Decree № 435/ 26.06. 2014

National Broadband Infrastructure Plan for Next Generation Access

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I. INTRODUCTION

The continuous technological advances, development of technology, broadband access and progress in telecommunications make the world we live in constantly changing. The result of this constant change in online environment is a new kind of world – a digital ecosystem**No index entries found.**[1], a product resulting from convergence of areas, such as Internet technologies, telecommunications, media and fun/entertainment industry.

These new trends focus our attention on the intensive support to create Next Generation Access etworks – the so-called NGA, which with its potential will contribute to the improvement of all aspects of broadband technology and broadband services. In the future NGA networks will have the speed and capacity to deliver content with high resolution (video or television), to deliver a multitude of advanced digital services at very high speed, to maintain speed demanding applications upon demand and deliver to customers (enterprises) affordable symmetrical broadband connections.

As a Member State of the European Union (EU), the Republic of Bulgaria needs to develop national strategic objectives that shall be consistent with the priorities and strategic objectives set out in the EU programme documents. In the field of information technologies, European programme documents that define the latest trends are the Strategy for smart, sustainable and inclusive growth 'Europe 2020', published in 2010, in particular one of the flagship initiatives set out in it - Digital Agenda for Europe (DAE)[22].

The main objective of the Digital Agenda for Europe is to achieve accelerated development of high-speed Internet access, making it possible to maximize the benefits from the existance of a digital single market for households and businesses with a time frame 2015 – 2020.

The program identifies seven interrelated priority pillars (Fig. I.1):

1. Creating a new single market to deliver the benefits of the digital era ;
2. Improving standardization and interoperability in the field of information and communication technologies (ICT);
3. Enhancing trust and security in the Internet;
4. Increasing access of European citizens to fast and ultra-fast Internet;
5. Stimulating cutting-edge research and development activity in the ICT field;
6. Providing skills to handle digital technologies of easily accessible online services for all European citizens;
7. Deploying the potential of ICT for the benefit of society.

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[1] In their nature digital ecosystems represent virtual spaces that are full of real individuals, businesses or entire communities.

[2] DAE/COM (2010) 0472 final

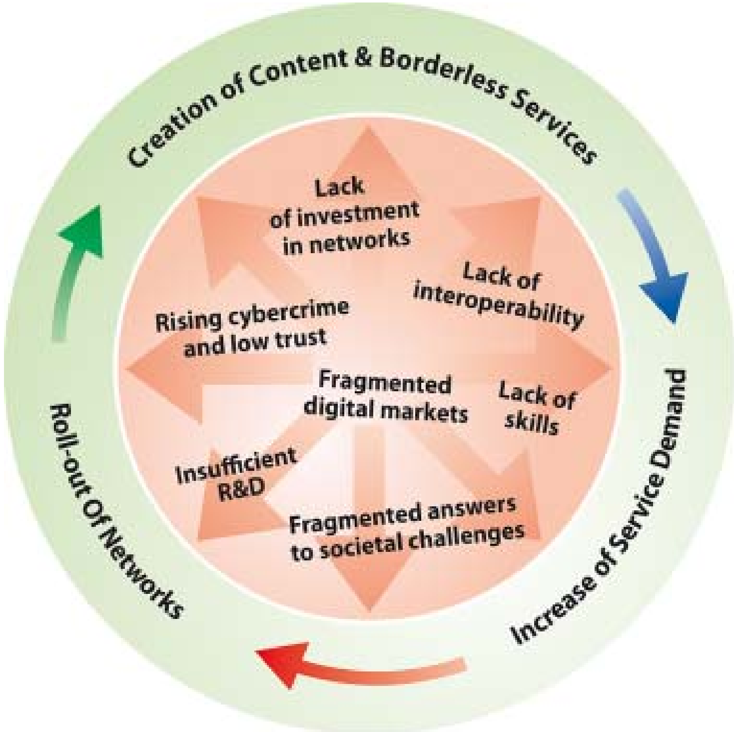

Figure. I. 1 DAE priorities

The Digital Agenda for Europe contains 101 actions that aim to assist the reboot of the EU economy and enable Europe's citizens and businesses to get the most out of digital technologies.

The program defines the following 13 specific objectives:

1. The entire EU shall be covered by broadband by 2013;
2. The entire EU to be covered by broadband above 30 Mbps by 2020;
3. 50% of all EU households to subscribe to broadband above 100 Mbps by 2020;
4. 50% of the population to purchase online by 2015;
5. 20% of the population to purchase online internationally by 2015;
6. 33% of SMEs to make online sales by 2015;
7. The difference between roaming and national tariffs to approach zero by 2015
8. To increase the usual internet usage from 60% to 75% by 2015 and from 41 % to 60 % among the disadvantaged persons;
9. to halve the proportion between the people in the EU that has never used the internet from 30 % to 15 % by 2015;
10. 50% of the EU citizens to use e-Governmenance services since 2015,
11. All key international public services, shall be approved by Member States in 2011, to be available online by 2015;
12. To double public investment in research and development in ICT (ICT R&D) to € 11 billion by 2020;
13. To reduce by 20% the energy used for lighting until 2020.

The use of new electronic services and high-quality TV and video conferences require faster internet than the one available at the moment in Europe. ***To reach the global***

leaders such as South Korea and Japan, Europe needs access to the Internet at speeds > 30 Mbps (fast broadband) for all its citizens and at least 50 % of the European households to subscribe to broadband above 100 Mbps (ultra-fast broadband) by 2020. The fourth pillar of DAE aims to turn these ambitions into reality by encouraging investment to build NGA broadband infrastructure, as well as to propose further harmonization of radio frequency spectrum.

In the EU Guidelines on the Application of State Aid in relation to rapid deployment of broadband networks of 26 January 2013 it is stated that broadband connections have strategic significance for European growth and innovation in all sectors of economy, as well as for social and territorial cohesion.

In DAE the objective of the strategy "Europe 2020" is confirmed, namely:

To achieve the above mentioned objectives it is necessary to build communications infrastructure based on next generation networks (NGA). It is estimated that for the construction of such infrastructure investment of up to 60 billion EUR is required,. Taking into account that the DAE objectives cannot be achieved without public support. Therefore, Member States are encouraged to use 'public financing in line with the EU rules on competition and state aid', so as to achieve within the specified deadlines the objectives for coverage, speed and penetation set out in the 'Europe 2020' Strategy. In the future, the demand for services is expected to rise, which require high-speed Internet access, since cloud computing will grow dynamically, the greater use of 'peer-to-peer', technological communications transition to 'All IP', social networking services and video on demand, training, health, commerce and administration.

The European Commission emphasizes the significance that all Member States should develop an operational broadband plan with clearly distinguished national targets in line with the European ones, as well as ideas to increase investment in fast and ultra-fast Internet, based on reliable and thorough implementation of the European regulatory framework for electronic communications, consistent application of radio frequency spectrum policy and adequate price reduction when agreed. For this reason, our country has developed and adopted a National Strategy on the Development of Broadband (209), which has been revised and supplemented by a time period of 2012 - 2015, and a National Operational Plan for the implementation of strategic objectives to it.

The curent document is a logical continuation of the operating strateg, The commitment to develop such program document at a national level is set in the preliminary terms of using the European Union funds for the next programming period of 2014 – 2020, in accordance with Annex IV to Regulation laying down general provisions applicable to the Funds covered by the Common Strategic Framework.

The national plan specifies the means, methods and deadlines to implementat the objectives set out in the Digital Agenda for Europe until 2020, to provide fast and ultra-fast broadband to all Europeans by building next generation access networks. The strategy 'Europe 2020 - for smart, sustainable and inclusive economy' highlights the significance of building next generation access networks as part of the EU growth strategy in the next decade and sets ambitious objectives for the development of broadband services.Tthe Digital Agenda for Europe (DAE) specifies the socio-economic benefits from broadband access for economic development, competitiveness, social inclusion and employment. The achievement of the Europe 2020 strategy objectives also depends on the provision of wide access to infrastructure at affordable prices and services for ultra-high speed Internet. Meeting the challenge to fund the construction of next generation access networks of good quality and affordable prices is a key factor for Europe to increase its competitiveness and innovation, to provide job opportunities for young people, to prevent the export of economic activity beyond the EU borders, as well as to attract investment.

II. TECHNOLOGICAL SOLUTIONS FOR BUILDING NGA INFRASTRUCTURE

Thie current National Plan outlines the possible medium and long-term guidelines with a time frame until 2020 for the development of broadband in Bulgaria, by means of developing next generation access networks (NGA)), through modernizing and upgrading the existing broadband infrastructures and /or building new networks with the latest technological solutions. As it was mentioned the National Plan is document that complements and develops the National Strategy for the Development of Broadband in Bulgaria within the period 2012-2015. According to statistical data, Bulgaria is among the countries in the EU with very good positions in the field of ultra-fast broadband and it has a good basis for the future widespread deployment of next generation broadband access networks (NGA). This is largely due to the fact that the majority of fixed broadband lines are built on the basis of high-speed cable technologies. It is important to point out that next generation access networks (NGA), are actually a part of Next Generation Networks (NGN). Next generation networks include two main components: a next generation core network (NGC) and a next generation access network (NGA).

NGC refers to the primary IP network and it is characterized by replacement of existing technologies for transport and switching with IP (Internet Protocol) technology in the transport or backbone network. It enables the implementation of simpler and cheaper network solutions that are used to provide all kinds of telecommunication services. High-speed broadband refers to access technology (optical fiber, copper cable, or wireless connection) and the deployment of various devices in the local loop, such as a street cabinet near the users to provide connectivity via digital subscriber lines (xDSL)[3] or deployment of optical fiber to the customer premises. It is characterized by providing the opportunity of considerably higher access speeds than those used currently, for better quality of service and speed symmetry in both directions.

The NGA term is usually used to describe the requirement of fiber optic cables to reach the end customer or to be very close to him, as in this case the last part of the access network (the last mile) is compensated by very high-speed digital subscriber lines (VDSL)[4].

Wireless technologies are also considered as an opportunity to implement next generation access networks, but in practice at the moment they cannot compete with the last mile fiber, because of limitations in their radio frequency spectrum unless high frequencies at short distances are used. These technologies can become part of NGA, but it will be only in limited cases, for example in some rural areas. Wireless technologies will be important, but upon increasing the needs of more and new media and digital services and applications that require wider bandwidth will rather complement the last mile fiber, but it will be still hard to replace it. Upon increasing the demand for higher speed, fiber broadband access is expected to be in the basis of NGA.

A potential opportunity to provide broadband are also satellite communications. Currently neither mobile nor satellite communications technologies can meet the

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[3] DSL – Digital Subscriber Line

[4] VDSL – Very High Speed Digital Subscriber Line

requirements of 30-100 Mbps provided subscriber access to the user. It is said that in the future the situation will change, owing to the development of next generation mobile network called Long Term Evolution (LTE) or other wireless technologies . According to some researches, LTE will be able to reach speeds of up to 100 Mbps downstream and 50 Mbps upstream. But the provided transmission speed depends on a number of factors, such as the number of customers using the services at the same time, distance to the base station, used frequency spectrum, etc. The use of smart phones with applications that are constantly updated and require high-speed transmission in both directions place significant restrictions in the use of wireless networks as an NGA element. Some of the possibilities for the implmentation of high-speed subscriber connections are listed below, which should provide the NGA parameters by means of wireless access.

2.1. Types of Next Generation Broadband Access Networks

In recent years there has been an explosive growth of Internet usage, both with respect to the number of users and the transmitted data volume. It is interesting to note that the aggregation volume of data circulating in the Internet is expected to increase at an annual growth of 30% in the following years, as the lowest capacity demanded by end users nearly doubles in every two years. Therefore, there is a growing need of bandwidth that leads to new access methods. In access networks based on copper conductors, there are several inherent technical and physical limitations that set barriers before the transmission speed, such maximum distance, bandwidth and the number of simultaneously active customers. On the other hand, access networks based on optical fiber are the only safe solution that will be able to take on the future need for higher and higher speeds, as the opportunities to transmit optical fibers are theoretically unlimited.

Several different technological platforms can be considered as basic broadband networks, including ADSL[5] (up to ADSL2 + networks), 'non-enhanced' cable networks (e.g. DOCSIS 2.0 – Data Over Cable Service Interface Specification), third generation mobile networks (UMTS) and satellite systems. According to the European Commission '*next generation access networks' (NGA)mean access networks which entirely or partically consist of optical elements and which are capable of delivering broadband access services with enhanced characteristics (such as higher throughput) as compared to those provided over already existing copper networks. In most cases, NGA networks are the result of renovating already existing copper or coaxial access networks.*

NGA networks are considered to have at least the following characteristics:

- reliably deliver services at very high speed to a subscriber with optical (or equivalent technology) transmission, close enough to the customer's premises, in order to ensure actual delivery of very high speed;
- support a number of advanced digital services, including converged services entirely based on IP;
- they have significantly higher speeds to upload files (compared to basic broadband networks).

[5] BG C 25/12 Official Gazette of the European Commission of 26.1.2013.

Therefore, according to the European Commission regarding NGA, mainly two technologies are widely recognized – fiber-to-the-cabinet (FTTCab[6]) and fiber-to-the-home/building of the subscriber (FTTH/B[7]). In recent years, there has been a discussion concerning NGA networks, but the high costs for their development in combination with great uncertainty mainly with respect to demand and revenue (which includes a corresponding uncertainty in terms of return on investment) prevent service providers to invest in NGA.

At the current stage of market and technology development, NGA networks are divided into:

- hybrid networks;
- optical access networks (FTTh), as the term FTTx refers to FFTC, FTTN, FTTP, FTTH and FTTB;
- some modern wireless access networks that can provide reliable high speeds to the subscriber.

2.2. Hybrid Networks

Currently, through the existing traditional local access networks subscribers are provided with *telephony (analog or digital)* and *analog cable TV*, as it is still common to apply the scheme in which for this purpose two different operators are used.

The main disadvantages of this access network express the limited opportunities to implement two-way duplex video services (video telephony, video conferencing, etc.) and the small bandwidth of the twisted copper pairs the length of which could reach several kilometers. Only in some special cases (for agricultural organizations) twisted copper pairs can be used to connect to nodes of ISP through modem connections, implemented by the xDSL technology.

2.2.1. *Hybrid Fiber Ccoaxial Networks*

Based on the traditional scheme for subscriber access it is possible to build a network with characteristics of NGA, such as the hybrid fiber-coaxial network HFC..

These networks are being constructed by coaxial and fiber-optic cable lines without using twisted copper pairs. The principal difference between HFC networks and traditional subscriber coaxial cable networks (along with the fact that fiber-optic tract is added) is the two-way transmission of information with the first type of networks, i.e. occurrence of signal flow from the subscribers to the main network node.

A typical example for that are the cable TV operators (CATV) which developed their infrastructure to such type of networks that allow two-way traffic and use DOCSIS 3.0 technology to increase the throughput of the network up to 160-240 Mbps downstream and 120 Mbps upstream for end users. But this will be shared speed between end users. In a wired node there can be from 50 to 1000 subscribers sharing the bandwidth. Each user

[6] FTTCab – Fiber to the Cabinet
[7] FTTH/B – Fiber to the Home/Building

will not get more than 160-240 Mbps downstream, while upstream bandwidth is shared equally by all users. Although cable modems are characterized by some of the same disadvantages as those of xDSL networks, the main advantage is that transmission rate does not depend so strongly on the distance.

DOCSIS (Data over Cable Service Interface Specification) is a standard for high-speed data transmission over the existing infrastructure for distribution of cable TV. It is used by operators of CATV systems to provide Internet access to their customers in parallel with the delivery of video signal through a coaxial or hybrid (optical + coax) network.

The first version of the standard (DOCSIS 1.0) was developed in 1997. In 2001 a second version was released (DOCSIS 2.0) which provides higher upstream speeds. Version DOCSIS 3.0 is developed in 2006, which not only provides a significant increase of speed in both directions, but IPv6 protocol maintenance is included.

The first DOCSIS standard was developed in the U.S.A.and it is therefore consistent with American standards for cable transmission of television signals (6MHz channel width). In Europe, cable operators use the PAL standard, i.e. channel width of 8 MHz. For this reason variants of European standards have been developed, the so-called EuroDOCSIS standards that bearing in mind their wider bandwidth provide higher downstream speeds.

The first and the second versions of the standard use one transmission channel in both directions. In the third version (DOCSIS 3.0) multiple channels can be combined in both directions, so as to increase transmission speeds. In other words, in this case the maximum speeds are limited not by the standard but by the capabilities of the hardware and configuration of the particular system. The versions are also compatible, i.e. at both ends of the line different versions of modems can be connected, as speeds over the line will be determined by the lower version modem. Table II.1 shows the speeds but the downstream and upstream directions with various versions of the DOCSIS/EuroDOCSIS standards .

2.2.2. Hybrid VDSL Networks

Another way to implement hybrid networks is the use of VDSL (Very-high-bit-rate Digital Subscriber Line) technology. VDSL is a type of DSL technologies which allows data transmission over copper pair at higher speeds - up to 52 Mbps downstream and 16 Mbps upstream when using a standard phone pair and 85 Mbps in both directions when using coaxial cable as a transmission medium. The technology is effective when the distributing module (DSLAM[8]) is so positioned as to ensure short subscriber lines, e.g., when combined with an FTTC[9] network architecture. The second generation (VDSL- 2) provides symmetric data transmission speeds up to 100 Mbps in both directions. The speed of transmission is highly dependent on the quality and length of the line. For example, if the maximum speed of 100 Mbps is achieved at about 300 meters, then at a distance of 1 km the speed drops to 50 Mbps, while with line length of 1.5 km the speed is comparable to that of ADSL technology. VDSLx technologies provide appropriate speeds to offer the so-called triple-play services (voice + data + HDTV) therefore they quicly found their application. Currently

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[8] DSLAM – Digital Subscriber Line Access Multiplexer
[9] FTTC - Fiber to the Curb

they are offered in almost all European countries and in a number of countries in America and Asia.

The dynamic development of communications technology to transmit signals over copper pairs allows hybrid access networks using optical fiber together with copper cabling technology to provide access at much higher speeds than those that are currently available. For example, vector technologies, used in DSL systems allow to achieve speeds of 100 Mbps over one copper pair and up to 200Mbps in two cable pairs. The latest genereration of this type of technology are Hish-speed Vector Digital Systems - VDSL2 which are based on technology that applies a multi-user approach to process the signals in the access node, so as to suppress interference between subscriber pairs.

The use of vector VDSL systems greatly increases the transmission speed (over 100 Mbps) of hybrid FTTB or FTTN networks. An example of this is the G.fast[10] project that defines a new technology for subscriber access over copper cable pairs to provide aggregate (in both directions) speeds up to 1 Gb/s at a distances of up to 250 m. The G.fast project is an initiative of ITU-T – of 2011 aiming at protocol standartization at the physical level. At the same time the FTTx architecture was included in one of the technical reports of ETSI (European Telecommunications Standards Institute) in relation to the application of methods for backward charge of subscriber access facilities. In 2012 these architectures have been developed in the a project of the so-called Broadband Forum.

Table II.1 Speed in Various DOCSIS Standards

Version	**Download**					
	Channel Configuration				**DOCSIS speed**	**EuroDOCSIS speed**
	minimum number of selectable channels	**minimum number of channels supported by the modem**		**selected number of channels**	**Maximum number of channels**	
	Number	Number	Number	Number	Mbps	Mbps
1.x	1	1	1	1	38	50
2.0	1	1	1	1	38	50
3.0	1	4	*m*	undefined	*m* × 38	*m* × 50
Version	**Upload**					
	Channel Configuration					**Upstream speed**
	minimum number of selectable channels	**minimum number of channels supported by the modem**		**selected number of channels**	**Maximum number of channels**	
	Number	Number		Number	Number	Mbps
1.x	1	1		1	1	9

[10] M. Timmers, M. Guenach, C. Nuzman, J. Maes.G.fast: Evolving theCopper Access Network. IEEE Communications Magazine • August 2013. pp. 74-79.

2.0	1	1	1	1	27
3.0	1	4	*n*	undefined	*n* × 27

2.3. Optical Cable Access Networks (FTTx)

When talking about optical access technologes we mean such network architecture where the line from the operator's office to the customer is entirely or partially built with optical fiber. They are also popular by the name FTTx, where X marks where the optical line ends (its beginning is always at the operator).

2.3.1. FTTN (Fiber to the Node)

With this type of access network fiber-optic cable is terminated in a distribution cabinet that serves a particular area and it is situated at a distance of 300 - 500m. up to several kilometers away from the end customers . The connection from the cabinet to the client is established by copper cables (telephone pairs or coaxial cable) when using variations of xDSL and DOCSIS protocols. Usually, the area that is served by the distribution cabinet has a radius of 1.5 km.

This architecture is the cheapest for implementation from the FTTx group, since it uses the maximum of the existing copper infrastructure. At the same time with the development of broadband service consumption, the potential to meet the demand for higher speeds is very limited due to the remoteness of the optical cable from the and tuser device and the limitations of access protocols operating over copper cables.

2.3.2. FTTC (Fiber to the Curb)

Networks of fiber-to-the-curb type, also popular as *FTTC networks* provide one of the simplest and most economical ways to increase the bandwidth of networks and provide new services to subscribers With FTTC networks, the optical cables from their central nodes are connected to curbs, equipped with electronic distribution facility. Quality twisted pairs (FTP type) are passed from the curb to subscribers, which unlike ordinary telephone pairs have much better technical parameters and significantly shorter length (up to 100 m). These pairs transmit signals at speeds of up to (or higher than) 100 Mbps. FTTC is essentially a special case of FTTN, as the fiber cabinet is located within 300 meters from the end users, i.e. it serves a smaller area and fewer number of customers. Therefore, in practice the last part of the access network (last mile) is shortened, which allows the use of technologies providing higher access speeds, such as VDSL. Most often FTTC access networks are implemented upon the development of VDSL- 2.

2.3.3. FTTP (FTTB, FTTH, FTTD)

A key concept in the development of next generation subscriber access networks is based on the idea that the optical fiber should be used as a transfer medium adjacent to the end user (subscriber), i.e. to establish connection with him through the so-called FTTP networks. In this type of networks the optical fiber, from the main network node, reaches directly to the end user's home. FTTP (Fiber to the Premises) is the general name of architectures in which optial cables reach the premises where customers are located. Depending on the final point of terminating fiber cables, the architecture is divided into FTTB, FTTH and FTTD.

In FTTB (Fiber to the Building) the optic cable is terminated in a common premises (or basement) of the building, while for allocation of signals to the end customers in the building different transmission medium (usually coaxial cable, UTP cable or wireless connection) is used. Actually FTTB is a hybrid solution in which the ultimate connection between the hub and the end user is based on copper cable with improved transmission characteristics (structured cabling systems). From this perspective, FTTB access networks have characteristics similar to those of FTTC with VDSL2 technology. Unlike solutions for point- to-point connectivity, here the fiber connection from the optical distribution cabinet to the building will be used by many users, whereby the optical connection can be seen as a backbone of the access network.

In FTTH (Fiber-to-the-Home), termination of optical fiber cables is made just next to the premises of the particular client, while in FTTD (Fiber-to-the-Desk) they reach directly to the end customer device (for example the computer).

FTTH is a fully optical solution, based on the development of fiber-optic cables along the entire route - from the optical distribution cabinet in the local exchange (main node) to the home or office, with the ability to reach speeds of several Gb/s per subscriber in both directions. In this solution the entire copper local infrastructure is replaced with an optical one, including the copper distribution cabinets.

The main difference between FTTB and FTTH is that the first optical infrastructure is developed to a certain optical distribution cabinet or a shared optical network device, i.e. it is used by many households. The inside household infrastructure is based on copper pairs, on the basis of UTP Ethernet[11] or xDSL solution similar to FTTC. However, FTTB and FTTH are often regarded as one and the same scenario, since they are similar in terms of throughput and prices.

2.3.4. Architectures of Optical Access Networks

There exist three main approaches to the development of optical access networks.

The first of them uses an optical access network, the topology of which is the point to point typology with separate optical fibers for each end user This is the simplest architecture of an optical network, built by analogy with traditional telephone networks - each client is connected to operator's by a separate optical fiber. Besides being the simplest,

[11] UTP Ethernet (Unshielded Twisted Pair Ethernet); Ethernet based on unscreen twisted pairs.

in this architecture transmission opportunities are huge, since the fiber resource is used only by one specific customer. On the other hand, the use of fibers is most uneconomical. This type of connectivity (direct fiber) is used most often by newly entering operators in the market, in order to quickly connect new customers at lower costs.

The second approach which aims to minimize the number of optical fibers, is the use of a *concentrator* (remote switch) near the end users.

The third approach for the creation of optical access networks is by using only passive optical components and technologies along the route of optical signals from their sources to their users. In these networks optical splitters, attenuators, isolators and optical filters are used.

