developments in particular countries, with regard to deduce any general conclusions.

The leading discussion in the thesis is concerned with the main question:

> *How Bulgaria has responded to market and regulatory challenges in their adoption of the EU regulatory framework?*

The subdiscussion is about the question:

> *What additional broadband policy measures on the supply side and demand side should be taken by the Bulgarian government for more accelerated broadband development?*

The additional discussion is about the given main priorities for development in Bulgarian broadband policy according to the priorities set by European Commission in the leading programming document Digital Agenda for Europe. And how Bulgaria can achieve the goals concerning those priorities in the urban and rural areas of the country?

The special scopes of interest presented in the paper are generally concerned with the relationships between the demand for the services and applications needing broadband capacity and the supply of broadband infrastructures. Moreover, in Bulgaria, the implications of the general move from a priority on creating competition in the broadband market into focusing on building new network

infrastructures is examined. This is allied to the continuous discussion on service versus infrastructure competition.

The paper discussed another important aspect of the analyzation of European Union broadband strategy and particularly what is the position of the Bulgarian policy measures. That aspect is the priority of respectively regulatory versus developmental measures (Falch & Henten, 2015; Lemstra & Melody, 2014). Some countries have prioritized creating a regulatory framework for the improvement of the telecommunication sector without enough direct public economic support for construction of infrastructure, on the other hand, other countries have pursued a developmental track with a greater rate of direct economic support for infrastructure growth.

The paper looks through another broadband dimension that is involved with the importance given to network development versus the application and usage of the network resources (Igari, 2013). There is an implied assumption in some countries that applications, services, and content will follow after the networks are built, for example, Japan is one of the countries that give more focus on increasing capacity and enlarging networks. Different countries give more support and emphasis on developing applications, services and public content. Some European states have given that emphasis to broaden and develop public services. That study will attempt to give an answer to the question on what prioritization, networks or content, EU and Bulgaria gives accent.

3. Methodology

There is an on-going discussion on the comparison and development of broadband strategies and infrastructure in the distinct countries around the world (Yoo, 2014). Similarly, there is a debate on the dominated aspects affecting that broadband development. The thesis is a study on broadband policy, specifically national, grounded on telecommunications regulation study. A research on telecommunications regulation is mostly founded on policy, economics, and law. Similar, this thesis is an analysis on cross-disciplinary research founded on applied social, economic and policy science

In this paper, it is observed the proposed framework for analysing broadband policy in various countries, by Falch & Henten (2016). The framework is conceptual with emphasis on policies and regulation. They outline three of the most valuable policy dimensions moving broadband developments and can be found in many varying mixtures in different countries. The denoted three dimensions are:

- Infrastructure vs. service competition
- Regulatory vs. developmental policies
- Networks vs. content prioritization.

Additional determinants are recognized that affect broadband developments, primarily the economic wealth of the particular country and the factors such as geography or distribution and educational level, which broadband policies have limited influence on. That conceptual framework emphasizes on dimensions, which are affected by regulation and policies and for that reason are subject to some extent of change – considering policy inertia.

Type of Data and Collection

Qualitative and quantitative are the types of data overall used through the paper, as there is a use of association of both promoted by secondary, and tertiary sources. The thesis is chiefly based on secondary sources, primarily researches such as questioners or interviews are not included.

For instance, quantitative data indicates the statistical and economic data serving the empirical data of economic effectiveness. The positivistic epistemological perspective is taken with regard to achieve an objectivism, with the intention of representing the empirical data as facts concerning the policies in the telecommunications. For objectiveness in the paper hence several sources have been used during the research. Some of used sources are official European and Bulgarian regulation papers and texts, expert and working group papers, newspapers, statistical databases, economic, political, technological and law journals.

Chapter 2

Literature review

In the literature review, the researchers will be observing at the connection and association between policies and market, as well as the theories will be discussed about broadband development suggested by some telecommunication regulation consultants. Examining the part of policy, the researchers will be directing on regulations as market is regulated by policies. Also, it will be looked at what forms the market. The researchers' policy review will be narrowed to that of telecommunications.

1. Definitions of broadband

The broadband definition is a relative term, according to its context. Some of the telecommunication contexts by which broadband can be characterized are Digital Subscriber line (DSL), data communications, television and video, and computer networks (Wikipedia, Broadband, 2017). Mainly, in telecommunications broadband states to a signalling method that can handle a comparatively wide range of frequencies (Wikipedia, Broadband, 2017). This wider bandwidth of a channel gives greater information carrying capacity. When information can be multiplexed at a high frequency, the Quality of service can be improved, therefore making the role of broadband substantial in delivering telecommunication services.

Simply, broadband indicates a high data rate internet access. It allows to download and upload services and digital contents at high speed. There are still differing opinions in particulars to describe the exact data rate. This is because, for determine broadband there is no precise data rate. In accordance with the Organization for Economic Cooperation and Development (OECD), broadband is having data transfer rate of 256kbps or faster in terms of download. On the other hand, the US Federal Communications Commission (FCC), in 2015, describe "Basic Broadband'" as data rate of 25 Mbit/s or faster for downstream and 3 Mbit/s for upstream. In accordance with the trend to increase the threshold of the broadband definition when higher data rate services become applicable (Wikipedia, Internet access, 2017).

It also is important to mark that broadband can be distributed on any network infrastructure like DSL, cable networks, satellite, mobile and wireless technologies. The essential matter is that the infrastructure must bear a high data rate internet access which alight in the capacity defined in the paragraph above. The cost and prices rely upon the availability of existing infrastructure, the new built infrastructure architecture, quantity of the customers and additional environmental considerations.

In Bulgarian broadband strategy, broadband is considered as the access – offering the users the conventional on-line experience to data, voice and video services simultaneously with equal speeds to or higher than 2 Mbit/s (Actualized National strategy for development of broadband access in Republic of Bulgaria, 2012, p.4), that is adhered to the definition of the International telecommunications Union (ITU) and the speeds seized by the Communications Committee of the European Commission (CoCOM).

2. Policy analysis

The rising number of policies that go back to the 1960s together with the policy analysis have come a part of the academic world (Parsons, 1996). Here a description for definition must be made since policy and politics are often confused. *Politics* is explained as "power in action" by Cambridge Dictionaries (2016), describing how a country is governed and what actions does the government make, whereas *policy* is "a plan of action or a set of rules agreed by a business, a political group or a government", in addition "a policy is an attempt to define and structure a rational basis for action or inaction", (Parsons 1996).

Moreover, Parsons (1995) disputes that among the number of familiar and overlapping interests in policy analysis are: analysis of the content of public policies, analysis of the connections of public policies to „problems", analysis of what people in charge do and the results of policy in terms of output and outcomes (pp. 29-30). One of the methods and frameworks of studying public policy resulting from those concerns is comparative public policy, that is a combination of social sciences like sociology, politics, economy, and history (Heidenheimer, 1985). It is deliberated as an appropriate theory as it studies "how, why, and what effect different governments pursue a particular course of action or inaction" (Heidenheimer stated in Parsons, 1996).

Furthermore, policy analysis involves "how policy is made, why, when and for whom", a representation of a specific policy and a criticism of it (Parsons, 1996). That is accomplished by examining how policies have fulfilled policy goals and what effect a policy may have on a certain specific problem. Frequently, the analysis centres on different stages of the policy analysis, for example, different ideas, opinions and assumptions about policy formulation, policy process, evaluation, or implementation.

The first assignment when doing a policy analysis is interpretation and understanding of the foundational structure which form the analysis of policy content, processes and problems (Parsons, 1996). When applying to a system like the European Union or the Bulgarian government, a policy style model can be preferred as a way to plan analysis and policy development, as this clarifies "community" structures in which policy communities interplay (Parsons, 1996). In that model, the policy-makers: seek to achieve consensus, seek to establish decisions, react to and anticipate problems.

Important to notice is that the way in which networks policy and communities function distinct over sectors and time, which some matters require a full policy community and the rest are handled with less or even without enough consultation. When the policy is engaged, numerous boundaries must be characterizing such as social, economic, historical, geographical, and cultural aspects (Parsons, 1996). That is the basics for understanding what a national regulatory body must take into consideration, and also the industry participants, industry efficiency and consumer protection.

When it approaches to policy assessment and evaluation, the political results and affects are considered as: "product of the political „incomes": expectations, values, beliefs and culture" (Parsons, 1996). Even though to reach an objective evaluation is difficult due to the character of the analyst and the contradictions, it is implied that one aspect is not enough to clarify what kind of importance a policy has on outcomes. Additionally, economic and social forces are discussed to be the variables defining outputs and outcomes within the policy process. An eternal understanding of the policies can be achieved, by analysing and comparing more aspects. Actually, human freedom, greater social fairness and dignity encouragement can be achieved by "more effectively and

efficiently and with an understanding of forces which are shaping society", (Parsons, 1996), which can contribute to new jobs and increased quality of life and life expectancy. That compose a broader picture which the theory of policy analysis engages in.

The paper gives emphasis on the development and outcomes of a national regulation, although a vast variety of topics are composed in public policy. These topics distance from the various frameworks and phases, among them are the content, decisions and actions taken by executives. Intentions for the selection of this theory is that it applies a broader prospective of the political aspects and socio-economic which the problem represents. Together with these measures, a considered policy analysis is selected as it "extends the analytic goal beyond the technical efficiency of the governing institutions to include an assessment of the political interests and needs of the larger political community" (Fisher, 1998). It is demanding to understand the policy ideas and national community influencing, in particular, the policy process and interpretation.

To sum up, the theory of policy analysis covers several activities and areas involved in building, performing and assessing processes of a policy. Due to the case that it combines socio-economic and political aspects in terms of analysing the development and effects of a policy, it is recognized relevant on the way to analyse broadband development in the national telecommunication industry.

3. What must be regulated?

The aim of telecommunication policies is to govern the telecommunication resources that are intended for the all people for reaching universal access. Some of often regulated telecommunication services are numbering, radio spectrum and right of way identified by William H Melody. In addition, Mr M H Au (2004) identifies sector specific regulated resources such as tariffs, interconnection, merger acquisition, fair competition, and licensing of mobile services. Also as variables regulated telecommunication service are recognized the universal services and Quality of Service. Unlike Mr Au who recognized the regulation of mobile services licensing, Shirley Svorny discusses about the regulation of licensing in the wide-ranging term of market entry for any service (Shirley Svorny, 1999). The law in every country, enforced by regulators, is established to regulates these services.

Why to regulate?

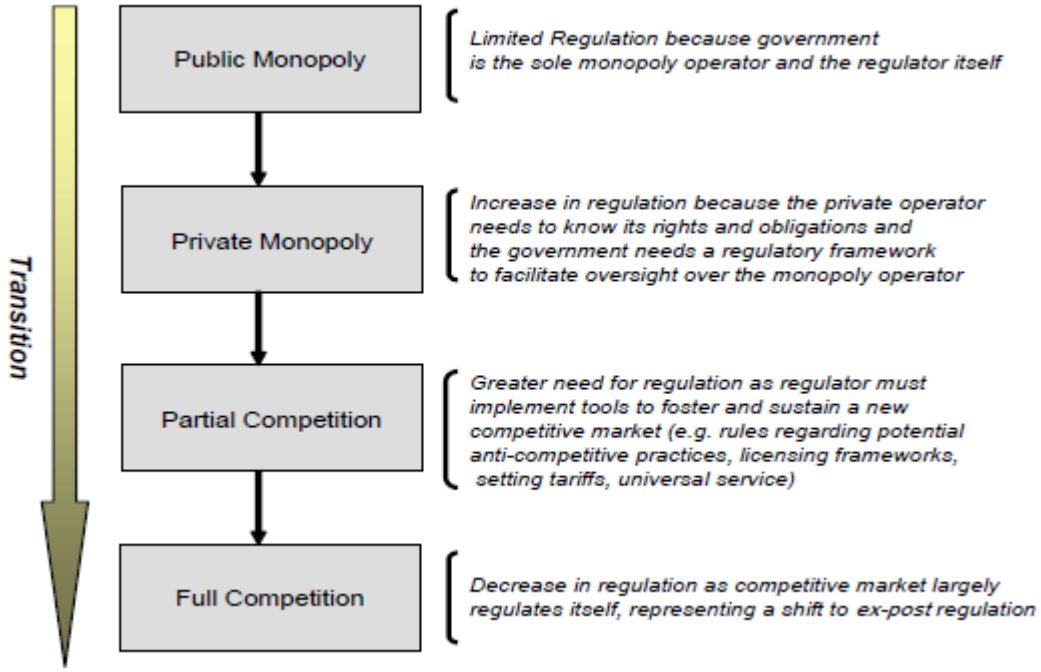
The demand for regulation differ depending on the environment of the market. While the construction of the regulatory framework may vary, some crucial elements must be included in one efficient regulatory framework, for instance decision-making processes, the functional elements of the regulatory authority, consumer protection, accountability, enforcement powers and argument resolution (Blackman & Srivastava, 2011). Suitable implementation and consideration of these characteristics are main aspects for creating a permissive environment for sector development and for raised welfare for consumers.

Large number of countries, in the 1990s, initiated the leading wave of reform when their national operators were privatized. Telecommunications services, before that time, were mostly provided in monopoly environment and so restricted regulation resided because the government was performing together as regulator and operator. In the bare beginning of liberalization, some countries have formed a regulator when presenting a private monopoly. The sector was overseen by those regulators and safeguarded for that the private operators understand and can comply with the rules in place.

In the second wave, which occasionally happens at the same time as the privatization, governments usually approve the entry of new services and service providers into the market. Commonly, this contains the changes of the licensing framework with regard to agree the admission of the new players, including the introduction of additional regulations and rules to permit participation of these operators in the marketplace.

When the exclusivity time of incumbent operator ends and complete competition can be presented then occurs the third wave of liberalization. The part of the regulator indeed rises when the full competition is introduced, (see Figure 1), generally through the initial stages of conversion from the previous monopoly to efficient competition.

Figure 1: Need for regulation



Source: Telecommunications Regulation Handbook and ICT Regulation Toolkit

As Blackman & Srivastava (2011) noted, regulation is not being an end by itself, but to some extent a vehicle to achieve, and afterwards sustain, extensive access, consumer protection and efficient competition. The regulatory reform should contain measures to be able to transit to a competitive efficient environment. The aims of those measures are:

1. Build functional regulators to supervise the introduction of competition;
2. Preparation of the incumbent operator to meet competition;
3. Controlling and allocating scarce resources in an unbiased way;
4. Enhancing and spreading access to ICT services and networks;
5. Advocating and protecting consumer interests, along with privacy and universal access.

When an entirely competitive environment is achieved, it is commonly agreed that the need for regulation is more narrowed. Nevertheless, in specific areas like universal service and access, market forces often fail to create the mandatory conditions to accomplish public interest objectives and so it requires for regulatory intervention. Regulatory agencies, equivalently, should make sure that spectrum is correctly controlled and allocated.

Furthermore, despite the welfares of innovative technologies, regulators also should be responsive and concentrating to the regulatory matters that arise from the employment of these novel technologies and their associated services. For instance, now regulators are dealing with problems like spam and consumer apprehensions concerning privacy, which 10 years ago, were not subjects of concern to regulators. Additionally, governments are revising their regulatory structures to conclude if their present organizational structures are appropriated for regulating a congregated marketplace with various services obtainable on one platform.

Similarly, regulators recognise that their present regulatory frameworks may hinder the operators' capability to offer triple or multiply play plans to customers or the usage of low-priced Voice over Internet Protocol (VoIP). Likewise, several governments are now running consultations concerning to evaluate what standard must be used for digital television services. Additionally, regulators must guarantee that consumers are aware of possible limitations related with the innovative technologies (e.g., some offered services might be with lower quality and emergency services might not be accessible).

One effectively implemented regulatory framework has leaded to enlarged investment, greater economic growth, minor prices, higher penetration, improved Quality of service, and faster technological innovations in the sector. Investors indeed consider as a critical factor the national regulatory environment in their investigation of whether to invest in a country (Blackman & Srivastava, 2011).

4. Economic arguments for broadband policy and public intervention

Firstly, it is significant to recognise the economic perceptions of why there is a necessity for implementation of broadband policy. Principally, there is a justification for the public sector to interfere or improve the market: in that case, the Bulgarian regulator and the European Commission have used regulations and broadband policy as an instrument for public involvement in the EU telecommunications market built on many arguments. The two crucial arguments, the political justifications, and public goods and broadband benefits are described below, adjusted from Cremer et al. (2001)[1].

Political arguments:

Based on Cremer (2001) there are political arguments that are usually used by the public sector to provision its reasons for implement broadband regulations and policy. In several countries, for instance, policymakers can employ broadband regulations and policy as tools to provision their regional policy along with to enhance welfare. The political arguments are still very subjective and vary in the different countries. As a recommendation, the priority for reasons to implement broadband regulations and policy must be grounded on the economic perceptions.

Public goods arguments:

Besides the political justifications, telecommunications services contain one of the two features of public goods: they are non-excludable and non-rivalrous. Non-excludable goods are those goods that can be used by everyone because cost doesn't reduce access to it. Non-rivalrous goods are those

[1] Cremer et al. (2001) noticed these arguments for the usage of the universal service obligation (USO); nevertheless, these views can also be used for broadband regulations and policy in general.

goods that are used by many customers at the same time at no added cost. To some extent, likewise to rail services and education, broadband services can be deliberate non-rivalrous but then excludable. Though the private sector can offer broadband services, can be made sure by the public sector and due to the features of the public goods of broadband services, that market failure does not appear. Some broadband policies and regulations have been settled and applied before the 2000s for avoiding the market failure, like under-provision of broadband services or a monopoly. However, to implement broadband regulations and policy is not straightforward, also must consider some market players and economic issues.

Broadband benefits (positive externalities) arguments:

Additional motive for the public sector to become involved and interfere in the broadband market is that many benefits to region or a country are offered by broadband services. Furthermore, diverse qualities of broadband services are probable to contribute differently to the welfares. In the same way as telephone service, broadband welfares can be created when more individuals subscribe to the service. When there are more customers, these products' values can be seen as network (positive) externalities. Generally, subscribers in are not informed about the network externalities when they choose to subscribe to some service; therefore, the market and broadband services can be undersubscribed and ineffective. Broadband regulations and policy hence have a part to solve or diminish this kind of market inefficiency.

While these arguments sustenance the concepts behind the broadband policy and regulations, there is disapproval that they can fail and instead to support they could distort the market, which is later debated. To be able to analyse and give recommendations for upcoming national broadband regulations and policy in Bulgaria, it is significant to comprehend the history of the achievement and failure of European broadband policies.

5. EU broadband policy in 1999-2010

EU has recognised the internet services and following broadband services since the Green Paper on the development of the common market for telecommunications service and equipment in 1988. Still, the first broadband policy that proposed stimulation of broadband development was brought in as "eEurope – An information society for all" in 1999 (Teppayayon, 2012). An overview is provided in that section of the history of broadband policy beginning from 1999 to the present EU Digital Agenda 2020. It is also discussed, the progress and some downfalls of EU broadband policies so far via the supply and demand dimension.

The first broadband policy has as a purpose to bring the EU citizens into the digital era, creating and achieving strengthen social cohesion and digital literacy. In the initial variant of eEurope, ten priorities took place: 1) leading young Europeans into the digital age, 2) low-priced internet access, 3) stimulating the growth of e-commerce, 4) all education and research communities to have fast internet , 5) implementing smart cards for secure electronic access, 6) making risk capital possible to high-tech SMEs, 7) creating e-participation for the disabled people, 8) providing online health care access, 9) enhancing smart transport and 10) ensuring two-way online electronic access for government (EC, 1999). The ten areas resided in the policy, however, the "cheaper internet access" area was most emphasised on. The logic for that was that most internet providers, at that time, had a dominant position in the market. Therefore, the EC tried to provide different choices and cheaper

internet services to the people. Respectively, to stimulate competition in the last-mile network, at the end of 2000, regulation on unbundled access to the local loop was executed for operators with significant market power (EC, 2000).

eEurope 2002 – Priorities and impact

The aim of eEurope 2002 was to encourage better internet connectivity in the European Union, encourage internet use by focusing on consumer protection and training and raise network competition. Additionally, three main objectives were grouped for the action plans:

- faster, cheaper, and secure internet services;
- investing in skills and people;
- internet use encouragement, (EC, 2001).

Alike the first eEurope policy, European Commission put more emphasis on cheaper internet services. While the key focus still was unbundled access to the local loop, a few regulatory frameworks were brought in after the distribution of eEurope 2002. Some of them were about access and interconnection, the 2002 regulatory framework, authorisation and licences, data protection and universal service. For this broadband policy, interesting was that faster internet had already been highlighted along with cheaper ones. That accent on faster internet obscure that the European Commission had started to identify the importance of internet speed and started a policy therefore to ensure faster services for the development of broadband.

Furthermore, one of the regulatory frameworks that was distributed in 2002 was a recommendation for analysis of market, containing the assessment of significant market power into the Community regulatory framework for electronic communications networks and services. With this framework, at that time, the focus of the EU policy was implied on approaching the supply side to make more competition in the market including and the growth of infrastructure for broadband access (in of broadband-related markets).

eEurope 2005 – An information society for all, was an action plan that accomplished eEurope 2002. The major goal of eEurope 2005 was to stimulate the development of secure content, applications and internet services. Moreover, eEurope 2005 pursued to convert digital connectivity in economic productivity. At that time, the main aim was the promotion of online public services, like e-learning, e-government and eHealth (EC, 2002). Corresponding to eEurope 2005, the focus of the action plan was the new regulatory framework for the radio spectrum. Additionally, increased online services and digital inclusion were underlined in that action plan.

i2010 – A European information society for growth and employment:

When the growth of productivity and the employment became more connected to the Information and communications technology (ICT) industry, the EC launched a new initiative, i2010, to provision more number of jobs as well as economic growth within the ICT sector. In i2010, three priorities were widely planned. These contained priorities were: strengthening ICT investment and innovation, single European information space, and encouraging European information society (EC, 2005). The first priority, intended to boost the state funding for research and projects related to ICT. The second, a single European information space, invoked for richer content, faster broadband services, a higher state of interoperability and improved security. The third priority, a wide-ranging European information society, put focus on developing ICT services to become more accessible, specifically via the usage of public services. After the i2010, several regulatory frameworks were actualized for

better response to the dynamics and new emerged technologies of the telecommunications market. In 2007, for instance, the EC revised the Recommendation on relevant product and service markets susceptible to ex ante regulation. Furthermore, in 2009, amendments have been made to the access and interconnection frameworks, 2002 regulatory frameworks and licences and authorisation frameworks.

In the period from 1999 to 2010, while broadband adoption and broadband access had been addressed in various forms through EU broadband policy, the policymakers seemed to put more focus on the access and infrastructure side more. Although, still there was no clear assumption on whether the European Union was on the proper track, since the previous decade, the market and broadband technologies had been transformed continuously and adequately. Therefore, in 2010, new ten targets and recent broadband policy had been proposed. The European Commission adopted a new initiative titled 'The EU Digital Agenda 2020', including eight action areas for developing the ICT sector in the European Union.