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

Active networks between the operator's office and customer equipment, where the optical network is terminated, include one or several cabinets with active equipment performing switching and routing functions. Active networks cover greater distances between the office of the operator and the customer, since a part of the network functions (second and third level of the OSI model) are exported close to the customer. Thus, on the one hand, the cost of fiber is reduced (one cabinet can serve up to 1000 clients) and on the other hand, the facilities in the operator's office are reduced and simplified.

With passive networks in intermediate points of the network passive optical splitters are used, which transmit the same signal to a group of customers (typically 32-128). In the operator's office the signals for that group of customers are encrypted, packed and transported by one fiber to the splitter where the signal is multiplied and transferred to the client over a separate fiber. Due to the encryption, each client has access only to the signal referred to him. According to the FTTH architecture, the line from the access point of the service provider to the end user consists entirely of optical fiber. The fiber terminates in the home or workplace of the end user. Therefore, each device in the customer premises is connected via a specially designated optical fiber to a switching port located at the service provider, or to the optical splitter, which in turn is connected by means of a separate power supply fiber. In passive optical networks (PON), each customer is connected to the optical network using passive optical splitter.

The benefits of FTTP PON are related to:

- Using purely passive components between the central office and the end user, which leads to a lack of active equipment in the access network, i.e. there is no need to look for a suitable location for cabinet equipment, to provide electrical power and air conditioning etc.;
- Less requirements for investments in optical fiber at the network segment, local exchange (LE) - external cabinet etc;
- Smaller space requirements within LE, as in LE fewer fibers and narrower trenches end;
- Less maintenance and fewer operational costs.

The disadvantages are primarily related to higher costs of optical fiber and shorter distances covered.

By using the excellent transmission qualities of modern optical fiber, passive optical networks have no restrictions in terms of topology which can be implemented, such as tree, token ring, highway, or a combination of these.

2.4. Technical and Economic Aspects of NGA Technologies

As noted in the previous paragraph, for the implementation of FTTx networks, different architectures may be used. In Point-to-Point (PtP) architecture all subscribers are connected to an access node through separate fibers. For the implementation of this architecture, a large number of fibers are necessary, which increases installation costs and maintenance. In addition, for each connection two interfaces are required, which leads to an increase of hardware and overall energy consumption in the network. In order to reduce the large number of fibers in the access network, point -to-multipoint architectures are used. One such architecture additionally introduces one or more extra aggregation layers between the subscriber and the local node (station). As noted above, with active networks, part of the network functions (second and third level of the OSI model) are exported close to the customer. Most often active optical networks are characterized by an active aggregation element (e.g. hub or Ethernet hub) in the last mile to the subscribers, as there are various implementation options, such as the hub to be located in a street cabinet or in a building next to the subscribers. On the one hand, the active optical network allows a reduction in the number of fibers compared to the passive one, but on the other hand, the number of interfaces is not reduced, i.e. it is not possible to reduce hardware equipment and energy consumption of the network. Unlike the active one, in the passive network aggregation is performed on the basis of passive devices and components, such as optical splitters or wavelength multiplexing, which means that passive the architecture enables to reduce the number of fibers, to optimize the hardware and reduce energy consumption.

The indicated opportunities of network implementation can be analyzed economically, taking into account the available technologies that could be implemented at a certain time. One exemplary approach to compare separate technologies that could also be currently used has been made several years ago by Deutsche Telecom and it is based on the aforementioned FTTH architectures and Ethernet technology[12]. The scenario for comparative economic assessment is based on point-to-point architectures and an active optical network. The switches of the active optical network in the last mile connect to the Ethernet switch in the local exchange via Ethernet optical lines (1GbE or 10 GbE). The final optical network device from the subscriber side is connected to an AON switch via Ethernet single optical lines (100Base-BX, 1000Base-BX). Two speeds of transmission are examined - 100Mbps and 1 Gbit/s. The passive optical network scenario has been modelled on the basis of a G-PON system and a separation ratio of 1:32, which allows transmission of 2.5 GB/s downstream and 1.25 GB/s upstream. The survey was conducted for densely populated urban areas, but a similar approach can be applied to sparsely populated areas. The analysis assumes initial construction of the whole passive access infrastructure, while the installation of equipment is based on a request for access by subscribers. The results of the comparative analysis are shown in Table II.2, as the comparison is based on the parameter 'relative price.'

[12] Breuer D., Geilhardt F., Hülsermann R., Kind M., Lange C., MonathT., Weis E. Opportunities for Next-Generation Optical Access. IEEE Communications Magazine, pp. 17 -24, February, 2011.

This sample techno-economic analysis reports the costs of active equipment and fiber cable infrastructure with the relevant installation costs. The costs for active cable infrastructure include construction works, cables, passive optical splitters, optical distribution framework (ODF) in the local exchange, external cabinets and power for active outdoor facilities. Table II.2 illustrates a sample comparison of the costs of implementing 1 GB/s access by means of G-PON and PtP /AON solutions. The comparison is made on the basis of prices provided by various equipment suppliers. The difference in prices for the same network element can be explained by different business strategies.

In the Deutsche Telekom study in question, it can be seen that costs per line decrease when increasing the number of connected subsctibers within a given settlement, but also that the G-PON technology provides the lowest line costs, regardless of the number of connected subscribers. Especially in the initial period which is particularly sensitive from an economic perspective, the total costs for one line are relatively low due to the high level of sharing the PON architecture. Although for point-to-point solutions equipment costs are lower in the case of a small number of subscribers (250-750 per service area), total costs are higher due to the cost of installing the infrastructure (optical cables). In the case of densely populated urban areas, the total costs for one line at AON scenarios with Ethernet switch in a street cabinet (transmission speed of 100Mbps) are about 1.5 times lhigher than those for G-PON solution. The total costs for one line in AON scenarios with Ethernet switch in a street cabinet (transmission speed of 1Gb / s) are about 2.3 times higher than the ones for the G-PON version. The worst result is obtained (in urban areas) at AON with Ethernet switch, where costs can become up to 2.7 times higher than in G-PON. This is mainly due to the high costs for installing a specific switch in the building that cannot be compared with a simple LAN switch. With a small number of subscribers initial costs when installing FTTH, PtP Architecture is a cheaper option than AON, since the initial investment costs to install AON outdoor facilities are very high.

Table II.2 Sample Comparison of Costs for the Implementation of access of 1Gb/s by G-PON and PtP/AON solutions

Network Element	**Description**	**Relative Price**
GPON		
ONT	data transmission	1
COOLT (GPONONT with 16 PON cards)		-
main costs	Incl. Base-board, cooling, supply, switch	78.67
Upstream fiber	10GBASE-LR X2 module	11.00
Linear card	2 pair 10GbE	6.91
PON card	4 pair G-PON ports including fiber class B	80.00
PtP with GbE interface		
ONT	Data transmission	0.87
CO switch (Ethernet with 8 linear cards)		-

Network Element	Description	Relative Price
Main costs	Incl. Base-board, cooling, supply, switch	179.66
Upstream fiber	10G BASE-LR X2 модул	20.26
Upstream linear card	6 pair 10GbE	126.57
Downstream fiber	1000Base-BX	6.58
Downstream linear card	48x1000Base-BX	83.53
AON (GbE switch in cabinet)		
PtP ONT	Data transmission	0.87
CO switch (Ethernet with 8 linear cards)		-
Main costs	Incl. Base-board, cooling, supply, switch	151.89
Fiber (up and down)	10GBASE-LR X2 module	20.26
Linear cards	4 pair 10GbE	101.28
Switch in cabinet (Ethernet with 5 linear cards)		-
Main costs	Incl. Base-board, cooling, supply, switch	130.29
Downstream linear card	48x1000Base-BX	83.53
Downstream fiber	1000Base-BX	6.58
Upstream fiber	10GBASE-LR X2 module	20.26
AON (GbE switch in building)		
PtP ONT	Data transmission	0.87
CO switch (Ethernet with 8 linear cards)		-
Main costs	Incl. Base-board, cooling, supply, switch	313.93
Upstream fiber	10GBASE-LR X2 module	20.26
Upstream linear card	4 pair 10GbE	101.28
Downstream fiber	1000Base-BX	6.58
Downstream linear card	48x1000Base-BX	126.59
Switch in building		-
Main costs	12-port 1000BASEs-X Ethernet switch	40.48
Fiber (up and down)	1000BASE-BX	6.58

Another important aspect when comparing various technologies is energy consumption, since in the course of time it has had major contribution to operational costs and a direct impact on environment. Comparative evaluation of consumed energy per port for various types of interfaces and network elements is shown in Table II.3. The difference between the consumption of interfaces of one and the same type could be explained by the fact that one node with high density of ports is more effective in terms of energy than one having low density. For comparison, Gb/s Ethernet and point-to-point architecture are used in the survey. It proves that in GPON solutions energy consumption is up to 84% lower. With AON, energy consumption even rises significantly in cases when equipment is placed in the open, as in this situation the decrease of speed causes almost no influence on the overall energy consumption.

Table II.3 Comparative Evaluation of Consumed Energy

Interface Type	Network Element	Port Density	Energy Consumption per port (W)
1000BASE-BX	CO switch	high	4.4
1000BASE-BX	Switch in the cabinet	medium	4.8
1000BASE-BX	Switch in building	low	6.7
100BASE-BX	CO switch	high	4.3
100BASE-BX	Switch in the cabinet	medium	4.8
G-PON -OLT	CO switch	low	22.3

2.5. Development of Optical Cable Access Networks

As it was indicated, with PON, the fiber-optic cable has been rolled out from the fiber-optic linear terminal to a remote node (usually an optical power converter) located in the service area (up to 20 km. from the central office). From the remote node, subscribers or optical network devices are connected by means of optical branches[13,14]. The existing PON (EPON[15], GPON[16]) usually use two separate wavelengths such as channels to transmit one fiber in both directions. The downstream channel (1490nm wavelength) by its essence is a distribution (broadcast) channel, since each optical network device filters the data that refers to it. The upstream channel (1310 nm) is shared by all optical network devices. Time multiplexing is used by applying an algorithm for dynamic allocation of working frequency bands, to provide various types of services to customers. Therefore, these networks are called TDM (Time Division Multiplexing) PON.[17]

Transmission speeds of existing PONs are limited to 1Gb/s in both directions for EPON and up to 2.5 Gb/s and 1.25Gb/s respectively in the upward and downward directions for GPON. To cover the requirements of servicing the increasing traffic, it is necessary for the existing networks to be further developed to NGA, by applying new transmission technologies, such as wavelength multiplexing.[18,19]

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[13] M. Andrade, G. Kramer, L. Wosinska, J. Chen, S. Sallent, B. Mukherjee, Evaluating Strategies for Evolution of Passive Optical Networks. IEEE Communications Magazine • July 2011, pp.176 – 184.
[14] G. Kramer, Ethernet Passive Optical Networks, McGraw- Hill, 2005.
[15] EPON – Ethernet PON
[16] GPON – Gigabit PON
[17] F. Effenberger et al., "An Introduction to PON Technologies," IEEE Commun. Mag., vol. 45, no. 3, Mar. 2007, pp. S17–S25.
[18] F. Effenberger et al., "Next-Generation PON-Part II: Candidate Systems for Next-Generation PON," IEEE Commun. Mag., vol. 47, no. 11, Nov. 2009, pp. 50–57.

2.5.1. Requirements for Future Generations of Passive Optical Networks

NGA PONs could develop or evolve in a different way depending on the requirements imposed on them. There are five basic requirements that could determine the path of their development.[20]

Minimizing investment related to equipment: In order to migrate to PON it may be necessary to use a new technology, in addition to the existing one or its replacement at terminal nodes of the network.

General maintenance: PON should allow the maintenance of existing devices, which means that NGA devices must operate in the same infrastructure, without affecting its support when possible. In the course of PON's development, even with one and the same category of users, traffic needs may be different. Some users may be satisfied with minimal services and they will not substitute their devices with the ones belonging to the next generation, or they will do so much later, when prices become comparable. For this reason, the development (upgrade) to NGA must enable collaborative work and support of existing devices and those of the new generation.

Maximizing the profit of existing resources: The efficient use of network capacity, by means of dynamic resource management (provision of frequency bands or wavelengths) results in revenues and faster return on investment.

Preservation and reuse of optical infrastructure: For efficient upgrade of the network, the remote device should not be replaced or optical cables must not be added to the existing PON.

Avoiding interruptions. In the course of migration to NGA, interruptions in network operation are expected to occur, but they should be avoided or minimized, depending on the devices that are being substituted. Interrupting the work of the terminal fiber-optic device will only affect the users connected to it, while in the case of a network device it will influence the work of the whole network.

2.5.2. Main Phases and Development Scenarios towards NGA

NGA development depends on many factors, including the development of technology and the costs for their implementation. There are two majour ways of technological development towards NGA; by increasing transmission speeds or by using future PON technologies.

2.5.2.1. Increasing the Linear Speed

[19] J. Zhang et al., "Next-Generation PONs: A Performance Investigation of Candidate Architectures for Next-Generation Access Stage 1," IEEE Commun. Mag., vol. 47, no. 8, Aug. 2009, pp. 49–57.

[20] J.-I. Kani et al., 'Next Generation PON — Part 1: Technology Roadmap and General Requirements,' IEEE Commun. Mag., Nov. 2009.

The natural evolution of PON to NGA aims to improve the capacity of existing passive optical networks to speeds that reach up to 10 GB/s for instance. In practice, there are already 10 GB/sPON next generation standards. Currently developed standards for this type of networks have been influenced by the possibility of parallel operation with already existing passive fiber-optic networks, prices for installation and support, as well as the opportunity of easy implementation. IEEE has ratified a new 10Gb/s EPON (IEEE-802.3av) standard in September 2009. ITU-T (Question 2, Study Group 15) has also issued a series of recommendations for 10Gb/s-GPON (XG-PON), mainly G-987.1, G-987.2 (both approved in January 2010) and G-987.3 (approved in October 2010). Both recommendations, (IEEE-802.3av and ITU-T) that propose NGA architectures 1(Next Generation Access 1)[21] constitute a good example of increasing the linear speed by allowing existence compatibility with already installed older generation of PON.[22,23] In a longer term, PON's evolution is expected to reach speeds of 100 Gb/s. However, for higher speeds, it is hard to reach the typical of the PON networks distances without increasing the signals. This migration could occur according to the 'if necessary' principle, as two evolutional phases are expected asymmetric and symmetric increase of speeds.[24]

With asymmetric increase of speeds, downstream traffic is usually higher than that of the upstream traffic. PONs are attractive namely due to the capability of signal distribution downstream over the channel. With the growth of broadband services (IP, HDTV), in practice the first phase of increase takes place (upgrade) of transmission speed. Another reason for asymmetric migration is the fact that the addition of the opportunity to transmit up to 10Gb/s upstream (symmetric approach) results in the necessity to use more expensive optical network devices. One such example is the introduction of Wavelength Division Multiplexing devices.[25,26]

With symmetric increase of transmission speeds, the speeds in both directions become equal, for instance up to 10 Gb/s depending on the traffic needs (i.e. multimedia services) of the system and the number of users connected in terminal points. In practice, there exist two ways of symmetric increase of speeds: by means of time-division multiplexing and by wavelength-division multiplexing.[27,28] In the first case, the increase of upstream transmission speeds is achieved by applying the method of sharing one wavelength at a time and using two different transmission speeds. This approach has been approved by IEEE for 10Gb/s EPON. It makes it possible to achieve reduction of installation costs, since the existing upstream channel works at the lower wavelength. Newer optical network

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[21] M. Andrade, G. Kramer, L. Wosinska, J. Chen, S. Sallent, B. Mukherjee, Evaluating Strategies for Evolution of Passive Optical Networks. IEEE Communications Magazine, July 2011, pp.176 – 184.

[22] ITU-T G.984 Series of Recs., 'Gigabit-Capable Passive Optical Networks (GPON).

[23] ITU-T G.987 Series of Recs., '10-Gigabit-Capable Passive Optical Networks (XG-PON).

[24] M. Hajduczenia, H. Da Silva, and P. Monteiro, '10G EPON Development Process,' Proc. Int'l. Conf. Transparent Optical Networks (ICTON), vol. 1, July 2007, pp. 276–82.

[25] S. J. Park et al., 'Fiber-to-the-Home Services based on Wavelength-Division-Multiplexing Passive Optical Network,' J. Lightwave Tech., vol. 22, no.11, Nov. 2004, pp. 2582–91.

[26] S. S. Wagner and H. Kobrinski, 'WDM Applications in Broadband Telecommunication Networks, IEEE Commun. Mag., vol. 27, no. 3, Mar.1989, pp. 22–30.

[27] F. Effenberger and H. Lin, 'Backward Compatible Coexistence of PON Systems,' Proc. OFC/NFOEC 2009, Mar. 2009.

[28] K. Choi et al., 'An Efficient Evolution Method From TDM-PON to Next-Generation PON,' IEEE Photonics Tech. Lett., vol. 19, no. 9, 2007, pp. 647–49.

devices are working with distributed feedback lasers, so that they could be incorporated to the existing infrastructure, which will reduce costs. In this case, however, practical implementation becomes more complicated, since it is necessary to introduce a supplementary mechanism in the network to control and manage various transmission speeds and synchronization.[29]

In the case of symmetric increase of wavelength-division multiplexing transmission speed, supplementary channels at 10Gb/s speed are added that work at different wavelengths. This approach may prove to be more expensive than the asymmetric one due to the fact that transmission media and systems cannot be fully re-used.[30] One example is the need to work in other bands, such as C and L, that could already be reserved for the use of analog or digital video broadcasting.[31,32,33]

2.5.2.2. Future PON Technologies

For migration to NGA there may be used some new or future technologies that have not been completely standardized yet, or they are being investigated. These technologies are based on the use of new transport telecommunications approaches on the basis of multiplexing methods, such as CDM (Code-Division Multiplexing) and SCM (Sub-Carrier Multiplexing)[34], or coherent passive optical networks. Through the use of separate wavelengths for different PON generations, one hybrid structure may be reached, where various PON generations operate independently of each other. Such hybrid networks could be based on CDM etc. OCDM-PON (Optical-CDM PON) where the increase of system capacity occurs as a result of introducing multiple code-division access.[35] Other examples of NGA PON network implementations are based on OFDM (Orthogonal Frequency-Division Multiplexing) etc. OFDM PON[36] or the coherent PON, which use coherent lasers to work in wavelength-division multiplexing mode at ultra-high density (ultra-denseWDM,U-DWDM).[37,38,39]

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29 K. McCammon and S. W. Wong, 'Experimental Validation of an Access Evolution Strategy: Smooth FTTP Service Migration Path,' Proc. OFC/NFOEC 2007, Mar. 2007.

30 F. Effenberger and H. Lin, 'Backward Compatible Coexistence of PON Systems,' Proc. OFC/NFOEC 2009, Mar.

31 J. Chen et al., 'Cost vs. Reliability Performance Study of Fiber Access Network Architectures,' IEEE Commun. Mag., vol. 48, no. 2, Feb. 2010, pp. 56–65.

32 F. Effenberger and H. Lin, 'Backward Compatible Coexistence of PON Systems,' Proc. OFC/NFOEC 2009, Mar. 2009.

33 L. Kazovsky et al., 'Next-Generation Optical Access Network,' IEEE/OSA J. Lightwave Tech., vol. 25, no. 11, Nov. 2007, pp. 3428–42.

34 A. Shami, M. Maier, and C. Assi, Eds., Broadband Access Networks, Technologies and Deployments, Springer, 2009.

35 K. Kitayama, X. Wang, and N. Wada, 'OCDMA over WDM PON-Solution Path to Gigabit-Symmetric FTTH,'IEEE/OSA J. Lightwave Tech., vol. 24, no. 4, Apr. 2006, pp. 1654–62.

36 D. Qian et al., 'Optical OFDM Transmission in Metro/Access Networks,' Proc. OFC/NFOEC 2009, Mar. 2009

37 J. M. Fabrega, L. Vilabru, and J. Prat, 'Experimental Demonstration of Heterodyne Phase-Locked Loop for optical homodyne PSK receivers in PONs,' Proc. Int'l. Conf. Transparent Optical Networks (ICTON), vol. 1, June 2008, pp. 222–25.

38 N. Cvijetic, 'OFDM for Next-Generation Optical Access Networks,' IEEE/OSA J. Lightwave Tech., invited tutorial, to appear Feb. 2012.

39 B. Charbonnier, N. Brochier, and P. Chanclou, 'O) FDMA Pon Over A Legacy30db ODN,' OFC 2011, 6–10 Mar. 2011.

2.6. Wireless Technology Perspectives such as NGA Technology

Due to the rapid technological development in the future, other technologies may also be able to provide next generation access services. For instance, connection to the end user could be provided by a combination of cable and wireless technologies. Taking into account the rapid development of modern wireless technologies, such as LTE-Advanced, and the increased spread in the LTE or Wi-Fi market, the fixed next generation wireless access (i.e. possibly based on one adjusted mobile broadband technology) could be a sustainable alternative to some cable NGA technologies (such as FTTCab), if certain conditions are met. There should be taken into account the fact that wireless environment is 'shared' (the speed of a customer depends on the number of connected users in the covered area) and it is by itself a matter of changing environmental conditions. Therefore, in order to ensure in a reliable way the minimal transmission speed per user that could be expected for NGA, fixed next generation wireless networks may need to be located with a certain degree of density and/or in modern configurations (as directing ones and/or several antennas. Wireless next generation access based on adjusted mobile broadband technologies should also be able to ensure the necessary quality of service to the users of a certain location, while other mobile subscribers are also serviced in the corresponding region.

2.6.1. Application of New Technologies and Approaches

If we look forward and accept the fact that until 2020, LTE-Advanced will be spread out and MIMO (Multiple Input – Multiple Output) technology will be developed to a level at which investment for their introduction have decreased considerably, so that at certain places their introduction could be justified instead of optical access. In fact, at a certain degree of mobile communications development, spectrum efficiency may no longer be possible due to reaching theoretically possible values and limitations of working frequency bands. In these cases, the only possibility is to increase the width of working frequency bands and/or to switch to other higher working bands and locate more and more densely situated base stations. Of course, this will result in even higher pressure over the prices of operational costs for access points, due to the inherent higher costs and lower energy efficiency compared to the ones of PON. For this reason, in the future, majour innovations in this field may be expected to focus on decreasing costs per one bit transmitted information and energy costs per one bit. This may occur through the approaches indicated below.

2.6.2. Changes in Cellular Infrastructure

In order to reduce significantly the amount of signaling information that is exchanged in the air interface, as well as among base stations, the approach for changing the concept of existing cellular networks may become attractive and there could be assumed that access will be implemented by means of terminals, served by multiple smart and self-organizing points of access. Various functionalities, such as signalization management, data transmission in both directions and mobility functions (i.e. localization and tracking) that are now provided by the serving cell, could be transferred for provision by one group of different 'cells' or even more generally, a group of cooperating antennas. Such development concept will assist a more massive introduction of new wireless technologies, such as MIMO and new beam-forming antenna technologies in places where NGA access cannot or it is inefficient to be provided through optical access.

2.6.3. New Air Interface Concepts

Besides the framework structure and the type of modulation used in air interfaces, it may be appropriate to consider and introduce new air interfaces that are based on unification of functions from various layers of the OSI model. This may be extremely valuable, if it is taken into account that NGA could also be used in the context of Device-to-Device communications (D2D). In these cases, the increase of transmission speed could be achieved by using greater frequency band and shared usage of MIMO with new modulation methods. Literature indicates that 10 Gb/s could be achieved provided that there exists 200 MHz bandwidth, application of MIMO with eight parallel branches and 256 times higher quadrature amplitude modulation (QAM) per one branch. Alternatively, with the existence of 350 MHz bandwidth, MIMO with six branches and 64-fold QAM[40] could be used.

2.7. Outcomes and Conclusions

Next generation access (NGA) networks are considered as an essential element to ensure fast broadband (>30 Mbps) and ultra-fast broadband access (>100 Mbps) providing services with enhanced features, improved quality of service and symmetry of speed rates in both directions. In practice, NGA networks are characterized by providing the opportunity of significantly higher access speeds than those provided by 'basic' broadband access networks (>2Mbps). Next generation access could be achieved by various technologies, but it is generally considered to be done via optical cables reaching the end users or much closer to them, as in the second case 'the last mile' is covered by very high-speed digital subscriber lines or wireless access, which are regarded as an addition to the last mile. According to the EC regarding NGA, mainly two technologies are widely recognized – fiber-to-the-cabinet and fiber-to-the-home/building of the subscriber. The opportunities of some future wireless access technologies that could provide reliable high speeds to subscribers are also being considered.