6. The EU Digital Agenda 2020 and the Digital Single Market Strategy

The European Union launched the Europe 2020 strategy, in March 2010, to established several goals for the EU in the next ten years. Some of the goals for the Europe 2020 strategy are accomplishing a low carbon economy, high levels of employment, and social cohesion. The Digital Agenda 2020 is one of the main approaches to support and stimulate for European citizens a better quality of life using the benefits of ICT. Seven pillars are incorporated in the Digital Agenda, which are:

1. Creating a vibrant single market to deliver the welfares of the digital age;
2. Improving interoperability and standardization in information and communication technologies (ICT) field;
3. Enhancing security and trust in the Internet;
4. Expanding access to fast and ultra-fast Internet of European citizens;
5. Stimulating cutting-edge research and innovation;
6. Providing skills to handle digital technologies and inclusion of online services for all European citizens;
7. Deploying the potential of ICT for providing benefits for the EU society (EC, 2010).

To measure those action areas, the EU Digital Agenda consist also of more than a few Key performance indicators (KPIs). Some of the example measurements in some of the pillars are:

- The difference between roaming and national tariffs must be closer to zero, by year 2015;
- 20% of citizens must buy cross-border online, 33% of SMEs must buy or sell online and 50% of citizens must buy services/products online, by year 2015;
- Common internet users must increase to 75% of all citizens, by year 2015;
- All European households must have access to broadband of at least 30 Mbps or more, and no less than 50% must be able to get access of broadband of 100 Mbps or more, by year 2020;
- 50% of European citizens must use e-government services, (Munisteri, 2013).

Several of the pillars are connected in different form to broadband services. In respect to Bulgarian broadband direction and the study of this thesis, the emphasis will be put on the fourth action area, fast and ultra-fast internet access. As it is shown above, for attempt to measure the usage and availability of broadband services, there are several KPIs. For instance, by 2020 all European

households must have access to broadband services with speed of connection at least 30 Mbps, and no less than 50% must be able to get access to broadband with a 100 Mbps or more connection speed. On the side of broadband usage, internet users must escalate to 75% of citizens and 50% of the EU residents must use e-government, by 2015.

For the achievement of these ambitious goals, since 2010, the EC has started or updated versions of more recommendations and broadband policies. Part of these policies in chronological order are: in year 2010, the Next Generation Access Networks (NGA) Recommendation, that provides a common regulatory approach for access to new high-speed networks that balance the need to stimulate investment and safeguard competition. Proposal for creation of the first Radio Spectrum Policy Programme. The program aims to make available the bandwidth of 800 MHz for electronic earth telecommunication services, including mobile broadband by 2013 (possible derogations until 2015), which are the basic condition for the higher distribution of mobile broadband, especially in rural areas. In 2012, the State Aid Broadband Guidelines, the Proposal for a Regulation on measures to reduce the cost of deploying high-speed electronic communications networks in 2013, and the next year the Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation.

In 2014, Jean-Claude Juncker has been elected as the new President of the European Commission, together with a new unit of commissioners. The “Digital Single Market Strategy” was one of the priorities of the new unit in the telecommunications sector and was adopted on the 6 May 2015, including 16 detailed initiatives which have been brought by the Commission till January 2017. Initially, three major areas have been set to be the central focus of it (EC, 2015). The three indicated areas are:

- Access: promote better access to digital services and goods;
- Environment: building the infrastructure for digital services, networks, and innovation;
- Economy and Society: establish long-term growth potential for a European Digital economy and society (Industry 4.0).

Some of the benefits of a DSM are the creation of opportunities and allows for new start-up companies and existing ones in a market of over 500 million people. Another benefit is that it can encourage modern open government. Effecting Digital Single Market could provide € 415 billion per year to European economy, stimulates employment and transform our public services. Also, it provides opportunities for citizens by equipping them with the right digital skills. Intensified use of digital technologies can advance citizens' access to culture and information, and improve their career opportunities (EC, 2015). Nevertheless, the discussion and analysis about the EU Digital Single Market Strategy are outside the range of this thesis. Therefore, the evaluation, analysis, and guidance of broadband policy in the thesis are primarily grounded on earlier broadband policies in the European Union and the EU Digital Agenda 2020, considering that are incorporated in Bulgarian broadband development strategies.

7. Complains about EU broadband policy

Number of scholars have criticised the EU to move slowly, especially in comparison with Japan the US, in the development of high-speed broadband, (for instance, see Yoo, 2014; Briglauer and Gugler, 2013). Moreover, the broadband regulation and policy in the European Union have been also

criticised; in the manner with the effectiveness of access regulation on the investments in next generation network (NGN) and disapproval that the EU give the impression of preferring service competition over infrastructure competition. Also, the focus of broadband policy is essentially mostly on the supply side, while the EU broadband policies as well as the EU Digital Agenda, include equally broadband adoption and infrastructure. It has stated by Batura (2014) that the actions for the EU Digital Agenda are still severely emphasised on the supply side.

For understanding all these matters and assessing the broadband policy in the EU as well as the Bulgarian national policy, revision of earlier literature is required to facilitate better understanding of the EU broadband policy along with to propose guidelines for future broadband policy to suits with the changing dynamics of the broadband market. The central aspect for the development of society and economy is considered to be the broadband services. Therefore, the summary of broadband welfares not only offer a broader understanding of the matter but as well address and imply that it is valuable to have suitable broadband policy that can force to larger broadband adoption and penetration and eventually an improved society and economy in a region.

8. Supply side and demand side dimensions and policies

In that section, will be introduced what are the supply and demand side policies and provided some based on them studies. That supply-demand discussion is closely related to the discussion on networks vs. content and services, which will be look through details in the next section. Later in that section is discussed the interventions and the efficiency of demand and supply policies.

Supply side

The supply side policy, in this paper, refers to broadband policy that means to expand the productive capacity of internet services, mainly the broadband network, infrastructure, and access. Policymakers can use various ways to enforce supply side policy at different levels of development and with diverse socio-political conditions. The form of the policies might be a tax, subsidy, director or indirect investment or regulation. The European Union, in the past decade, accentuated the practise of supply side policy using regulation. Some of them are the assessment of significant market power under the community regulatory framework. the regulation on unbundled access to the local loop, the access and interconnection frameworks and the 2002 regulatory frameworks. The studies are broadly discussed, considering that the paper cannot cover earlier studies for all policies of supply side. However, most of the supply side policies are summarised in brief.

Categorisation of the supply side policies was introduced in the report by FSR (2011). The types of policies are sort into three groups created on their objectives: 1) diminishing private operators' costs of deployment; 2) supporting private operators' entrance to the market; and 3) interventions that contain the direct expansion of broadband infrastructures by public sector. While this classification is useful for expressive purposes, it is central to mention that actual world public initiatives frequently adopt a combination of the different objectives and tools. Adapted from the report (FSR, 2011), the table below present an overview of the objectives of intervention equivalent to the categorization, along with examples of exact policies.

Table 1: Supply side policy categories

Objectives of supply side policy	Examples
Reducing operators' costs	- Policy on sharing the infrastructure - Mandating access to local facilities (licensing/franchising and rights of way) - Fiscal incentive - tax credit and supply side subsidy - Policy on administrative simplification - Low interest and long-term loan programme
Supporting private operators' entrance to the market	- Territorial mapping programme -Spectrum policy - encouraging spectrum trading/sharing and efficient use of digital dividend - Policy on infrastructure competition
Direct development of broadband infrastructures by the public sector	- Public-Private Partnerships with either private or public ownership of the network infrastructure - Direct investment in the networks - Increase public information points and facilities - in libraries, schools, and metropolitan areas - Providing broadband services through municipal utilities

Adapted from FSR (2011)

On the supply side, there are several policy tools, but the most efficient seems to be the direct investment from the government since it ensures broadband infrastructure overall along with resolving the problem of incumbent barriers. Nevertheless, the usage of direct public funding has some drawbacks. Somehow is blurred whether a great sum of money must be consumed only for broadband developments, especially considering the recent economic condition in the EU. Additionally, the incentives for telecommunications operators to build and advance the broadband infrastructure cannot be raise by the usage of public subsidy. To encourage extra investment from the private division, direct expansion of broadband infrastructure might also be realised by the involvement of private sector. This kind of association between the private and public sectors investments is termed public-private partnership (PPP). One of the benefits of PPP is that whereas it goals to resolve market failure with the public-sector support, it also enhance public policy by bringing private sector investments (Falch and Henten, 2009).

The spectrum policy is other vital policy tool from the supply side. The wireless technologies, like Long-term Evolution (LTE), is presently one of the factors with greatest importance for the mobile broadband growth. The spectrum policy purpose is to efficiently operate and allocate spectrum.

Illustrations of spectrum policy are supporting a market-based method for assignment of the spectrum, letting re-farming of the spectrum and assignment of the shared spectrum access. Additionally, the supply side policies encouraging operators to spend money in broadband infrastructure are also loan programmes, fiscal incentives, administrative simplification, and territorial mapping programmes. Overall, these kinds of broadband policies might be realised along with further broadband policies.

Demand side

Formerly, demand-side policies have involved noticeable less attention than supply-side policies, both in the actual policy practice of worldwide countries and in the related literature (non-academic and academic). Demand-side policies in the literature have been the entity of fewer wide-ranging empirical analysis and have lately turn out to be a relevant subject for examination. Prior to concerned international policy practices, while most nations have implemented e-government policies, the usage of other demand-side policy tools particularly directed at growing broadband penetration has been rather limited. The considered countries that have presented a bigger engagement to demand-side policies, although with different tools and emphasis are Sweden, South Korea and the UK.

The general reasons for the embracing of demand-side policies lures on the concepts of indirect and direct network externalities along with on a fairly sufficient literature on new technology and ICT adoption and usage that demonstrates that the direct fiscal cost of novel technologies is only one of the stimulating adoption factors. The first breakthrough piece was from Rogers (1995) on the diffusion of innovations, and later the identification of the ease of use. The literature advocates that basically reducing the instant and direct cost of broadband access connections through supply-side policies might not be sufficient to rouse broadband subscriptions.

In the report by FSR (2011), the demand-side policies were characterised accordingly to the pursued main objectives. On one hand, there are policies designed for falling the price of access to broadband services, whose motivation exist in in the fact that, mostly for some disadvantaged collections of clients, the affordability can be measured as an obstacle to broadband adoption. These goals may be followed through a variation of policy tools, including tax credits, subsidies, demand measurement and demand aggregation initiatives (see Table 2).

On the other hand, some policies meant at growing the perceived cost of broadband services. The motivation for this kind of involvements is more articulated, as described by Hauge and Prieger (2010). There are policies (e-government policies for instance) that might have the outcome of increasing the worth of the available content in the internet are well-suited with the concept of consumer sovereignty and thus with the idea that, the consumer exposes her true evaluation for broadband services, through its choice not to purchase those services. Therefore, that policies are more suitable with a limiting sight of governments' interference in the economy. In comparison, the implementation of other policies presumes a wider view of the public intervention scope. In that case those policies inspired by the goal to "educate" the customer by increasing his/her awareness of the welfares from broadband adoption or his/her capability to gain advantages from broadband services (Hauge and Prieger, 2010).

Another valuable distinction to be drawn from demand-side policies involves their application to, specifically, the advancement of new network rollout or the extension of broadband coverage. These policies certainly have been used to arouse the adaption of current broadband infrastructures. Also,

they have been used to growth the success of investors' business plans for the outspread of NGN, hence allowing zones where investment have not been bearable inattentive public intervention to become beneficial. While their usage is the stimulation of NGN rollout, demand-side incentives turn into catalysts for investment from private sector in network rollout (Jeanjean, 2010).

As summarised by FSR (2011), demand side policy tools are characterised and separated into two: reducing the costs of adopting broadband access and services and increasing the worth of broadband access and services. In Table 2 is shown an overview of demand side policies. Also, it is possible that some of the supply side policies might profit the demand side and vice versa.

Table 2: Demand side policy types

Objectives of demand side policies	Examples
Increasing value of broadband access and services	- Increasing the demand from broadband by providing better availability of public services, such as e-education, e-health, and e-government - Policy on digital literacy - Increasing quality of broadband services, like internet security and quality standard - Rising awareness of the welfares of broadband services by both businesses and households, like by supporting e-commerce and IT education
Reducing costs of broadband access and services	- Policy on demand aggregation - Demand tax reductions or subsidies for broadband access and services (and complementary products) for customers or target groups

Adapted from FSR (2011)

As it is exposed in the table above, in general demand side policy is used to rise the demand from customers for broadband adoption. Additionally, the usage of demand side policy could be united with supply side policy to support the EU achieving both adoption and access goals. Among the common methods for increasing broadband demand is through online public services, along with consumer awareness and rising broadband quality. The skill of peoples and IT education are significant aspects that lead to higher broadband usage. Tax reductions and demand subsidies for broadband access and services are also normally used for the targeted groups that the legislators' intent to boost to usage of broadband services by decreasing the price of them. This approach of price decrease can also be practical to other goods that are complementary to broadband services, for example laptops, tablets and computers.

A case of a policy tool that gain profit from both the supply and the side demand is policy on demand aggregation. That programme associates possible customers' demand for broadband services to

advance allocation of resources. Although this policy can advance the bargaining influence on the demand side, also it can be used to assure that there will also be sufficient incomes on the supply side (FSR, 2011).

Increasing beneficial content (E-government)

Governments in most of the countries have selected to act as buyers and "lead users" of broadband technologies. By this action, they mean to rise the returns to investment in broadband, predominantly in situations in which private demand is still latent, by means of the creation or improvement of e-health, e-government, or e-education applications. The justification for these initiatives is in the fact that improved availability of beneficial content must act as a driver of broadband adoption. For a clarification of the reasons why applications and content instead of infrastructure availability, must be considered as main drivers of broadband penetration with precise regard to the EU situation, for instance see Preston and Cawley (2008). Widespread are mostly the actions of digitalization of the Public Administration, by which governments offer on-line information to people, provide some bureaucratic services and can broadcast local administration council meetings.

A leading nation in terms of attention devoted to e-government initiatives has usually considered to be Japan, together with South Korea, though almost all countries have implemented policies of this type. These actions have become even more eminent in Japan when fibre network deployment has reached a progressive stage and has been launched the U-Japan strategy (MIAC, 2005). Numerous European countries are also at the lead of e-government. In a benchmarking report prepared for the EC, indeed, was shown that Malta, Ireland, Portugal, and Austria are top performers in relations of sophistication of on-line services and that Italy, Portugal, Austria, Malta, Ireland and Sweden have accomplished complete on-line availability of e-government services (Capgemini et al., 2010).

The present relationship between e-government services and broadband should be gestated as a two-way relationship. On the one side, the spread of broadband would expand the use of public services and arrangements for delivering them. On the other side, the choice of distributing public services over online platforms is a potential instrument for exciting broadband penetration (FSR, 2011).

The advancement of broadband makes it probable to use on an important scale product and progression of innovations that need high bandwidth. That includes the new multimedia devices and new applications (virtual worlds, 3D and HD video, online gaming, and so on), smart grids, user-generated contents, e-education and e-health, cloud computing and grid computing. Particularly, grid computing allows the aggregation of computing resources spread among terminals, whereas cloud computing enables for a flexible use of applications and services obtainable on the web (“in the cloud”). Several of these technological advances might have applications in the delivery of services in e-government or to public administrations activities and, as such, are expected to extend to the public sector the positive things of technological progress in terms of variety, quality, and innovativeness of facilities available to the residents. Simultaneously, there is also a secondary effect that can rise from large-scale distribution of e-government made possible by broadband systems. Actually, broader access to information over the use of broadband technologies can work as a pedal to decrease the used costs of public services by inhabitants, to increase the part that reputation can act as a monitoring system, to endorse the adoption of good practices by the public administrations and to expand the state’s performance in relations of provision of public services.

Despite the scale of the potential welfares they may generate, so far e-government initiatives have mixed success worldwide, both as an approach intended to facilitate access to public administration services and as per a strategy for the advancement of broadband adoption. Nonetheless, the impartially limited literature on e-government seems to show some inappropriate optimism on e-government actions and to overlook important aspects (Heeks & Bailur, 2007). Stages of usage of e-government services give the impression to be relatively low even in the most progressive countries, maybe because the plan of e-government initiatives does not always consider the needs of end-users (Van Deursen, Van Djik and Ebbers, 2006)

Increasing digital literacy, awareness and ICT skills

These policies might have a dual objective. Primary, they may be intended to increase users' awareness of the welfares from broadband. Secondly, they may be intended to target businesses with low standards of ICT skills, predominantly SMEs (Small and medium-sized enterprises).

The first type of policy initiatives might take many forms, including advertising campaigns IT alphabetization initiatives, the institution of Community Information Centres and Community Technology Centres, educational vouchers and policies aimed at growing the usage of broadband in education. These actions may be directed to the people in general or, ever more commonly as broadband penetration growths, they may target "weak" sectors of potential demand, categorised by a low ability/propensity to use innovative technologies, and made up mostly of schoolchildren, housewives and the elderly.

The leading countries in terms of implementation of this policy tools have assuredly been South Korea (particularly with "10 Million People IT Education Project") and Japan (with the "IT Human Resource Development Plan") but numerous other nations have trailed suit, as per it is the case for Mexico (Sistema Nacional e-México), Ireland (SchoolIT2000), and the Czech Republic (State Information Policy in Education). Some methods of incentive to private demand have also focused on inhabitants of rural communities, for instance in the USA, the project "Connected Nation" and the plan "Backing Indigenous Ability - BIA" in Australia. The most widespread analysis of e-inclusion or digital literacy programs is presented by Hilding-Hamann et al (2009a, b), who give an overview of a remarkable number of digital inclusion worldwide programs.

As in other areas, South Korea's initiatives are principally interesting because they are taken on in the context of a comprehensive project and because of additional interesting features. South Korea's digital literacy program emphasised on the people expected to have the highest impact on households' performance and decisions concerning broadband, specifically housewives, which is thought to be an important success aspect of the policy (Choudrie and Lee, 2004).

The Swedish government initiative are interesting for the specificities of its execution that aiming to rise IT literacy between schoolteachers and, also the Digital Inclusion Project of the USA-based Digital Inclusion Group, that accepted a model built on partnership with local communities to distribute to low-income parts of the population a "TechPak" including two devices for internet access (mostly modem and computer) and support and training services.

Some consideration has been concerned also by the institution of Community Technology Centres (CTCs) (also named community telecentres, networks, or Free-Nets), specifically local centres dedicated to increasing IT skills, particularly in rural or disadvantaged regions. CTCs are mainly organized and diffused in a network in the USA, (CTCNet). Analysis of the performance of 36 community centres established in Texas, USA, was revised by Strover, Chapman and Waters (2004),

to find evidence of beneficial effects in both terms of higher access and social and digital inclusion more generally. The experience of CTCs was also reviewed by Mok, Koong and Liu (2002) and positive effects were found. However, both papers highlight that results tend to be varied, with achievement of these actions depending much on the specificities of implementation.

The second type of policy initiatives intents at increasing businesses' awareness of the welfares from broadband access and businesses' capability to derive welfares from broadband adoption. Projects of improvement of ICT penetration in SMEs tend to highlight time and cost savings originating from the acceptance of some broadband applications like e-commerce and digital payments. In Finland, the funding to business demand objects to help firms adapting their business models to innovative broadband applications. In France, it has engaged the method of the arrangement of industrial districts categorised by the existence of ultrafast broadband connections. The project "Proteus" in Germany, boosts the adoption of precise standards for e-business actions and the German government has offered consultancy services and prizes for the development of state-of-the-art uses of broadband technologies in SMEs.

The selection of demand side or supply side interventions

Nearly all off the literature concentrates on the analysis of specific supply side and demand side tools and on the definition of national policies. So far scarce attention has been dedicated to broader interrogations concerning the relative qualities of supply side and demand side policies in beneficial terms, the timing of their implementation and the choice of their suitable combination. On one side, the general opinion found so far in several papers is that there has been much attention on the supply site. On the other side, in many countries there is also a general trend towards more emphasis on demand stimulation. In brief review, in that section, the contributions that have worked on these issues will be revision.

A few of papers have tried to identify the welfare implications of choice to, respectively, supply side and demand side policies, with an emphasis on subsidies. The first involvement on this issue per FSR (2011) was a study by Austan Golsbee (2002) that empirically examines the impact of investment subsidization and usage subsidization in beneficial terms by determining market level demand curves on the foundation of survey data on the willingness of consumers to pay. Golsbee deduced that "subsidising usage generates more adoption than does subsidizing fixed costs but consumer welfare gains are much smaller – about half – and revenue costs are much higher" (Golsbee, 2002). The reason is that a demand side subsidy is limited to markets with already existed services and thus has the result of inducing customers with a low evaluation of broadband to subscribe (marginal consumers), whereas funding consumers that have anyway subscribed (infra-marginal consumers). In comparison, a supply side subsidy has the outcome of allowing broadband subscriptions by customers with high evaluations for broadband services that would not have get access to a broadband connection as it boosts operators' entry into earlier unserved markets, so involving higher welfare advantages. The resultant policy recommendation is hence to obligate state resources to investment subsidies instead of usage subsidies.

Goldsbee's examination was settled in the context of the discussion surrounding the first-generation broadband in the USA (primarily grounded on DSL, cable and satellite) and cannot be enclosed in a straightforward way to the NGN debate.

In contradiction, Jeanjean (2010) studies the issue of the selection between demand side and supply side subsidies from the perception of NGN and different outcomes were reached on the foundation

of a theoretical model. The main difference regarding Goldsbee's study rests on the detail that Jeanjean clearly considers that demand side subsidies, by growing demand from broadband, might lower the limits of investment profitability of operators and encourage investment in unserved areas earlier. Demand subsidies might specifically act as catalyser for investment and so to accelerate rollout of the network. Starting from this foundation, he assumed that "subsidizing the demand is more efficient, in welfare terms, than infrastructure subsidies as long as the consumers' demand for ultra-broadband remains elastic enough and that the decrease in cost is dynamic enough to allow private operators to extend the roll out of the infrastructure fast enough without subsidies". Furthermore, a main difference among the two forms of subsidies is that the time-period of customer subsidies might be flexibly accustomed and does not certainly need to be endless, whereas investment subsidies are sunk, viz they cannot be renewed when the investment has been completed.

The study provides understanding of the strategy of policies in rural and dense regions. Certainly, Jeanjean (2010) assumes that customer subsidies turn to be more efficient in dense areas for stimulate rollout (where there is a higher demand and customer subsidies would last for short time), while infrastructure subsidies turn to be more effective in rural regions, where subsidies must be extensive and perhaps unspecified to stimulate investments from telecom companies.

Although interesting, those studies do not give a complete analysis of the suitable combination of supply side and demand side policies. Primary, only subsidies were considered, leaving away other types of demand side intervention. Secondly, they do not reflect the possibility of a mix between supply side and demand side policy tools. Thirdly, indirect and direct network effects were not considered (as well as the development of new services that are based on ultrafast-broadband). Fourth part, other types of externalities were not considered. Fifth, they do not completely reflect the probable distortions tangled by the choice of the two forms of intervention. Therefore, that is an area of examination where more analysis is for sure needed.

By means of the subject of the suitable combination of supply side and demand side policies, some papers offer understanding from an empirical perception. The supply and demand are certainly strictly entangled. On one hand, one significant difficulty of new networks deployment is the absence of appropriate demand as it affects the financial sustainability of the project. On the other hand, the network existence can promote demand.

The current empirical evidence does not appear to support the last statement. Studies by Tookey et al. (2006), Youtie et al. (2007), and Sunada et al. (2011) deliver evidence on the case that network availability does not essentially arouse demand to a substantial extent and strain the necessity for demand side policies by way of a vital instrument to stimulate adoption and actual usage of broadband together with supply-side policies.

A wide-ranging survey was performed by Youtie et al (2007), united with case studies in the community of La Grange, Georgia, for the starter of an internet television-like service called LITV, designed to be easy and free to use. That analyse has shown that only by falling the cost of technologies thru supply side policies is not enough to stimulate concrete adoption, even when complementary devices for the supported technology usage (e.g., computers) are available previously to the household.

Comparable conclusions on the necessity to combine supply and demand side policies to encourage efficient adoption are made by Sunada et al. (2011), using the outcomes of a 2005 web-based survey

operated in Japan to evaluate demand for diverse broadband access approaches and reproduce the result of the enlargement of the FTTH coverage zone on customers' converting to FTTH. It was found that, because of heterogeneity of the consumer, expansion of coverage zone does not inevitably result in a growth in FTTH subscribers and determine that indirect network effects, such as the supply of complementary services, are critical to stimulate operative FTTH adoption.

Also, on the foundation of the analysis of public policies for broadband advancement in rural parts of Scotland, Tookey et al. (2006) conclude that the availability of broadband does not direct to adoption. Tookey et al. (2006) are more precise on their conclusion that in these regions, better outcomes in terms of adoption might have been accomplished if demand side policies (for example raising awareness campaigns) has been implemented not only beforehand, but also afterward when availability had been achieved. It is noted that campaigns planned to promote awareness have been cut at the moment when broadband connection had become accessible and link this momentary misalignment to the detail that adoption has failed behind. They also indicate that the misalignment might be ascribed to an absence of coordination between local initiatives (network deployment) and national initiatives (awareness campaigns).

Those studies seem to confirm the more subjective evidence on the achievement of public initiatives combining supply side and demand side policies, definite by Latteman et al. (2006), Troulos and Maglaris (2011). Comparison of the practices of Neunen and CityNet in Amsterdam illustrates that, given very similar demand and environmental conditions, the initiation of subsidies along with investments in infrastructure might lead to actual different results of broadband penetration (Kramer, Lopez and Koonen, 2006). Furthermore, mechanisms that increase awareness inspire active participation of the peoples to choices concerning network rollout could also strive positive outcomes on effective adoption rates. For instance, Zurich is one of these cases, where a public choice has been set in place (Fibre Suisse, 2010) and other experience of Lyse Tele in Norway, where potential subscribers are given the opportunity to install by themselves the final part of their household connection (Analysis Mason, 2008).

Therefore, cases for synchronised investment in supply side together with demand side policies can be obtained from the literature. Still it should be mention that the available evidences so far are limited and consequences from them are vastly dependent on demand assumptions. Additionally, these studies do not clearly incorporate in the factors of supply side analysis thus they do not, firmly, answer to questions concerning the interaction between supply side and demand side policies.

The question of when to interfere turn out to be particularly relevant when investments in NGNs are considered, as divergent to traditional networks. The reason for that is the entity of investments essential to create NGNs infrastructures is extremely greater than the volumes of investment essential for an upgrade of remaining copper networks. Lastly, a few papers study more straight the matter of the timing of supply side intervention essentially, without considering the time of interventions on demand side. The balance involved in selecting the timing of intervention is briefly address by Eskelinen et al (2008), which noted that delaying investment has downsides in the form of lost consumers' and producers' welfare, while it can lead to saved resources, since demand tend to increase and costs to decrease with time. Further observations were made by the Broadband Stakeholders Group (2010), that the delay of investment might allow to target money more suitably, since with time more information becomes accessible on benefits and costs of infrastructure investments.

9. Dimensions of the broadband policy

As it was observed in the section below the overall trends in broadband development literature are generally concentrated on indirect and direct policy interventions, demand, and supply factors, demand-pull and supply-push, and regulatory measures. On account of the chosen framework, in this section, we will focus on three concerns: regulatory versus developmental policies, infrastructure versus service competition, and networks versus content prioritization. Regulatory versus developmental policies is a matter that relates to demand-pull and supply-push and to indirect and direct policy measures. Infrastructure versus service competition is an issue often allocated with linking to regulatory discussions. Networks versus content is a topic relating to demand and supply factors too.

Regulatory vs. developmental policies

That dimension differentiates among two different methods to ICT policy - a developmental and a regulatory method. This discrepancy is motivated by Johnson (1982) and by Majone (1997), and in a few studies, is used on broadband policy (see Falch & Henten, 2015). Johnson introduced, in the paper on the post-war miracle in Japan, the notion of the developmental state in opposite to the regulatory state. Conferring the Johnson, in a developmental state the part of the state bureaucracy contains “first, to identify and choose the industries to be developed (industrial structure policy); second to identify the best means of rapidly developing the chosen industries” (Johnson, 1982).

The developmental state is contradicted with regulatory state, where the state is mostly involved with promoting economic competition, but in practical matters not with direct intervention. As a case of a developmental state was Japan while as an example of a regulatory state was declared the US. Johnson (1982) declares that state involvements and specially the part of the Ministry of Trade and Industry (MITI) played an influential part in the successful Japanese economic development. He proposes, in a future contribution, that each of the East Asian countries (Taiwan, Hong Kong, China, and South Korea) have established their own forms of the developmental state (Johnson, 1999).

Per Majone (1997), European countries were required to transform their mode of governance in a track to a regulatory model in reply to the challenges formed by growing international competition and expanding economic integration in the late 1970s within the EU. This involved liberalization of markets, privatization of public corporations as well as public utilities, and regulatory reforms. Factually, the main approach of regulation in Europe has been public ownership (Majone, 1997). Along with privatization, new modes of governance had to be established. Privatization had to be leaded by regulatory reform, expressly within the range of public utilities

In relation with the present thesis, regulation embraces mainly activities accepted by national telecom authorities, in particular Bulgarian authorities. That contains sector specific regulation, while regulatory matters addressing the economy more largely are absent from that framework.

The aim of a regulatory approach is to form a steady policy framework for a liberalized telecom market with actual competition. The tools of this approach are market failures correction and rulemaking. Nevertheless, direct market intervention is to be avoided. The institutional economics theoretically supports that approach. Here the argument is that a stable regulatory environment stimulates investments and decreases transaction costs.

The developmental method is to inspire investments and the usage of ICT by numerous initiated activities in public sector. The tools contain policies, that are more invasive than those used in the

regulatory approach. These instruments can be direct market intervention and public investments, e.g. in the method of public private partnerships serving public support to infrastructure expansion or subsidies to supply or use ICT services. This method is braced by, for example, Stiglitz (1998) and is in line with notion of the developmental state (Johnson, 1982). Nevertheless, less intrusive measures are also included, like advancement of ICT skills of the residents or demand stimulation thru public consumption.

Inside the ICT area, EU policies have involved developmental as well as regulatory initiatives. The initiatives by EU have followed at least three diverse tracks. The initial path introduced by the EC emphasised on the telecom manufacturing industry and encompassed standardization and funding of precompetitive research. Even when these actions carefully were distinct in a way so that to be prevented market distortions, the first track is evidently in line with the developmental style of governance. The second path concentrates on the liberalization of the service industry and was presented in 1987 with the Green Paper. The goal was to excite competition and growth on a shared European telecom market, and the tools were liberalization, privatization, and regulation. The third path has a wider view, by means of consistence of the complete ICT ecosystem. That track includes a sequence of following development plans like i2010, e-Europe and Europe 2020. Numeral developmental initiatives are included in these plans for stimulating the usage of ICT applications such as e-health and e-government.

At that time, Majone (1997) noticed a European trend in the direction of the regulatory mode of governance. But presently, it seems like the developmental mode of governance has grown importance, regarding ICT. One cause is that the used regulatory instruments, or the way in which they have been used, conferring to some researchers (Melody, 2013), have recognised to be insufficient to enable the broadband infrastructure development at a suitable speed, and because of it many nations are searching for another policy instruments (Falch, 2007).

In a summary chapter, Lemstra & Melody (2014) put in use the notion of the developmental state comparing different national strategies. In the study, South Korea applies the developmental model, while the US is given as an example of a regulatory state. Most of the EU countries are found between these two extremes. France is leaning more towards the developmental model, while UK is oriented towards the regulatory model. Nevertheless, several developmental initiatives have been taken, even in the US (Falch & Henten, 2010).

The industrial policies are back in style, according to Greenwald & Stiglitz (2012). Inside the ICT area that is linked to the rising importance of access to ICT services. But that renewal does not indicate a return to inspired policies practiced by Keynesian in the post-war time. Nowadays developmental initiatives should be considered in a way, so that they follow the internal market regulation and a liberal market environment in the EU. The choice of technologies and resource allocation are port out to private enterprises, when that is possible, for example with the formation of public private partnerships.

Infrastructure versus service competition

In the policy discussions on broadband developments a frequent issue has been the infrastructure and service competition. Infrastructure competition (facility-based) stand for the competition between different broadband infrastructures when similar technologies are used or competition depend on the usage of dissimilar technologies. Service competition intends that identical infrastructures are used by the network operators but they compete on network services (Falch &

Henten, 2016). The technologies frequently used are cable modem (based on cable networks), DSL (based on PSTN-infrastructures), fibre, mobile or another wireless technology. It must be mention that the description of infrastructure differs, as in many publications full unbundling is characterized as facility-based competition. The reason is that network operators should invest in their private active components like routers and switches and that only the passive cables are collective. Facility-based competition, in this situation, is defined as competition among independent network infrastructures, where only sharing of masts or ducts is acceptable.

In the 1990s, when broadband begins spreading to the business market and universal residential, any mobile broadband solutions were not available and the question was how to generate competition in the fixed broadband range. As to a great extent, the infrastructures were possessed by the incumbent operators, the primary and immediate issue was how these infrastructures be made reachable to alternative telecommunication operators. The problem of broadband competition was therefore comparable to the narrowband telephony problem, where competition was also mainly established to be built on service competition. The issue of mobile telephony was dissimilar as per networks had to be built from scratch and significance was on producing competing infrastructures.

However, in broadband provision the emphasis was on service competition, there was no dispute to whether service competition stayed as “good” as infrastructure competition. Generally, infrastructure competition was recognised as the most justifiable solution in the long Nevertheless, service competition meanwhile needed to be encouraged as it might otherwise take long to form competition in broadband markets. Therefore, the issue became how infrastructure competition can be based in the longer run while in a shorter perspective creating service competition, increasing subscriptions and bringing broadband prices down of broadband services run (Falch & Henten, 2016).

Martin Cave (2006) stylized the theory of the Ladder of investment (LoI) that became the answer to this question, to a certain extent in Europe. The knowledge of the LoI theory is that by using the infrastructures of present operators, new ones will enter the market, and then the operators will climb up the stairs of the ladder as they get an improved grip on the marketplaces, and sooner or later installing their own infrastructure. Since it was launched that theory has been widely examined (Bourreau et al., 2010). It has been applied by regulators in practice, and it has been tested and discussed by academics. From the that side, there has been disapproval. The critique has stood that the opportunity for different operators to get entree to the networks of the incumbents will lean towards to limit the investments in new infrastructures by new arrivals. Additionally, it has been specified that new operators do not go on board on a trip from the lowest service-based stairs to the maximum infrastructure-based stages. They would either go directly to infrastructure investments or stay with service competition.

In a reply to such critique, Cave has revealed that in fact there are operators which start from leas of capacity or consuming bit stream access and finally grow into unbundling usage (Cave, 2014). Though, that is also where end is. A path that leads from unbundling to funds in own cable infrastructures might not exist. The ladder of investment only relates to the different types of competition not counting new deployment of cable.

With reverence to the matter of the implications for service-based competition investments, Yoo (2014) has claimed that it might be correct that service-based competition leads to higher subscription rates and so to lower prices, but then service-based competition does not drive to advanced coverage by high-speed connections, like Next Generation Access networks (NGA). Yoo has

shown that there is a connection between low proportions of NGA coverage and high proportions of DSL lines provided by new competitors.

The overall conclusion appears to be that service-based competition endorses instant competition, leading to higher subscription rates and lower prices, but that it might put boundaries to investments in new infrastructures and high-speed technology coverage. Static competition is supported by service-based competition, while dynamic competition is supported by infrastructure-based competition.

When the brake through of DSL technology for broadband was made, the preferred mode of regulatory intervention became to be the service-based competition. Provisions for mandatory interconnection and prices access rules were settled. This spread over the Europe along with the US and many other nations. However, the policies of the European countries and the US comparatively rapidly diverged. While the European Union preserved a strong focus on service-based competition, the US decided to leave behind the emphasis on service-competition and to put priority to infrastructure competition.

Largely service-based competition has been exercised on DSL technology but could also apply to fibre and cable. The main reason that the centre of discussion is DSL is being that the most widespread networks were the PSTN infrastructures, and in addition that the incumbent telephone operators did not consume the same leading place in other technology areas like fibre and cable. Actually, European operators were forced to divest their cable networks in order to encourage competition (Falch & Henten, 2016).

Mobile has occupied fairly a different regulatory path. In the early 1990s, when mobile digital communications were launched, more than single operator was normally provided and licensed with operational frequencies. To encourage the deployment of mobile networks, national roaming was generally not permitted. There remained to be complete infrastructure competition. Though, that has transformed with the developments in mobile. The fierce competition on mobile market has been diminished the prices to a level where the quantity of operators with own networks (MNOs) has started decrease. With the unremitting new generations of mobile technologies, it turns to be less economically sustainable with direct and full infrastructure competition. That is the cause why, facility sharing has progressively been indorsed politically.

Realised from a general point of view, the regulatory lines of mobile and fixed technologies have developed in reverse directions. While broadband regulation for fixed line has turn out to be less focused on towards service-based competition, mobile has advanced in the direction of putting more stress on service competition. However, according to Falch & Henten (2016), that has been combined with a larger gradation of public subsidy of fixed infrastructure advancements, where the most prominent grouping will be service competition on the foundation of the infrastructure with public funding. Other combinations are also possible. Public funding could go to operators, for example, in an open bid, where other infrastructure providers will compete with the winning operators.

Network vs. content prioritization

The last third dimension is involved with content and networks. Are broadband policies mostly concerned with the network deployment or are they as well concerned with the distribution and creation of content? Networks and content are obviously complementary. Widespread content distribution is no longer practicable without suitable network facilities and networks without content will be worthless. Nonetheless, focuses of policy prioritization can vary from a prime emphasis on

network deployment or content creation. But the question remains: which is the main driver for the network development and complementary content?

In the current thesis, the attention is on policy implications. The balancing development of networks and content does not essentially need any public intervention, but if considered important, public policy can support content provision as well as demand, and network provision along with demand. Network providing (supply) as well as demand can be founded on developmental along with regulatory policies, and the similar applies to content providing (supply) and demand. Moreover, network provision as well as demand can be united with the prioritization of service-based or infrastructure-based competition. Also, the similar applies to content provision as well as demand. Multiple combinations are possible.

In ICT policies in Europe, the Digital Agenda earns much consideration to the content part. To a great extent, the Digital Agenda is concerned with the ICTs applications, what ICTs and precisely broadband could be applied for relating to business as well as residential applications. Since the beginning of the telecom reform course, in European ICT policies there are two focal paths. One movement emphases on the network part and has mainly been concerned with the regulation and liberalization of the telecom sector. The other movement has been also concerned of network progress but has, primary and foremost, been participating with the development of applications, content, and services. The Digital Agenda is the newest form of this tendency, which beforehand has been indorsed under the headings of i2010, e-Europe and Europe 2010.

A few countries in EU have been specifically concentrated on applications, content, and services. For instance, that applies to the Nordic countries, where big focus has been put on applications for e-government. Necessities on businesses and citizens to search for information, to apply for public services and report to public authorities have subsidised for promoting the acceptance of broadband. The main concern might not have been on the implications for extension of broadband, but it has been understood as an intensive act for supporting a digital society embracing applications, content, and services along with network infrastructures.

Although telecom policies, discussing infrastructure matters, has been topic to severe academic study for more than a century, examination on policies concerning applications, content, and services is of a more current origin. Separately from the fact that previously telecom infrastructures in most places were subject to public possession and therefore, network policies were endemic, the cause can be that traditionally industrial policies have fixated on the manufacturing sector and infrastructures rather than on services. Additional motive is that the IT sector factually has established in a liberal environment with limited regulation (Falch & Henten, 2016).

In the rouse of the telecom network privatization, competition regulation has meant to ensure that the previous monopoly markets were reform into competitive environments. A smaller amount of advert has been given to regulate monopolies in the service marketplaces. That does not mean that ICT applications and content are completely unregulated. Certainly, there is no exact sector competition regulation, but in other areas there is regulation. ICT services are regulated by way of any other types of services. Additionally, the progress of electronic information services has shaped novel regulatory problems regarding marketing, privacy, security, etc. Nevertheless, the scope varies from telecom regulation.

The situation is the reverse, when it comes to facilitation policies. The competition concentration has disguised that public contribution in development of the network has been measured as a no-go

area, because it will distort competition. European Union, for example, only permits funding of infrastructure in bordering and rural regions. In contrast, public contribution in the application, content, and service development is less controversial. The public subdivision is a key provider of services, and the delivery of electronic public services is encouraged in diverse manners in any country. The principal objective might be to empower either public investments or to improve quality of service distribution (shorter response time, 24 hours' access, etc.). Still, public supply and demand of electronic services can as well stimulate private demand and use for network services.

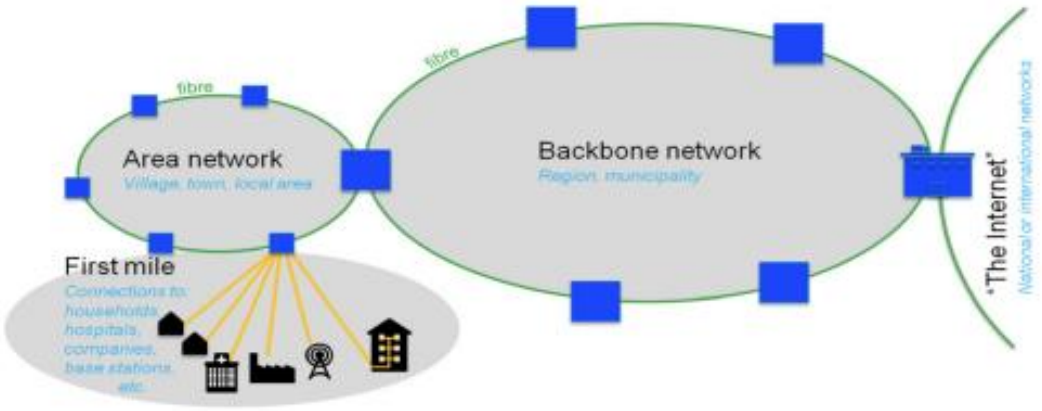
Chapter 3

1. Broadband access technologies

Geographical parts of a broadband network

The broadband access network is commonly invented of three separate parts: the first-mile (also refer as last-mile) connections to the customers, the area networks (backhaul) and the backbone network. The connection of the first mile are the links from the users (which might be companies, single homes, schools, hospitals, radio base station sites, local administration offices, etc.) toward the access nodes (AN) where the initial traffic aggregation takes place. The area networks link numerous AN aggregating further up the local traffic in the network. That as well is done with a circle of optical fibre cable, though tree topologies might be used (normally cheaper, but then less robust). Microwave connections might be used as a short- to medium-term solution, if in the region, a rather little number of users are going to be connected and the funds are restricted (EC, Guide to High-Speed Broadband Investment, 2014). The backbone network usually contains of a circle of fibre optic cable (in one cable can have several, even hundreds of optical fibres) joining different zones of the region or municipality. At this point all the traffic from all users in the municipality or region is aggregated.

Figure 2 : Topology of a broadband network



Source: EC

Today several wireless and wireline broadband technologies are used to provision local access networks. In a country to have various broadband access selections stimulates intermodal competition, increases consumer choice, boosts innovation and quality, and is usually related with lower retail prices. Nevertheless, countries might not be able to employ all technological choices, because of technical, historical, financial, or regulatory reasons. As the Bulgarian government search for ways to encourage broadband development, it will need to identify the limitations and strengths of the existing infrastructure level of development, for its possibilities to upgrade along with the development of competition policies and appropriate incentive.

Wireline technologies

Digital Subscriber Line (DSL)

DSL technologies use special conditioning techniques to enable broadband

Internet access over that PSTN copper wire, because of that is the most mutual form of connectivity in the early years of broadband and remains dominant in many countries. The DSL internet speeds are up to 8 Mbps (ADLS) and 24 Mbps (ADSL2+). That technology remains a common for delivering high-bandwidth information to small businesses and homes over the copper telephone line. DSL allows the service of surfing the internet while making a telephone call, by way of a single line supports distinct data and voice channels.

Asymmetric digital subscriber line (ADSL) broadband can be deployed cheaply and quickly (clients can often easily install their individual ADSL modems). ADSL is widely available, but as clients search for more reliable performance and higher speed many are shifting away from it. ADSL speeds can slow down because of bad wiring in home, ISP congestions, and interference from other electrical devices. In addition, the connection speed over the distance degrades, meaning that locations that are away a few kilometres from the local exchange cannot achieve the maximum possible download and upload speeds. The theoretic maximum upstream rate of 640 kbit/s and maximum downstream bit rate of 6 Mbit/s are definite by the standard. In the next standard ADSL2 are applied more efficient coding and modulation to expand the quality, bit rate and coverage.

Very high-speed digital subscriber line (VDSL) is the second generation of broadband that allows for better symmetrical data rates accomplished by more frequency bandwidth to the copper wire addition and using enhanced modulation techniques. VDSL is used to deliver high speeds over small distance in the phone copper network. Upload speed of 12Mbps and 50Mbps of download speed is achievable over distance of a few hundred meters. VDSL can outspread fiber optics networks, using configuration like “fiber to the cabinet”. That option decreases the cost of distributing fiber all the way to the household, while still allowing for faster speeds than on all copper networks are possible.