The practical implementation of NGA depends on a variety of factors, including technology development and the costs for their implementation. There are two main ways of technological development towards NGA, by increasing transmission speeds or by using future PON technologies. The choice of development options depends on specific NGA requirements that must comply with the minimization of investment related to equipment,

[40] B. Raaf, W. Zirwas, K. Friederich,s E. Tiirola, M. Laitila, P. Marsch, R. Wichman. Vision for Beyond 4G Broadband Radio Systems. DOI 978-1-4577-1348-4/11. 2011 IEEE.

maintenance of existing devices, effective use of network capacity, protection and re-use of the existing optical infrastructure.

Besides technology, in each specific case, it is also important to consider the opportunities for the implementation of a particular network topology. It is necessary to conduct benchmarking economic assessment of the ways of implementing various topologies and network architectures, such as point-to-point, an active or passive optical network. The region and/or the settlement where the network is being established, the transfer rates that have to be achieved must be taken into account.

Bulgaria is among the EU countries with very good positions in the field of ultra-fast broadband access and it has a favourable basis for the forthcoming widespread deployment of next generation broadband access networks, but in order to achieve the objectives set out in DAE regarding 'access to the Internet at rates > 30 Mbps (fast broadband access) for all its citizens and at least 50% of the European households to be subscribed to the Internet with speeds higher than 100 Mbps (ultra-fast broadband access) until 2020', it is necessary to provide NGA to all settlements in our country. At present, high costs for NGA development combined with uncertainty mainly regarding demand and revenues (which includes the corresponding insecurity in terms of return on investment) hinder service providers and private investors from investing in NGA. In this respect, in order to achieve the DAE objectives, it is necessary for the state to take specific measures and develop mechanisms to foster consumption. The EU states that NGA development in terms of achieving the DAE objectives could not be done without the support of public resources. For this reason, it is recommendable to use public funding, according to the EU rules on competition and state aid, for the establishment of next generation access – NGA networks, by modernizing and upgrading the existing broadband infrastructure and/or developing new networks with the latest technological solutions.

III. SOCIAL AND ECONOMIC EFFECTS FROM THE PROVISION OF ACCESS TO HIGH-SPEED AND ULTRA-HIGH SPEED INTERNET VIA NGA

The development of information and communication technologies (ICT) led to a turbulent technological progress in all spheres of human activity and seriously affected the development of society. It caused fundamental changes in all aspects of its operation, while its socio-economic impact constantly increases.

The provision of necessary broadband infrastructure and Internet, as a platform to provide various e-services is of key significance for the development of ICT, as well as for the dissemination of their positive impact. Not by chance the Digital Agenda for Europe highlights the need to ensure the deployment and development of high-speed broadband access for all citizens, as well as to facilitate and stimulate investment in new very fast, open and competitive internet networks that would represent the arteries of future economy and a majour prerequisite for the widespread usage of ICT-based e-services for citizens, businesses and state governance. In this sense, the existence of modern broadband infrastructure, respectively the access to high-speed Internet is the fundamental key prerequisite to achieve the so-called digital growth.

Access provision to high-speed and ultra-high speed Internet by means of NGA, as well as ICT in general, have a complex impact on the development of society, but its positive socio-economic influence could be seen in the following main trends:

- economic effects;
- social effects;
- impact on environmental protection

3.1. Influence on the Economic Development of the Country and the Regions.

NGA infrastructure development for high and ultra-high-speed access to the Internet has a significant positive influence on the economic growth of the country (area), measured by the gross domestic product (GDP). It also has a positive impact on employment and productivity of labour. Moreover, the economic effects are not only direct and short-term in nature, that is, those that are related to the growth of economic activity in infrastructure development, expressed in involving contractors, purchasing materials, temporary increase of employment etc. Greater significance also have indirect effects from the use of established access infrastructure, as well as the effects caused in other sectors and activity fields (structural changes in economy, emergence of new products and businesses etc.), which have medium and long-term impact. Thus, for instance, for Germany[41] it is estimated that investment in broadband infrastructure in the amount of EUR 36 billion will ensure direct return of EUR 22.3 billion and EUR 137.5 billion as an indirect effect. In other words, high-speed and ultra-high speed access to the Internet act as a powerful catalyst for the economic development of countries and regions.

A great number of studies illustrate the positive influence from the provision of NGA infrastructure for high-speed and ultra-high-speed access to the Internet over **the growth**

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[41] Theimpact of Broadband on Jobs and the German Economy, 2010.

of the gross domestic product of countries (regions). For example, a research of the Booz&Company[42] consultancy company indicates that the top countries classified in terms of broadband access have 2% higher GDP growth than the last ones in the classification. Widely cited are the results of Nina Czernich and colleagues[43] research which found out that 10 % increase in the degree of broadband access penetration results in GDP growth of between 0.9 % up to 1.5 %. A research, conducted among 22 countries by the Organization for Economic Cooperation and Development /OECD/, stated that 10 % increase of broadband access penetration degree leads to GDP growth by 0.25 %. On the basis of an empirical study the McKinsey&Company[44] consultancy enterprise arrives at the conclusion that each 10 % increase in the degree of broadband access penetration to households results in a GDP growth of the country by 1.4 %.

An analysis of the European Commission[45] determines that broadband access provision could create more than 2 million jobs in Europe and lead to GDP growth by at least EUR 636 billion. Only for Great Britain the anticipated effect of GDP until 2015 is over 21.9 billion[46].

It should be pointed out as studies indicate that not only broadband access but also its speed has a great positive impact on GDP. Thus for instance[47] one study proves that the doubling of speed in a certain economy leads to GDP growth by 0.3 %. The return on every EUR 1, invested to improve speed is EUR 1.55. However, broadband access provision should be a priority for countries with lower penetration rate, while speed increase – for countries with high rate of coverage.

It has been proved that the provision of NGA infrastructure for access to high-speed and ultra-high speed Internet has also a strong positive **impact on the employment of population**. Studies indicate[48] that any increase in the number of users of broadband services by 1000, establishes 80 new jobs. In Germany it has been estimated[49] that NGA network development will ensure 968 000 new jobs for the period 2010-2020. For the conditions of Britain it is determined[50] that any investment in broadband access at the amount of GBP 5 billion will create 280 500 new and sustainable jobs. In the USA it has been estimated[51] that any growth of broadband coverage by 1 % will result in an increase of population's employment by 0.2% up to 0.3% annually.

High-speed and ultra-high-speed access to the Internet also has a significant positive influence on **productivity of labour**. A research, conducted in 15 OECD countries and 14

[42] Booz&Company, Digital Highways: The Role of Governments in 21 Century Infrastructure, 2009.
[43] Czernich, N., Flack O., Kretschmer T., and Woessman L., (2009), Broadband infrastructure and economic growth, CESifo Working Paper No 2861.
[44] McKinsey&Company, Mobile Broadband for the Masses, 2009.
[45] Broadband: a Platform for Progress, A Report by the Broadband Commission for Digital Development, ITU/UNESCO, June 2011.
[46] The Economic Impact of a Competitive Market for Broadband, 2003.
[47] Socioeconomic Effects of Broadband Speed, Research by Ericsson, Arthur D. Little and Chalmers Uniwersity of Technology, 2012.
[48] Socioeconomic Effects of Broadband Speed, Research by Ericsson, Arthur D. Little and Chalmers Uniwersity of Technology, 2012
[49] The impact of Broadband on Jobs and the German Economy, 2010.
[50] The UK's Digital Road to Recovery, 2009.
[51] Crandall, R., Lehr W. and Litan R, (2007). The Effect of Broadband Deployment on Output and Empoyment: A Cross-sectional Analysis of U.S. Data.

from Europe[52] indicates that any new high-speed line per 1000 people causes labour productivity to increase by 0.1 %, while Booz&Company[53] estimates that the increase of broadband access penetration rate by 10 % leads to the increase of labour productivity by 1.5 % over the next five years.

3.2. Impact on Business Development

Provided high-speed and ultra-high speed Internet access by NGA infrastructure has a significant positive impact on business development. By the opportunity of fast access, as well as the exchange of information and ideas, it facilitates the adoption of novelties, improves innovative capacity of business organizations and intensifies their innovative activities. It promotes the introduction of new and more efficient business models and strategies, as well as the improvement of the overall organization and management of activities. This results in increasing the degree of adaptivity to market requirements, the flexibility and efficiency of production processes, as well as to improving trade relations. As a result of the provided high-speed and ultra-high speed access to the Internet, supply chain management improves, delivery processes are optimized, a number of useful novelties are introduced, such as electronic negotiations and invoicing, online employment of workforce, work from home, online payment, e-commerce, new consumer services, online coordination of joint actions. Greater and greater dissemination acquire strategies on mass customization, outsourcing, creation of product novelties together with users (co-creation) etc, which enhance the competitiveness of businesses and improve their agricultural results.

The provided high-speed and ultra-high speed access to the Internet is of great significance for businesses in the field of services. It causes the emergence of multiple new services in all sectors and leads to significant changes in the way of their provision. The greatest influence is observed in information-intensive sectors, such as ICT services, finance and insurance services, market services, consultancy and advertising services, tourist services etc.

Provided high-speed and ultra-high speed access to the Internet also facilitates globalization processes and leads to intensified competition. In this way, it promotes incessant introduction of novelties, in order to improve the activities of business organizations and the quality of customer service. It encourages foreign investment and facilitates the penetration of foreign markets.

Provided broadband access to the Internet also stimulates entrepreneurial activity and facilitates the process of starting a new business. It has a very high positive impact on the activity of small and medium-size enterprises (SME) that comprise 99.8 % of all companies in Bulgaria. In an international scale it has been found out that SME-s which actively use Internet services grow twice as fast as the others, the share of their export is two times higher and they ensure twice more jobs.

[52] Economic Impact of Broadband: An Empirical Study, 2009.
[53] Booz&Company, Digital Highways: The Role of Governments in 21 Century Infrastructure, 2009.

As a result of taking the opportunities provided by the access to high-speed and ultra-high speed Internet, business organizations enhance their productivity, decrease their costs and improve the efficiency of their overall activity. This has been proved by the results of a number of studies. Thus, for instance, Thompson and Garbacz[54] have arrived at the conclusion that any growth of broadband coverage by 10 % results in increasing efficiency by 3.6 %. According to another survey[55], the widespread use of new business opportunities provided by the Internet will increase the total revenues in Germany, France and Great Britain by 79 billion dollars with simultaneous decrease of costs by 8.3 billion dollars. Clarke and Wallsten[56] reveal that any increase of Internet users by 1 % leads to export growth by 4.3 %. Adams[57] has estimated that average costs to open a new account that banks in the USA make, will drop down from 65 USD if opened on paper and up to 0.15 USD if opened online.

3.3. Impact on Citizens' Revenues

The provision of high-sped and ultra-high speed access to the Internet via NGA infrastructure has also a positive impact on the revenues and well-being of citizens. In the first place, it is a result of increasing employment and provision of higher quality and better-paid job positions, facilitated process of starting a proprietary business, provided opportunities to work from home and its access to persons with physical disabilities and people from remote areas. Simultaneously, the costs that citizens and households pay drop down. This is a result of the emerging opportunities to work from home and online shopping that lead to saving transport and other expenses. By taking advantage of the services based on high-speed and ultra-high speed Internet access, citizens are saving more and more expenses for telephone calls and postal services, administrative costs, those for medical care, education etc. The increasing competition among companies and the growing supply of products and services result in retaining the growth, and in a number of cases to decreasing their prices. It seriously affects the welfare of citizens and households, especially if the preceding growth of their incomes is taken into account. Studies indicate that in 2009 as a result of Internet usage, the citizens of France have saved expenses in the amount of EUR 7 billion, while in the USA they are EUR 46 billion. The average amount of saved funds per household in Great Britain as a result of online shopping and payment comes up to GBP 1000 per year.

3.4. Social Effects of High-speed and Ultra-high Speed Internet Access Provision, via NGA

Social effects are related to changes in the behavior of individuals, groups and the society in general, as a result of high and ultra-high speed access to the Internet. They are

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54 Thompson H. and Garbacz C., (2009), Broadband Impacts on State GDP: Direct and Indirect Impacts.
Varian H., Litan R. Elder A., Shutter J., 2002, The Net Impact Study

55 Varian H., Litan R. Elder A., Shutter J., 2002, The Net Impact Study

56 Clarke G. and Wallsten S., 2006, Has the Internet increased Trade? Evidence from Industrial and Developing Countries, Economic Inquiry 44(3).

57 Adams J., Account Opening: Seizing the Half Who Try Online. American Banker, June (2009).

the result of providing equal access of all citizens to NGA infrastructure, improving the access to basic community services (state and municipal, educational and other services), enhanced social safety and security of transportation, improved healthcare system etc.

A significant part of the social effects of high-speed and ultra-high speed Internet are the result of providing equal access to broadband infrastructure to all citizens, including persons with fewer opportunities and those who live in rural and remote regions, irrespective of their age, education and social position. They reduce **economic and social isolation of** particular individuals and entire settlements and make them active participants in social life. On the one hand, the provided easy and fast access to information and images through the Internet establishes conditions for economic development of underdeveloped regions and improves the income and living conditions of their residents. Business organizations develop, new businesses emerge, the area becomes attractive for new investments, the variety of offered products and services rises, new high-quality jobs are creates, the qualification of employees improves etc. On the other hand, particular individuals obtain new opportunities that improve the quality of their life – easy and convenient communication with the others, work at home and flexible working hours, e-commerce, electronic financial transactions and banking, electronic forms of remote access to education and healthcare services, online state and municipal services and a number of other e-services. Serious savings of time and costs are made and comfort is ensured.

Significant social effects are anticipated from the development of e-Government, e-municipality, e-health and e-education systems. The development of **e-Government and e-municipality will** ensure easy, fast, convenient and cheap access of citizens to state and municipal services, reduce corruption and encourage business development. In a study of 2008, Aston Campbell Associates have estimated that for Great Britain each online contact or transaction with the Government saves up between GBP 3.30 and GBP 12.00 compared to traditional implementation forms. On this basis, Price Waterhouse Coopers[58] have calculated that if each of the 10,2 million adults who still lack broadband access to the Internet establishes instead of the traditional way, one online contact or transaction with the Government per year, this will save up the sum total of GBP 900 million annually. It is not a coincidence that in the Digital Agenda for Europe the European Commission has set out the task for e-Government services to be used by 50% of the citizens until 2015.

The provision of high-speed and ultra-high speed Internet access supports the development of **electronic education**. The fast two-way access to the Internet, the opportunity to exchange video materials and conduct conference calls enable the introduction of e-based remote learning. This saves the learners time and expenses, what is very important – enables disadvantaged persons and people from remote regions to obtain education. e-education also provides the opportunity of life-long learning and increasing the qualification without leaving production activities. At the same time, broadband Internet access ensures an easy access to up-to-date information and e-libraries, supports continuous updating the taught material, thus it helps to increase the quality of education. It accelerates scientific and research activity at universities and research centres, which has a serious positive reflection on economy, education and life quality.

[58] PriceWaterhouse Coopers, 2009, Champion for digital inclusion: The economic case for digital inclusion.

High-speed and ultra-high speed Internet access is a prerequisite for the development of the **e-Health system,** providing opportunities for remote communication and exchange of high resolution images. The development of online health services will ensure fast, quality and cheap examinations, identification of diagnoses, remote prevention and treatment. This will save time and expenses not only for patients but also for healthcare centres. Healthcare services will be more timely and more convenient for patients who will take advantage of them from home. According to Access Economics for Australia the benefits from the widespread online health services will amount from 2 up to 4 billion AUD, while the Centre for Information Technology Leadership have estimated that in the USA remote health examinations will generate the effect of USD 21 billion per year. Another study[59] indicates that the support of e-health cards system in its mature stage will cost European Countries EUR 304 million per year, but it will provide the effect of EUR 1.4 billion per year. The development of Online Information Exchange System between health centres and doctors will save EUR 6 billion per year.

The provision of high-speed and ultra-high speed Internet access has a significant impact on **enhancing security for citizens and community and reducing crime**. It is the basis for citizens to establish fast and reliable contacts with police, fire brigade and urgent medical care if necessary, which is a condition for their timely reaction. Contemporary electronic facilities and services, based on high-speed Internet access underlie crime prevention. The systems for exchange of information, photos and video assist the police to fight with crime and they improve significantly its efficiency. Management and control of transportation traffic benefits to a great extent from the opportunities provided by high-speed and ultra-high speed Internet access.

As a result of the overall impact of high-speed and ultra-high speed Internet access **citizens' welfare and above all their quality of life improves significantly**. It is associated with the reduction of economic and social isolation of certain individuals and settlements, the increase in their income and costs reduction, opportunities to work at home, saved time to travel and access to basic services, the increase of leisure time, possibilities of easy communication with friends and relatives, access to information, movies, electronic games etc.

3.5. Effects from access provision to high-speed and ultra-high speed Internet on environment protection.

Infrastructure development for high-speed and ultra-high speed access to the Internet also has a significant positive influence on environment protection. It is related to improving people's ecological awareness and knowledge, reducing harmful transport emissions, providing opportunities to introduce energy-saving technologies, the caused change in the structure of produced products and services which leads to reducing the cost of energy and non-renewable resources, reducing the costs for paper and more.

The provision of high-speed and ultra-high speed Internet access results in significant reduction of harmful transport emissions. It is due to the improved traffic flow

[59] Fornefeld M., Delaunay G. and Elixmann D., 2008, The Impact of Broadband on Growth and Productivity.

management, enhanced transport management systems in towns and reduction of travels. Travels decrease as a result of the provided opportunity of citizens to work from their homes and use online services. With the development of video-conference connections and rapid exchange of information, the number of business trips also decreases. According to a research conducted by Fuhr and Pociask[60] remote work will reduce greenhouse gas emissions by 247.7 million tons due to fewer travels, by 28.1 million tons due to economies of offices and 312.4 million tons as a result of saving energy by businesses.

High-speed and ultra-high speed access to the Internet favours the introduction of smart grids and smart buildings that allow remote and flexible management of energy consumption, as well as to achieve significant energy economies. According to a research conducted by McKinsey Global Energy and Materials[61] broadband access will cause the introduction of smart grids in electrical energy, which will lead to energy savings of USD 1.2 trillion. It will also result in reduction of costs for end users, which. until 2020 will be 23 % higher annually and it will prevent the emission in atmosphere of 1.1 gigatons of greenhouse gasses. The State of California's program to stimulate the introduction of smart buildings has found out that by means of a combined use of broadband access and other technologies, it is possible to achieve reduction of consumed energy in new commercial buildings by 70 %, while in the old ones up to 50 %.

3.6. Outcomes and Conclusion

The positive social and economic impact from the provision of high-speed and ultra-high speed Internet access by means of building NGA infrastructure can be traced in the following main trends:

- economic effects

The construction of NGA infrastructure for high-speed and ultra-high speed access to the Internet plays the role of a powerful indicator for the economic development of countries and regions. It has a significant positive impact on their economic growth measured by the Gross Domestic Product (GDP), as well as on employment and labour productivity. Moreover, economic effects are not only direct and short-term in nature, that is, those related to the growing economic activity in building infrastructure. Indirect effects of using the established access infrastructure are much more important, as well as the effects that are induced in other industries and fields of activity (structural changes in economy, emergence of new products and businesses etc.), which have medium-term and long-term influence.

Provided high-speed and ultra-high speed Internet access has a significant positive impact on the development of businesses, as well as on the income and welfare of citizens.

- social effects

The provision of equal access to broadband infrastructure results in reducing the economic and social isolation of particular individuals and entire settlements and makes them active participants in public life. Considerable social effects are anticipated from the

[60] Fuhr J. and Pociask S., 2007, Broadband Services: Economic and Environmental Benefits.
[61] Unlocking Energy Efficiency in the U.S. Economy, McKinsey Global Energy and Materials, July 2009.

improved access to basic public services by developing the systems of e-Governance, e-Education, e-Health etc. The provision of high-speed and ultra-high speed Internet access has a significant impact on improving the security of citizens and society and reducing crime. As a result citizens' quality of life improves.

- effects on environmental protection

The construction of infrastructure for high-speed and ultra-high speed access to the Internet has also a significant positive influence on environmental protection. It is related to the improvement of people's ecological awareness and knowledge; the reduction of harmful transport emissions, due to its improved management; the provision of opportunities to introduce energy-saving technologies; the induced change in the structure of produced products and services leading to reducing the costs of energy and non-renewable resources; decreasing the costs for paper etc.

IV. REVIEWING THE SITUATION OF BROADBAND ACCESS STRUCTURE

4.1. Reviewing the roll out, supply and consumption of high-speed and ultra-high speed Internet access, products and services in Bulgaria based on this access

The analysis of roll out, supply and consumption of high-speed Internet aims to provide updated information on penetration, supply and use of ITC and in particular high-speed and ultra-high speed Internet in Bulgaria.

The analysis has been made on the basis of information obtained by official sources, such as the National Institute of Statistics, sources of the European Commission, as well as data received by operators - Internet providers, Communications Regulation Commission (CRC), the Ministry of Transport, Information Technologies and Communications, consultants to the Ministry and the National Association of Municipalities.

For the purposes of this analysis official letters - questionnaires were additionally sent to 53 operators, as well as to the responsible institutions of: the Ministry of Regional Development, the Ministry of Infrastructure, the Ministry of Transport, Information Technology and Communications, the Ministry of Investment Planning, the Ministry of Agriculture, Communications Regulation Commission and the National Association of Municipalities.

Information was provided by only one operator, while the responses of CRC, MTITC and the Association of Municipalities contained partial information.

Figure. IV.1 Regional Centres in Bulgaria

As a country situated in south-eastern Europe, Bulgaria has the territory of 110 993 km^2. According to the data of December 2012, the population of the country is **7 282 041**. As of 31.12.2012, 5 306 233 people live in towns, or 72.9%, while - 1 975 808 live in villages, or 27.1% of the country's population. For the first time in demographic history of the country, the population in villages falls below 2 million people. Towards the end of 2012 settlements in Bulgaria were 5 278, 257 of which are towns and 5 021 - villages. The distribution of population in terms of settlements at the end of the year is a result of its natural and migratory movement, as well as the result of administrative changes in the structure of settlements in the country. In 2012, Decisions of the Council of Ministers closed 24 settlements, 20 of which were closed by accession to another settlement. At the end of 2012 the settlements without population are 172. In 1 130, or 21.4% of the settlements live between 1 up to 49 people. Seven towns in the country have 100 thousand people. 34.0% of the population lives there.

According to the study published in December 2013 by the National Institute of Statistics, regarding the use of ICT by households and individuals, in 2013 more than half of the households (53.7%) in Bulgaria had access to the Internet at home. In spite of the growth of 2.8 percentage points compared to the previous year, it ranks our country last among the EU countries (the research of the National Institute of Statistics has also been conducted in the other countries according to the Eurostat methodology).