The enhanced form of VDSL is the VDSL2, that can provide even quicker speeds up to 100 Mbit/s for less than 300 meters’ distances, by reducing interference and extending distances. In Europe is being used to extend the life of copper networks, providing faster broadband lacking the cost of investing in fiber networks to the home.

Data over Cable Service Interface Specification (DOCSIS)

DOCSIS is a standard for high-speed information transmission over the present infrastructure for delivery of cable TV. Operators of CATV systems use it to provide Internet access to their clients simultaneously with the distribution of video signal over a hybrid (coax + optical) or only coaxial network. The original DOCSIS standard was created in the U.S.A. and thus it is reliable with American standards for cable transmission of TV signals (channel width of 6 MHz). The cable operators in Europe use the PAL standard, that is with 8 MHz channel width. This is the reason that modifications of European standards have been created, the so-named EuroDOCSIS standards considering that their wider bandwidth afford higher downstream speeds.

The first two versions of the standard take usage of one transmission channel in both directions. DOCSIS 3.0 is the third version and to increase speeds, multiple channels can be united in both transmission directions. DOCSIS 3.0 technology increase the network throughput up to 120 Mbps for upstream and 160-240 Mbps for downstream for end users. But this speed is shared between clients. There might be from 50 to 1000 subscribers in a wired node sharing the bandwidth. Each subscriber will not gain more than 160-240 Mbps downstream, although bandwidth for upstream is equally shared between all clients. Although cable modems are represented by some of the similar

drawbacks as those of xDSL networks, the key plus is that transmission rate does not depend so powerfully on the distance.

Optical Cable Access Networks (FTTx)

When mentioning optical access technologies, it means network architecture where the line from the internet provider's headquarters to the client is completely or partly constructed with optical fiber. They are common known by the term FTTx, where X characterizes where ends the optical line (its start is always at the provider).

FTTN (Fiber to the Node)

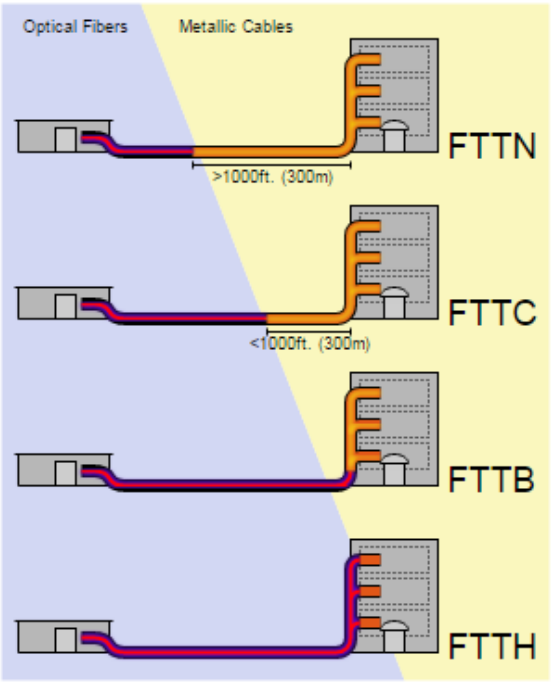
Fiber-optic cable, with this kind of access network, is stopped in a distribution cabinet that assists a certain area and it is located at 300 - 500m. distance up to some kilometres away from the end users. By copper cables is established the connection from the cabinet to the user (coaxial cable or telephone pairs), using variations of DOCSIS and xDSL protocols. Typically, the range that the distribution cabinet serves had a radius of 1,5 km. That type of architecture is the cheapest for employment from the FTTx set, because it uses the existing copper infrastructure on maximum. At the similar time with the broadband service consumption development, the possibility to meet the request for higher speeds is very restricted due to the big distance of the optical cable from the client device and the limits of access protocols working over copper cables.

FTTC (Fiber to the Curb)

The network type fiber-to-the-curb, common known as *FTTC networks* offer one of the most economical and simplest ways to growth the bandwidth of networks and deliver new services to clients. By FTTC networks, the optical cables from provider's central nodes are linked to curbs, supplied with electronic distribution facility. From the curb to users are passed quality twisted pairs (FTP type), that unlike usual telephone pairs are with much improved technical parameters and quietly shorter length (up to 100 m). Those pairs spread signals at speeds of up to 100 Mbps or even higher.

FTTC is principally a special case of FTTN, by means of the location of the fiber cabinet - within 300 meters from the subscribers, i.e. it serves a smaller range and fewer number of clients. Consequently, in reality the last portion of the access network (last mile) is reduced, which lets the use of technologies supporting higher access speeds, VDSL for example. FTTC access networks are most frequently implemented upon the development of VDSL2.

Figure 3: Diagram of Several FTTx Systems



Source: Wikipedia, https://upload.wikimedia.org/wikipedia/commons/9/9e/FTTX.svg

FTTP (FTTD, FTTH, FTTB)

The main concept in the progress of next generation access networks is grounded on the idea that the optical fiber must be used as a medium transfer adjacent to the subscriber, i.e. to create connection with him over the so-termed FTTP (Fiber to the Premises) networks. In this kind of network, the optical fiber from the core network node, spreads directly to the client's home. Fiber to the Premises is the universal name of architectures wherein optical cables reach the premises where subscribers are located. The architecture is separated into FTTB, FTTH and FTTD, depending on the last point of terminating fiber cables.

In FTTB (Fiber to the Building) the optic cable is ended in a shared premise (or basement) in the building, while for distribution of signals to the end users in the building diverse transmission medium is used (typically UTP cable, coaxial cable, or wireless connection). In fact, FTTB is a hybrid solution where the final connection between the end user and the hub is constructed on copper cable with enhanced transmission features (structured cabling systems). From that viewpoint, FTTB access networks have alike features to those of FTTC with VDSL2 technology. Unlike the point-to-point connectivity solutions, here the linking fiber from the optical distribution cabinet to the building would be used by several clients, by which the optical connection could be understood as a backbone of the access network.

In Fiber-to-the-Home (FTTH), end of fiber cables is made just next to the premises of the specific subscriber, whereas in Fiber-to-the-Desk (FTTD) they range straight to the end user device, like computer or laptop.

FTTH is a completely optical fiber solution, founded on the development of fiber cables for end to end - from the distribution cabinet in the local area (main node) to the office or home, with the capacity to reach in both directions speeds from 1 Gb/s to several Gb/s per user. In this architecture, the whole copper infrastructure is changed with an optical one, together with the copper distribution cabinets.

The key difference between FTTB and FTTH is that in the first one the optical infrastructure is established to a certain distribution cabinet or a shared optical network apparatus, that is used by several households. The household infrastructure on the inside is built on copper pairs, based on xDSL or UTP Ethernet solution alike to FTTC. Nevertheless, FTTH and FTTB are often viewed as the same scenario, when they are comparable in terms of prices and throughput.

Architectures of Optical Access Networks

Three chief approaches exist to the progress of optical access networks. The first one uses an optical access network that have point-to-point topology with dispersed optical fibres for each client. This architecture of an optical network is the simplest, constructed analogical with traditional telephone networks - clients are separately connected to provider by a distinct optical fiber. Besides the simplicity, transmission opportunities in this architecture are huge, since only one specific client uses the fiber resource. Alternatively, the usage of fibers is to a greatest extend uneconomical. This kind of connectivity (direct fiber) is often provisioned by newly entering operators in the marketplace, in direction to quickly connect new clients at lower expenses.

The second method is the usage of a *concentrator* (remote switch) close to the end subscribers, which purpose is to minimize the number of optical fibers. The third approach for the construction of optical access networks is by putting only passive optical technologies and components along the way of optical signals from their sources to their subscribers. In these kinds of networks are used attenuators, optical splitters, isolators and optical filters.

Networks with collective resources of the optical fiber could be passive - Passive Optical Network (PON) and active - Active Optical Network (AON).

Active networks among the providers' headquarters and clients' equipment, where the optical network is ended, consist of one or more than a few cabinets with active equipment carrying out routing and switching functions. Active networks range larger distances from the office of operator to the client, since a portion of the network roles (second and third level of the OSI model) are transferred close to the client. Therefore, the cost of fiber cable is reduced (single cabinet can serve up to 1000 users) and additionally, the facilities in the provider's office are simplified and reduced.

At the passive networks are used passive optical splitters in intermediate points of the network, transmitting the similar signal to a group of clients (characteristically 32-128). The signals for that set of clients are encrypted, packed in the operator's core and transported by one fiber to the splitter, where the signal is multiplied and transferred to the subscriber over a separate fiber. Because of the encryption, user has separately access only to the signal mentioned to him. Conferring to the FTTH architecture, the line connection from the service provider access point to the subscriber consists completely of optical fiber. The fiber ends in the workplace or home of the end user. Hence, each device in the client's locations is linked via a particularly selected optical fiber to a switching port situated at the service provider, or to the optical splitter, which sequentially is connected by means of a discrete power supply fiber. Every customer, in passive optical networks, is linked to the optical network by passive optical splitter.

The welfares of FTTP PON are associated to:

- The usage of purely passive components among the central office and the client, which leads to a lack of active equipment in the network, explicitly there is no necessity to look for an

appropriate location for cabinet equipment, to provide air conditioning and electrical power etc.;

- Fewer requirements for investments in fiber at the network segment, local exchange (LE) - external cabinet etc;
- Reduced space requirements in LE, as in LE end fewer fibers and narrower trenches;
- Fewer operational costs and less maintenance.

The drawbacks are chiefly related to higher costs of optical fiber and the coverage of shorter distances.

By the outstanding transmission qualities of current optical fiber, passive optical networks have no limitations in terms of topology which can be realised, such as token ring, tree, highway or a mixture of these.

Another Wireline Broadband

Although cable modem, DSL and FTTP technologies account for closely all worldwide subscriptions, additional technologies comprise Local area networks (LANs) that are Ethernet-based and Broadband over powerline (BPL). Wireline LANs can connect numerous subscribers in a big building like business offices or apartments. Typically, the users are connected directly to an Ethernet or fiber backbone, where through the LAN is distributed the broadband access. Some nations describe the LAN subscriptions as a distinct wireline broadband access type. LANs could be wireline (using twisted pair or coaxial cable [10Base-T or Cat3]) or wireless, created on the IEEE 802.11 or 802.3 standards. They are commonly placed within a public access facility or a home.

Broadband over powerline for providing high-speed Internet access uses the electricity distribution network. BPL functions by separating data traffic from the flow of electricity. That separation happens by using a higher frequency to transport data over the copper wires, united with encoding techniques that segment data traffic into several low-power signals or that extend the bitstream through a wide bandwidth (Kelly and Rossotto, 2012).

Mobile Broadband Access

The vast success of cellular telephone service confirms the appeal of wireless technologies as a local access solution. Reasons for their success contain being normally cheaper and easier to deploy than fixed line solutions and users' affection for mobility. Technological innovations propose the near-term prospect for widespread mobile access to the Internet, by means of next-generation wireless networks hold the technological capability to deliver bit rates at close equality with current wired options, however not yet at the similar price points. The aptitude of carriers to offer these services will hang on to whether enough radio spectrum can be allocated for mobile broadband services and whether innovations in conservation techniques of spectrum can help providers to meet customer demand.

Mobile services are distributed over a variety of radio frequency spectrum bands, with basic services being accessible on different bands in diverse countries. Common used bands are 850 MHz, 900 MHz, 1800 MHz and 1900 MHz, along with 2.6 GHz (these all bands are supported in "quad band" handset). In terms of data speeds, 3G (third-generation) mobile broadband speeds for download range from 384 Kbps (using W-CDMA technology) to more than 42 Mbps, delivered by high speed packet access technology (HSPA).

For most of the people, mobile broadband is the best alternative to wireline services. Though mobile broadband does not have the reach of satellite broadband, it is widely available, providing services in regions where there is no cable or DSL connectivity. One of the advantages of mobile connectivity is that it allows for internet from anywhere, contrasting the fixed line connection which is not much usage to a user when she or he leaves home. Nevertheless, drawbacks of mobility become seeming in terms of pricing packages, as the best-value monthly packages are with lengthy and expensive contracts. There are as well places where the infrastructure does not exist or the signal is weak, which offer a bad experience for clients. Worldwide, it remains much more expensive to use mobile broadband services than fixed broadband for transmission of huge volumes of data. That creates a drawback for retrieving virtual private networks (VPN) or using multiplayer gaming via mobile broadband. Such services and products can be delayed by variable latency times and slow upload speeds initiated when mobile network services is weak. Contradicting, there is a fact that migration between diverse operators is very easy and the coverage sometimes extends into regions that wireline solutions may fail to reach.

WiMAX

Worldwide Interoperability for Microwave Access (WiMAX) is an alternative to xDSL, cable and fiber optic networks, it allows high-speed voice, data and video transmission with a speed of 75 Mbps and more. WiMAX combines the benefits of Wi-Fi as the connection speed and 3G as a wider coverage. WiMAX provides a stable radio link and achieves an increase in transmission speed for each following user. The technology is presented in two separate versions - mobile WiMAX (which is also often mentioned with the name of the standard 802.16e) and fixed (802.16d).

Wi-Fi

Wi-Fi refers to the IEEE 802.11 family of standards specifying wireless local area networking over 2.4 and 5 GHz frequency bands. Wi-Fi is not typically deployed as a commercial local access network; it is used most often to redistribute a broadband connection to a wider group of users in homes, offices, and “hotspots.” Wi-Fi technology has gone through several updates that provide varying speeds depending on the frequency and version used (see Figure 4). In 2016 were introduced new standards which will provide to diverse usage scenarios. The latest 802.11ad standard working on the 60GHz, that can deal with the problem of enormous file transfers and the fairly new 4K movie streaming. Standard 802.11ah (HaLow) facing the problem of the current Wi Fi networks, range and power consumption. The future 802.11af, that WiFi network will make usage of the television spectrum frequencies extending between 54MHz and 790MHz, creating it one of the longest WiFi network range but without the huge speed disadvantage that HaLow networks will meet.

Figure 4: WiFi speeds

Standard	Maximum Speed	Frequency
802.11 (legacy)	1.2 Mbps	2.4 GHz
802.11a	54 Mbps	5.8 GHz
802.11b	11 Mbps	2.4 GHz
802.11g	54 Mbps	2.4 GHz
802.11n	150 Mbps	2.4 & 5 GHz
802.11ac	800 Mbps	5 GHz

Source: https://propakistani.pk/wp-content/uploads/2016/01/Capture-3.jpg

IMT-Advanced

For several years, the ITU has been occupied on standards for the next generation of wireless systems. It distributed a circular letter, in March 2008, specifying the provisions for IMT-Advanced (International Mobile Telecommunications-Advanced) networks. One of the requirements, with great significance, is peak data rates of 100 Mbps for high mobility and for low mobility 1 Gbps. In 2010, the ITU publicised that two technologies encountered the requirements for IMT-Advanced: Wireless-MAN-Advanced and LTE-Advanced (ITU, 2010).

LTE and LTE-Advanced

In 2004 started the development of LTE mobile network standard. One aim was to reach higher data speeds to provision the progressive growth of Internet access over mobile phones. Initially, the targeted speeds were 50 Mbit/s for uploads and 100 Mbit/s for downloads. LTE uses Single Carrier-Frequency Division Multiple Access (SC-FDMA) for uploads and OFDM for downloads. LTE is planned for flexibility of frequencies, with bandwidth requirements fluctuating from 1.25 and 20 MHz and support for both unpaired (TDD) and paired (FDD) bands.

3G Partnership Project (3GPP) has supported the development of the LTE. The 3GPP Release 8, distributed in December 2008, formulates the foundation for primary LTE deployments. It has theoretical maximum upload speeds of 75 Mbit/s and download speeds of 300 Mbit/s. In direction to meet international requirements for fourth-generation (4G) mobile networks, 3GPP advanced LTE Release 10 and Beyond (LTE-Advanced), that was submitted in October 2009 to the ITU (Kelly and Rossotto, 2012).

The first LTE deployment in the world, was by TeliaSonera when it at the same time launched networks in Oslo, Norway, and Stockholm, Sweden, at the end of 2009 consuming the 2.6 GHz frequency band (TeliaSonera, 2009). In 2014, the first Bulgarian telecom operator that launched 4G in urban areas of the country was Max Telecom (Max Telecom, 2014).

Satellite

Separately from its part in the backbone and international segments of the broadband supply chain, satellites are as well used to deliver direct user access to broadband services, mainly in remote zones where fixed line broadband is not obtainable and there is no terrestrial high-speed wireless coverage.[2] The customers uses a dish or satellite antenna that is linked to a satellite modem. Speeds fluctuate relining on the weather, antenna, and the satellite technology. For some applications, like gaming, an issue can be the latency. Though they serve precise niches, because satellites do not propose the similar price to quantity ratio as per other broadband solutions.

5G Wireless

Currently, there is no defined clear standard for fifth generation wireless systems, but there is recognition that in the few years there would be a further advanced wireless technology than the current 4G standard. The employment of standard under a 5G umbrella likely be around the 2020 year. If implemented, it is anticipated to deliver wireless communication with nearly to limitations, which is why some specialists are referring to the provision of 5G technology in relations of *a real*

[2] In the United States, clients in remote regions without wireline broadband accessibility were offered a discount for satellite broadband access (including no equipment or installation charges) through the American Recovery and Reinvestment Act. See HughesNet, “Frequently Asked Questions,” http://consumer.hughesnet.com/faqs.cfm.

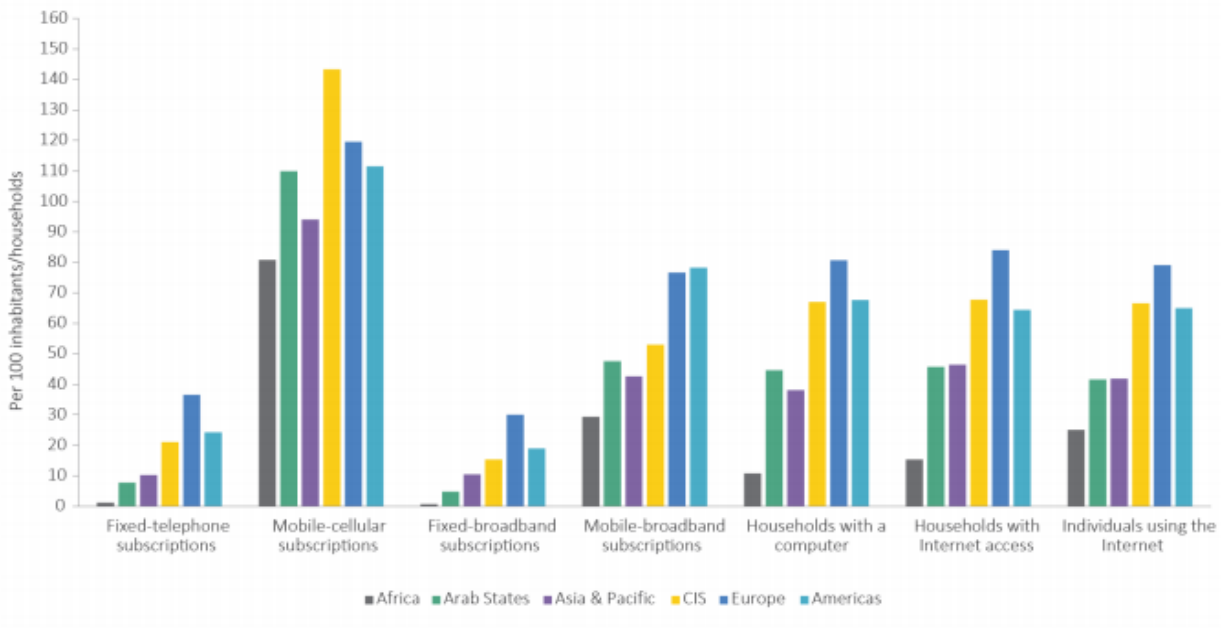
wireless world (Churi et al., 2012). The fifth-generation technology is also observed as a means of creating novel features to the mobile world, for instance, multimedia newspapers and watching television programs with the clarity of an ultrahigh-definition television.

2. Broadband state in European Union and the world

Worldwide

At the end of 2016, almost six billion people, that is 84 per cent of the global population, live in a region that is covered by a mobile-broadband network (3G or above). The new LTE networks have spread rapidly over the last three years and today grasp almost 4 billion people enhancing the quality of Internet use (ICT Facts and Figures, 2016). According to the International Telecommunication Union, in 2016, almost 1 billion households in the world have Internet access, of which 60 million in India and 230 million households are in China. In Europe, 84% of households are have Internet access, compared globally with half of all households. The graph below shows the internet penetration by region in 2016.

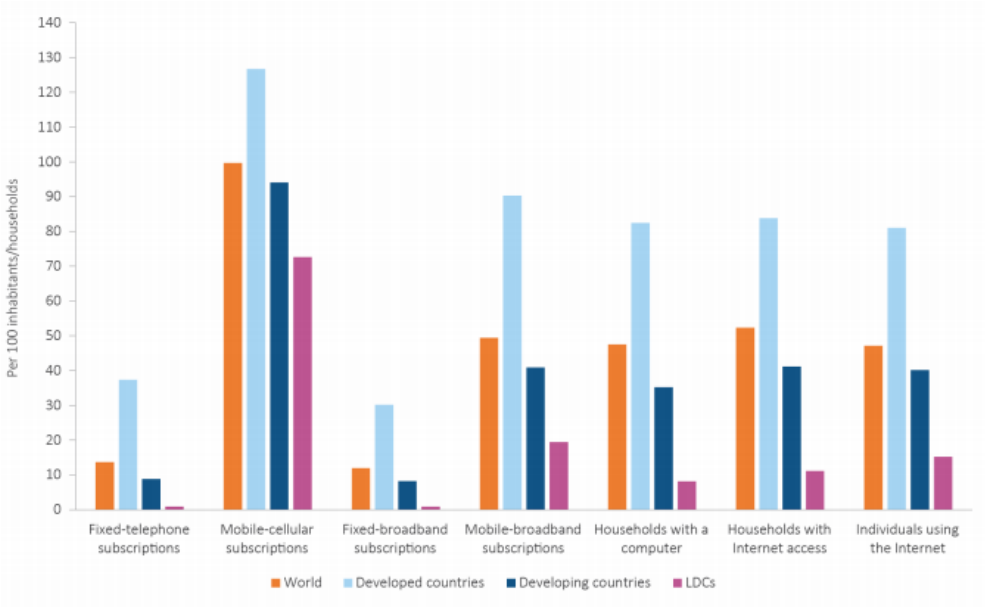
Figure 5: ICT penetration levels by geographic region in 2016[3].



Source: ITU.

[3] * ITU estimates.

Figure 6: ICT penetration levels, by level of development, in 2016.



Source: ITU.

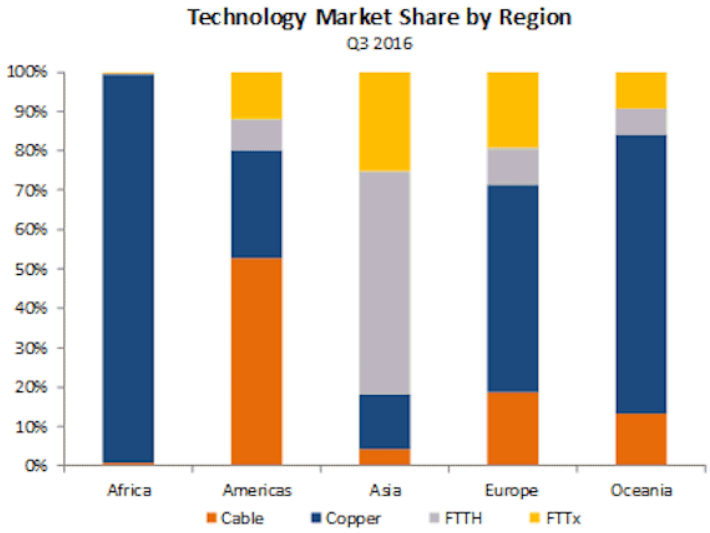
These charts demonstrate the continued and substantial digital divide between areas and between developed and developing countries. Although penetration rates for mobile-cellular subscriptions are high in all areas, and in four of them surpass 100 subscriptions per 100 inhabitants, they are still significantly lower in the Africa and Asia-Pacific regions. Penetration rates for broadband networks as well as internet and computer access are also higher in the Europe, CIS (Commonwealth of Independent States) and Americas regions. It is also shown that Europe is a leader in most of the categories of Internet services per 100 inhabitants/household, for instance in household with internet access.

In the recent report by Point Topic (2016) has been revealed that during Q3 2016 the full number of world fixed broadband subscribers raised by 2.25% and now stances at 822.7 Million, the growth majority has been increased by pure fiber optic connectivity (FTTH/P). In the developed economies (like UK, USA, Germany etc.) fixed broadband markets are highly replete, the growth rates are staying still and even falling in some cases, while in East Asia the situation is different and now it accounts for a stunning 70% of all net adds and a significant portion of that is due to China. Parallelly, the entire Europe correspond for about 18% of growth.

Technology trends

Naturally, as it is shown on the chart below, there is a big regional difference in the kinds of used broadband technologies, thru Africa being almost dependent to copper based lines (DSL, ADSL etc.), the cable (DOCSIS) networks still dominated in the Americas. The broadband copper lines still hold strong stand in Europe and also in other regions of the world. Even though they remain gaining a clear decline as subscribers progressively upgrade to faster fibre optic and hybrid fibre (FTTC / FTTx / VDSL) based solutions.

Figure 7: Technology market share by region, 2016.



Source: Point-Topic.

Over the last 2016 year, the figure of copper lines has diminished globally by 11.6%, although ultrafast FTTH/P facilities have enlarged by 76.9%. This is barely a disbelief because various countries around the world have started to outspread pure fibre optic lines, which over the extended term must replace entirely copper connectivity.

Nevertheless, it should be pointed out that the impact of China is skewing the global statistics. China added closely 41 million FTTH connections in the period of six months to the end of September 2016, which globally established 89% of all FTTH net adds over the equal period. At the same time, fixed wireless networks are progressively giving way to LTE based Mobile Broadband services, which is presented as one technique to get homebased broadband in numerous countries and areas, for instance Eastern Europe and Scandinavia.

In the report is noted that the yearly growth in Satellite has slipped from +10% among Q3 2014 and Q3 2015 and over the past year is +4.6%, which can be because its feasible market has reduced as competing fixed line networks advance their coverage.

On the other hand, the figures of cable based (DOCSIS) broadband technologies (for example, Virgin Media, UK) remain to preserve a nearly unchanged stage of 6.8% annual growth, which is partway because the technology has been relatively effective at quickly and inexpensively rolling out broadband upgrades (Point Topic, 2016).

Broadband in European Union

The European broadband market is developing at an accelerated pace, making some European countries world leaders in this field. Some differences currently exist in the provision and usage of e-services and quality highspeed internet access between different regions in Member States countries, and between Member States themselves. The European Commission sees as the main obstacle to the growth of broadband is the deficiency of a more competitive environment and some regulatory weaknesses.

The dynamics of the European economy largely depends on the development and introduction of novel technologies. Access to high speed Internet via broadband opens serious opportunities for

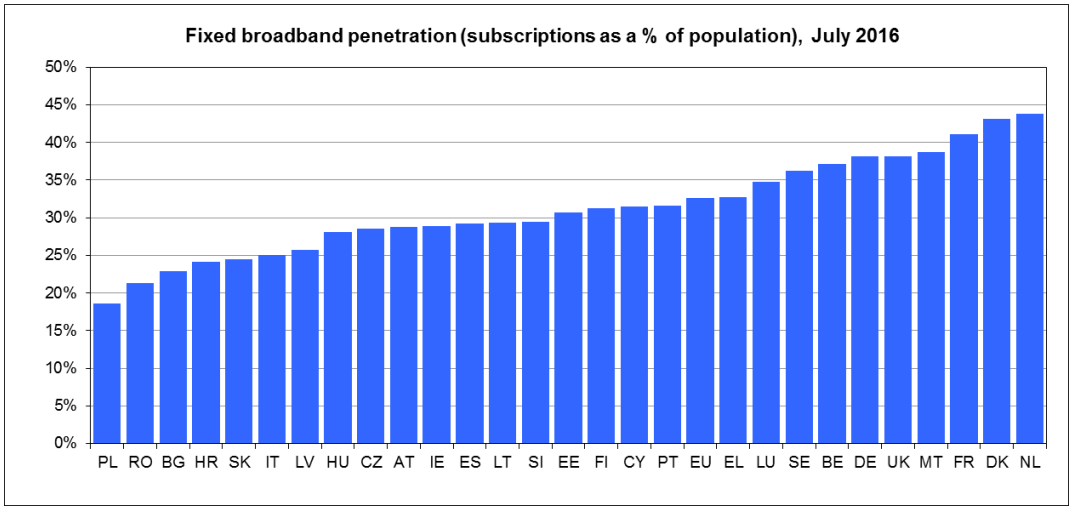
growth. European Commission has identified a few tools that can be deployed on local level to improve accessibility to high speed Internet.

In report for the digital progress in EU (EC report, 2016) was stated as an overview that basic broadband is accessible by all citizen in the EU, when all main technologies are considered (fibre to the premises (FTTP), xDSL, cable, LTE, HSPA and Satellite). Fixed-wireless and fixed technologies cover 97 % of all EU households. It was also defined that Next Generation Access technologies are available to 71 % of EU homes and can deliver at 30 Mbps or more download. In the middle of 2015 the total coverage of 4G mobile (LTE) internet access enlarged by seven percentage points from 2014 and reached 86%. However, the coverage in rural areas is considerably lower for fixed technologies (91 %), and particularly for NGA with only 28%.

Market for fixed broadband services in 2016

The EU broadband market continues to grow with 167 million fixed broadband lines in 2016 and about 6 million new lines (1.1% annual growth base) and remains one of the largest in the world. At the middle of 2016, the 32.7% of the population in the EU was subscribed to fixed broadband internet connection (see Fig. 8). Eight Member States are reaching 35 per cent or more of population. In the best performing countries - Netherlands (43.8%) and Denmark (43.1%), more than two fifth of the population has a broadband connection, a substantial proportion of them is using an infrastructure that is not own by the incumbent operator. Immediately after these countries, France is ranked and hold value of 41.1% on this indicator.

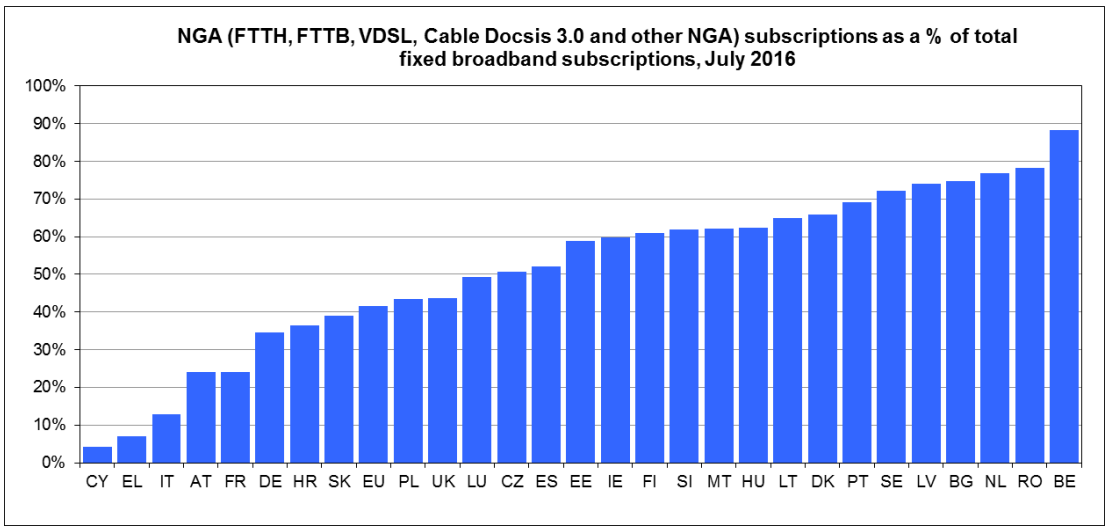
Figure 8: Fixed broadband penetration, July 2016.



Source: EC

NGA subscriptions went sharply up in the last two years, but only 41 % of all subscriptions in July 2016 are NGA technologies as it is shown in the chart below. Over 75 % of all fixed broadband subscriptions in Belgium and Romania are NGA, whereas the same proportion is less than 10 % in Cyprus and Greece that lagging of the other Member States.

Figure 9: NGA subscriptions as a % of total fixed broadband subscriptions, July 2016.



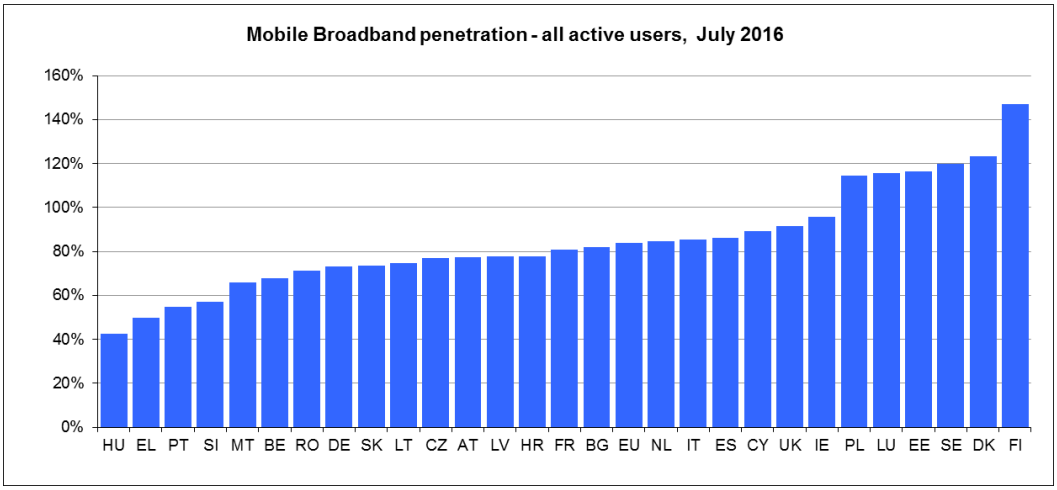
Source: EC

Market for mobile broadband services in 2016

Mobile broadband represents a fast-upward segment of the broadband market and a major source of revenue growth for mobile operators in the EU. Therefore, the mobile and wireless technologies are becoming more important for responding to the need for broadband communications services. The transition from fixed to mobile technologies can also be an important factor for the delay in the development of fixed broadband connections. It is noticed that some of the countries with the lowest rate of growth of new fixed broadband connections, demonstrate high growth rates of mobile broadband penetration.

Around 80 % of total active mobile SIM cards use mobile internet. In Poland, Luxemburg, Estonia and the Nordic countries, there are now more than 100 subscriptions per 100 people, while in the usage proportion is still below 50 % in Greece and Hungary. It is indicated that most of the mobile broadband subscriptions are activated on smartphones rather than on notebooks or tablets.

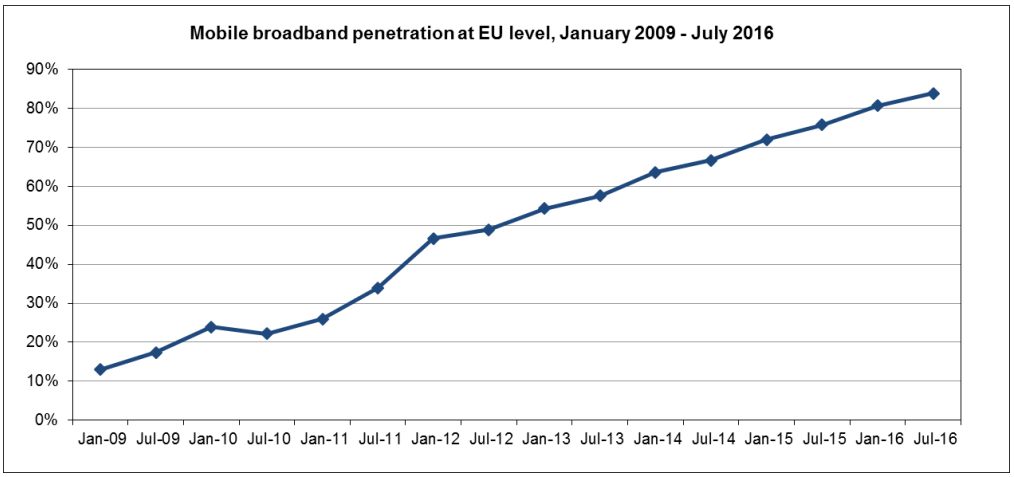
Figure 10: Mobile Broadband penetration – all active users, July 2016.



Source: EC

In the chart below can be seen that up to 83 mobile broadband SIM cards are active per 100 people in the European Union. The growth is progressively linear over the last four years and every year around 40 million new subscriptions is added.

Figure 11: Mobile Broadband penetration at EU level, January 2009 - July 2016.



Source: EC

The trends of broadband development in EU Member States illustrate that for a very short period of time, high-speed and ultrahigh-speed Internet has become one of the foundation of the modern economy. This provides a strong base for Member States to support the usage, accessibility, and deployment of new broadband infrastructure. Accordingly, they can take full advantage of the provided benefits as well as strengthen and support Europe's competitiveness in global market.

Chapter 4

1. Telecom and technical market history of Bulgaria

Bulgaria was important telecoms and computer electronics manufacturer of the COMECON[4], in the period from 1970s until 1990. Bulgarian computer and computer associated exports equalled to 48 % of the nation's total export. In 1989, telecommunications and electronics accounted for 25 % of the Bulgarian industrial production and overall 130 thousand people were labouring as well as 8,000 high-level engineers. Owed to this industrial history Bulgaria had a comparatively high fixed telephone line penetration (ARC Fund, 2002).

After 1990, that industry collapsed completely. Leaving numerous people with knowledge about software and electronics, but without an occupation as the technology dramatically changed. The economy has stabilized since 1997, though already in 1995 some of the more entrepreneurial people had begun the first saleable Internet Service Providers. With the novel technologies, there was a noticeable lack of skill, but also open field for innovative indigenous start-ups. The public in Bulgaria rapidly got used to the personal computers and Internet thru Internet Café's and Telecentres. A change away from using public access points has been resulted in 2004, by means of the households increasingly buying computers and an Internet access connection.

Factually, (since 1991) there have been relations among the Bulgarian incumbent BTC and OTE and KPN Telecom operators. Nevertheless, in 2000 the government of Bulgaria measured too low the take-over bid by their consortium. Shortly after their refusal the Telecom-crash of 2001 happened.

Efforts to sell off to external investors got delayed until 2004, when BTC was traded to Viva Ventures. Now, it is renamed to Vivacom and now is the operator that provide the widest range of telecom solution in Bulgaria. Because of the prolonged sale of BTC, first in 2004 ADSL was launched. After the market was liberalised in 2002, at which point BTC was not yet traded, the unreachability of the duct and copper network strappingly stimulated CATV firms and ISPs to find their own way and with new self-constructed networks to launch broadband services (Rood, 2010).

Nowadays the broadband market in Bulgarian is characterised by two types of ISPs:

> **First-level ISPs** - organisations whose main business is in offering broadband internet connectivity to end users countrywide and serve as per primary internet providers to all second-level ISPs. First-level ISPs also offer to the large company clients and have established international backbone with the chief European internet exchanges.
>
> **Second-level ISPs** - typically operate within a single town or several adjacent cities. They generally deliver internet connectivity and associated services to small business and end users.

In Bulgaria, the number of second-level ISPs has noticeably varied. In the year 1999, it gotten to more than 150, but after sequences of acquisitions and mergers the figure fell to about 50-60 firms in 2001. Nevertheless, with the creation of the new broadband networks to avoid Vivacom (BTC), the chief DSL-provider, their number had blown up to 670 in 2009.

The beginning of the broadband market

[4] The Eastern European mirror-organisation to the Western European Economic Community

Related to other states in the EU, the information society in Bulgaria started to develop on later time. The Bulgarian broadband market was nearly non-fictional in 2005, and the broadband penetration was less than 1 percent of 7.7 million population.

But around in the last decade the households with fixed broadband connection were raised from 26% to 63% of all households, respectively in the 2010 and 2016[5]. That solid growth of broadband subscriber lines to the home and emergence of high-speed services could be mostly credited to the efforts of local LAN service providers. Their provision answered the growing need amongst clients for an inexpensive broadband product, with quality of connections and high speeds. Before couple of years, broadband LAN had developed into the leading type of access technology in usage.

One of the key reasons for this market situation had been the leading position of previously state-owned incumbent BTC (now rebranded to Vivacom), which delayed up to 2005 the deployment of xDSL. For years, in Bulgaria the fixed telecom market has been considered by the clear dominance of the incumbent and limited competition, even after the liberalization of the market in 2002 and the BTC privatization in July 2004. Since the access to the duct and copper networks was impossible, CATV firms and ISPs decided to discover their own way to introduce broadband with small self-constructed aerial cable networks.

In the beginning, these networks were constructed on an amateur base and with minimal regulation by national or local government, the result was a situation where LAN operators positioned their cables in the private area by crossing overhead cables crossways the gaps of flat blocks. In other situations, they had accessed the ducts of the incumbent without any approval or payment.

Individuals were wiring up their neighbourhood without regulation by the local or national government, keeping operational and building costs low. These little costs have been a crucial driver for the fast growth in both the figure of LAN operators and their subscribers. Then, typical 10 Mbit/s broadband LAN subscription costs per month 20 Bulgarian Lev (€10.22), around 45 BGN for a 50 Mbit/s subscription (Rood, 2010).

Currently, at the end of 2015, the total number of firms registered with CRC with the intentions to provide data and / or internet access services are 921 and compared to the previous year, an increase of 2.7% was recorded. The number of enterprises, providing real services for Internet access and data transfer is 669 as for an annual growth rate of 4% (or 25 more businesses) is reported as compared to 2014[6].

Market consolidation around year 2010

The Bulgarian broadband market has in progress to consolidate in the last decade. In the end of the last decade, numerous of the smaller networks had merged or had been taken over by bigger operators. Cable operators had been the key drivers of consolidation, taking over firms offering broadband services by LAN networks to provide Internet with speeds that, due to technical limitations, could not be reached over their own networks.

These cable operators now install LAN networks and they along with Tier-1 ISPs had made head-ends and were distributing IPTV and Video-on-Demand at HDTV quality. Tier-2 ISPs often must bring closer to their networks edge fiber backhaul or swap capacity on their switches to provision these heavy

[5] http://digital-agenda-data.eu/charts/country-profiles-the-relative-position-against-all-other-european-countries#chart={"indicator-group":"broadband","ref-area":"BG","time-period":"2016"}
[6] Data from CRC annual report for 2015. http://crc.bg/files/_bg/I_final_2015.pdf

applications. There was therefore a steady specialization assuming: Tier-2 emphasis on the distribution plant and Tier-1 on the more IT concentrated service platforms. Still most Tier-2 ISPs have for uplink to the Internet more than one Tier-1 ISP.

According to the Rood (2010) the typical arrangement between Tier-2 ISPs who assist villages and towns outside the main cities / backbone Points-of-Presence is that the fiber road is invested by the Tier-2 ISP, but the Tier-1 then leases a fiber pair true this cable when is needed to reach a business client in the town.

Another significant driver for the industry consolidation had been the restrictions laid down by the regulator CRC, which forced LAN operators to put underground their fiber optic cables. Before 2009, no actions for the unregulated situation had been taken to overcome it, but that legal amendments had specified the CRC the right to fine providers for cables that are through the air. And after that, many ISPs have been fined.

The Bulgarian government tried to increase internet literacy

Despite growing availability and acceptance of broadband in the last decade, in Bulgarian the absence of computer and/or internet skills remained high. In 2006, survey data from the National Statistics Institute of Bulgaria showed that Bulgarian households owing a computer was only 21% of the total, related to the EU average of 60%. Particularly in the rural regions of Bulgaria, the availability of IT skills and computers among the population remained low. The Bulgarian government, understanding the need for improved IT skills, together with other organizations had launched a sequence of skill-development projects. Samples of projects are:

- The iCenters Project - started in 2006, this partnership between UNDP (United Nations Development Programme) and the Government of Bulgaria, provided IT related services to people in communities, which are small or economically underdeveloped.
- The project for home internet for teachers - the Ministry of Education and Science provided to the teachers a monthly reimbursement for homebased internet access.
- The SELF project - introduced by ISOC-Bulgaria among others, that project intended to provide a platform for the collaborative sharing and formation of free training and educational materials on open standards and free software.

Later, there were signs that the government IT stimulation programs are paying off. The homebased internet for teachers' project had been an achievement and had seriously advanced educators' interest in ICT usage. According to Rood (2010), there were closely 47,000 teachers participating in the project at that time. Instead off a big contract between the Ministry and a single internet provider, which would have enforced them to obtaining ADSL with the incumbent Vivacom, it was adapted to the very fragmented broadband market.

A database was created by the ministry, where all ISPs in Bulgaria, keen to offer service to teachers, could record their prices and offerings into that database, which occasioned in 28,000 different packages / prices entries. Educators could select their own broadband ISPs and package as per the ministry provided them a monthly refund of BGN 15 (€7.50).

The major Bulgarian training program, established and realised by iCentres, has been successful and has educated around 45,000 people in basic IT skills. However, that training program was a practical divergence from the original UNDP-initiative to form these iCentres. The Internet cafés and

telecentres were noticeable too late. At the same time as the facilities were arranged, the Bulgarians stopped using them and took Internet for their home.