Table IV.1 Access to the Internet by Regions in Bulgaria

Data	2013 in %	Number
Total for the Country	53.7	1 439 944
Total by Statistic Regions		
Northwest	42.8	130 087
North Central	49.6	158 960
Northeast	51.5	180 470
Southeast	46.5	177 702
Southwest	64.3	526 340
South Central	52.7	266 655
According to the Type of External Connections		
Dial-up or ISDN	0.6	8 595
Mobile narrowband connection (WAP, GPRS)	2.7	39 535
DSL (ADSL, SHDSL etc.)	9.0	129 652
Other broadband connection (cable, Ethernet, PLC, Wifi, WiMax, 3G, UMTS, HSDPA)	92.8	1 336 204

Source: National Institute of Statistics

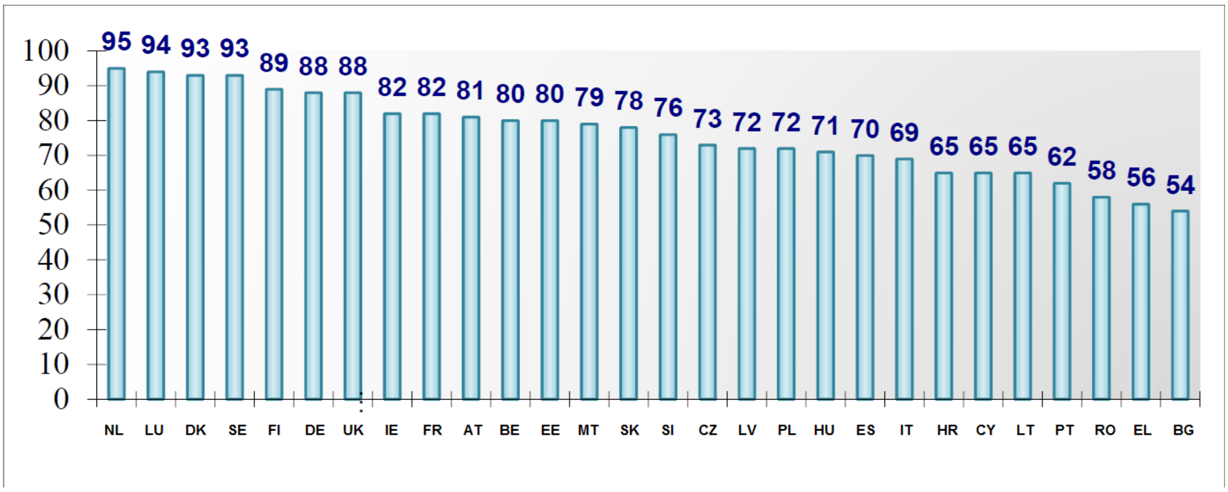
Table IV.2 Access to the Internet in Terms of Households

Data	2013 in %	Number
Total	53.6	1 437 496
By Types of Households		
Families without Children	47.5	984 369
Families with Children	74.6	453 127
by Location		

Densely Populated Areas	65.9	858 733
Areas with Average Population	54.4	102 917
Sparsely Populated Areas	40.0	475 846

Source: National Institute of Statistics

Table IV.3 Share of Households Having Access to the Internet in 2013



Towards the beginning of January 2014, Bulgaria is 18th in the world in terms of download Internet speed, according to NetSpaceIndex of oOkla.[62] The tendency of wider penetration of new technologies is indicative. For the period of five years the relative share of households having access to the Internet has increased by 24.1 percentage points, while the use of broadband connection marks growth of 27.5 percentage points. Compared to the previous year in a regional aspect there is also increase in the relative shares of households having Internet access, for all statistic regions, except the South-Eastern region, where there is a decrease of 3.1 percentage points

The South East region, where the capital belongs, has the highest relative share of households with access to the Internet - 64.3%. It is followed by the South Central and the Northeast region, where a little more than half of the households have access to the Internet – respectively 52.7 and 51.5%. The households from the Northwest region considerably lag behind the tendency of the country, where 42.8% of all households have access to the Internet.

The data from the studies conducted so far by the National Institute of Statistics regarding the use of ICT indicate that the most active users in the network are youths aged between 16 and 24, as in 2013, 79.5% of them use the Internet every day or at least once a week.

22.6% of the individuals in 2013 have used the global network to interact with state administration and local government. Most significant is the share of individuals who have obtained information by an Internet page or the web-site of public administration (20.9%),

[62] http://www.netindex.com/download/allcountries/

followed by those who have downloaded official forms from an official Internet page (12.7%) and the ones who sent filled out forms (8.5%) during the last twelve months.

In January 2013, the National Institute of Statistics indicates that the share of enterprises having access to the Internet reaches up to 89.1%, or 1.7 percentage points more compared to the previous year. The type and speed of the used connection improve - 77.9% of all enterprises use fixed broadband connection. 33.3% of the enterprises have mobile broadband connection through a portable device. Compared to 2012, this indicator reports growth of 7.9 percentage points.

Table IV.4 The Share of Enterprises Having Access to the Internet

Data	2013 in %	Number
Total	89.1	24 848
According to the size of enterprises		
10 – 49 employed persons	87.4	19 744
50 – 249 employed persons	95.8	4 384
250+ employed persons	99.1	720
Note: The percentage is calculated on the basis of agregation of enterprises with more than 10 employees		

Source: National Institute of Statistics

The Digital Scoreboard study of the European Commission indicates that Bulgaria possesses a relatively low number of fixed broadband access networks, but the country is above the average level in terms of next generation access. Although Bulgaria marks a slight progress in fixed and mobile broadband access, data shows that our country still faces the digital divide of regions in terms of broadband and ultra-fast broadband infrastructure.

Access to broadband services in Bulgaria must be improved and investment in building infrastructure, especially in rural regions should increase. According to the data of the Digital Agenda Scorebored, in 2012, fixed access to the Internet covers 89.6% of all Bulgarian households (95.5% in the EU). The access to 30 Mbps used for download by means of next generation access technology was used by 60.7% of households (53.8% in the EU).

According to the study conducted by Vitosha Research EOOD, in 2013 Internet access of households shows an increase in rural regions by 11 points, compared to a similar research conducted in 2011. The access of households in rural regions is 52 %.

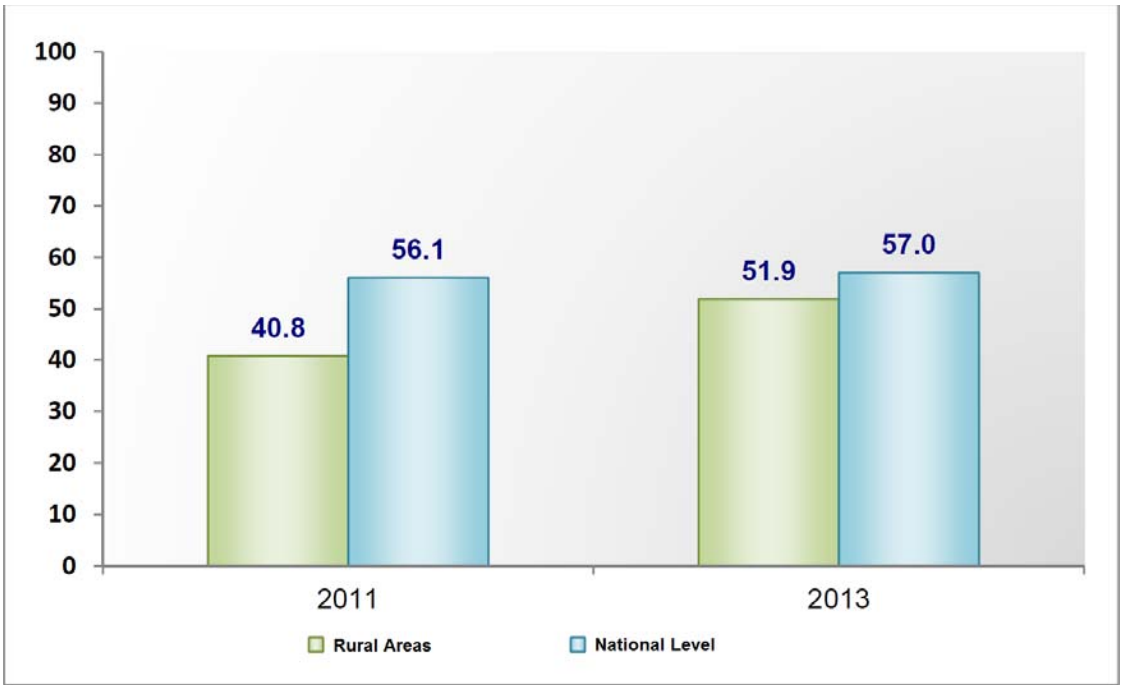


Figure. IV.2 The Share of Households Having Access to the Internet

Villages are the main reason for the low levels of Internet connectivity. 33.5 % of all households in villages have access to the Internet. The difference between regional towns and the other towns is not significant (68% with both types of settlements). Sofia makes an exception with considerably higher access share of households to the Internet – 74%.

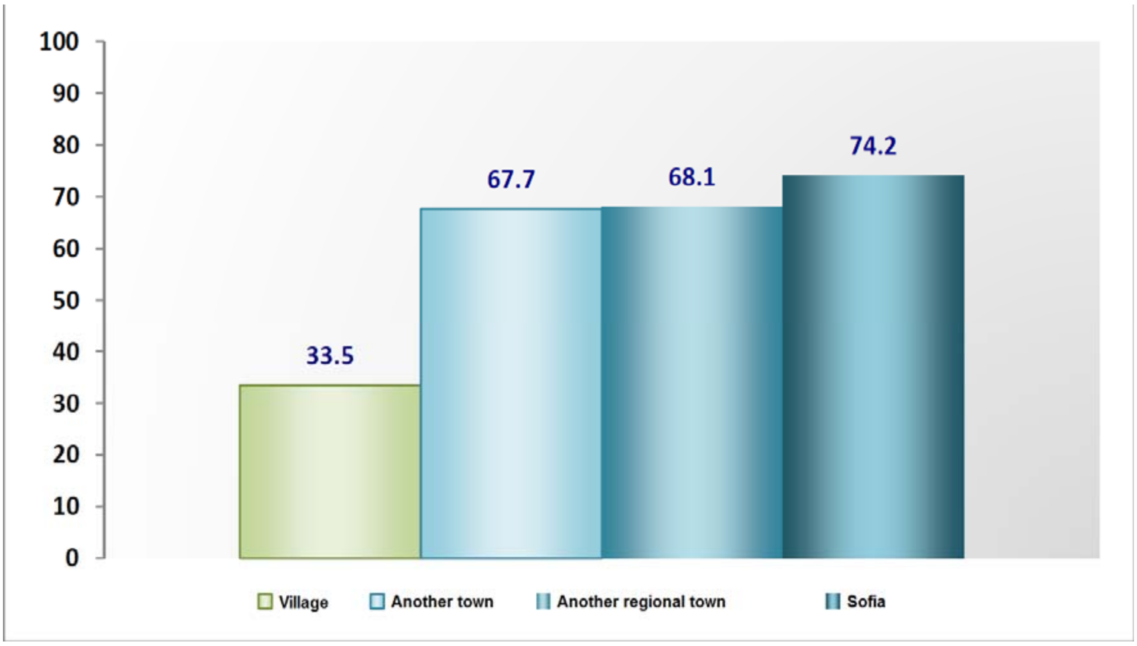


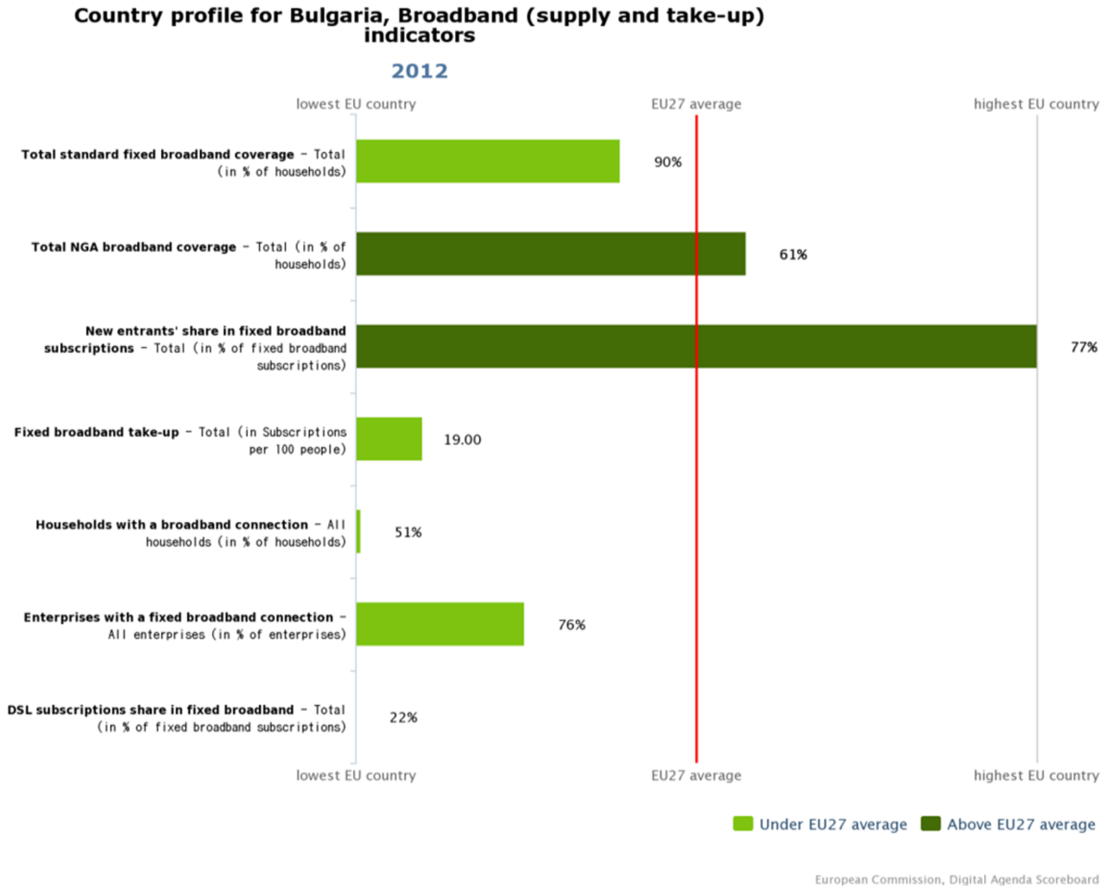
Figure. IV.3 Share of Households Having Access to the Internet by Type of Settlements

According to the study of the European Commission, 19 % are subscribers (subscribers as a percentage of population) of fixed Internet access in January 2013, far below the average of 28.8% for Europe, but 3 % higher than the data for 2012. The share of high-speed connectivity (at least 30Mbps) in Bulgaria is much higher than the average for the

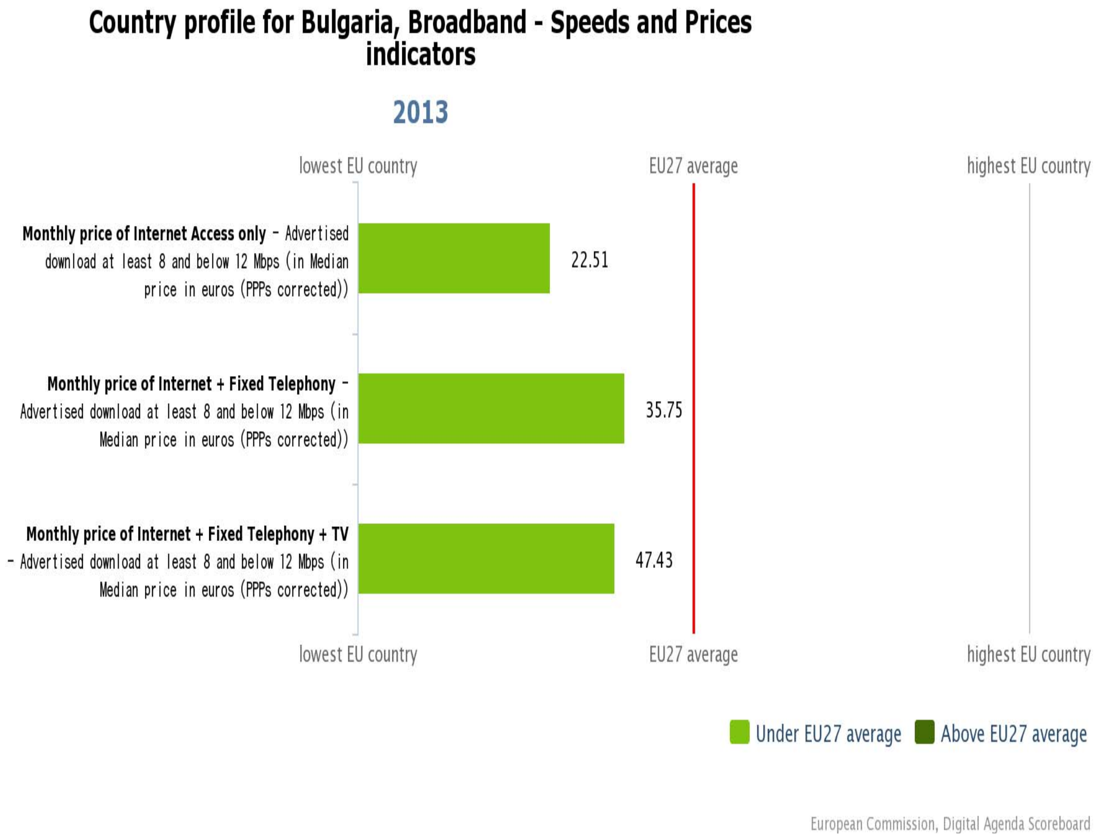
European Union (35.1% against 14.8% in the EU), although ultra-fast connectivity (at least 100Mbps) is hardly 1.2% of all subscribers (3.4% in the EU). Third generation mobile access (HSPA) is available for 99.4% of the population in 2012 (96.3% in the EU), while the fourth generation /LTE/ still lacks commercial supply. The percentage of mobile Internet(subscribers) is 39.7% in January 2013, which is below the EU average – 54.5%.

The graph of Figure IV.4 below shows the data for Bulgaria in terms of the corresponding indicators.

a)



b)



c)

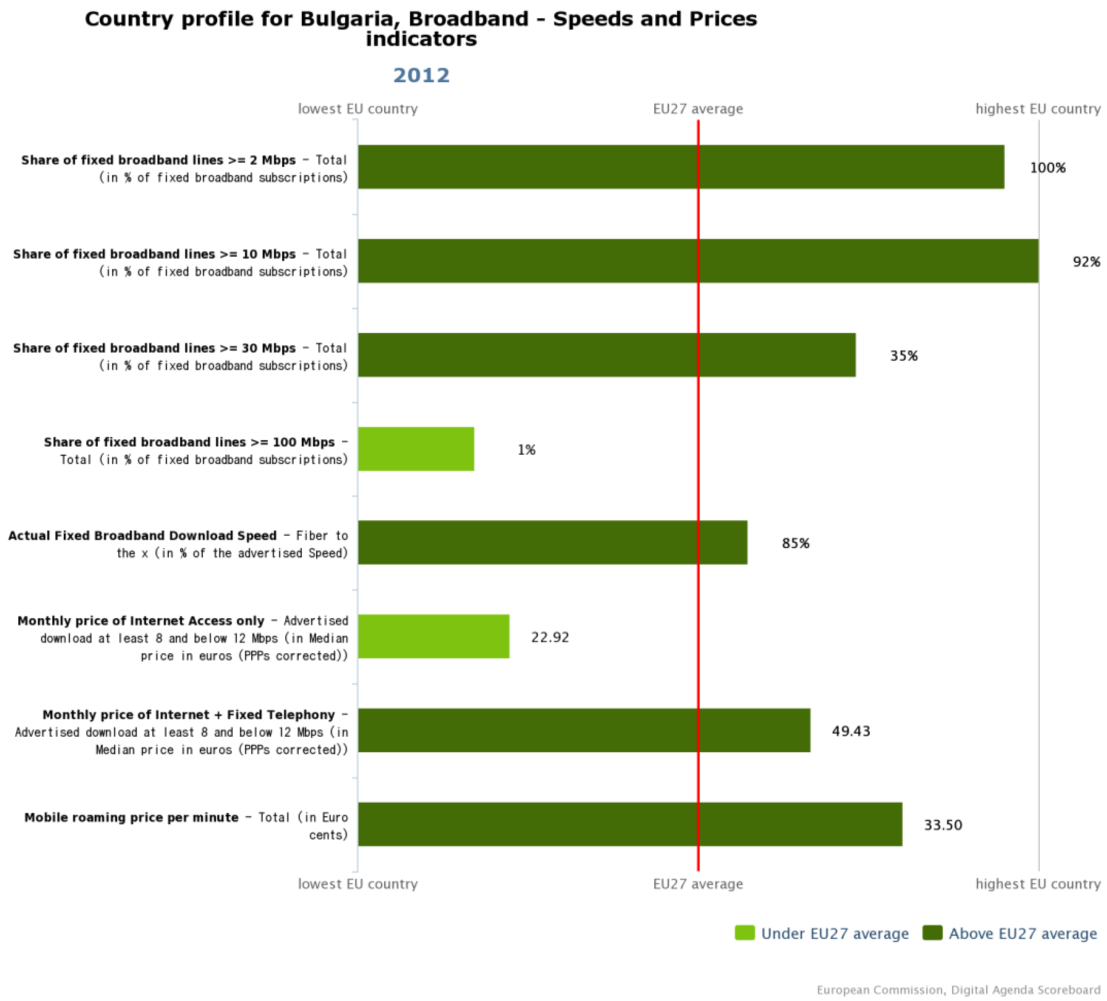


Figure IV.4 High-speed Connectivity Indicators in Bulgaria

4.1.1. National Penetration of Broadband Connectivity Technologies in Bulgaria

Bulgaria is below the EU average in terms of fixed broadband access penetration, both for the country in general and in rural regions. Although the country is above the average EU levels regarding NGA coverage, it was found out that there was no coverage in some rural areas at the end of 2012. In 2013 settlements without an Internet provider diminish. This may be explained by the technological profile of the country.

In 2012, the DSL technology covered 85% of the households, but this percentage was still below the average coverage for the European Union of 93%. Since DSL is typically the leading technology to ensure standard fixed broadband access, it explains why Bulgaria is below the average EU levels. In 2012, there was no information on the VDSL coverage.

FTTP coverage is somewhat above 7% for households, which is extremely low compared to the average coverage in the European Union, especially in comparison to other countries of Eastern Europe. The key technology to ensure NGA to households in Bulgaria is Docsis 3.

Towards the end of 2012, 20% of households in Bulgaria live in rural areas. Docsis 3 cover 60% of all households and it is considered to be the most probable way to achieve coverage beyond the rural regions.

The overall broadband growth advances slowly in 2012. The scope of WiMAX has grown by further 126 thousand households at the end of 2012, while no other access technology has achieved more than 2% growth.

Bulgaria has unequal broadband coverage, with different pattern that what is known in Western Europe. For instance, the capital city of Sofia lags behind the leading regions in terms of standard coverage, but it is first regarding the NGA coverage. Tourist areas, such as the coastal regions are among the leading ones with 100% of standard fixed broadband coverage. Most areas have 80% and 94% coverage. Those in North-western Bulgaria have the lowest rates, starting below 50% and hardly reaching 70%. Most areas in the country have above 50% coverage, while connectivity of households in rural regions is below 10%.

Table IV.5 Coverage by Broadband Access Technology in Bulgaria

Technology	BG - 2012		BG - 2011		EU27 - 2012	
	Total	Rural	Total	Rural	Total	Rural
DSL	85.1%	53.5%	84.8%	53.7%	92.9%	76.3%
VDSL	0.0%	0.0%	0.0%	0.0%	24.9%	4.8%
FTTP	7.3%	0.0%	5.6%	0.1%	12.3%	3.0%
WiMax	21.1%	11.9%	16.9%	9.4%	17.2%	16.2%
Standard cable	57.1%	0.0%	56.2%	0.0%	42.0%	7.3%
DOCSIS 3 cable	57.1%	0.0%	56.2%	0.0%	39.3%	5.8%
HSPA	99.4%	97.0%	98.0%	90.1%	96.3%	82.1%
LTE	0.0%	0.0%	0.0%	0.0%	27.0%	10.2%
Satellite	100.0%	100.0%	100.0%	100.0%	98.6%	98.6%
Standard	99.8%	99.0%			99.4%	96.1%
Standard fixed	89.6%	59.2%	89.1%	58.3%	95.5%	83.2%

NGA	60.7%	0.0%	59.3%	0.1%	53.7%	12.4%

Unlike the old member-states of the Union (EC15), where broadband development is mainly based on DSL technology, Bulgaria as **a new member-state „shows completely different patterns in the choice of broadband technology"** especially from those countries that lack legacy broadband infrastructure, it focuses investment towards other technologies. In Romania, Bulgaria and Lithuania, as well as to a smaller degree in Estonia, Latvia, Slovakia and the Czech Republic, provision of fixed broadband lines is much more based on optical technologies, rather than in the old member-states.[63] In spite of the lower rates of penetration and use of broadband, **contemporary technological development in Bulgaria and Romania is based mainly on FTTx + LAN technologies**. As a result, yet in 2009. Bulgaria ranks first in the EU27 according to the share of broadband lines offering access with speeds above 10Mbps, followed by Portugal, as both countries have a little more than 60% with the EU27 average of 23%.[64]

Bulgaria is among the leading countries in Europe and among the top 10 in the world in terms of fast and ultra-fast broadband access coverage, but it is among the last ones, that is, slightly below the EU average levels, respectively regarding penetration and use of Internet and Internet-based services among the population. The utilization of the country's advantage based on the comprehensive next generation coverage (NGA) faces serious challenges above all due to the lack of long-term and efficient national policies, coordination and integration between them. In the last two decades broadband coverage development is mainly based on business and technological patterns, elaborated for the conditions of inefficient regulation. The retail market of broadband access in the country is among the most fragmentary ones in the EU, since according to the regulator in the field – the Communications Regulation Commission, in 2012 there have been over 1150 enterprises offering the service 'access to the Internet' to end users, with nearly 800 of those are actually active operators.