Current use of internet

Nowadays, the statistics from the National Statistics Institute of Bulgaria showed that Bulgarian households owing internet access at home are 63.5% of total in 2016[7] with broadband type of connection are 98.8% of all household with internet. Also, is visible from the statistics that more experienced uses with people deploying it for productivity and work related purposes (Sending / receiving e-mails) as well as participating in social networks, but not only for information searches and leisure[8]. Nevertheless, on average, Bulgarians engage in online actions much less than other Europeans. The internet users in the country engage on smallest amount in online transactions such as online shopping (27%) and online banking (7%). These statistics have also diminished compared with last year (EDPR, 2017).

Nevertheless, the last report for Digital Economy and Society Index by the EC show that online are 58% of Bulgarians. As it is shown on the figure below, two thirds of inhabitants do not have basic digital skills and the number of STEM graduates have not increased, despite growing demand from the labour market.

Figure 12: Human Capital, Bulgaria DESI 2017

	Bulgaria				EU
	DESI 2017		DESI 2016		DESI 2017
	value	rank	value	rank	value
2a1 Internet Users	**58%** ↑	**27**	**55%**	**27**	**79%**
% individuals	2016		2015		2016
2a2 At Least Basic Digital Skills	**26%** ↓	**28**	**31%**	**27**	**56%**
% individuals	2016		2015		2016
2b1 ICT Specialists[5]	**2.3%** ↑	**22**	**1.9%**	**25**	**3.5%**
% individuals	2015		2014		2015
2b2 STEM Graduates	**14** →	**22**	**14**	**22**	**19**
Per 1000 individuals (aged 20-29)	2014		2013		2014

Source: Digital Economy and Society Index 2017 – Bulgaria, European Commission

Some IT companies[9] have set-up their own academies and offer extensive IT training to students, but still, the Government does not recognise this method of alternative education. The Digital National Alliance (DNA) holds many initiatives targeting at educating the digital skills free of charge of different groups – teachers, students, women, etc. Presently the DNA is undertaking a project together with the Ministry of Education and Science aiming primary school teachers, since they are crucial in distribution of digital skills. A new law expects additional time for teachers to advance new skills and the intention of the project is to fit in the use of technology much more into the educational process and to be more attractive (EDPR, 2017).

Bulgaria could profit from a strategy of digital skills for training the workforce with the essential digital skills and supporting remaining private initiatives. According to the EDPR (2017), the MTITC

[7] http://www.nsi.bg/en/content/6099/households-who-have-internet-access-home
[8] http://www.nsi.bg/en/content/6109/individuals-using-internet-personal-purposes
[9] Including Telerik, SoftUni, VMware and SAP

started the development of that king of strategy. It will hold measures, subsidised mostly by European Structural and Investment Funds. For 2018 are scheduled e-government related skills projects and are counted in the Roadmap of the eGovernment Strategy.

2. Bulgarian Broadband Market

In this section, market revenues, the penetration, coverage, trends in client prices and future views are observed.

Market revenues from 2015

According to CRC (Communication Regulation Commission) report for year 2015[10], the total volume of the electronic communications market in Bulgaria is start almost unchanged compared to 2014, amounting to BGN 2.505 billion. The accessible data indicate that the overcoming of the negative trend of decline in the volume of the market continues, commenced in 2014, with the total volume of the market of electronic communications in 2015 accounted for 2.9% of the total GDP of Bulgaria.

The revenues from segment "Data and Internet Access" amounted to BGN 403,332 million, increasing by 9,3% compared to 2014. The retail services amounted to BGN 360,942 million and increased by 9,5% compared to 2014 while revenues from wholesale services reached BGN 42.391 million and reported an increase of 7.2% compared to the previous year.

The data presented shows that in the overall revenue structure of the segment no

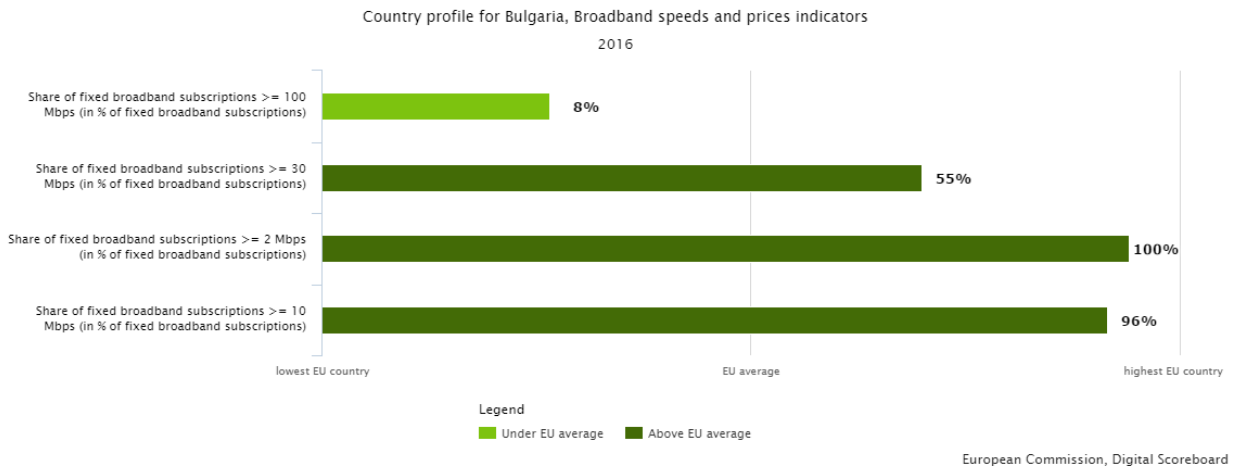
There are significant changes and it remains relatively stable. Biggest relative share (77.8%) are the revenues from retail Internet access services, which in the past year reached BGN 313,944 million and reported growth in absolute terms 8.1% compared to 2014. In 2015, the number of subscribers of Internet access services in the country marks an increase even higher than reported in 2014. As of December 31, 2015, the total number of Internet subscribers (from fixed and wireless Internet access) are 6 071 815 and increased by 31% compared to the end of 2014. In 2015, the users with package services (including fixed and mobile access), increased by 52% to 3 418 204, with their relative share being over 56% of the total number of subscribers using services for Internet access.

Fixed broadband market

Currently, in Bulgaria the total coverage of fixed broadband networks remains at 95% of households in 2016, that is slightly below the 98% of the EU average. The policy ambition is that by 2020 50% of all citizens must have access to 100 Mbps. In 2016, only 8% of the population had that opportunity. The data from DESI 2017, concerning the Connectivity indicator (see the first Figure 13 below), Bulgaria's performance is below average or the EU, there is a lag in the development of broadband networks in Bulgaria. Access to 10 Mbps have 96% and access to 2 Mbps have 100% of all household fixed broadband subscription.

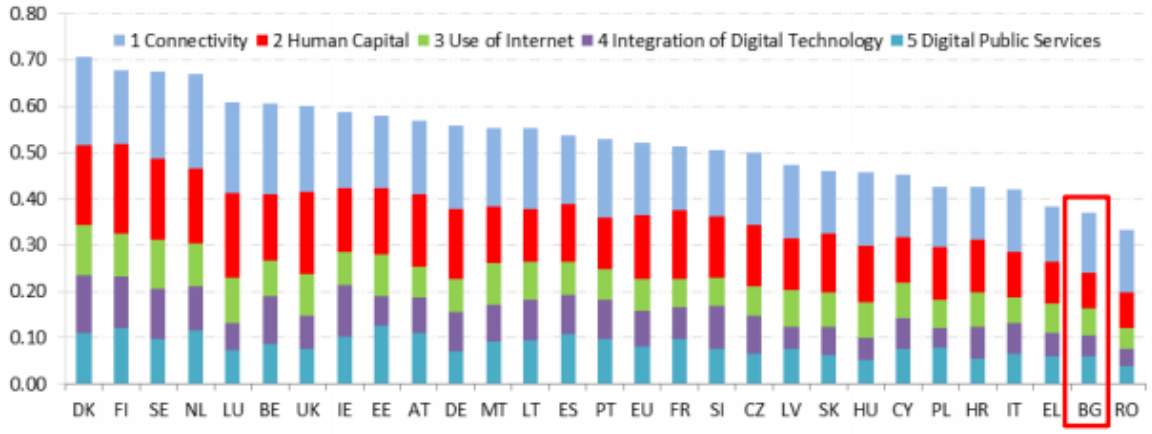
[10] http://crc.bg/files/_bg/I_final_2015.pdf

Figure 13: Digital Economy and Society Index (DESI), ranking 2017



Source: EC, Digital Scoreboard

Figure 14: Country profile for Bulgaria, broadband speeds, 2016



Source: EC, Digital Scoreboard

Nevertheless, in rural areas the fixed broadband coverage remains expressively below the EU average with 81% versus 93%. Networks providing at least 30 Mbps (next-generation access (NGA)) are accessible to almost three quarters of Bulgarian homes (74%). But the rural areas remain poorly covered with only 17%, in comparison with the figure of the EU average (40%) is below. It is worth mentioning that Bulgaria's strength is in relations of take-up of high-speed broadband, with more than half (55%) of fixed Internet subscriptions donation high-speed connections (11th in the EU) which is above the EU average. The figure of 4G coverage Bulgaria is just 66%, which is lagging the EU average (84%)[11].

[11] Source: https://ec.europa.eu/digital-single-market/en/news/europes-digital-progress-report-2017-country-profiles-telecom-country-reports

Table 3: Broadband coverage in Bulgaria, 2015-2016

Coverage	BG-2015	BG-2016	EU-2016
Fixed broadband coverage (total)	95%	95%	98%
Fixed broadband coverage (rural)	81%	81%	93%
Fixed NGA coverage (total)	72%	74%	76%
Fixed NGA coverage (rural)	17%	17%	40%
4G coverage (average of operators)	no data	66%	84%

Source: Broadband Coverage Study (IHS and Point Topic). Data of October 2015 and October 2016.

The lowest fixed broadband price (12-30 Mbps) is €12.13. That is the second lowest price in the European Union, in contrast to the average of €21.33. The lowermost price in the EU is €11.42[12].

Table 4: Fixed broadband market shares in Bulgaria, 2015-2016

Fixed broadband market shares	BG-2015	BG-2016	EU-2016
Incumbent market share in fixed broadband	24.3%	25.1%	40.7%
Technology market shares			
DSL	14.3%	12.1%	66.8%
Cable	16.0%	16.9%	19.1%
FTTH/B	42.2%	47.3%	10.7%
Other	27.4%	23.8%	3.4%

Source: Communications Committee. Data of July 2015 and July 2016.

Contrastingly, a remarkable progress has been made by Bulgaria in total on fixed NGA coverage, reaching more than 50% of FTTH/B coverage. However, because other Member States are continuing faster for most of the other indicators, Bulgaria is in a group of countries in the EU demonstrating rather slow development.

Mobile market

According to the Mobile Broadband Price Study (Van Dijk) 2016 and EC (see note 4 for Bulgaria), packages plus mobile broadband on handsets in Bulgaria are expressively more expensive than in the EU on average, costing almost double the average. The difference between EU-28 and Bulgarian average prices has even enlarged over the last year. Prices for mobile broadband on tablets and laptops are more similar with the EU-28 averages.

[12] Source: Fixed broadband prices in Europe in 2016 (Empirica). Prices expressed in EUR/PPP, VAT included. Data as of autumn 2016.

Table 5: Mobile market, Bulgaria 2015-2016

Mobile market	BG-2015	BG-2016	EU-2016
Market share of market leader	39%	39%	34%
Market share of second largest operator	33%	33%	28%
Number of MNOs	5	5	-
Number of MVNOs	-	-	-
Market share of MVNO (SIM cards)	-	-	-

Source: Communications Committee. Data as of October 2015 and October 2016

On fixed broadband, a person seeking to subscribe to a fixed broadband connection should spend on average 1.7 % of his/her income. This number is higher than the average of EU of 1.2%. Nevertheless, this might be the only reasons for the stumpy take-up of fixed broadband in Bulgaria. Other explanations such as different social interest, demographical, consumer's behaviour preferences for distribution products, or the aging population relatively and low levels of digital skills in some remote region may better explain this state of performance.

Digital Services

The Bulgarian performance respecting to digital public services stays well below the average for the EU and the country slid two positions – in DESI 2016 was 23rd and 25th in DESI 2017. Still, one specific area presented strong progress the Open Data, for which Bulgaria has become a trendsetter in Europe Top 10. The open data portal[13] is a fundamental web-based public information system that lets management and publishing of reusable information in a machine-readable and open format. The platform is created in a manner that permits complete extraction of the available information or portions of it. Data are available for free and can be used for non-commercial or commercial purposes, along with for applications development built on them.

Figure 15: Digital public services, Bulgaria, DESI 2017

	Bulgaria				EU
	DESI 2017		DESI 2016		DESI 2017
	value	rank	value	rank	value
5a1 eGovernment Users	**10%** ↓	**27**	**15%**	**26**	**34%**
% internet users (last year)	2016		2015		2016
5a2 Pre-filled Forms	**19** ↓	**25**	**23**	**21**	**49**
Score (0 to 100)	2016		2015		2016
5a3 Online Service Completion	**71** ↑	**23**	**64**	**23**	**82**
Score (0 to 100)	2016		2015		2016
5a4 Open Data[13]	**76%** ↑	**7**	**56%**	**9**	**59%**
% of maximum score	2016		2015		2016

Source: Digital Economy and Society Index 2017 – Bulgaria, European Commission

[13] https://opendata.government.bg

Bulgaria adopted a Roadmap, on 5 April 2016, for implementation of the Strategy for the Development of e-Government for the time 2016-2020. It plans the activities and measures for the implementation of the strategic aims, along with the financial resources required and responsible institutions.

In June 2016, the Electronic Governance Act was revised, introducing an important change: the formation of a new State e-Government Agency (SEGA), the purpose of which is to organise e-governance policies. SEGA, in terms of structure, participates in the "Electronic Governance" Directorate of the MTITC and the Executive Agency "Electronic Communication Networks and Information Systems".

The agency has only been functional since 1 December 2016 and newly, on 14 February 2017, launched its website[14]. SEGA goals to centralise all procedures associated with e-Government. It is tasked with introducing and issuing control-related policies, regulations, rules, and good practices in the arena of electronic governance, budget planning, strategic planning and control, coordinating altogether interdepartmental projects and sector-related policies. The agency is also accountable for sustaining the government cloud (G-cloud), the central registers and the communication network of the State Administration.

In May 2016, a novel Electronic Identification Act was approved and came into force on November. Additionally, adjustments were made to the law on national identification documents. This is a crucial step to the accelerated introduction of e-Government as it outlines a unified arrangement for electronic identification of businesses and citizens. It permits Bulgaria to start as of 1 January 2018, issuing electronic identification cards (EDPR, 2017).

These are some of the legislative and organisational changes that the country accepted in 2016 to overcome the difficulties that have prevented it from making visible progress in the part of usage and provisioning public services. Bulgaria will need to exploit on these efforts and works to deliver visible and concrete results.

[14] https://www.e-gov.bg

Chapter 5

Bulgaria, alike other EU countries, should conform with the EU overall rules in the sector. The liberalization course in Bulgarian telecommunication regulations can be seen in the context of the process of telecommunication liberalization at the European Inion lately stage, though Bulgaria only newly, in 2007, joined the EU, and was in the bottom of the EU statistics. Nevertheless, as EU policies are primarily issued in the form of directives to be transferred on the national level, there are alterations in the exact national rules and, accordingly, the method of implementation and as well schedules for enactment.

1. National broadband plan and investments in broadband

The „National Broadband Infrastructure for Next Generation Access Plan" (NBP) is the latest, from 2014, Bulgarian broadband strategy. The plan established the following main broadband priorities until 2010 in line with the Digital agenda for Europe:

1. Providing the chance of equal access to high-speed and ultra-high speed Internet by evolving broadband infrastructure, to reach full coverage in the territory of the country at higher than 30+ Mbps access speed.
2. Encouraging the use of services over broadband access networks, so that minimum 80% of businesses and 50% of households to subscribe to broadband access above 100 Mbps.

The national strategic objectives for the implementation of those two priorities of the plan until 2020 consist of:

- providing full coverage with next generation access all over the territory of the country;
- evolving fixed broadband networks to accomplish 90 % access at speed of over 100 Mbps;
- ensuring the prospect of broadband access and optic connectivity at speeds above 100 Mbps to at least 50 % of the homes in the country;
- guaranteeing the opportunity of broadband access and optic connectivity with speeds more than 100 Mbps to all business organizations;
- developing the optic broadband infrastructure connecting all public institutions with speeds more than 100 Mbps;
- prospect of full integration with European optic infrastructures.
- increasing the segment of population that uses the electronic services and Internet of up to 75%;
- increasing the coverage and refining the quality of electronic services in the field of healthcare, education, administration etc., grounded on the usage of next generation broadband access (NGA);
- promoting and facilitating the usage of electronic services over next generation broadband access by businesses;
- enhancing trust in electronic services and the Internet by introducing high security norms and standards (NBP, 2014)

Bulgarian broadband plan has six investment priority extents. These reproduce its broadband target structure and foresee different measures for "black", "grey" and "white" areas. In terms of

investments, the Bulgaria's NBP allocates about €27 million for grey areas and nearly €120 million for white areas. The network distribution techniques will rest on the population density. Consistent with the eGovernance agency, development plans of municipals do not address broadband. A detailed and extensive roadmap has been created to be implemented more effectively the NBP. As of July 2016, the country had an NGA broadband coverage (above 30Mbps) proportion of 74% of households[15]. Nevertheless, the coverage was only 17% in rural regions according to the Digital Agenda Scoreboard, which is underneath average rate of the EU of 40%. Overall, the NBP highpoints the importance of private investments to accomplish nationwide roll-out of ICT high-end infrastructure.

The Bulgarian aim is also for 80% acceptance rate for 100 Mbps by 2020 in the business sector. There are no distinct municipal or regional broadband plans. Due to the uncertain political situation in the country and the vital ongoing internal adjustment debates, the execution of the wide broadband distribution project co-financed by the European Agricultural Fund for Rural Development (EAFRD) has not in progress yet as prearranged in the national broadband plan and its roadmap. The timeframe 2015-2020 is roughly established in the Roadmap for the progress of the project. As DG AGRI accepted in October 2016, the ex-ante regarding Broadband, the Bulgarian authorities have just started the actions for the roll-out of the project. Regarding that, meetings between stakeholders were held to outline the exact scope of the locations and the measure that would be affected. Presently, under the guidelines of Regional Development Plan, an ordinance for the execution of Sub-measure 7.3 Broadband Infrastructure is under planning.[16]

The national NGA network has continued to grow gradually since December of 2015, when the in the country was completed the first NGA broadband co-financed by the European Regional Development Fund 2007-2013. That project will be discussed in detail in the next section. The government has also allocated €30 million under the EAFRD (2014-2020) for the roll-out of additional NGA broadband. Bulgaria intents to further decrease building costs for NGA broadband deployment by merging them with the costs of road restoration and other import infrastructure projects, therefore that gives to the EAFRD funding a multiplier outcome.

According to the EC, Bulgarian applicants have submitted a notable number of projects (five in total) under the Connected Communities Initiative [17](CCI), a dual partnership between the World Bank and the European Commission providing technical support to European broadband project organizers. Though, it is clear that while the best Connected Communities projects are projected to be eligible for funding from the European Fund for Strategic Investments (EFSI), Connecting Europe Facility and probably other sources of financing, it is very likely that it will be crucial to combine private funding and financial instruments with European, municipal and national grants in order to accomplish the NBP aims.

The present NBP recognises the problem of a digital divide, but still put priorities on the expansion of cable networks primarily available in urban regions. Nevertheless, the second importance focuses on FTTx networks in "grey" and "white" areas to address the digital divide. The NBP attempts to launch PPP-models to mitigate risk for distribution within rural areas, although with mixed results. Bulgarian NBP emphasises the importance of local actors, but on this time, there appears to be room for

[15] Source: Communications Committee. Data of July 2015 and July 2016

[16] According to the Europe's Digital Progress Report 2017. Available at: https://ec.europa.eu/digital-single-market/en/news/europes-digital-progress-report-2017

[17] https://ec.europa.eu/digital-single-market/news/connected-communities-initiative

improvement. Collaboration between local municipalities to combined demand is not happening on a large measurement.

It is considered that costs of deployment must come down, to diminished the digital divide. Bearing in mind the fairly high prices for NGA access, the put in place tax deductions may not be enough to boost a larger share of households to adopt higher bandwidths. Also, supplementary measures are desired to rise customers' interest. Even though Bulgaria has in place an important plan for broadband development, in the future it should make additional efforts.

2. Phases of regulation

The legal regulation of telecommunications in Bulgaria is provided by the Telecommunications Act, effective since 15 August 1998. Substantial amendments to the Act were introduced in 2001 and come into force on February 5, 2002. The terms "telecommunication activity" and "telecommunication" were defined in the Law as well as the rules for operation of the telecommunication operators were specified. The sector services and activities, according to the Telecommunications Act, were liberalised except for the provision of the fixed voice services (long distance, local, international and transit) among terminal points of the fixed telephone network, the delivery of leased lines and the real-time transmission of trans-border voice for the purpose of providing the international voice services by public telecommunications operators (Verikoukis and etc., 2004).

The straightforward formulation in the Telecommunications Act is the separation of the roles of state governance (which are the Council of Ministers (CM), the Minister of Transport, Information Technologies and Communications and the National Radio Frequencies Spectrum Council ("Radio Frequencies Council")) from the regulation of the telecom market (in the person of the CRC). The clear description of the responsibilities and rights of the institutions engaged in determining the policy and accomplishing the regulation in telecommunication sector was also contained within the Act.

As an independent authority. the CRC is vested with the explicit powers to control and regulate the compliance of delivery of electronic communications with the relevant law. The main responsibility for implementation of the competition rules falls within the competence of the Bulgarian Commission on Protection of Competition ("CPC"). The CPC and the CRC shall performance in cooperation and coordination.

The overall legal framework for the issuance of the licenses for performance of telecom activities follows the EU regulatory framework outlined by the Council Directive 97/13/EC of April 10, 1997 on a mutual framework for individual licenses and general authorizations in the field of telecommunications services.

The telecommunications market in Bulgarian was officially and fully liberalised on 1 January 2003. In that time, generally, the EU 2003 regulatory framework has been transposed in the presently effective Bulgarian legislation.

Subsequent the country's accession to the European Union on 1 January 2007, a new Law on Electronic Communications was adopted (promulgated in State Gazette issue 41 of 22 May 2007, as later supplemented and amended, the "LEC").

3. Legislative changes – the new law

Law on Electronic Communications is the basic law regulating almost all aspects of the telecommunications. With the admission of the country in the EU, have been made and still are made changes in the law leading to synchronizing the national legislation with that of the Union. Because of this, the volume of LEC has significantly grown, covering a wide range of issues.

Consequently, when introducing the requirements of the Directive 2014/61 / EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks (Directive 2014/61 / EU) and update regulations that set requirements for the deployment of electronic communications networks and the construction of related infrastructure, the Council by MTITC selected a different approach, specifically Draft Law on electronic communications networks and physical infrastructure has been prepared. The preparation of a special law regulating the construction of high-speed broadband networks, is provided in the Government Program for Stable development of the Republic of Bulgaria for the period 2014-2018 - item 7 "E-government and government administration", objective 2: "Providing quality, efficient and easily accessible e - services for citizens and business " and the Updated Electronic Communications Policy of the Republic of Bulgaria 2015-2018[18].

The proposal for a special law has been prepared by an interdepartmental workgroup. During the preparation, wide-ranging meetings were held with stakeholders such as associations and industry operators to get involved and consider the real experience and good practices.

The proposed draft Law on electronic communications networks and physical infrastructure is in accordance of Chapter Seventeen of the applicable LEC, concerning the construction of the electronic communications networks. With removed out-dated provisions, imperfections in the implementation process, also others being adapted and tailored with the technological development and some liberations, is created the new special law.

The main objective of the plan is to improve the investment environment in the ICT sector by reducing the administrative burden and business costs, such as establishing clear rules and procedures for and reduction of the costs of deploying high-speed broadband networks.

The bill is structured in nine clear and logical consistency chapters. There are: general provisions, objectives, access to information for physical infrastructure, provision of access to and shared use of physical infrastructure, coordination of activities, deployment and installation of electronic communications networks and building their physical infrastructure, electronic communications networks and infrastructure in buildings, dispute resolution, control and administrative penalty provisions.

In Chapter one "General" and in Chapter two "Objectives" is structured the scope of the law and the strategic objectives are pledged to achieve in the light of the introduced directive. The purposes are:

- facilitating and stimulating high-speed deployment electronic communications networks by encouraging joint use the existing physical infrastructure;
- creating conditions for more efficient and less costly construction of new infrastructure;

[18] Available at: http://www.strategy.bg/StrategicDocuments/View.aspx?lang=bg-BG&Id=955

- improving the planning and coordination process of building a physical infrastructure for deployment, use and development electronic communications networks;
- reducing the administrative burden and creating conditions for simplification of administrative procedures related to the issuance of acts by the competent authorities involved in the construction, maintenance, development, and modernization of physical infrastructure;
- improving cross sectoral coordination in relation to shared planning, building, use and maintenance of physical infrastructure for the deployment of electronic communications networks.

The Chapter three "Access to physical information infrastructure" provides for the creation of a Single information point. It is envisaged that The Agency for Geodesy, Cartography and Cadastre will perform the Unified Data Point functions.

The Single information point is essential for the achievement of the objectives of the law, because it is entrusted with functions to maintain a single database of up-to-date information to facilitate the coordination of shared construction and use of physical infrastructure, as well as the deployment of electronic communications networks. The updated data will include information for:

- existing physical infrastructure suitable for deployment of electronic communications networks;
- information on planned physical infrastructure building activities, and / or for the deployment of electronic communications networks;
- procedures and normative acts regulating the activities, essential for the deployment, maintenance and improvement of electronic communications networks and their associated physical infrastructure, including the authority's aptitude to carry out these activities, and issue the relevant acts, as well as the fees (tariffs) for their issuance;
- sample documents for obtaining permits and other acts for infrastructure and network deployment;
- contact details of all competent government bodies and network operators related to construction and deployment activities.

The Single Information Point will be entrusted with keeping the public register of notifications for the location of transceiver stations of wireless broadband networks, which will also be part of the information published by it.

It will also be provided due to the technical possibility of the Simple Information Point the insurance to fill in and submit electronically applications and other documents required for the deployment, maintenance, and improving electronic communications networks and physical infrastructure, as well as to receive information on the course of their examination by the competent authorities. The future creation of that technical opportunity will considerably ease the investment process in consistent with the "one-stop-shop" concept of the modern complex administrative service.

The chapter Four provides rights and easements associated with building physical infrastructure and network deployment. The arrangement is based on a Chapter seventeen of the LEC, including it the acquis communitarian resulting from the Directive. The legal institutes are summarized and divided into two sections: the provision of rights and easements.

Access to existing infrastructure and shared use of physical infrastructure by network operators must be on transparent, proportionate, fair and reasonable conditions, including price. By accessing and sharing already built infrastructure will reduce costs, will ease investment process and will accelerate deployment of high-speed broadband networks, will help to overcome the difficulties, when deploying electronic communications networks in hard-to-reach areas, as well as in regions where new engineering and construction activities would have adverse environmental impacts or would require serious financial investments.

In chapter "Coordination of Activities" is first created procedure for access to information on planned activities for the deployment or installation of physical infrastructure. The availability of detailed and up-to-date information on all planned activities as early as possible is essential for effective coordination of shared construction and deployment of broadband networks.

Upon written request by the telecom operator or on the initiative of a network operator, each operator should provide to the Single information point minimum information about current or planned construction, installation or assembly activities related to its physical infrastructure within the scope of the request. That is for the purpose of negotiating arrangements to coordinate the deployment, maintenance, or operational activities, improving the network elements, or physical infrastructure building.

This information enables each operator to comply the deployment of networks with planned repairs of another operator and on this way to coordinate and synchronize construction, repairs, or other activities. Except of the lower cost of reconstruction, the coordination of activities is important to the community because that can avoid the constant repairs of public spaces and equipment and the so called “Continuous digging of streets" and related with it dusting, pollution, noise and total decrease of the quality of life near repair works.

A crucial point in the draft law is the distinction between the telecommunications networks and the physical infrastructure in which they are located. Physical infrastructure such as canals, pipes, shafts, buildings, antennas structures, towers and pillars will be built at current requirements of the Spatial Development Act. That is why in chapter "Deployment and installation of electronic communications networks and building of their physical infrastructure" in two separate sections is defined the order for carrying out activities related to the construction of infrastructure (Section I) and deployment and installation of networks (Section II). The aim is to ease the deployment of telecommunications networks and the simplification of administrative procedures.

In the next chapter is governed the deployment of electronic communications networks in buildings. Achieving the Digital Agenda's technology objectives requires the construction and deployment of physical infrastructure for broadband to reach as quickly as possible the end user. The requirements are when designing new structures and in the case of renovation to envisage the construction of physical infrastructure suitable for the deployment of high-speed broadband networks. Correspondingly, are set out the conditions for granting the access to built-in infrastructure.

In the draft law is proposed the Communications Regulation Commission to has the role of a dispute resolution authority, associated to existing infrastructure access, including the price of access, coordination of construction, provision of information for planned construction, providing access to physical infrastructure in buildings and deployment of broadband networks. The powers of the Communications Regulation Commission and the procedure of resolving disputes are also regulated.

In accordance with the proposed directive was foresighted the law to come into force on 1 July 2016, except for the provisions relating to the creation and exchange of information through the Single information point as well as the obligations in the design of new buildings and major repairs of existing ones, providing the deployment of physical broadband infrastructure. But until that time, the government approved the only the draft of the Law on electronic communications networks and physical infrastructure.

The envisaged legal changes are another step taken by MTITC, to create prerequisites for accelerated development of modern communication infrastructure. The establishment of next generation broadband networks will continue to be extremely important technological criterion for Bulgaria to become country with economy of knowledge and advanced information society through the ubiquitous use of Information and Communication Technologies by citizens, businesses and the public sector.

4. Universal service

While access and interconnection regulation has changed during the different phases of liberalization, universal service policies have remained constant. Potentially, universal service provisions can be used for extending broadband, but only Dial-up Internet access is included as part of universal service definition.

More specifically, Universal Service (US) is defined as a group of services with a prearranged quality that shall be presented to all users at accessible price, regardless of their location in Bulgaria. The USO scope is explicitly regulated by the Electronic Communication Act 2007 and includes, amongst others:

- connection to the public telephone network and access to the publicly accessible telephone services;
- provision of directory services; access to public pay phones;
- access to public telephone services by disabled persons;
- free of charge emergency calls to the consistent national numbers and to “112”, etc.

Currently, the former incumbent operator the Bulgarian Telecommunications Company (BTC) provide the universal service. The CRC has started a process for the designation of a universal service provider to determine if other entities are keen to provide the service as well as the conditions and terms that will be acceptable for such entities. Nevertheless, irrespective of the quantity of undertakings that have presented an interest in providing the service, there are no other actually providing it, since most of them have stated that a review of the effective legislation as well as equal treatment of the undertakings is required (Kunze and Ivanova, 2015)

Followed closely by the regulatory organ, has been the expansion of the coverage of broadband services, but a universal service obligation for these services has not been considered, however it could be an option if the broadband coverage does not develop with suitable levels.

Frequency regulation

The organ that manages the use of the radio spectrum for civil needs is the CRC. It grants the use of radio bands and frequencies after national coordination and clearance with all central government departments, state bodies and concerned service providers. By the CRC, the actual management of

the spectrum is made by implementing a combination of regulatory, administrative, and technical measures that provide for effective use and management.

After conducting tender procedures in 2005, CRC issued first three 20-year individual licenses for the provision of mobile telecommunication services of the UMTS standard, for launching commercial 3G services. "Mobiltel" EAD was awarded a Class A licence, and „BTC Mobile" EOOD and "Cosmo Bulgaria Mobile" EAD were awarded Class B licenses. Afterwards, from June 2015, the CRC has provided the entire frequency band at 900 MHz for equivalent use of the same three mobile service operators.

The first commercial 4G Long Term Evolution network in country has launched by the wireless broadband operator Max Telecom (Max Telecom, 2014). The operator walked away from the nation's frequency auction in December 2011, with a 2×8MHz block in the 1800MHz spectrum band and next indicated that the firm would begin rolling out an experimental LTE mobile broadband network in the second half of 2012 with Nokia Solutions & Networks (NSN) contracted in July 2013, overlaying its remaining WiMAX system.

Following on from the conclusion of its network upgrade and renovation project in 2015, Telenor Bulgaria launched the second commercial 4G LTE technology on 1 December 2015 (TeleGeography, 2015). The new network, which works in the 1800MHz band and offered to clients maximum download speeds of 75Mbps. Shortly after that, the other two big operators (Mtel and Vivacom) introduced their working commercial LTE networks.

Although in the frequency band at 1800 MHz, CRC has granted 102 MHz in 2015, appropriated for 4G LTE technology services and having vacant resources.

In April 2016, the additional frequency spectrum in frequency band at 1800 MHz, that will allow higher speeds on the mobile internet, for 4G/LTE services were granted to the four leading LTE service providers (Mtel, Vivacom, Telenor, Max Telecom brands), (Kirilova, Dnes.bg, 2016).

In 2011, after a legislation amendment, an undertaking that has been approved a permit for usage of radio frequency is allowed not only to transfer the permit or part of the obligations and rights under it, but also to lease the particular resource. That can only be done under the CRC's prior authorization. This is the case with one the major mobile operator Mobiltel (Mtel) that has lent its rights of use of spectrum between the 3.4-3.8 GHz frequency band to one of the WiMax providers in the country.

That kind of policies supporting spectrum swapping, spectrum sharing and trading might play also a role to allow using of advanced technologies, along with cognitive radio techniques. That frequency flexibility, in addition with technology neutrality, appear to be two of the important characteristics of spectrum policies, interpreted as tools for the promotion of broadband penetration (Alcatel-Lucent, 2009).

In the middle of 2016, Bulgarian government actualized the Radio Spectrum Planning and Distribution Policy. The aim is to ease the penetration of new wireless technologies, such as 4G and future 5G, building the Single European Digital Market, the use of geostationary services for the need of National Security, and the introduction of the new railway communications. In the document are reflected the national and international changes occurred during the last 10 years, affecting the spectrum planning and allocation activities. The adopted policy by the Council of Ministers outlines the trends and guidelines for planning and distribution of spectrum within the country in the short

term - by the end of 2017, in the medium term - by the end of 2019 when the next World Radiocommunication Conference will be held, and in the long run - beyond 2020.

It is planned that by the end of 2017 it will be possible to start the process for usage of 800 MHz bandwidth for terrestrial networks, which will be for telecoms. A redistribution of the usage of the 3400-3600 MHz band is also envisaged. The goal is to ensure the conditions for effective use pf that band. In addition, the next year is planned to re-plan the TV channels in IV and V band by the CRC. The objective is to release spectrum used for DVB-T (digital television) and wireless broadband networks to ensure a harmonized use of the 700 MHz band.

Another important aspect for the country is to continue work on ensuring effective use of geostationary orbit positions defined by the international agreement. Also, coordinated activities are planned with military to release their frequency bands to cover the entire railway network in the country and ensuring the interoperability of rail communications.

5. Initiatives to develop broadband infrastructure

As the most significant project in the country is highlighted the "Development of broadband access in Bulgaria by building a critical, protected, secure and reliable public ICT infrastructure" („Развитие на високоскоростен широколентов достъп в България посредством изграждането на критична, защитена, сигурна и надеждна обществена ИКТ инфраструктура"), which started in the autumn of 2012. The project is implemented under Operational program "Regional Development", Priority Axis 2: "Regional and Local Accessibility", Operation 2.2: "Information and Communication Network" by ИА „ЕСМИС" (Executive Agency "Electronic communications networks and information systems"). The approved budget of the projects is around 39 million levs[19]. The main objective of the plan is to build critical, protected, secure and reliable Next-generation broadband infrastructure for the needs of e-government and the creation of prerequisites for development of broadband services for citizens and business in the disadvantaged regions of Bulgaria.

Additionally, objectives of the strategically implemented documents are implemented:

- Creation of prerequisites for the development of e-government in Bulgaria in selected areas for intervention by providing NGA connectivity to the state and public institutions in these areas, including educational, cultural, social and health institutions;
- Development of the broadband NGA market for wholesale services in the targeted Bulgari areas by building up the necessary infrastructure for that;
- Creation of prerequisites for the development of market for NGA services for citizens and businesses in the targeted areas by providing favorable and equal conditions for Internet providers to offer NGA-based services for citizens and businesses in these regions;
- Creating preconditions for enhancing competitiveness of the local economy by facilitating and stimulating the use of broadband from IT-business to introduce new business models and the provision of new services to end users, leading to increasing employment and living standards of the population;
- Enhance confidence in Internet services by imposing security and behavior norms to modern international standards;

[19] http://umispublic.government.bg/srchProjectInfo.aspx?id=72722

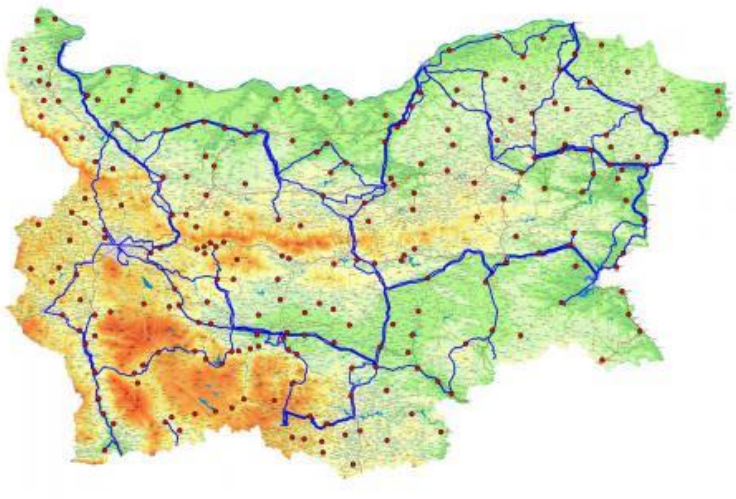
- Promoting social cohesion by providing access to on-line services for people living in sparsely populated and remote areas, thus overcoming the tendencies for the isolation of this part of the population of the social and cultural life in the country.

The project is geared to implementing NGA networks in early identified underdeveloped areas that are not attractive to businesses, due to economic backwardness and lower density. The official implementation was in the end of 2015, the project provides construction of optical NGA infrastructure in 29 municipalities centres and 24 small settlements, with a total of over 900 km of optical cables. The selected settlements have a total area of 7 919 sq. km and represent 7% of the country's territory. They have 277,765 people, which is 8% of the population living outside the district towns and the capital, or 4% of the population of Bulgaria. Once the project has been implemented, all the design and development activities building the last mile network to connect the end users, including funding and managing it, will be assign to private operators for 13 years. The selected operators can rent it to local ISPs. The operators will be selected with an open tender under the Public Procurement Act procedure and will be in this sense indirect beneficiaries under the conditions specified in the contract and EMSIS retains the right to ownership.

This approach follows the so-called Public Outsourcing model according to EC Guide to Broadband Investment. The advantage of this model is to provide better financial efficiency of the public funds invested through attracting and consuming the expertise of private business, as well as the possibility of better control over the operation of the network. This model is recommended by the EC when the financial parameters of the project is below the threshold that could attract a private investor interest, but they are sufficient to have a private interest in operating already built network.

For the next programming period (2014-2020), the plans of the Ministry of Transport, Information Technology and Communications include connecting all other municipalities (the red points on the map below), so that the whole country is effectively covered with e-government.

Figure 16: Map of Bulgaria with new optical cables



Source: ComputerWorld

The network was built up by two consortia - one for Northern and Southern Bulgaria. Northern districts were won by the Broadband Bulgaria Consortium, which is comprised of Telelink and

Marmet firms. For the southern part of the country, the offer of the consortium "CBB-TCB 2015" was selected. It includes two state-owned enterprises - "Communications Construction and Reconstruction" (DS SVV) and "Transport Construction and Rehabilitation" (DS TSW), which are under the transport ministry's hat. The deadline for completing the task - initially by the second half of September 2014 - was extended to November, then by May 2015, to end at the end of 2015. The delay of the procedure was due to the slow state administration and the long terms for obtaining construction and wiring authorization.

With a delay of several months, the ESMIS started the procedure for selecting telecoms in 2016, which will support the already established infrastructure for Internet access in sparsely populated, but there are not selected yet. Two concessionaire companies must be selected - one for the north and one for the southern part of the country, who will be responsible for the next four years (additionally were 13 years) and sell wholesale Internet to smaller local suppliers. Telecoms that have served a service of similar size and volume over the last three years will be admitted to participation. That is likely to limit participants to major national operators. However, they will not have the right to build additional infrastructure within the settlements nor to sell services to end customers (Capital.bg, 2016).

Chapter 6

Digital divide is a term that illustrates inequality in access, the use of information technology services, including the Internet, between the social groups in urbanized territories and those in the small and remote settlements. As it was already mention, the total coverage by fixed networks and Next Generation Networks in the rural areas in Bulgaria is significantly below the EU.

Indeed, the lagging coverage in remote areas is not a problem only in Bulgaria, but as overall for the EU, but still the country continues to be among the countries with the lowest percentage of households subscribed to fixed broadband. The European Commission has indicated that this can be attributed to insufficient skills of the population to use digital technologies and in the field of the poorly developed broadband infrastructure outside the main cities that leads to the digital divide between urban and rural areas. In addition, is the prolonged procedure for obtaining permits to build communications networks and reduced public funding restrict investment in sector. The mountainous relief of Bulgaria and the significant percentage of NATURA (НАТУРА), around 40%, creates additional holdups in the construction of broadband networks.

The definition of governmental measures in terms of deployment, upgrading and modernization of broadband infrastructure should have a special focus on remote and sparsely populated areas where there is no communication infrastructure and market logic does not define its economy as profitable building it. So far, two projects have been implemented in Bulgaria through the European financing under the OP for rural development, both of which emphasized on the construction of a fixed infrastructure.

In Europe, the price for the operators to connect a household to the Internet through the establishment of fixed infrastructure in urbanized areas varies between 150 and 540 euros. For distant regions, however, this expenditure reaches € 2,700 (Broadband Commission Report, 2014). Obviously, from the point of view of economic viability and return of the investments, the ISPs have no incentive to invest in fixed infrastructure in these areas.

At the same time, high-speed networks are identified as one of the important factors for stimulation of the social inclusion of the population living in distant or poorly populated areas. They provide the opportunity to work online and so on to attract young people to settle in these areas. For the elderly population with mobility restrictions is an opportunity for promotion the quality of life and the use of services typical of the big city. For example, through telemedicine, consultations and even interventions are being carried out by medical professionals, without the need for an adult or a difficult person to travels over the long distances.

1. Analysis of the measures for overcoming the digital divide in the country

The investment of public funds for the construction of high-speed networks in remote areas is domineering in order to avoid the digital dividing of part of the society. Next generation mobile networks are one way to achieve broadband internet access. In Bulgaria, due to the lack of free spectrum for civilian needs in the 700-800 MHz band and the lack of incentive measures for public-private partnerships, the coverage in rural areas of next generation mobile network are not well developed.

At the same time, global consumer behaviour data show a lasting interest in mobile internet. Subscriptions for mobile services are expected to double by 2019, with smartphones already accounting for half of the mobile sales phones. The monthly consumption of traffic by a smartphone user is expected to reach 4.9 gigabytes in 2020[20]. Downloading video content increases as percent of the internet traffic and therefore requires higher capacity and higher network speeds.

The market situation in Bulgaria is characterized by an increased demand for services for access to the Internet, whereas the requirements of the users are increasing about the quality of these services. Satisfaction of the consumer demand in line with the strategic objectives set at the Community level is not only restricted on the construction of a fixed infrastructure

The trends in market development and sustained growth in demand for broadband services is a condition of investment interest on the operator's side for the construction and upgrading of the mobile networks for the period up to 2020. The plans of the participating companies in the Bulgarian market include the provision of broadband internet access by introducing LTE technology to the majority of the settlements currently falling under the categories of "white" and "grey" areas. Information on market participants' plans by settlements until 2020, was provided to MTITC in 2015 and should be considered when updating the areas in which it is acceptable the deployment of broadband infrastructure in the necessary scale to be implemented through public support. The application of such an approach is in line with Community rules, the definition also covers as far as wireless networks for NGA based on point 57 of the Guidelines of the EU.

Identifying areas meeting public support requirements at broadband deployment is a prerequisite, but not a guarantee for the implementation of the strategic objectives. This is because the construction of the infrastructure requires a certain amount of time. Given the number of settlements in Bulgaria, currently falling into the so-called " "White zones", betting on a model based solely on deployment of broadband networks in practice limits the opportunities for appropriate achievement of the goals. With the development of technologies as an appropriate alternative is to organize the broadband internet access via mobile networks. Basically, an advantage of these networks is the construction of a coverage that allows the use of the same services without a fixed location in the given area. At the same time the mobile networks require substantial investment in view of the legislation requirements for construction, quality creation of the facilities and reliable and safe use of them. Through the adoption of an appropriate minimum set of measures in the draft law Electronic communications networks and physical infrastructure, the country can has a favourable impact on the formation of investment intentions by market participants and, accordingly, to ease its role in relation to the realising concrete projects in this area and providing the necessary financing (OECD, 2013).

Measures that government bodies can take:

- Possibility of using spectrum in the 800 MHz band for civil needs as soon as possible.