4.2. Development of High-speed and Ultra-high Speed (NGA) Access in Three Countries

ICT development for economic growth and social inclusion is among the leading priorities for the next programming period -2014-2020 of the European strategic initiative – Europe 2020 and two of its main pillars 'The Digital Agenda for Europe' and the 'Innovation Union'. According to the latest assessment of the Digital Agenda for Europe, the ecosystem of interacting ICT constitute a key factor for the EU growth, which until the year 2010 has contributed to 20% of the overall growth of productivity, 5 % of the overall Gross Domestic Product and 25% of the total business scientific and research costs in the Union.[65] As indicated in the beginning of this document, the Digital Agenda for Europe is based on seven pillars that set the general development framework of all member-states, and in

[63] SEC (2010) 627 – Europe's Digital Competitiveness Report, Vol. 1, Commission Staff Working Document

[64] SEC (2010) 627 – Europe's Digital Competitiveness Report, Vol. 1, Commission Staff Working Document, pp. 37

[65] SEC (2010) 627. Europe's Digital Competitiveness Report, EC, 17.5.2010

order to evaluate the progress of each country regarding those pillars, the Digital Agenda sets out thirteen objectives, the progress of which could be measured in a single indicator and which have to be achieved by every country in a definite deadline. Each of the thirteen objectives is designed in such a way, so as to provide information on the development of more than one of the seven pillars.

Eleven of these objectives are related to the supply and use of broadband access to the Internet as a basic condition for the existence and functioning of the interacting ICT system. The supply and use of broadband in each country constitutes a direct result of the development of two other fields that are essential to utilize the opportunities offered by the ecosystem comprised of interoperable ICT (e-commerce, e-learning, e-inclusion, e-healthcare etc.). The first field covers dissemination and the level of skills and knowledge to work with ICT or the so-called digital literacy – from using a computer and the Internet for elementary tasks to highly specialized activities, such as programming and development of information and communications systems. The second field covers the leading role of business enterprises from the ICT sector to develop competitive and innovation-based economy, based on the provision and use of broadband access.

Table IV.6 Bulgaria's Progress Regarding the Objectives of the Digital Agenda for Europe -2020

Pillars	Objectives	Achievement Deadline	EU level at the end of 2012	Level in Bulgaria at the end of 2012
Pillar I: Digital Single Market Pillar II: Interoperability and Standards Pillar III: Trust and Security Pillar IV:Fast and Ultra-fast Internet Access Pillar V: Research and Innovation Pillar VI: Improving Digital Literacy, Skills and involvement Pillar VII: ICT-based benefits for the EU community	Fast broadband access coverage for all (>30 Mbps)	2020	54%	61.00%
	50% of households using ultra-fast broadband access (>100 Mbps)	2020	2%	1%
	100% growth of public costs for Research and Development In ICT (compared to 2009)	2020	60%	..
	33% of all SME-s selling online	2015	13%	4%
	20% of the population purchasing online from foreign countries	2015	11%	4%
	50% of the population purchasing online	2015	45%	9%
	60% of people with disabilities regularly using the Internet	2015	54%	29%
	75% of the population regularly using the Internet	2015	70%	50%
	15% maximum must be the share of population that has never used the Internet	2015	22%	42%
	50% of the population using the e-Government	2015	44%	27%

Source: Annual Report on the Progress of Member-states regarding the Objectives of the Digital Agenda for Europe - 2020

4.2.1. Development of Broadband in Bulgaria in Comparison with Germany, Poland and Romania

In Romania, Bulgaria and Lithuania, as well as to a smaller degree in Estonia, Latvia, Slovakia and the Czech Republic, provision of fixed broadband Internet lines is based much more on optical technologies, rather than in the old member-states.[66] The same study indicates for the first time that prices to access broadband Internet with us are among the lowest ones in the EU, even in the cases of higher speeds. According to the results, towards the end of 2009 prices for Internet access in Bulgaria (unbundled service) for speeds between 144 kbps and 20+ Mbps fall within the limits of 15 and 24 EUR, calculated in purchasing power parity or between 7 and 11 EUR in absolute values.[67]

Besides the geographic proximity and the fact that Bulgaria and Romania became EU members at the same time, the development of typologically similar business and technological patterns in these two countries, is the main reason to choose the second one in the comparative analysis. The choice of Germany is based on the fact that it is one of the three countries (along with Great Britain and Italy) with the greatest number of public investments, constituting state aid to develop broadband infrastructure, especially in rural areas during the last three years. With its high values of Internet usage and penetration, including broadband access among the population, business enterprises and the public sector, Germany could be considered as ‘a controlling’ country in terms of the successful application of state aid in building broadband infrastructure in rural regions. Poland is chosen due to the fact that regarding public investment it launched a similar pilot project to that of Bulgaria in rural areas, which aims to offer broadband access to end customers and which is also being implemented under a scheme of granting state aid. At the same time, the values of Internet use and penetration in the country are similar to the EU27 average levels, which from Bulgaria’s perspective could be regarded as an achievable objective for catching up development in short and medium-term.

In Bulgaria, both the Smart Specialization Strategy and the National Development Programme: Bulgaria 2020, review ‘the digital growth’ (based on the use of ICT) and innovation in business and society as complementary and mutually reinforcing conditions for economic and social development. Bulgaria is among the leading countries in Europe and among the top 10 in the world in terms of fast and ultra-fast broadband access coverage, but it is among the last ones respectively slightly below the EU average level regarding penetration and use of Internet and Internet-based services among the population. Besides the extremely high level of broadband coverage, an advantage of the country is its pricing affordability, also measured in relative purchasing ability, as well as the development of competitive ICT-based business sector in an international scale, resulted in imposing a number of Bulgarian companies as leaders in very specialized

[66] SEC (2010) 627 – Europe’s Digital Competitiveness Report, Vol. 1, Commission Staff Working Document
[67] Ibid

market niches in the global market, penetration and use of ICT among enterprises in economy as a whole.

Utilization of the country's advantage, based on the comprehensive fast broadband coverage faces serious challenges above all due to the lack of long-term and efficient national policies, coordination and integration between them. Despite the large number of Internet providers, during the last decade the majour trend in this market is consolidation and concentration, as large enterprises are between 10 and 15 in number, operating at a national or regional level, which according to different estimates comprise between 50% and 70% of the overall market, measured as the number of customers. The regular survey on the provision of broadband access to the Internet, conducted already for the third consecutive year by the Applied Research and Communications foundation (ARC BCS 2012)[68] indicates that reinforced competition in the market has led to relatively equal prices of services in the whole country, as lower price offers for respectively lower class of services are preferred in smaller settlements, while in towns, especially in the large ones, a higher class of services at correspondingly higher prices are used. At the same time, even in rural areas, newly-built networks in the majority of cases technologically allow the highest possible speeds, including high-speed (>100 Mbps) broadband Internet access, mostly through a combination of an optical network and LAN technology, if there is enough interest on the part of end customers. An important trend that is growing in the last two years is construction of optical networks between and inside the small settlements in combination with proposals for bundled services, even by the smallest local operators which in many cases act as intermediaries of larger regional or national operators. A majour disadvantage of the national policy in this field remains non-application of the existing regulations to submit information in the Cadastre and the land registry of Geodesy, Cartography and Cadastre Agency regarding newly-created networks, which sets a serious obstacle both before planning public investment to develop broadband infrastructure and before mapping the existing coverage and used technologies for the purposes of planning policies.

Regarding access speeds offered to end-customers, data shows that official statistics used to measure the country's progress according to the objectives of the Digital Agenda for Europe underestimates the actual state above all in terms of basic coverage (>1 Mbps) and fast (>30 Mbps) broadband access. For the second consecutive year, the results of the research conducted by Applied Research and Communications foundation confirm that almost the entire population (98%) resides in settlements where basic broadband access is offered, while more than half (56%) of the population – in settlements where fast broadband access is offered. Regarding the population which lives in rural areas, the survey results indicate that over 30% of its inhabitants live in a settlement, where a service to end customers with download speeds >=30 Mbps is offered. This discrepancy in data is due to different methodologies – one registers access technologies, while the other one – access

[68] ARC Broadband Coverage Study (2012) is a study that is exhaustive for the whole country at the level of settlements and it covers both characteristic features of Internet access provision (types of offers, speeds and access prices, types of technology), as well as the factors that determine the social and economic development of settlements (demographic indicators, provision of education, health, administrative and social services, Internet penetration in settlements etc.) and it is conducted according to a standardized methodology annually since 2010.

speeds, as well as due to the significantly more complete scope of data in ARC BCS 2012, which covers exhaustively all settlements in the country. This shows that in terms of broadband access supply Bulgaria is among the leading EU countries, but the utilization of that advantage to achieve digital growth will be threatened in short-term, if the business sector's progress in this field is not supported by an active and efficient state policy regarding the supply of public electronic services, stimulation of ICT-based innovations in enterprises, establishment of a favourable framework to improve e-skills among population, and mostly among learners, as well as enhancing electronic involvement – especially in relation to people with disabilities.

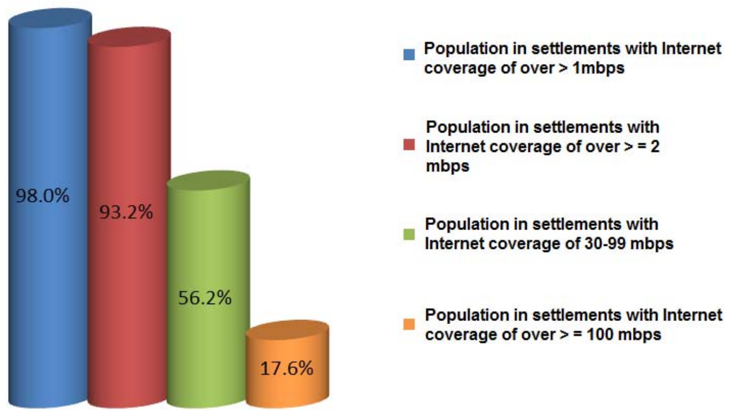


Figure IV.5 Broadband Access Coverage in Bulgaria towards December 2012[69]

According to the latest comparative survey on broadband access coverage, assigned by the EC within the monitoring on implementation of the Digital Agenda for Europe[70], Bulgaria lags behind mostly in terms of next generation access (NGA), respectively, that combination of technologies which allow the achievement of at least 30 Mbps or higher speeds to download data from the Internet with the end customer.[71]

[69] Source: Applied Research and Communications Foundation (ARC BCS 2012)

[70] Broadband coverage in Europein 2012. Mapping progress towards the coverage objectives of the Digital Agenda. Final Report by Point Topic.SMART 2012-0035

[71] According to the methodology used by the researchers, monitored broadband access technologies are: DSL, VDSL, FTTP, standard cable, Docsis 3 cable, WiMAX, HSPA, LTE and satellite. Regarding the speed that they can reach, the above mentioned technologies are divided into technological combinations: standard broadband access (including all technologies without satellite), standard fixed broadband access (including DSL, VDSL, FTTP, standard cable, Docsis 3 cable and WiMAX) and next generation broadband access (including VDSL, FTTP and Docsis 3 cable- technologies that could reach speeds of 30Mbps).Ibid.

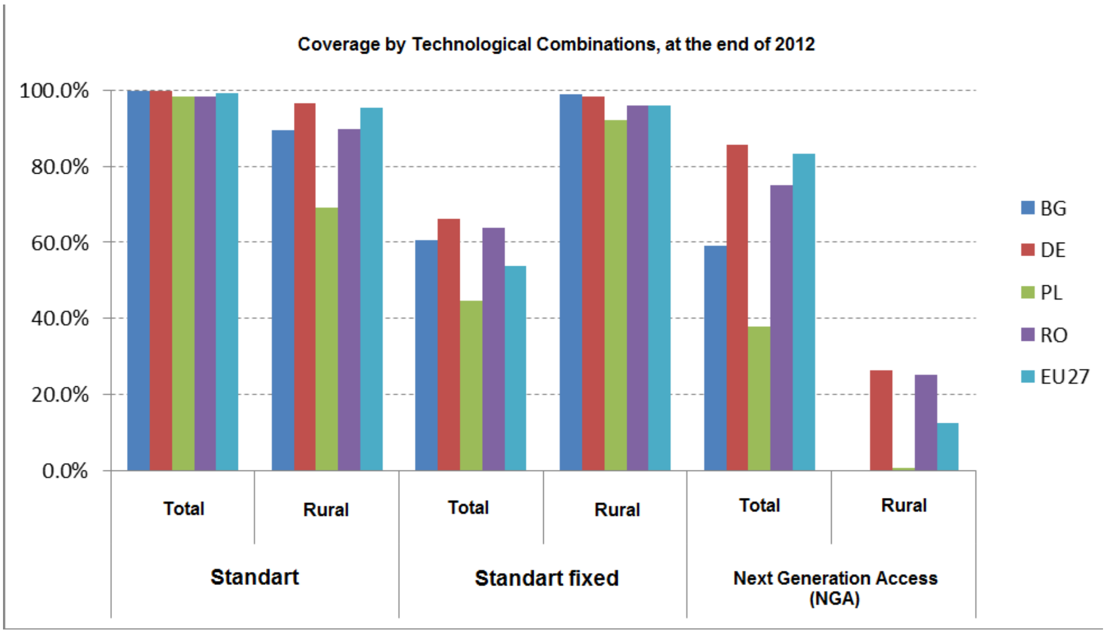


Figure IV.6 Coverage by Technological Combinations, at the End of 2012[72]

In recent years, many countries in Europe have increased public investment in developing broadband infrastructure, especially in rural regions. The greatest projects are being implemented in Great Britain, Italy and Germany, but the same thing happens in many other countries, including in Central and Eastern Europe. In 2012 the EC has approved 21 public investments for development of broadband infrastructure, as the allowed state aid is approximately EUR 6.5 billion, which is more than three times higher than those allowed for 2011 and almost the entire amount (6 billion.) constitutes schemes, approved to be applied in the above mentioned three countries.[73] In Bulgaria, after a delay of almost two years and replacement of the overall model from an open network with access points in small settlements to an open network that complements state backbone infrastructure with terminal access points in community centres, at the end of 2012 procedures were launched to choose a contractor for the development of broadband infrastructure in rural areas, funded with EUR 20 million under the Regional Development Programme.[74] This is the largest project in this field for the entire 2007-2013 programming period and after obtaining state aid permission by the EC at the end of 2013, the actual construction of planned infrastructure is expected to begin in 2014.

As it was pointed out above, in a comparative aspect, Bulgaria is among the leading countries both in Europe and the world in offering broadband access (coverage), including the technological level of development, access speeds and price affordability, but it is among the last EU countries in terms of Internet use and penetration throughout the population and nearly around the EU27 average regarding Internet use and penetration among enterprises. These results are due to both the development of some global trends,

[72] Source: Broadband coverage in Europe in 2012. Mapping progress towards the coverage objectives of the Digital Agenda. Final Report by Point Topic. SMART 2012-0035

[73] Digital Agenda for Europe Scoreboard 2013, EC, 2013.

[74] Project BG161PO001/2.2-01/2011 'Support for the Development of Crucial, Secure, Safe and Reliable Public ICT Infrastructure', with a beneficiary EA - Electronic Communications Networks and Information Systems.

such as convergence of technologies and services for end customers and some national specific features and inherited characteristics in the development of ICT and services based on them, such as the imposition of fiber-optic technology as a main transmission medium for newly-built networks in Bulgaria during the last decade, and last but not lease, as a result of inefficient regulation in the sector.

While in broadband Internet coverage measurement there are substantial differences in the results of the studies discussed above, this is not a fact when measuring the Internet use and penetration throughout population, businesses and the public sector, where data from various sources is nearly identical. Therefore, for the analysis below comparative data by Eurostat are preferable.

The analysis indicates that while in most member-states of Western Europe, basic broadband (>1 Mbps) is available for over 95% of the population, both in urban and rural areas, in Eastern Europe the access to such type of connection differs considerably among the regions. This in turn hinders the achievement of the other objectives related to penetration and use of ICT and ICT-based services among population, businesses and the public sector. For the period between January 2012 – January 2013, more than 188 000 new connections have been introduced in Bulgaria. Although the penetration degree of basic broadband in Bulgaria is among the lowest ones in Europe – hardly 19%, the country marks an increase by 3% in terms of this indicator for the same period, which is a positive sign for the rapid penetration of these technologies and it also positions Bulgaria in the second place (after Lithuania by 3.1%) regarding penetration growth in Europe.

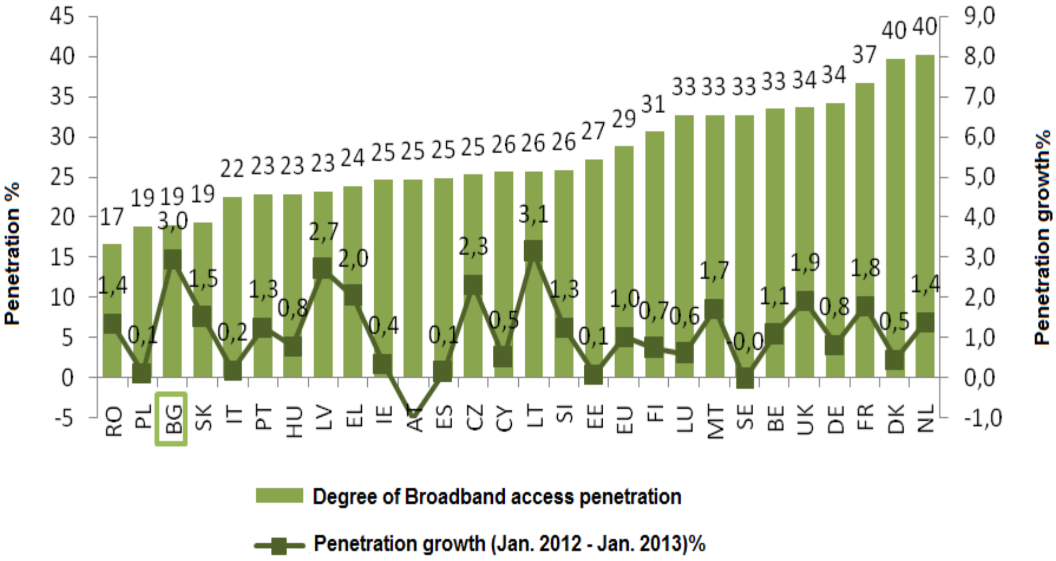


Figure IV.7 Broadband Penetration in the EU (2013)[75]

[75] Source: Broadband Indicators

4.2.2. Broadband Internet Market

Regarding concentration in the broadband access market, Bulgaria is among the leading EU countries in terms of the limited share of the traditional telecommunications operator that owns 23% of the market, with average EU values of 53.8%. According to this indicator, the countries of Central and Eastern Europe (CEE) have a significant advantage over the old member-states, respectively for Poland and Romania this value is 28%, while in Germany it is 44.6%. This result is due above all to different business and technological patterns, developed in the CEE countries that were discussed in the above analysis and which lead to intensive development of new providers applying technologies that do not rely on the use of DSL-based infrastructure of the traditional operator.

In January 2013, the new market entrants in Bulgaria have had a market share of 77% – according to the average EU value of 58%, or 7% more compared to the previous year. This is not only the highest market share covered by new providers in the EU, but also the highest growth in this indicator throughout the entire Union. This shows high competition levels in this industry, which should result in lower prices for consumers. Given also the comparatively low introduction levels of this service, it is a sign that the internal market is developing fast and Bulgaria has the chance to catch up with the remaining member-states.

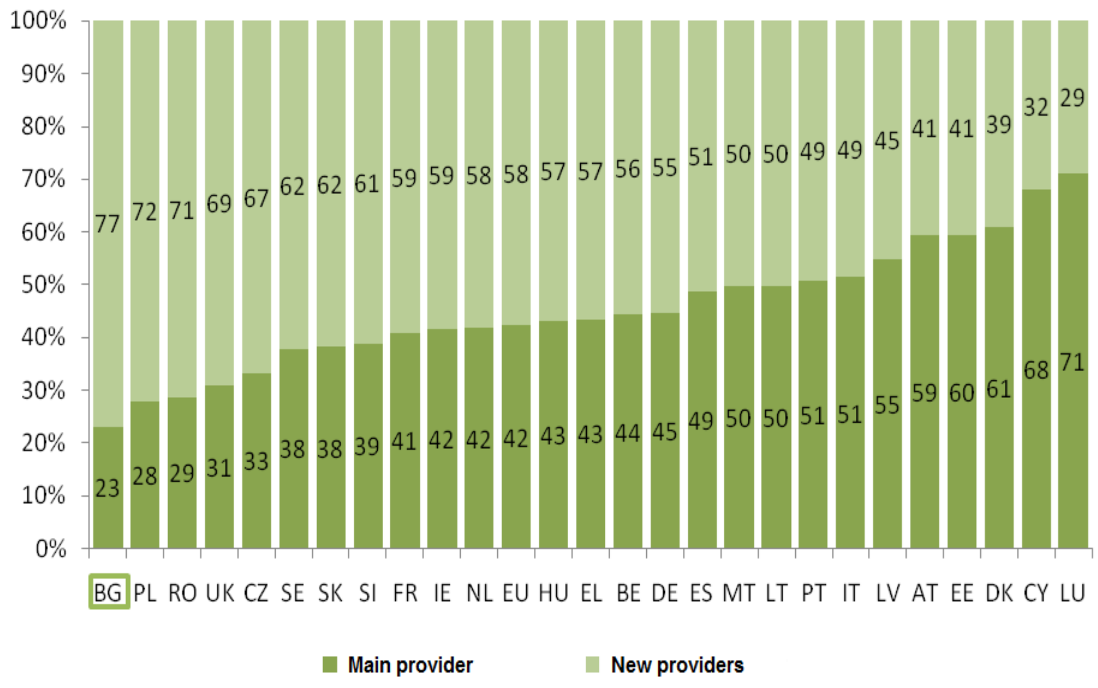


Figure IV.8 Fixed Broadband– Market Share in Bulgaria (2012)[76]

In terms of the provision and penetration of broadband access – fixed and mobile, high-speed (>30 Mbps) and ultra-high speed (>100 Mbps) – significant differences have been observed among the countries in Europe. It makes impression that leaders regarding one of these factors have values that are similar to the EU average, or even among the lowest values related to other factors. Therefore, the different factors listed below should not be

[76] Source: Broadband Indicators

considered in isolation from one another, but in their integrity and according to the particularities of each country.

According to official statistical data, fixed broadband provision (coverage) in Bulgaria (DSL or networks based on cable modem) is relatively low – only 89.6% of the Bulgarian households have the opportunity to use such access with the EU average of 95.5%, In comparison with the selected three countries, Germany is the leader in this respect with 96.6% of the homes, while Romania is at the same level as Bulgaria, and Poland lags behind considerably with the lowest values in the EU of 69.1%. Concerning the provision of next generation access (>30 Mbps), Bulgaria also lags behind in comparison to Germany and Romania, although with its 60.7% it ranks above the EU average of 53.8%. Poland again takes one of the last places with only 44.5%.

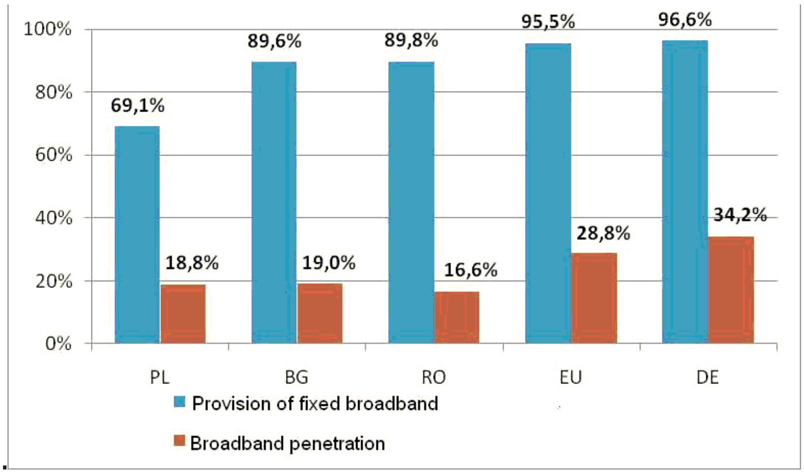


Figure IV.9 Provision and Penetration of Fixed Broadband, as % of Households, 2012

In terms of fixed broadband access penetration, Bulgaria lags behind even more, as the country takes one of the last places in the EU. For compensation, regarding the penetration of high-speed broadband access of at least 30 Mbps, the country takes one of the leading positions in Europe with its 35.1%. Despite the essential advantage of high-speed Internet lines, Bulgaria lags behind in ultra-high speed access (> 100 Mbps). With the average EU values in the amount of 3.4% of all subscriptions, the country marks significantly low values (1.2%) and it is positioned after countries such as Poland, which lag behind in a number of indicators related to the provision and deployment of broadband access. The performance of Romania stands out, where the share of high-speed subscriptions is three times higher than the average for Europe, while the share of the ultra-high speed ones – five times and a half.

The most widespread technology for broadband access provision in Bulgaria is FTTH/B. The situation in Romania is similar, while in Poland and Germany DSL technology is traditionally the most preferable.