The deployment of mobile networks through LTE deployment is directly depending on the possibility of using the full spectrum in the 800 MHz band. In case that this spectrum is provided for civil use, the market situation will also provoke interest, on the part of other market participants to target their business strategies for providing Internet access via creation of their wireless networks. In

[20] Ericsson's estimate is reported in D. Thomas, S. Bond, Smartphone poised for revolution in media access, Financial Times, 3 June 2015

accordance with the arrangements reached at Community level, Member States had to ensure the provision of the 800 MHz band (Frequency band 790-862 MHz) for electronic communications services in accordance with the harmonized technical conditions established pursuant to Decision No 676/2002 / EC, and in particular in accordance with the provisions of Decision 2010/267 / EU. Bulgaria is one of the Member States that has difficulties in securing the under-consideration bandwidth, and this resource is currently being used for the purposes of national security.

The State should take timely action and, in the short term, to ensure the possibility of using the entire spectrum of 2x30 MHz in range 800 MHz for civilian use to deploy wireless broadband networks. Partial release of individual bands in the 800 MHz band and providing them only to a limited number of operators by auction would lead to distortion of competition, artificially inflated price of this spectrum and like ultimate effect - to delays investment in networks and the development of new consumer services. Such an approach would be in contradiction with the DMS, which is expected to introduce pan - European governance criteria spectrum for the encouragement of investment in broadband mobile networks.

Currently, as an addition to the study of options for spectrum refarming and sharing spectrum in the 800 MHz band held, in October 2016 Bulgaria designated that 2x10 MHz in the 800 MHz band for terrestrial networks capable for electronic communications services (811-821 and 852-862 MHz). The rest spectrum remains for military use. They are topic to tests to determine the compatibility of civil terrestrial networks in bands 852-862 MHz and 811-821 MHz and military radio electronic equipment in next to bands before the channels newly made available are auctioned (EDPR,2017).

- Take certain legislative initiatives to stimulate private investment for network building.

According to the EU Guidelines, the implementation of state intervention includes mainly legislative measures - relieving regulatory regimes for broadband networks, and to be no distinction between service technology - wired or wireless. Presently, one of the main reasons for limitation of private investments for network building are the presence of cumbersome administrative procedures, the pursuit of which requires considerable time and financial resources. According to Zaharieva (2016) these practical problems for building broadband networks are related to legislative decisions and procedures and can be summarized as follows:

- Creation of electronic communication infrastructure (base stations, masts, canal network, etc.) is carried out on the basis of the common building legislation, with all the required documents and without specific regulation for electronic communications networks;
- The construction of electronic communications infrastructure falls into one of the highest categories of construction (third category) - by analogy with industrial installations, construction of buildings, factories, power plants. As a result, the process of building each individual base station takes approximately 1 year in the absence of complications in authorization procedures;
- Construction permits related to networking are issued in the conditions of decentralization by each of the 265 municipalities in the country and in the absence of unified rules. Each municipality applies its own procedures, conditions and prices, which prevents the introduction of a unified approach to the same construction.

In practice, there is also a difference in the approach of the administration to the reviewing the documents of different operators (investors), which can prevent competitive environment. In the

case of the administrative bodies, and other institutions involved in the process of issuing building documents in many of the cases are reported to have a great delay. Common case is where, because of such delay is lost interest in realization of the investment intention. Every change of equipment of an existing base station, and replacing antennas due to technological modernization are considered new construction and as a new one required building permit - a procedure that is associated with a significant additional cost of money and time on the part of operators.

The measures set out in Directive 2014/61 / EU create preconditions for relieving applicable regulatory regimes and stimulating private investment interest. Regarding the development and modernization of the broadband mobile networks, the new law or eventual amendment of the TDA should enable operators to exchange equipment in the networks, without a new building permit, when the replacement does not lead to constructive changes to the existing structure. The last one may be verified and certified by a registered design engineer. It is important to be underline that compliance with the rules on electromagnetic radiation will not be changes and the control of regional health inspections provided for in the Health Act Remains unchanged. A possible approach that will solve many problems about costly and delayed construction of next generation mobile networks is

- Swap of existing roof Base Stations as a result of the modernization, not to be considered as a new building and not to be required building permit, when the construction of the building is not affected and not increases the load;

Undertaking legislative initiatives involving the implementation of the above mention measures will greatly facilitate the following procedures, related to development, modernization and maintenance of mobile electronic communications networks. The administrative burden and the costs of preparing, presenting, and approving the construction papers will be reduced. Lightening regulatory regimes will generally have a favourable impact on the development of competition and will ensure access to quality services for more users.

- Provide reliefs for building of networks in the remote and difficulty access areas

One of the main problems faced by operators is related to deploying their networks in remote and hard-to-reach areas. In these cases, even if there are more liberal regimes for building of networks, the need for substantial investments is a barrier to the implementation of such plans. Good European practice gives examples of achieved interaction at the level of country-operators, which to a considerable extent solves the problem of building infrastructure in remote and hard-to-reach regions. Slovakia, for example, as part of its broadband access project to "white" areas, saw the need for the infrastructure building in the remote and hard-to-reach areas to be used for both wired and wireless to help the provision of broadband access. By this project, which also represents approved State aid[21], operators have the opportunity to employ the state-run infrastructure (masts for mobile stations), install equipment and accordingly provide coverage on their mobile networks, at a reasonable level of investment.

By analogy with Slovakia, the regions with potential to be categorized in Bulgaria as "white" areas also cover areas with difficult mountainous terrain. In these regions, the emergence of private investment interest is unlikely given the size of the necessary investments, especially in the case of wiring broadband networks. That is why the application of Slovakia 's experience in the construction

[21] State aid SA.33151 (2011/N) – Slovakia Basic broadband deployment in white areas of Slovakia

of the infrastructure (masts for mobile stations) in remote and difficult to access areas will encouraged operators to secure coverage of their mobile networks in these areas. From a consumer point of view, the entry of more operators into the affected areas is a prerequisite for improving the quality of the services offered, and this will help to achieve the strategic goals set at national level.

2. Deductions on the state of broadband access in Republic of Bulgaria (SWOT analysis)[22]

SWOT is an abbreviation for Strength, Weaknesses, Opportunity, and Threats. It is usually used as an instrument for evaluation. This section is an evaluation of the development of broadband in Bulgaria based on the Bulgarian broadband strategy. The question this section will response is: What are the existing strengths, weaknesses, opportunities and threats of the Bulgarian broadband development?

Strengths

- The membership in the European Union, where broadband is set as a priority for building an economy and information society, based on knowledge, enables our country to participate fully and equitably in all initiatives on this matter.
- The market environment and business leadership have evolved:
  - The local networks and wired broadband are brought to levels above the distribution and ratio speed/cost in the other Member States;
  - Ultra-fast optical lines, built using FTTx technology, which represent a relatively significant share of all fixed broadband lines in the country, compared to the situation in the EU, which is a very good prerequisite for the building on phases Next generation broadband access networks, in accordance with the program objectives of the EU.
- The eased regulation of the broadband transmission environment, delivers initiatives, especially in passive infrastructure.
- The enhanced interest of the ICT technologies, provoked by successful national projects, such as: Internet in schools, National Research and education network, telecentres, "virtual libraries" and others.

Weaknesses

- The fast market penetration of LAN - networks and cable networks for distribution of radio and television signals, offering Internet access at high speed, has led to relatively weak development of typical broadband access technologies (xDSL).
- Insufficient effective regulatory and normative framework for support of the authorization procedures and the process of broadband construction infrastructure.
- Reduced communication connectivity between the central and territorial executive bodies.
- Despite the strong interest in the Internet, this environment is being used relatively low for business and transactions compared to other countries.
- The programs for forming e-skills for work with computers and internet environment are episodic and with insufficient scope to achieve the necessary self-confidence.

[22] Based on the National strategy for broadband development in the Republic of Bulgaria

- There is no need for broadband access as a measure in the operational programs to match the scope and scale of the EU's programming documents.
- Low purchasing power of the population, leading to small investments with short-term nature.
- Lack of serious planning and coordination of the investments in optical connection technologies closest to the homes.

Opportunities

- The concentration of the population in large cities and areas of relatively small coverage distances. In small, remote, and underdeveloped areas should be created conditions for effective investment.
- Participation in the EU broadband initiatives and programs. The low broadband development benchmarks of Bulgaria are grounds for special support from such Community measures.
- Geographic location of the country is at the crossroads of important international optical highways.

Threats

- Possibility of chaotic development in this area due to lack of adequate control and regulations. An appropriate corrective is complementing the mechanisms and forms of control by regulators, and the imposition of responsibility for insurance by the undertaking side with significant market impact on the relevant access market to its infrastructure. The EC recommends this specific form of regulatory intervention.
- Shifting the priority to build broadband access between many actors and agencies within their specific and not related to the essence of the priorities of broadband access. Given the fact that the broadband development is a horizontal procedure affecting several agencies, one of the ways to minimize the effects of this risk is to strengthen the coordination and synchronization of the plans and activities of the central and local authorities on matters concerning the construction, operations and maintenance of electronic communications infrastructure, including and access to broadband.
- Insufficient use of opportunities provided by the European funds. Possible action to minimize that risk is to increase the capacity of the administrations that oversee and are responsible for the use of European funds, as well as the implementation of more active and targeted campaigns to improve awareness of potential beneficiaries under the particular operational programs.
- Poor knowledge of the rules for the application of State help for support of private investment in the sector. This risk could be avoided through the enhancement of the coordination and interaction of the administration and the business in the sectors requiring or admitting being subject to the state aid restrictions.
- Insufficient use of the public-private partnerships opportunities, which could irritate broadband projects due to a lack of sufficient financial resources, especially in remote regions. The effect of this risk could be reduced by carrying out analyses of opportunities for the expanding of PPPs based on the newly adopted Act for Public-Private Partnerships with active business engagement and enhanced cooperation between public authorities and private investors in the realization of PPP capabilities.

Chapter 7

1. Discussions and Conclusions

Inside the EU, telecom markets in the late 1990s were liberalized. But affording to Majone (1997) the change to a more regulatory style started much earlier and was connected to the motivation of creating an inner European market. Although the EU members are using a common framework, there are vast variations in practice in how it is applied.

When broadband was introduced in 1998, the broadband unbundling was not a part of the liberalization of EU telecom market, and countries did not discourse the matter before year 2000. The unbundling of the local loop has been a portion of the EU regulatory framework from 2000, and operators with a dominant position in the market are required to afford full unbundling to their competitors at cost based rates. The final aim is still to reach facility-based competition, and numerous EU reports have conceitedly proclaimed a growth in facility based competition for xDSL services.

The issue about the broadband unbundling in Bulgaria was addressed in the lately 2007. By the end of it there were no investments in the LLU and the shared access lines were only two. Despite the interest in a bitstream offer of different operators, as a first instrument to start providing broadband services, no contracts had been signed by 2008. Also, then in the law the definition of the local loop covered only the twisted metal pair. The contentious point was the high wholesale prices, which formed a price-squeeze effect. Regulatory measures were taken of CRC, in November 2007, by price restrictions on bitstream services toward the price-squeeze effect, and after that the incumbent revised and reduced the bitstream prices. Nevertheless, on DSL there was no competition. The incumbent operator in January 2009, hold 97% of the market. It seemed that, as a result of the changes in the market conditions for other DSL operators, through shared access the two unbundled lines are not available any more. Then only one offer in the DSL market came from an alternative operator available only on the business market, through bitstream. It appeared difficult for other operators to enter the broadband market of DSL, due to access conditions and high prices.

Cable and LAN providers have earned from the lack of control and regulation and have accessed the ducts of the incumbent without any payment or authorisation. In some situations, they had laid down illegally cable networks, until 2009, when CRC enforced them to put underground their fiber optic cables. LANs also link with bigger servers that permit the downloading of content without certainly paying copyright fees. As well, the demand for access to unbundled local loops of the incumbent has disappeared, as DSL as lesser in price and capacity, stability of connection to LAN and cable based broadband contributions aspects of offerings end users most value. That actions by the Bulgarian LAN operators, and afterwards small and large private, as well as mobile, providers continued the deployment of the country with broadband access networks at very high speeds.

Furthermore, the Bulgarian government put strong push for network building and fully focus providing fast and ultra-fast Internet for all citizens, with the adopted in 2014, National Broadband Infrastructure Plan for Next Generation Access. Together with the important project in the country the "Development of broadband access in Bulgaria by building a critical, protected, secure and reliable public ICT infrastructure, which goal is to build critical, secure and reliable Next-generation

broadband infrastructure for the needs of e-government and the creation of basics for development of broadband services for citizens and business in the disadvantaged regions of Bulgaria.

Nowadays, the Bulgarian broadband market is at admirable cross-platform competition, together with cable, DSL, LTE, fibre, and LAN-based services. While the portion of the market seized by cable has to some extent enlarged in recent years, the DSL sector is behind and losing market share because of clients being migrated to fibre networks. Operators as well as Cooolbox and Vivacom now provide gigabit services, with the fibre infrastructure of Vivacom covering about 1.07 mil premises by September 2016. As mentioned, around two-thirds of subscribers, by late 2015, were connected to fibre networks.

How Bulgaria has responded to market and regulatory challenges in their adoption of the EU regulatory framework?

The Bulgarian policy, with NBP prioritization put a prime emphasis on network deployment, with future intention for creation of eminence content. As main part of that content are the e-government services and associated welfares of them, which will bring more worth of the broadband access. The key strategic document that gives the vision for the development of the e-government in the country is the "Strategy for Development of e-Governance in the Republic of Bulgaria 2014-2020" with three strategic objectives: 1) Providing quality, efficient and easily accessible e-services to citizens and businesses; 2) Transforming administration into digital administration through the integration of information processes; 3) Promotion, access, and participation.

Furthermore, the government took big step for creation of valuable content, also open and free of cost, with the creation of new Open data portal of Republic Bulgaria. That is in direction with the application of the European ICT policies, the entire Digital Agenda put much consideration to the content side. Greatly, the Digital Agenda is concerned with the ICT applications, i.e. what ICTs and exactly broadband can be used for relating to residential applications as well as business.

The Open Data Portal is a single, central, public web-based information system that provides for the publication and management of information for re-use in an open, machine-readable format along with relevant metadata. The platform is built in a way that allows for the complete retrieval of the published information or parts of it. Providing open access to public data has both economic effects and broader public relevance. Some of them are opening new jobs and generating and realizing business ideas with the help of open data sets. According to the European Commission's assessment, the provision of open access to data and the possibility of re-use on a European scale can bring economic benefits to EU Member States, worth approximately € 40 billion per year.

Broadband Cost Reduction Directive[23] – transposition state in the country

The deadline for transposing the Broadband Cost Reduction Directive in the state expired on 1 January 2016, the country is noticeably lagging with the adaption of it. Infringement proceedings were opened against Bulgaria by the European Commission for failure to notify transposition measures. Some steps we taken with the adoption of already five pieces of national legislation transferring the Directive, specifically: The Law on access to public information; the Law on spatial planning; the Law on electronic communications; the Procedural Administrative Code; an Ordinance

[23] Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks

for rules and standards for design, construction and commissioning of cable electronic communications networks and associated infrastructure.

Conclusion of the remaining national actions, in actual the Law on electronic communications networks and physical infrastructures, is continuing and has been deferred due to the uncertain political situation in the Bulgaria. Meanwhile, the Ministry of Transport, Information Technology and Communications has accepted preparatory steps for the formation of the Single Information Point in harmony with Article 4 of the Broadband Cost Reduction Directive.

According to the Literature review and the analysis of the Bulgarian broadband strategy in this thesis, the main finding is that Bulgaria put more focus on broadband access and in particular with the adoption of the Digital Agenda for Europe, on the main four pillar of it: expanding access to fast and ultra-fast Internet of the European citizens. However, this does not mean that on the other aspects and pillars of the Agenda, the government is not taking the necessarily actions for transposing it into the national policy. The other activities and adapted policy tools of the adoption of the EU regulatory framework were previously indicated and discussed.

> *What additional broadband policy measures on the supply side and demand side should be taken by the Bulgarian government for more accelerated broadband development?*

Firstly, as advised by an analysis of the literature, broadband policy must give focus on both broadband access and adoption. This implies that supply side policy and demand side policy should both be enhanced. Nevertheless, the decision to choose which policy tools to use depends on the stage of broadband development in the country. Presently, Bulgaria gives more emphasis on the supply side. Accordingly, we the discussion is on what broadband tools are implemented and what can be proposed for the achievement of Bulgarian targets on high-speed broadband adoption and access.

The condition of the Bulgaria broadband is look through and separated into two situations: the urban areas with numerous broadband infrastructure and the rural areas of the country, indicated with an absence of high-speed broadband infrastructures.

In the first situation, the urban areas, which are densely populated, with numerous broadband infrastructure. Indicated that there is previously competition and sufficient infrastructure in the region, the aim of Bulgarian policymakers is to preserve this situation and ensure demand from the residents. Furthermore, in this condition, broadband policy can be used to provision the information society and an improved quality of life for citizens in the region. Market mechanism tools, on the supply side, must typically be applied not to distort the market and preserve the strong supply situation. A policy guideline could be the infrastructure competition, which is the situation seen in Bulgaria. By competition from diverse technologies, for instance fibre, cable and wireless, the prices on high-speed broadband services are expected to drop. Simultaneously, with the competition from dissimilar technologies, new services and innovations can as well be established. On the demand side, policy can have great outcomes when there is sufficient broadband diffusion. Moreover, the high demand in the country can drive the progress of new applications and content that eventually affect broadband infrastructure and services. The demand side policy in the country is beginning to develop with introduction of the e-government services and can be more encourage by increasing public online areas like libraries and parks, more public online services (e-health and e-education), along with diminishing the non-adopted groups.

In the second situation, the rural areas of the country, indicated with an absence of high-speed broadband infrastructures. The situation can be realised in mountains and rural regions where is hard to reach a broadband infrastructure. In this case, more broadband infrastructure requests to be applied with quick speeds. It is vital for the Bulgarian policymakers in this case to guarantee in the areas broadband infrastructure. Direct public investment as well as European subsidies, on the supply side, are used and considering for the presents. Also, more public-private partnerships might need to be measured to provide the necessary broadband infrastructure. The mobile technology should too be used to provision regions through which cannot pass wireline (or fibre) broadband. Our country has numerous regions like this and as an alternative approach USO can be considered by the government. Later, the usage of infrastructure sharing could ease competition amongst the services. However, if there is a demand for private sector investments, used with care should be the infrastructure sharing. On the demand side, the amount of broadband infrastructure can be expected to later develop into a monopoly, therefore legislators must safeguard that the price of the services is reasonable. Furthermore, tax reductions or demand side subsidies for the mark groups can be applied if it is required.

In general, internet security and digital literacy and strengthen social cohesion, which are ones of the main priorities set by The EU programming documents, they also boost the demand side, not only in that rural situation, but overall in the nation. Those are scopes in which Bulgaria can set out more activities to develop for benefiting the consumers. As it is seen in the EDPR (2017), the digital skills of the population and in the overall workforce are between the last in the EU as only around a third (31%) of Bulgarians have at minimum basic digital skills related to the EU with more than half.

Additionally, the country took some measures to boost digital literacy. One of them is the launch of Bulgarian Digital National Alliance for Digital Jobs as part of the European Commission's Grand Coalition for Digital Jobs initiative. Along with, in the educational subject, the government accepted a "Strategy for the effective implementation of ICT in Education (2014-2020)". Its key purpose is to deliver flexible and equal access to education. By method of implementation, a new law was approved on school and pre-school education and amendments were made to the present Higher Education Act. The new law on school and pre-school education contains numerous provisions on ICT education in schools. It is foreseen that digital skills will be involved in the new school programmes as crucial competences, with orientations to specific training in computer sciences and care for individual development. In the higher educational system, the Ministry of Education and Science is executing several changes, identification of protected specialisations advancing from new places in universities and state subsidy that would bring in the next years a broader pool of eminence ICT professionals.

The strategic education reform will progress ICT associated education in universities and schools, which will benefit the level of digital literacy of people entering the labour market, and will rise the number of ICT specialists. Latterly, Bulgaria might also profit from a clear strategy for training with the essential digital skills the labour force. Funding for enduring learning initiatives for workforces of all ages could be provided over the European Social Fund, specially the Human Resources Development Operational programme.

Measures for overcoming the digital divide in the country

The digital divide in Bulgarian populated urban and rural areas can be overcome by a proposed set of measures, which will stimulate investment in mobile broadband networks. The specific policy measures proposed for implementation by the national rule makers are:

- Release of the entire spectrum within the range of 800 MH, which should be made available for use by functioned mobile operators for construction of additional coverage of their fourth-generation mobile data networks (LTE) within 2-3 years.
- Along with the creation of fixed infrastructure, ECMIS or the separate municipalities to build masts for mobile stations in remote and hard-to-reach areas, which are subsequently leased to operators. It is a strong incentive that will encourage private investors to provide coverage on their mobile networks in these areas and will thus guarantee the population in these areas to get broadband access at speeds that are consistent with the targets set in the Digital Agenda for Europe.
- Transposing the Directive 2014/61/EC into national legislation, through the draft law Electronic Communications Networks and Physical infrastructure, in which should be provided effective measures for a fast pace replacement of equipment of the mobile broadband access networks.

2. Limitations

The purpose of this thesis is to provide understanding of broadband policy in the country Bulgaria and of the EU, and as a Member State how implements the EU regulatory framework into national legislation. Also, understanding the economic benefits from broadband development by analysing it through broadband market, adoption, and infrastructure in the country. Nevertheless, this thesis cannot cover all EU broadband policy aspects that are realized or must be in the future by the rule makers in Bulgaria. Therefore, not all policy tools and its outcomes can be investigated for the preposition of implementation in the Bulgarian strategy for development of broadband.

Nonetheless, overall, the thesis can make contributions by signifying policy and economic aspects of broadband policy in Bulgaria with full accordance of the EU programming documents, to the national policymakers. Furthermore, other counties may benefit from the Bulgarian practises by learning from the successes along with its failures from the regulatory and market challenges in their adoption of the EU regulatory framework. This thesis could also contribute to the academic arena of broadband policy research in Europe and Bulgaria.

3. Future research recommendations

For future research, number of options exist to outspread the knowledge of this thesis. The future study on the development of broadband in the country case Bulgaria, for gaining more practical and good understanding, should conduct and gain data from the general users by surveys, as well as interviewing experts, private sector specialists, and regulatory bodies.

For the supply side of broadband policy, most researches have studied at macro level in what way the policy tools affect broadband acceptance and development of services, infrastructure, or investment in one region or a group of nations, like is the case of the European Union. A study of a

definite country, such as this, might be better analysed it on a comparison case with other country. Moreover, recently there have been excessive progresses in the advance of wireless technology and the future arise of 5G technologies. The study of the mobile 4G LTE and the future 5G, with respect to the broadband infrastructure and policy measures and obstacles, and the swap is also interesting among fixed and mobile broadband access. On the demand side of broadband policy, whereas there are numerous researchers on broadband elements, the investigation in what way specific policy tools affect broadband adoption is still restricted. With nations implementing more tools on the demand side, the accessibility of information could support this kind of study in the future.

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