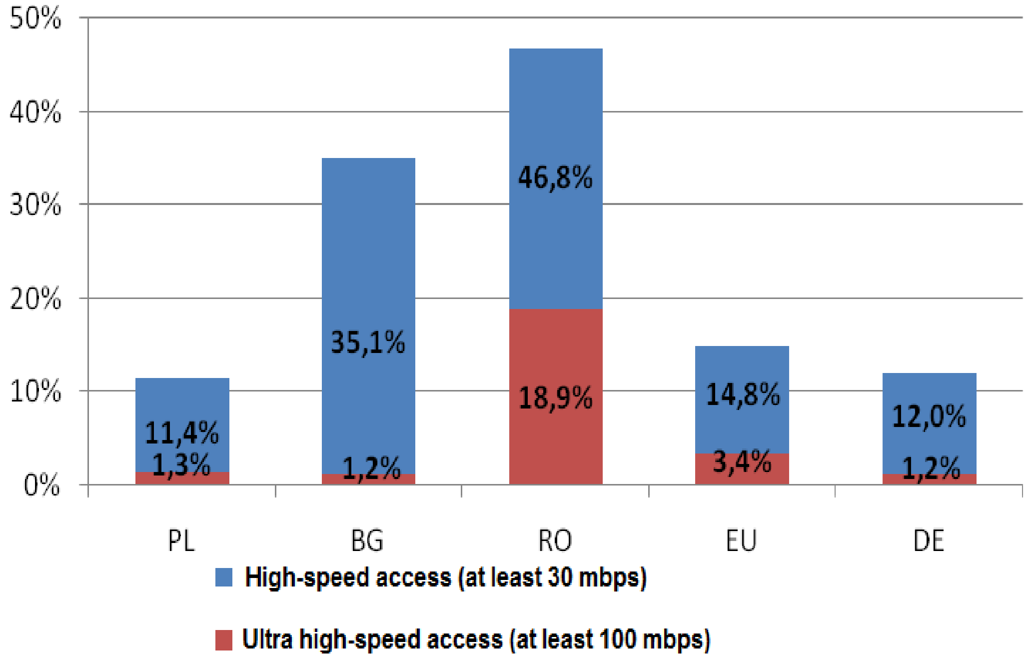


Figure IV.10 High-speed and Ultra-high speed Access, as % of All Internet Subscribers, 2012

Regarding the supply of mobile broadband, in spite of the lagging behind, the share of population having access to third generation technologies (HSPA) in Bulgaria is comparable to the average European levels of (99.4% compared to 96.3%). At the same time, with only 39.7% penetration of such access, the country significantly lags behind most countries and the EU average of 54.5%. In Poland, the low levels of broadband provision (coverage) are compensated to a significant degree by one of the highest penetration levels of mobile broadband access among the population – 74.1%, while Germany (41.1%) lags behind according to this indicator. As far as the fourth generation of mobile broadband technologies (LTE), they remain completely unknown for the local market. LTE тtechnologies are considerably better developed in the rest of the countries, since in Germany and Poland they are available to more than half of the population and in Romania for every fifth inhabitant (23.6%).

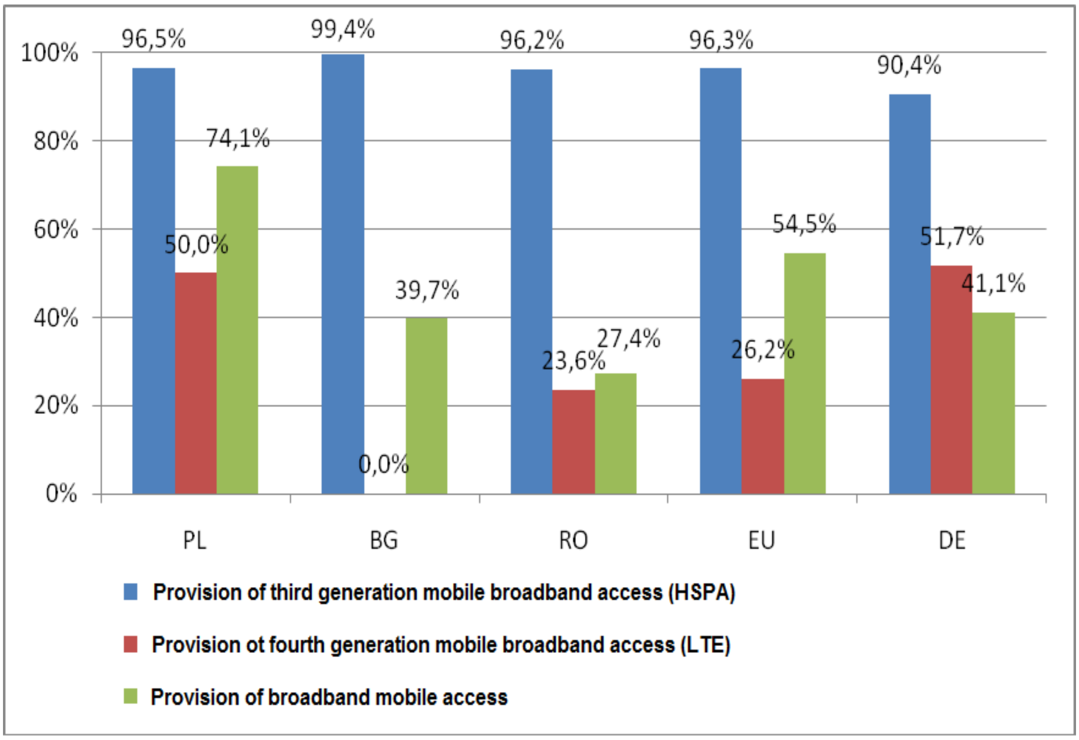


Figure IV.11 Supply and Deployment of Mobile Broadband, 2012

4.2.3. <u>Internet Access</u>

In recent years there has been an increase in the total number of households that have access to the Internet, as in 2012, Bulgaria scores 51% - with an increase of 6% compared to the previous year, but it is still below the EU average of 76%. As it could be expected, the Internet use with us is comparable to that of Romania, as our northern neighbour outraces us slightly in the recent years reaching 54% in 2012.

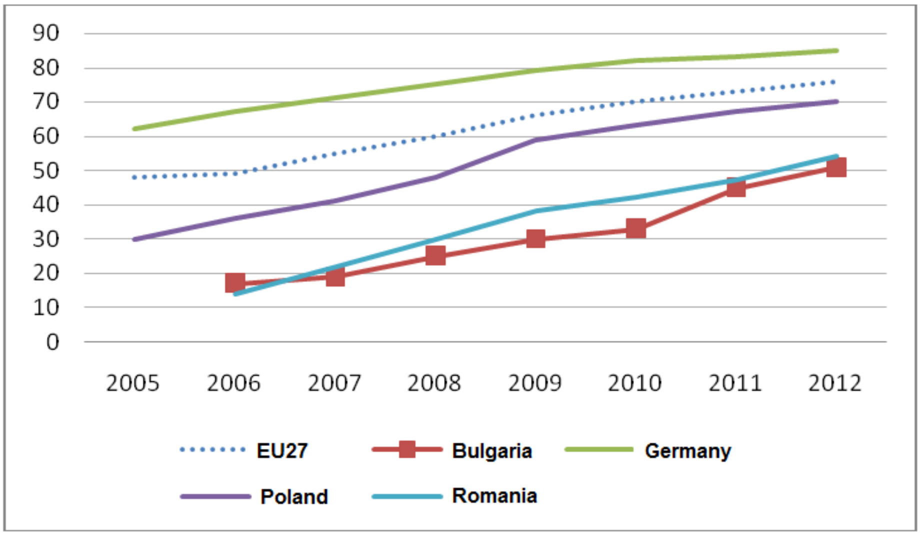


Figure IV.12 Internet Access, as % of the Households, 2005-2012

In spite of the relatively low percentage of households using the Internet in Bulgaria, all such households are using broadband connection, in comparison with the other 3 countries where les than 95% of all households use this type of Internet. Bearing this in mind, each of the subsequent data analyses for Bulgaria will be valid both for the overall Internet and broadband consumption.

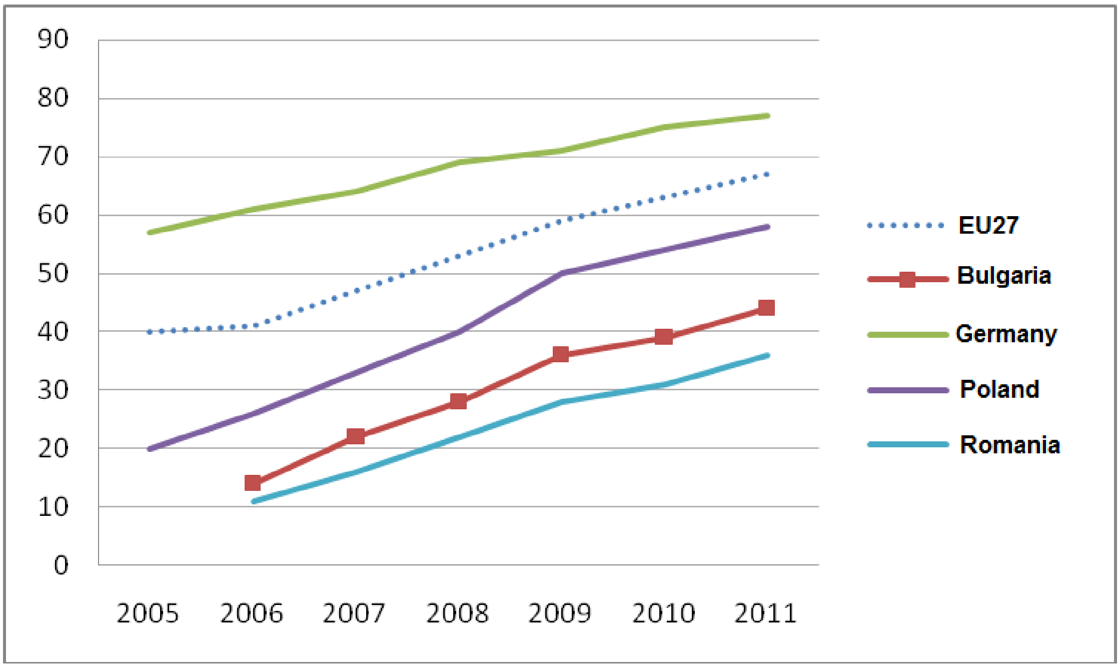


Figure. IV.13 Persons Accessing the Internet, % of the Population, 2005-2012

Once again the typical for Europe increase in the number of Internet users is observed, as in the year 2011 in Bulgaria 44% of the people have had broadband Internet access, by 5% more compared to the previous year, and again we are below the average for Europe of 67%. According to this parameter we are ahead of Romania (36%), but we lag behind considerably after Poland (58%) and Germany (77%).

It should be pointed out that people using the Internet in Bulgaria, as well as in the EU are mainly regular users, as 93% of the EU citizens with access to the Internet have used it in the course of the last 3 months. In this respect, Bulgaria (91%) slightly lags behind both the European average and the corresponding share of Germany and Poland, but it is ahead of Romania where this share is 89%.

In terms of devices to access the Internet, Bulgaria performs relatively bad compared to the selected countries, as it is only ahead of adjacent Romania.

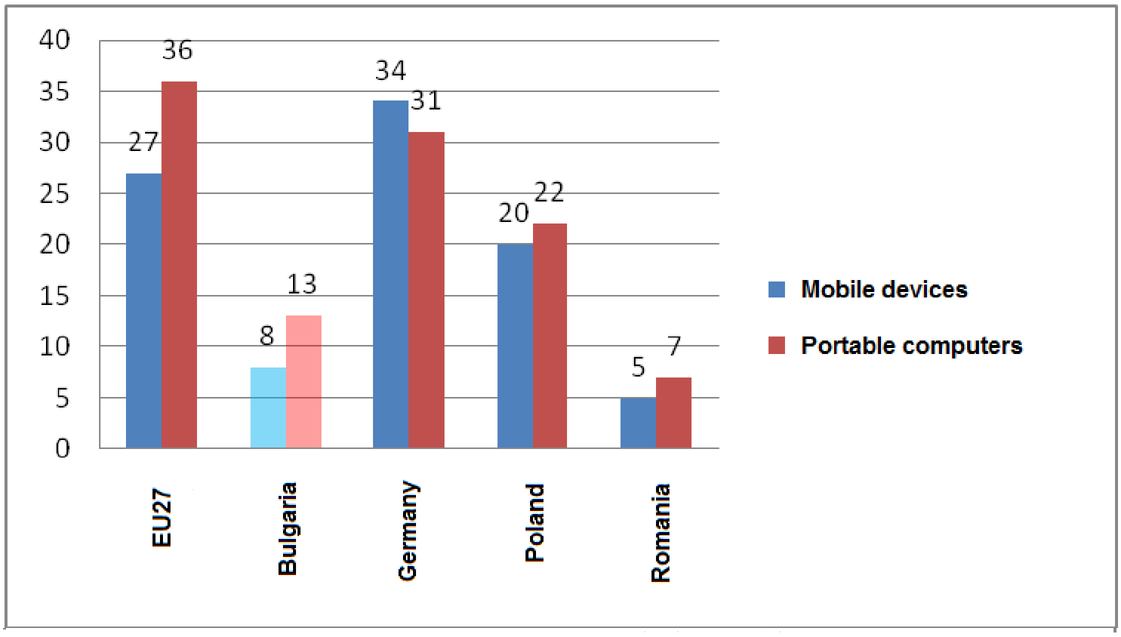
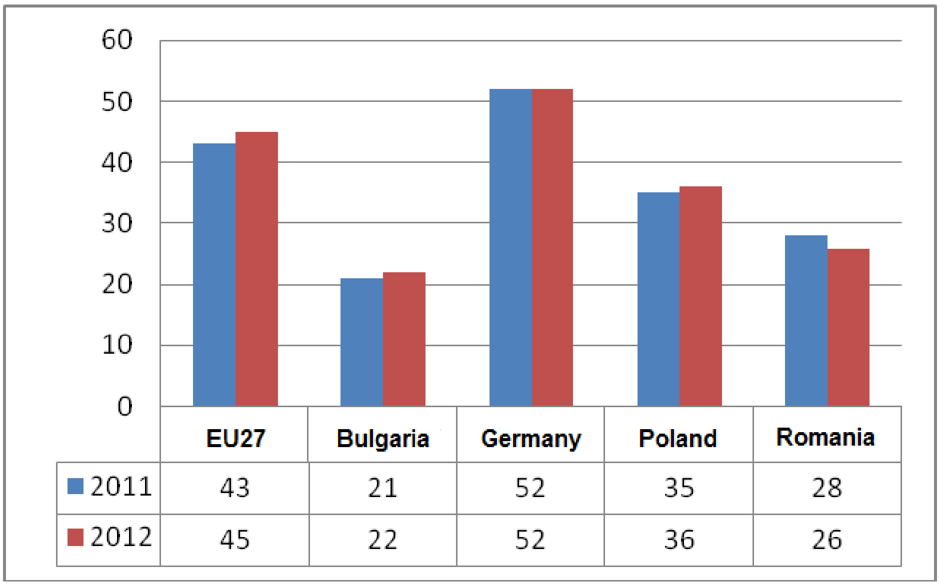


Figure IV.14 Devices to Access the Internet, as % of All Internet Users, 2005-2012

Regarding the Internet access at the workplace, for the last two years a minimum increase has been observed in the share of employees using computers connected to the Internet within all enterprises (organizations with 10 or more employed persons). Bulgaria marks 1% growth compared to the total share of employed persons in 2012 reaching 22%, but once again it remains below the EU average of 45%.

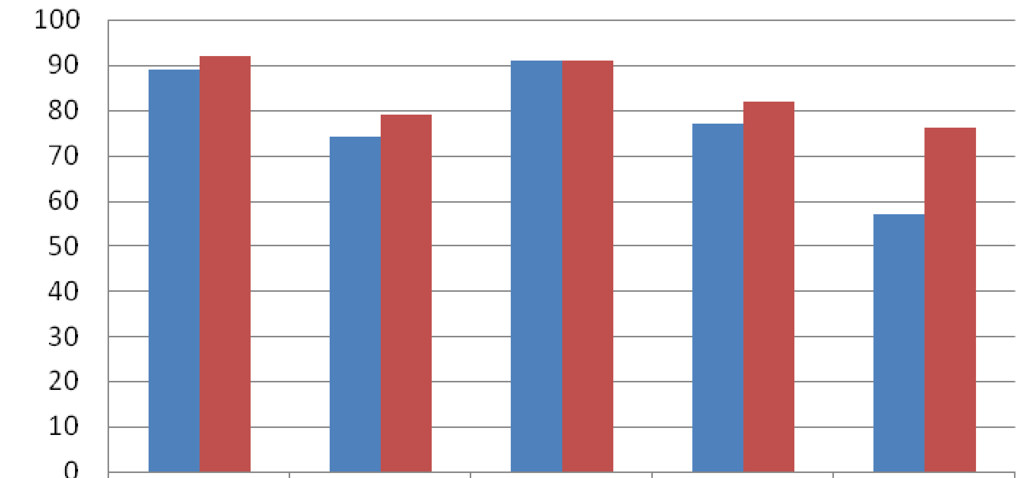


	EU27	Bulgaria	Germany	Poland	Romania
2011	43	21	52	35	28
2012	45	22	52	36	26

Figure IV.15 Internet Access at Work, as % of Employed Persons Using Computers Connected to the Internet, 2011-2012

At the end of 2012, 79% of the enterprises in Bulgaria have broadband access and according to this indicator the country also lags behind the Union's average of 92%, in spite of this it is equal to such countries as Poland (82%) but it has better access than Romania

(76%). Bulgaria, however, remains far behind Germany with its access of 91%. A steady growth could be noted for the year 2012, in Bulgaria, Poland and Romania, and a standstill in Germany due to saturation in the market.



	EU27	Bulgaria	Germany	Poland	Romania
2011	89	74	91	77	57
2012	92	79	91	82	76

Figure IV.16 Enterprises Having Broadband Access, as % of All Enterprises, 2011-2012

Similar picture is seen with the relative share of enterprises having access to broadband compared to all enterprises with access to the Internet – Bulgaria scores 90%, by 6% below the EU average, after Germany (94%) and Romania (96%), but before Poland (88%). It is interesting to point out that while with households there is only broadband Internet access, according to official data Internet access for enterprises is not always of such type. The last conclusion should be reviewed with consideration, since a number of surveys indicate that Bulgaria lacks supply of service with minimal speed below 1 Mb/s, which means that in fact all possible Internet users have only broadband access available.

4.2.4. ICT Skills and Learning

Bulgaria takes one of the last places, along with Greece and Romania according to the share of population that uses the Internet regularly (at least once a week) or more often. In 2012 only half of the population (50%) have used the Internet at least once a week, which shows a slight growth compared to 46% in the previous year. These values are considerably lower in comparison with the EU average and nearly half of the countries having the highest share of persons that regularly use the Internet, such as Iceland and Norway. The tendency of growth in terms of these shares for the period 2006-2012 shows that in Bulgaria the reported growth based on 2006 is 127%, which ranks the country second after Romania with 139% growth.

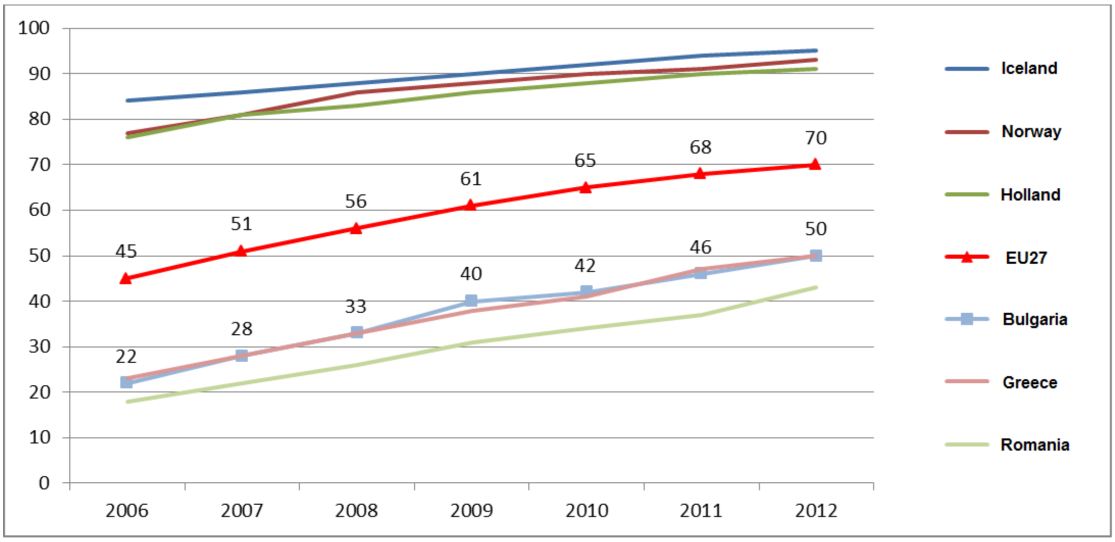


Figure IV.17 Persons Using the Internet Regularly (at least once a week) as % of the Population[77]

In comparative terms with the selected 3 countries, Bulgaria ranks as the second lowest country (after Romania) both regarding the share of regular Internet users and the share of those who actively use the Internet.

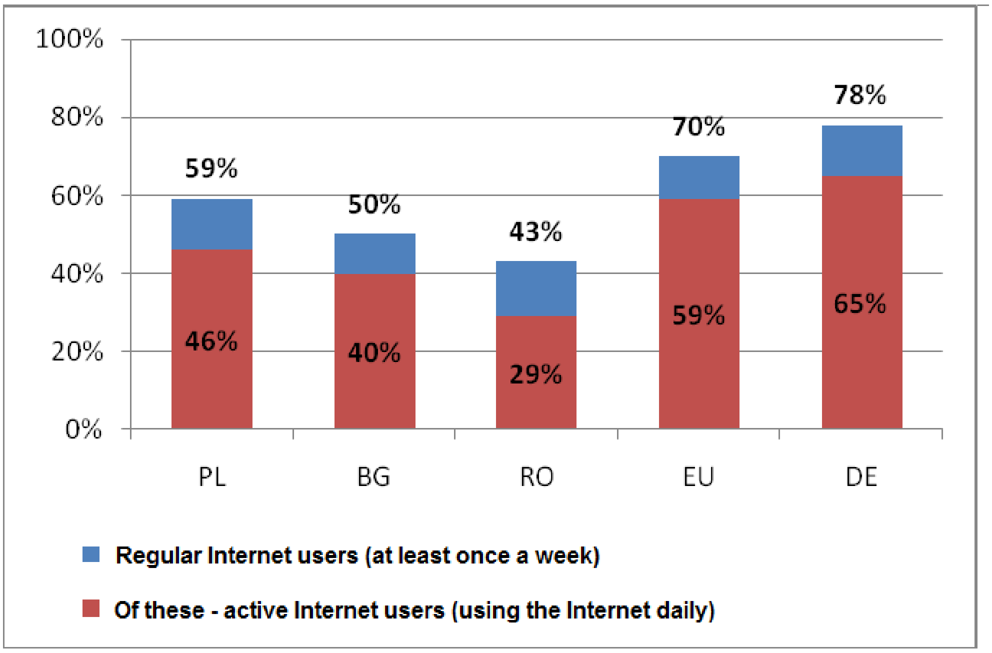


Figure IV.18 Share and Profile of Internet Users, as % of the Population, 2012

Bulgaria also ranks second lowest in the EU in 2012 according to the share of persons who have never sued the Internet (42%), which is nearly double the average EU value of (22%), as the change compared to the previous year is positive and it is equal to 4 percentage points. These results to a great extent also predefine the low levels of

[77]Sourse: Eurostat, 2013

operational skills to work with computers and use the Internet throughout the population compared to both the EU average and the leading countries in this respect.

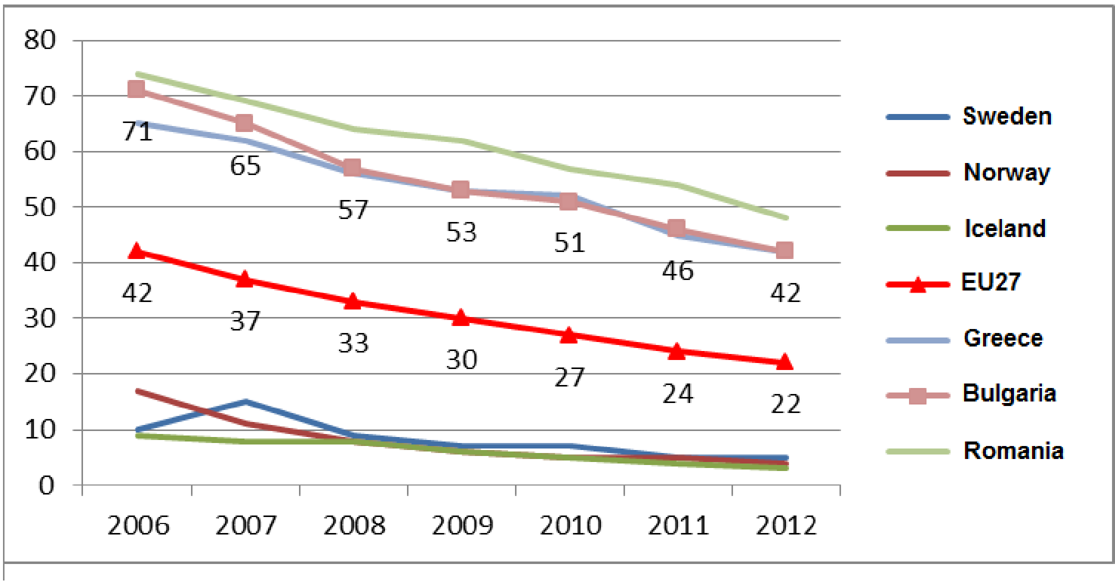


Figure IV.19 Persons Who Have Never Used the Internet in % of the Population[78]

Among the most popular activities for the Bulgarian consumer in the Internet rank reading online newspapers, searching for information about products and services and making telephone and video calls. While in terms of these activities consumer behaviour in the country does not differ significantly from the European practice, the low interest in Internet banking and online shopping makes impression. It is most likely due to the lack of reliable infrastructure, trust and traditional culture of e-commerce, as well as the relatively low levels of users with high and very high computer skills.

In 2012.almost half of the population (42,4 %) have had some, be it basic skills for operational work with computers, which is 25 percentage points lower than the average EU values of (66,6 %). The shares of population having computer skills with different level of complexity are unequally distributed and indicate two unfavourable trends for the country. On the one hand, the increase in the level of complexity the difference between the corresponding share of population in Bulgaria and the average EU values grows. This shows that our country lags behind above all in the development of highly-specialized skills which are essential to enhance economic competitiveness and production of products and services of high added value. On the other hand, in comparative aspect, in terms of every single complexity level of skills possessed, Bulgaria also lags behind the EU average.[79]

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[78] Sourse: Eurostat, 2013

[79] Digital Agenda for Europe 2020: Internet activity and digital skills in Bulgaria - 2013 report, p. 2. EC, 2013. (available online athttps://ec.europa.eu/digital-agenda/sites/digital-agenda/files/BU %20internet %20use.pdf)

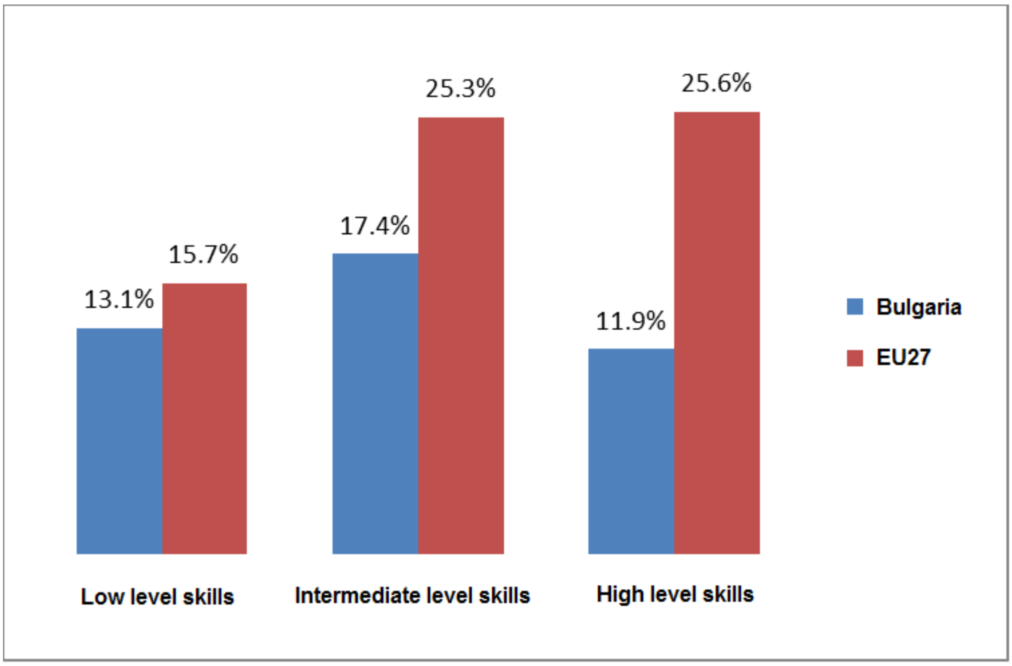

Figure IV.20 Levels of Computer Skills Towards the End of 2012 as (% of the Population[80]

Bulgarian policy on improving e-skills among population focuses on training within the formal educational system – from pre-school to higher education. Re-training courses and studies for those who have graduated from their education are offered both by the business sector and institutions related to the formal educational system, including the financial support of Human Resources Development Operational Programme.[81] Traditionally, Bulgaria is proud of the high quality of its IT specialists, including those graduating high and higher education, but in the last decade, the quality of education in the ICT field is deteriorating, since according to an expert evaluation of managers from leading ICT companies in the last five years, the time necessary for internal company training of students without labour experience has doubled – from six months to one year.[82] State policy to support the application of ICT in the formal educational system, as well as for the purposes of acquiring basic and specialized skills and knowledge to work with ICT, during the last decade focuses primarily on capital investment in technologies and services[83] and much less on stimuli and regulation of learning content.[84] These investments had a positive

[80] Source: DAE Scoreboard 2013, Country Presentation – Main Indicators

[81] According to the data of the Ministry of Education (Manging Authority fHRD OP), nearly 10 thousand people have passed pre-qualification courses for the period 2007-2012, as almost half of them have attended a general or a specialized course in the field of ICT.

[82] Assessment is based on profound interviews with five managers of ICT companies, primarily in the field of software development.

[83] For instance Modernizing the Vocational Training System National Programme and the Information and Communications Technologies in schools National Programme etc. Despite the focus on capital investments in technology and services, in 2012 the number of computers (no matter if connected to the Internet or not) in Bulgarian schools remained half below the EU average. (Digital Agenda for Europe 2020 report on Survey of Schools: ICT in Education. Country Profile: Bulgaria, November 2012)

[84] For instance a project on Education of Better Quality, funded under the Human Resources Development Operational Programme, develops a draft project of state educational requirements on mandatory and profiled training in subjects, as well as learning curricula in primary, lower secondary and higher secondary education,

impact on the conditions to acquire general digital literacy, especially in primary and secondary education, but the main challenge remains the change of content for specialized skills and knowledge, in order to meet appropriately the contemporary requirements of the labour market. This is especially true for the field of higher education.

4.2.5. e-Governance

The introduction of simple and at the same time efficient digital public services, both for citizens and enterprises, is of great significance to achieve economic growth in Europe. They are also necessary in order to achieve more effective, fast and economical state administration. Such types of services enable a standardized exchange of information with users, involving them in the development of policies and democratic decision-making. Besides benefits for citizens, technological solutions have significant advantages for the governments themselves. Intelligent use of data is a main tool to predict trends, to combat crime and corruption and improve the efficiency of the very services. The Government could also use electronic methods to investigate customer needs before introducing a new service, so as to make it most appropriate.

In 2012, only 27% of the Bulgarian citizens have used the Internet for consumption of e-Government services, while 11% have sent completed forms. At modest growth rates regarding the previous year, the values continue to be considerably lower compared to the European levels (respectively 44% and 22%). One of the few consumer behaviour indicators, in terms of which Bulgaria's performance approaches the average European levels, is the share of enterprises using the Internet to interact with public authorities (83% compared to 87% for the EU27).

The European Commission's report on Public e-Services of 2012, elaborated on the basis of a study among Internet users provides a general overview on the manner and purposes of using e-services in the EU. According to the data, the most popular cases where survey participants have used e-services in Europe are to look for a job (73% of the cases), to file tax returns (68% of the cases) and apply for higher education or student loans (60% of the cases). In Bulgaria almost half of the survey participants (48%), have stated that they do not regularly use institutional e-services, therefore they have no preferences regarding online platforms for such type of services.

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including the ICT field and Informatics. Another similar, though with much more limited budget and scope, is the joint project of the Ministry of Education and the British Council - Professional Skills - „Skillsforemployability" (2010 – 2012)

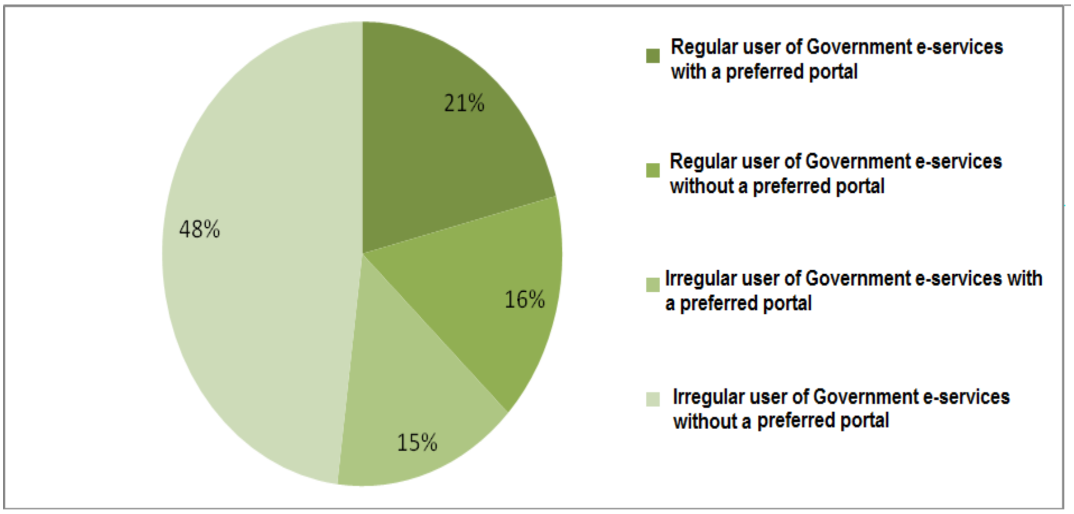

Figure IV.21 Use of Institutional e-Services in Bulgaria (2012)[85]

The report investigates the degree to which three main types of services have been developed – setting up a business and the initial commercial services; looking for a job; education. The level of online development of a certain service is determined in terms of the extent to which information is available and the very service could be performed online through a designated portal.

In Bulgaria, e-services for establishment of a new business and a new job search are developed at 76%, while the EU average is respectively 75% and 72%, which indicates that e-services in the country are relatively well-developed. Regarding services related to higher education, however, they are only developed at 44%, or 28% less compared to the EU average. Therefore, it is necessary to invest in this field, in order to facilitate the application process for higher education.

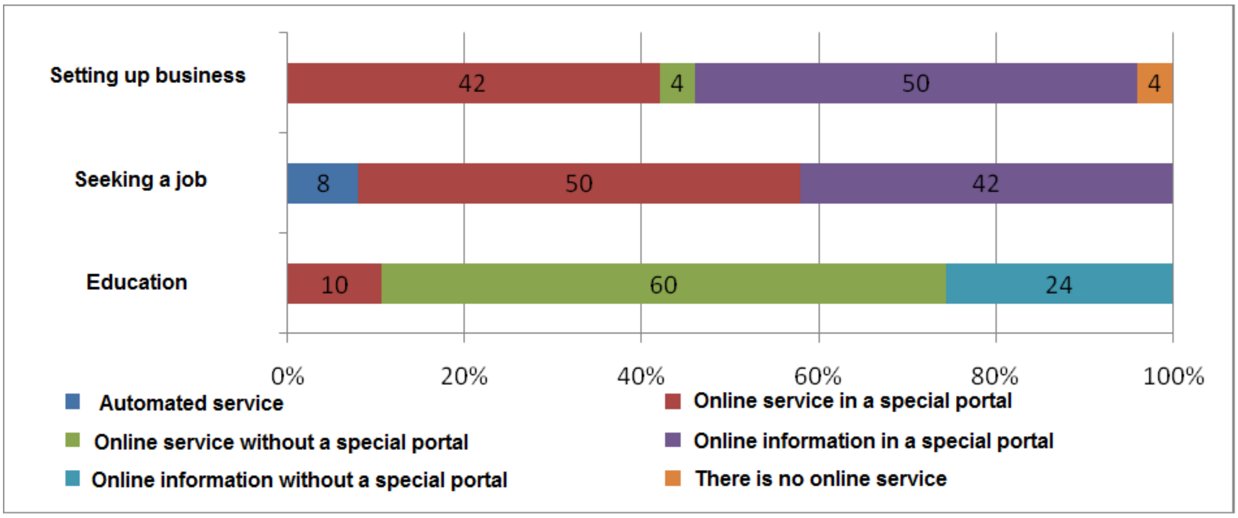

Figure IV.22 Development of e-services to set up a business, job search and education in Bulgaria (2012)[86]

[85] Source: European Commission, Electronic Public Services, 2012

[86] Source: European Commission, Electronic Public Services, 2012

The report also explores the degree to which users are satisfied with public e-services. According to the study 68% of the respondents would use these services again, and only 37% assume that the quality of service meets their expectations. Among the main reasons indicated in the survey, due to which Bulgarian Internet users do not use government e-services is the fact that a great deal of those services cannot be performed entirely online and at least a part of the procedure requires personal attendance or forms that should be completed in paper. Subsequently, measures must be taken, in order to provide the entire procedures, not only parts of these by electronic means. The survey participants also point out that they often do not know about the existence of specific online sites/platforms for certain services. This fact shows the necessary for such type of platforms to be promoted, so that users could be notified on which services are available online. The most widespread reason for Bulgarians not to use available e-services is that they still prefer personal contact with government officials. This is a sign that e-Government efficiency does not only depend on availability and quality of services, but also on public attitude towards online services.

4.3. Findings and Conclusions

As indicated above, in comparative terms Bulgaria is among the leading countries both in Europe and the world in supply (coverage) of broadband access, including in terms of the technological level of development, access speeds and price affordability, but it is among the last countries in the EU with respect to internet use and penetration among the population and about the EU27 average regarding Internet use and penetration among enterprises. These results are due to both the development of some global trends, such as convergence of technologies and services to end customers and some national specific features and inherited characteristics in ICT development and services based on them, such as the imposition of fiber-optic technologies as the main transmission medium with newly-developed networks in Bulgaria during the last decade, and last but not lease due to the inefficient regulation in the sector.

In terms of provision and penetration of broadband access – fixed and mobile, high-speed (>30 Mbps) and ultra-high speed (>100 Mbps) – significant differences have been observed among the countries in Europe. It makes impression that leaders regarding one of these factors have values that are similar to the EU average, or even among the lowest values related to other factors. Therefore, the different factors should not be considered in isolation from one another, but in their integrity and according to the particularities of each country.

According to the latest comparative survey on broadband access coverage, assigned by the EC within the monitoring on the implementation of the Digital Agenda for Europe[87] Bulgaria lags behind mostly in terms of next generation access (NGA), respectively, that

[87] Broadband Coverage in Europein 2012. Mapping progress towards the coverage objectives of the Digital Agenda. Final Report by Point Topic.SMART 2012-0035

combination of technologies which allow the achievement of at least 30 Mbps or higher speeds to download data from the Internet with the end customer.[88]

With the provision of next generation access (>30 Mbps), with its 60.7% Bulgaria ranks above the EU average value of 53.8%.

Regarding the Supply of mobile broadband in spite of the lagging behind, the share of population having access to third generation technologies (HSPA) in Bulgaria is comparable to the average European levels of (99.4% compared to 96.3%).

A significant finding is the tendency to level rural regions with the country's average regarding the use of ICT and services. A key factor for currently observed lagging behind of rural regions from the national level remains the financial status of households – the income of households living in rural areas is lower than the average for the country. This factor correlates with the highest degree of completed education which in general is lower among the inhabitants in rural areas. These two factors (focusing on income) determine underdevelopment of rural areas compared to the country's average in using ICT and services at present. The tendency for development of broadband services continues both at a national scale and in rural areas. The significant increase in the use of mobile devices to connect to the Internet both at home and outside makes impression, respectively the more and more frequent use of wireless access to the Internet. Settlements without a single Internet provider become fewer and fewer, while in practice, all households connected to the Internet have access to at least basic broadband, as more and more households have Internet access of over 30 Mbps. Penetration of bundled services, especially the service including Internet and television determine the changes in the types of connectivity and the greater price affordability – this is probably one of the reasons to observe a significant growth in households having access to the Internet among the most poor households (income group of up to 500 BGN.)

Although Bulgaria remains last in the EU regarding the share of households having Internet access, the speed of internet connectivity is quite high, with the tendency of getting faster and faster. The main obstacles before the Bulgarian households are financial in character, not so much misuse of the Internets benefits or the lack of Internet providers. However, the reduction of prices to access the Internet and access devices, as well as binding Internet access as a bundled service in combination with television, allow even the poorest households to gain access to the Internet.

Continuous development of electronic communications infrastructure in smaller settlements and rural areas could enable these services to reach increasingly higher share of households, regardless of their social and financial status.

[88] In accordance with the methodology used by researchers, the necessary broadband access technologies are: DSL, VDSL, FTTP, standard cable, Docsis 3 cable, WiMAX, HSPA, LTE and satellite. In terms of the speed that they could reach, the above stated technologies are divided into technological combinations: standard broadband access (includes all technologies except satellite), fixed standard broadband access (including DSL, VDSL, FTTP, standard cable, Docsis 3 cable and WiMAX) and new generation broadband access (including VDSL, FTTP and Docsis 3 cable- the technologies that could reach speeds of 30Mbps).Ibid.

V. REVIEW OF THE REGULATORY FRAMEWORK AT A EUROPEAN AND NA, TIONAL LEVEL IN THE FIELD OF HIGH-SPEED AND ULTRA-HIGH SPEED ACCES TO THE INTERNET

In May 2010 the European Commission proposed a five-year plan for deployment of a digital economy, also popular as the Digital Agenda for Europe (DAE)[89].

One of the seven majour objectives of the Digital Agenda (DAE) is provision of high-speed access to the Interned (with download speed of 30 Mbps or more) until the end of the decade for all European citizens. High-speed access may contribute to an intensive growth of economy, creation of jobs, citizens' welfare; to ensure easier access to services and content, in order to faster overcome the crisis. *Europe needs massive provision of high-speed and ultra-high speed broadband access to the Internet at competitive prices.*

In this relation measures have been taken, in order to implement DAE, both at Community and national level by the member-states.

5.1. European Community – Policy Initiatives and Regulatory Framework

For consistent implementation of the DAE objectives, the European Commission takes a series of consecutive actions, by means of Communications and Recommendations.

5.1.1. Communication of 20 September 2010 on the European Broadband Access

The Commission's Communication of 20 September 2010 on the European Broadband Access: to invest in growth, driven by digital technologies[90] proposes a general framework of actions at Community and member-states level, in order to implement the broadband access objectives set out in DAE, and it requires member-states to *elaborate relevant national operational plans*. It reports that the development of broadband networks may be critical without public intervention, that there is a risk for the construction of high-speed broadband networks to be concentrated mainly in some densely populated areas, while remote and underdeveloped areas would remain isolated.

5.1.2. Recommendation of 20 September 2010 on Regulated Next Generation (NGA)[91] Access.

According to the Recommendation on a Regulated next generation access NGA constitutes cable access to networks, which consists wholly or partially of optical elements that have the capacity to provide broadband access services with improved features (for instance higher bandwidth) as compared to those offered by already existing copper networks.[92]

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[89] COM (2010) 245 final/2
[90] COM (2010) 472 final
[91] (2010)/572/EC)
[92] *Remark:* The Recommendation on Regulated NGA Access of 2010 in the future must be also considered in the context of a Recommendation regarding coordinated obligations of non-discrimination and methodologies to

The Recommendation on NGA of 2010 imposes 'maximum pressure' by NRA on undertakings with significant market power by all possible obligations for access to any networks (passive and active) at cost-oriented prices. Most European NRA to a great extent ignored the application of this Recommendation in their practice, which resulted in a variety of approaches to determine access and pricing obligations.

Just the opposite approach is set out in the new Recommendation on Coordinated Obligations of 11 September 2013, which defines that NGA access should be freed from the obligation for cost-oriented wholesale prices, in order to enhance investment flows, only when access is provided on the basis of 'equality at the entrance'[93] – exactly the same products, prices and procedures are proposed to competitors, as the sharing of retail services of the undertaking with significant power in the relevant market. The applied scope of the Recommendation of 11 September 2013 covers both existing and next generation networks, as far as both types of networks could offer broadband services; it is also applied to wholesale markets to access the physical network infrastructure and broadband access

5.1.3. Resolution for the Purposes of DAE to Introduce Broadband Coverage

In July 2011 the European Parliament adopts an unbinding resolution, in which it specifies the DAE objectives for development of broadband access. In this resolution the European Commission is offered to define a speed of 2 Mbps for basic broadband access (unspecified in DAE), to which all Europeans must have access opportunities until the end of 2013. The parliament recommends:

- In 2013 a minimal speed of 2 Mbps in underdeveloped areas and 'much higher speeds' in the key cities;
- Ensuring subscription of 100 Mbps until 2015 for 15% of all households in Europe and establishing conditions to achieve the 2020 objectives;
- 2020. – ensuring coverage of 30 Mbps for all Europeans and 100 Mbps for subscriptions of 50% of all households in Europe.

It should also be pointed out that since October 2011 the work on coordinating the mechanism to connect Europe[94] has started, also popular as „Connecting Europe Facility". The facility covers large-scale actions, mainly in infrastructure spheres regarding deepening European integration and encouraging the development of a digital single market.

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determine costs, in order to encourage competition and improve the environment for investment in broadband infrastructure of 11 September 2013

[93] „equality at the entrance" – exactly the same products, prices and procedures are offered to competitors, as the department of retail services of the undertaking with significant market power in the relevant market – item .6 "g" from Definitions of the Recommendation of 11 September 2013 (C(2013) 5761 final.

[94] The full texts of the proposals are located on the following Internet address:
http://ec.europa.eu/budget/reform/commission-proposals-for-the-multiannual-financial-framework-2014-2020/index_en.htm
http://ec.europa.eu/commission_2010-2014/president/index_en.htm

5.1.4. EU Guidelines Regarding the Application of State Aid Rules in Relation to the Fast installation of Broadband Networks of 26 January 2013

The treaty on the functioning of the European Union settles a general ban on state aid but it also foresees an opportunity for provision/use of public resources to achieve some Community objectives (when state aid is 'compatible/admissible'). The guidelines establish the criteria in terms of which the Commission shall assess compatibility/admissibility of state aid, both for traditional basic broadband and next generation access. In the EU Guidelines on the Application of State Aid Rules in relation to fast deployment of broadband networks of 26 January 2013[95] , the differential approach on state aid was reproduced from the 2009 Guidelines[96] regarding three different areas:

- areas that lack broadband connectivity – 'white areas';
- areas where only one network structure is available – 'grey areas';
- areas where at least two broadband infrastructures operate – 'black areas'

5.1.5. The Recommendation on agreed obligations of nondiscrimination and the methodologies to determine costs

In the Recommendation of 11 September 2013 on agreed obligations of non-discrimination and the methodologies to determine costs, in order to encourage competition and improve investment environment in broadband infrastructure, it is indicated that the establishment of regulated predictability is essential to encourage effective investment and innovations in new and modernized infrastructure, in next generation access.

Taking into account the objectives defined in the above mentioned documents, the National Plan for Next Generation Broadband presents proposals that refer to some elements of the records cited, but they do not encompass all national measures which shall be introduced and implemented at a national level and which arise from the final provisions of the acts. These measures shall be further developed in details in the revised sector policy in the field of electronic communications.

5.2. Bulgaria – State Policy, Legislative and Regulatory Framework

Bulgaria sets out its national strategic objectives, following the Community priorities for the development of the ICT sector. In compliance with the Initiative of the European Union[97] – 'i2010 - Broadband Access for All" and the Community Guidelines on the Application of State Aid Rules related to the rapid deployment of broadband networks[98], a 'National Strategy on Broadband Access Development in the Republic of Bulgaria"[99] has been adopted. It defines the notion 'broadband access' or 'the access that simultaneously

[95] /2013/C 25/01/
[96] (2009/C 235/04)
[97] http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm
[98] http://www.mtitc.government.bg/upload/docs/nasoki_za_burzo_razgr_shirokolentovi_mreji_bg.pdf
[99] Decree № 232 of 28.09.2009

provides voice, data and video services, upon online connectivity at a preferable lower limit of 1Mbps.'

The national strategy has already been updated in response to contemporary pan-European objectives and requirements regarding the time period of 2013 - 2015 [100]and it includes a national operational plan for implementation of the national strategic objectives to develop broadband acceass[101].

5.2.1. The Law on Electronic Communications

The country of Bulgaria regulates basic prerequisites regarding inclusion to the European legislative framework on Electronic Communications and the Community market environment, by the Law on Electronic Communications (LEC) which came into force of 22 May 2007 and the provisions on its implementation. LEC harmonizes our national legislation with the European Regulatory Framework on Electronic Communications of 2002/2009.[102] by taking into account the specific national features that refer to competition and technological development. This regulation has achieved:

- Synchronizing the legal and regulatory framework regarding liberalization of the electronic communications market and accelerating integration processes in Europe's digital single market and supply of cross-border networks/services;
- Consecutive application of the principles of stability, transparency, subjectiveness, predictability, equality and proportionality;
- Clear defining the functions and powers of state authorities that implement state governance in the sector;
- Comprehensive definition of the functions and competences of the Communications Regulation Commission (CRC) as the independent state authority to regulate and control electronic communications in the country and its relations with other national regulators;
- Defining the general requirements[103] to enter the market of public electronic networks and services, as well as the specific terms and conditions to provide permits for efficient use of limited national frequencies and numbering resources;

[100] http://www.mtitc.government.bg/upload/docs/AktualiziranaStrategia.pdf
[101] http://www.mtitc.government.bg/upload/docs/NacionalenOperativePlan.pdf
[102] Directive 2002/21/EC of the European Parliament and the Council of 7 March 2002 on the general regulatory framework for electronic communications networks and services (framework Directive), Directive 2002/20/EO of the European Parliament and the Council of 7 March 2002 on the authorization of electronic communications networks and services (Authorization Directive), Directive 2002/19/EO of the European Parliament and the Council of 7 March 2002 on the access to electronic communications networks, their infrastructure and the interconnectivity between them (Access Directive), Directive 2002/22/EO of the European Parliament and the Council of 7 March 2002 on the universal service and users rights related to electronic communications networks and services (Universal Service Directive), Directive 2002/58/EO of the European Parliament and the Council of 12 July 2002 on processing personal data and protecting the right of personal life privacy in the electronic communications sector (Privacy Directive), Directive 2002/77/EO of the Commission of 16 September 2002 on the competition in the markets of telecommunications networks and services (Competition Directive), amended respectively by the Directive 2009/140/EO of the European parliament and the Council of 25 November 2009 on better regulation and Directive 2009/139/EO of the European Parliament and the Council of 25 November 2009 citizen's rights.
[103] http://crc.bg/files/_bg/Public_Internet-2.pdf

- Establishing procedures to define, analyze and evaluate the relevant markets of networks/services that are subject to ante-regulation to impose specific obligations on enterprises with significant power in these markets (with dominating position), in order to provide conditions for efficient competition;
- Improving the legal model to protect citizen's interests – end users of public electronic communications services, as a component of the common European policy on services of public interest;
- Establishing a special legal framework regarding the rights to use property in developing public electronic communications networks.

An indisputable **achievement of** this legal framework is the provision of ***legislative stability, predictability and equality, 'better regulation'***[104] for competitive electronic communications and completion of a functioning single market, priority protection of citizens.

5.2.2. Legal and Regulatory Aspects to Implement the National Strategic Objectives for Rapid Development of NGA

Legislative and regulatory aspects shall focus on the implementation of the national strategic objectives for rapid development of high-speed and ultra-high speed next generation broadband access in the country (NGA)

- Entering the electronic communications market[105];
- Regulating competition in the 'wholesale' broadband access market and related markets;
- Property rights for development of electronic communications networks and infrastructure.

The convergence of electronic communications networks, services and technologies set the requirement of technologically neutral regulation and imposed regulation of ***universally valid, open and free legal order*** to implement similar communications activities and services, regardless of the technologies used. This significantly alleviated legal order to start the provision of electronic communications networks and/or services promotes the development of these services and creates an opportunity for undertakings and users to benefit from economies of scales of the single market. The only permission to

[104] 'Better regulation' is understood as simplifying and improving the quality of regulation, by means of: ongoing reduction of sector ex-ante regulation, where market development allows – '50 % reduction of regulations and focus on broadband competition', simplifying the procedure to define, analyze and evaluate market and identify an operator with significant impact in the relevant markets and imposition, continuation, modification and removal of special obligations, as well as with repetitive examination of these markets (article 7 of the Framework directive), application of new ex-ante measures, such as functional and/or structural separation, co-sharing of passive infrastructure.

[105] LEC helps to overcome a number of legal and regulatory bariers for the legislative establishment of the complete liberalization of the sector, after phased optimization and removal of some licensing regimes. The implementation of public electronic communications starts under general requirements for certain measures and /or services and it is only bound by a written notification of CRC regarding starting up an activity according to the generally established and familiar in advance terms and technical requirements, without the need of explicit subsequent sanction/approval by the administrative authority; issuing permits by the regulator only in cases when provision of certain electronic communications networks and/or services is a subject to the use of individually allocated frequency and/or numerical resources by the patrimony of the Bulgarian state.

make electronic communications is required in cases when an individually specified scarce resource is necessary, which is limited due to natural particularities or technical reasons – numbers of the National Numbering Plan and addresses, as well as radio-frequency spectrum.

5.2.3. The Law on Electronic Communications and the EU, the Law on Spatial Planning and the Acts on their Application

The development of electronic communications networks and related infrastructure is implemented in accordance with LEC, the Law on Spatial Planning (LSP) and the acts on their application. Depending on the characteristics, significance, complexity and exploitation risks, constructions of electronic communications networks fall from III to VI category, under article 137 of LSP and Ordinance № 1 of 30 July 2003 on the nomenclature regarding the types of constructions[106]. According to the location/scope of networks, investment projects for their construction are being coordinated and approved by one or more municipalities, respectively one or more areas. This certainly creates serious difficulties on the spot, given the difference in approaches, qualification and pace of work in different municipalities or areas.

The Law on Electronic Communications consistently developed operating mechanisms to attract investment for the construction of electronic communications infrastructure - the most significant tangible prerequisite to achieve effective infrastructure competition, for knowledge-based economy.[107]

‘Promoting investment in infrastructure and stimulating innovations has been raised as one of the objectives of art 4 of LEC.

The rights of each undertaking that provides public electronic communications networks and services to construct, use and control electronic communications networks and facilities is explicitly settled among one of the 4 majour rights, arising from art. 74 of the Law. This right is further supported by:

- ***easement***, established under art. 287 – art. 294;
- ***the right for special use of roads***, under art. 295 – art. 298;
- ***the right to use*** linear engineering networks of transport, water supplies and sewage, electricity supplies, distribution of electricity, gas supplies, hydro-meliorations[108], including their easement areas, of water and irrigation facilities and natural water pools – public ownership, under art. 295 – art. 298, which for undertakings arise yet along with notifying CRC regarding the provision of electronic communications networks and/or services. Through legislative settlement of these scarce real rights which gained popularity under the common name ‘right of way”[109], the Bulgarian law meets the requirements of ECPP 2002/2009. This legislative framework is entirely in the spirit of the recommended by the European Commission measures on establishment of optimal legal and administrative alleviations to stimulate investment in deploying high-speed and ultra-high speed next generation broadband access.

[106] Prom. SG, Number .72/2003, amended and supplemented. Number .23/2011 and Number .98/2012
[107] Lisbon Strategy
[108] Within the meaning of § 5, item 31 of the Law on Spatial Planning
[109] ROW – Framework Directive, Authorization Directive

The construction of duplicating backbone electronic communications networks at a national, as well as local level (backhaul) are a distinctive characteristic feature of the Bulgarian communications market, despite the relatively low demand/consumption[110]. The last amendments and supplements of LEC seek solutions to alleviate the procedures on coordination and approval of investment projects related to communications networks, issuance of construction permits and reduction of the corresponding deadlines, in order to overcome the regulatory barriers ahead of the accelerated development of networks, including settlement of measures to promote construction of next generation broadband access networks.

- art. 281, para. 4 of LEC introduces instructional deadline of up to 6 (six) months to approve an investment project, including.a complex project regarding an investment initiative and issuance of construction permit for public electronic communications networks, facilities and related infrastructure, from the date of submitting the investment project/initiative by the undertaking that provides public electronic communications networks and/or services.
- Competent authorities are obliged to consider in one-month period requests for provision of rights to install facilities and related infrastructure for public electronic communications networks.
- Public authorities are forbidden to set additional requirements related to the activities of planning, constructing, bringing into operation and maintaining electronic communications networks and facilities, which are contrary to LEC, LSP or other special laws or regulations for their implementation.

Municipal administrations play the crucial role to coordinate and approve investment projects. They intersect the entire information for the future constructions of technical infrastructure (transmission lines (networks) and related facilities of water supplies, provision of energy, electrification, heating supplies, gas, electronic communications and other community activities) in the territory of each municipality. In these cases every municipal administration exercises two of its powers:

- Establishing a real right to use immobile property, private municipal property, under the Municipal Property Act (MPA); and
- Coordinating and approving investment projects and issuing building permits, as well as the other acts to conduct civil works, including issuing a permit or certificate to bring into operation and usage, in accordance with LSP.

When coordinating/approving any projects related to building and majour repairs of infrastructure sites, municipalities can set objective and transparent, equal conditions to the corresponding operating utility service companies, to ensure access for construction of broadband access communications networks (NGA) in the territory of the corresponding municipality.

For the implementation of EUROPE 2020 strategic objectives, LEC settles additional powers of CRC which:

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[110] This consequence may constitute an essential reason for non-admission for state aid, as being incompatible with art. 107, paragraph .3 of TFEU.

- ***May*** impose on all undertakings that provide public electronic communications networks and/or services, ***co-location/or co-use of electronic communications infrastructure facilities***, i
- It can require from undertakings that provide public electronic communications networks and/or services, to provide the necessary information for the preparation of a detailed description of the nature, availability and geographical location of their electronic communications infrastructure, when it is unavailable for collection via official channels.

The legislator explicitly provides ***free*** use of bridges, roads, streets, pavements and other property – public municipal property, for making and maintenance of electronic communications networks of undertakings that provide electronic communications networks and/or services (art. 295, para.7 of LEC). Thus, a considerable financial resource that must be provided for the use of public municipal property shall no longer be considered as one of the structure barriers before network development. It is supposed to enhance private investment interest. This essential legal prerequisite for deploying next generation broadband access could be supplemented if necessary by a lsimited public financial resource.

5.2.4. Regulatory Acts on the Implementation of LEC in Order to Stimulate the Rapid Development of Broadband Networks

The regulatory acts on the implementation of LEC, which directly develop and supplement the legal framework and have significance for the stimulation of the rapid development of broadband networks are:

- Ordinance № 18 of 3 June 2005 on the contents, terms and conditions for establishment and maintenance of specialized maps and registers regarding the telecommunications infrastructure[111] deployed by operators.

The Ordinance is fundamental for the creation of the database about the existence and parameters of electronic communications networks in the country and they will serve to create an actual map regarding the penetration of basic and ultra-high speed broadband access (NGA), population coverage and the use by households. It is planned to analyze the synchronization of the ordinance with the Guidelines on State Aid of 2013 and Directive 2014/61/EU of the European Parliament and the Council regarding the measures to reduce costs for deployment of high-speed electronic communications networks (OBL 15523.05.2014).

- Ordinance № 1 of 19 December 2008 on the terms and conditions of implementing access and/or interconnection[112]

[111] Prom. SG, Number 53/2005
Prom. SG, Number .63/2009
[112] IProm. SG, Number .5/2009

The regulatory act sets the regulatory framework and applicable structure elements for the implementation of various types of access to interconnect networks of various architectural network levels. After the liberalization of the Bulgarian communications market in 1992, this is the second ordinance that regulates interconnectivity conditions of public electronic communications networks, developed in the spirit of the Access Directive[113] of the European Regulatory Framework 2002/2009. Between the he regulator and operators on the one hand, and on the other among the very operators lasting relationships have been established regarding the implementation of access and interconnection. These relationships are subject to regulation, they are associated with imposing specific obligations due to the existence of undertakings with significant impact on the relevant markets[114].

- Ordinance № 5 of 23 July 2009 on the terms and conditions to determine the amount, location and the special regime of governing the easements of electronic communications networks, facilities and related infrastructure[115].

It regulates the size, location and specific terms to exercise the rights of established easements for various types of electronic communications networks, facilities and related infrastructure. At this stage it is recommendable to examine the efficiency of the implementation of the Ordinance, since as a result of the analysis, if necessary changes and supplements will be offered. If necessary, changes could be proposed to amend or supplement the act, with view to more accurately achieve the objectives.

- Ordinance № 35 of 30 November 2012 on the rules and regulations for design, construction and bringing to operation of cable electronic communications networks and related infrastructure[116]

This Ordinance sets the requirements regarding cable electronic communications networks and related infrastructure in accordance with LSP and special laws. Settled by it rules and norms of design, construction and bringing into operation the indicated elements of the technical infrastructure are applied within urbanized areas and outside these. This act by means of the established unified requirements assists operators' efforts to cope with the different practice and competence of local administration.

In the market analysis of markets 4 and 5[117], we must also take into account the trend that outlines the European Commission's (EC) draft Recommendation on reducing the corresponding markets that are subject to *ex-ante* regulation[118]. In particular, a new definition of broadband markets has been proposed, due to two factors: 1) differences in the needs of retail customers, such as citizens, small and medium-size enterprises (SME), compared to corporate users; and 2) stronger focus on functionality with access regimes,

[113] Directive 2002/19/EC on the Access to Electronic Communications Networks and Their Infrastructure and Interconnectivity
[114] Markets 1, 2, 3 under the Recommendation of EC 2007/879/EO of 17.12.2007
[115] Prom. SG, Number .63/2009
[116] Prom. SG, Number.99/2012
[117] Markets 4, 5 under the Recommendation of EC 2007/879/EO of 17.12.2007
[118] http://ec.europa.eu/digital-agenda/en/news/draft-revised-recommendation-relevant-markets

rather than on technological implementation means, which is associated with the migration from copper networks to optical NGA access.

The Commission emphasizes that the needs of broadband access for citizens and SME-s are met by standardized products that are sold in packages with other services (usually voice). Providers meet these needs by using a rich variety of competing technological products, including. NGA, cable, DSL, WiFi, fixed wireless radio, mobile services. At the same time corporate users have higher requirements for speed, quality, often a guaranteed level of service etc. The Commission reports that wireless and mobile technologies still fail to meet such requirements.

While the previous analysis was based on the difference between the physical (unbundled access to the local loop) and the non-physical (bitstream) access, now the EC focuses on the functionality that various possible means have for access and especially for the terms and degree of control, offered to access-seekers. In fact, the migration from copper to optical fixed networks caused a situation where existing regulatory obligations may not be effective in the future. It is mainly true in cases when unbundled access is no longer possible (for instance optical PON networks) or it is uneconomical (at the sub-loop level).

Due to the above listed considerations the EC proposes to distinguish three wholesale broadband markets, based on the following criteria: 1) high quality, sought by corporate users; 2) location of the transmission point; 3) basic transmission functions offered; and 4) flexibility in differentiating services for access seekers. The proposed markets are:

- for local wholesale access that allows more control by the user; access is provided in the local exchange or closer; sufficient control, so that this access functionally substitutes unbundled access to the local loop;
- for central wholesale access, not so direct, with a standardized control level by the user; access is implemented at a regional or national level;
- for high-quality wholesale access, guaranteed supply/availability with high quality services; high quality network management, including the backhaul part; connection to the network in points, mainly connected to businesses, not to the mass user.

According to the EC, at present there are no effective prerequisites to define a separate backhaul infrastructure market.

5.3. Broadband Market Analysis

In accordance with the European Regulatory Framework 2002/2009, LEC introduced in sector regulation, notions, categories and principles of the competitive right, as a gradual transition from the dominant *ex-ante* sector regulation to *ex-post* general competitive regulation, in order to guarantee that preventive regulation applies only in cases when competitive right is not sufficiently efficient to ensure loyal competition in the electronic communications market.

The regulatory process in analyzing and evaluating the relevant markets is conducted in accordance with the principles of lawfulness, transparency, publicity, consultativeness, equality, proportionality, technological neutrality in terms of networks and electronic communications services with reduction of regulatory intervention to the minimum necessary level.

In order to define, analyze and assess the markets of electronic communications networks and/or services at a national level, we apply the provisions of LEC and the Methodology on the terms and conditions to define, analyze and assess the relevant markets and the criteria to identify undertakings with significant impact on the market[119]. In periods of three years CRC identifies the corresponding markets of public electronic communications networks and/or services, susceptible to *ex-ante* regulation, it examines, analyses and evaluates the efficiency level of competition for the relevant markets and if a lack of efficient competition is found out, it identifies undertakings with significant impact on the corresponding market, in order to impose, continue, amend or abolish specific obligations of these undertakings.

The relevant markets of public electronic communications networks and/or services, where effectiveness of competition is evaluated, are 'wholesale' or 'retail markets that have a product and geographic dimension. The relevant market of a certain product/service includes all those products/services that are mutually substitutable or replaceable to a sufficient degree not only in terms of their objective characteristics which are particularly appropriate to satisfy the constant customer needs, due to their prices or purpose, but also because of the conditions of competition and/or the structure of demand and supply in this market. After identifying the relevant product market, its geographic dimension is also defined. The geographic market encompasses a certain area where the corresponding interchangeable public electronic communications networks and/or services are supplied and where competitive conditions are equal and they differ from these in adjacent geographic regions. Geographic markets can be local, regional, national or covering the territory of two or more countries (for instance Pan-European markets, markets that coincide with the territory of the European Economic Area or global markets).

The aim of the analysis and evaluation of the relevant market of services is NRA to identify the existence or lack of efficient competition, that is, to find out if there are undertakings with significant impact on the corresponding market. Undertaking with significant market power is an enterprise that alone or jointly with others benefits from a position that is equal to dominance, that is, it has the economic power which enables it to act to a significant extent independently of competitors, consumers and end users. In order to designate a certain enterprise as an undertaking with independent significant impact on the market, CRC identifies its market share in the relevant market and all or some of the criteria, set out in the Methodology. Only after evaluating the lack of effective competition in the corresponding market and existence of an undertaking with significant impact on this market, CRC has the competence to impose, extend or amend specific, proportional particular and justified measures, if necessary. When based on the relevant market analysis, existence of efficient competition is found, the Commission does not impose specific obligations on undertakings that provide public electronic communications

[119]Methodology on the terms and conditions to identify, analyze and evaluate the relevant markets and the criteria to define undertakings with significant market power (Prom. SG. Number.89 of 13 November 2012)

networks and/or services in the corresponding market, and if such have been imposed for a previous period, it amends or abolishes them.

CRC has made assessment and analysis of the 'wholesale' broadband access market finding out that this market lacks effective competition. In order to encourage effective competition and sustainable development of the 'retail' broadband market, conditions must be created at the 'wholesale' market level. It is necessary to promote easy penetration of new entrants in the 'retail' broadband market, to improve the competitive environment, in order to alleviate alternative enterprises (AE)[120] in providing access to electronic communications networks and infrastructure that are not susceptible to duplication. An additional measure in this respect is to impose an obligation for access to passive (physical) infrastructure, such as the channel network of the undertaking with significant market power.

This means of regulatory intervention is consistent with the Commission's Recommendation of 20 September 2010 on Regulated Access to Next Generation Access Networks (NGA)[121]. Given the characteristics of the national market, imposition of an obligation to access underground duct network is essential for the unobstructed way to reach end users, by purchasing 'wholesale' access services.

CRC can identify the relevant market (sub-market) for provision of 'wholesale' broadband access, susceptible to ex-ante regulation based on a test with cumulative application of three criteria:

- existence of high and non-transitional structures[122], legal or regulatory barriers to enter the market;
- lack of opportunity to promote and develop competition in the market for up to two years ahead; Since it is necessary the analysis on existence of effective competition to report future development, the relevant market is defined by evaluating anticipated or hypothetical technological or economic changes within a reasonable future period of time.
- Insufficient effectiveness of the competitive right to overcome market entry barriers and provide conditions for competition on the relevant market. *Ex-ante* sector-specific regulation applies to provide additional preventive pressure.

After conducting the three criteria test, CRC arrived at the conclusion that the 'wholesale' broadband market is only restricted to bitstrem access and it is susceptible to *ex-ante* regulation with a time horizon of 2 years.

Based on the market analysis, CRC identified an undertaking with significant impact on the 'wholesale' broadband market. Therefore, in order to overcome competitiveness issues, *ex-ante* regulation is necessary as prevention against possible actions of this undertaking, aimed at applying pricing and non-pricing discriminatory techniques regarding

[120] The undertakings that enter the market after the liberalization of the sector.

[121] The Commission's Recommendation of 20 September 2010 on Regulated Access to Next Generation Access Networks (NGA).

[122] Structural barriers for market entry are such barriers that as a result of necessary initial costs or conditions of demand, create unequal conditions between undertakings with significant market power and new undertakings entering the market that hamper or prevent market entry. Legal or regulatory barriers are barriers that are not based on economic conditions but a result of legislative, administrative and other state measures, which to some extent restrict access to the market of potential competitors or their future behaviour.

undertakings that seek access to network (passive and active) infrastructure or broadband access in providing services to end users. CRC determined that the SMP undertaking on this market must be imposed with special obligations that are consistent with the nature of the service.

The above description represents the existing regulated market for 'wholesale" broadband access provision in the territory of the country, in accordance with LEC, the Methodology on the terms and conditions to define, analyze and assess the relevant markets and the criteria to identify undertakings with significant market power, In taking any actions regarding public support (other than private investment) for the development of territorial deployment of 'wholesale' and 'retail' broadband access service, there must be taken into account the effects of sector regulation conducted by CRC, the behaviour of the undertaking with significant impact on this market and the possible violations or restrictions of competition that could arise in separate regions.

5.4. Proposals on Amendments in Current Legislation

Proposals for amendments in current legislation, aimed at regulating the rapid development of broadband networks, must be made only after profound investigation of effectiveness of applying the existing legislative and regulatory framework, which shall underlay the process of updating sector policy in the field of electronic communications (in force of 2015). Only then the corresponding amendments and supplements of LEC and/or LSP and the regulations for their implementation can be proposed. An appropriate regulatory framework was established, in order to stimulate investment in networking. Its effective implementation must be achieved by state and municipal administrations, stakeholder trade companies and coordinating organizations.

Additionally, appropriate legislative decisions in LEC, LSP, the Law on Cadastre and Property Register are necessary to ***expand and bind the powers of CRC, the Ministry of Investment Planning and the Agency for Geodesy, Cartography and Cadastre,*** *in order to* collect, maintain and use a database of the specialized maps of companies/operators that operate technical infrastructure (supplies of electricity, water supplies, gas supplies, central heating, road infrastructure etc). In the unit that constitutes ***a unified information access point a*** true minimum information will be submitted about the existence of technical infrastructure or the upcoming development of such; The remaining aspects related to the type of information about the various types of technical infrastructure, the opportunities, terms and conditions of its use will be reviewed in the sector policy in the field of communications.

- ***new EU Guidelines on the Application of State Aid Rules in relation to the rapid deployment of broadband networks, including those of the NGA type will be reflected in the updated sector policy in the field of electronic communications, which outlines the trends and priorities in the sector*.**

Regulatory acts related to infrastructure development, including that of communications, as LSP, could set out requirements in terms of:

- planning the NGA communications infrastructure in developing detailed territorial plans by municipalities;
- involvement in investment projects and complex initiatives on building or repairing technical infrastructure, technical solution for access provision to the passive part the relevant network infrastructure for next generation communications network operators and NGA;
- involvement in projects of new buildings, as well as in basic repairs of existing buildings, building installation project for NGA.

VI. VISION AND NTIONAL PRIORITIES AND OBJECTIVES

The vision of the Republic of Bulgaria set out in the current plan is:

'Encouraging the socio-economic development of the country by creating conditions for Bulgarian citizens and businesses to benefit to the maximum from the opportunities of the developing electronic services based on broadband infrastructure for equal next generation (NGA) access with 100 % (full) coverage of the area'.

6.1. National Priorities until 2020.

Priority 1. Providing the opportunity of equal access to high-speed and ultra-high speed Internet by developing broadband infrastructure, in order to achieve full coverage in the territory of the country at access speed higher than 30+ Mbps.

Priority 2. Promoting the use of services over broadband access networks, so that at least 50% of households and 80% of businesses to subscribe to broadband access exceeding 100 Mbps.

6.2. National Strategic Objectives until 2020

6.2.1. Objectives for the implementation of Priority 1:

- providing next generation access with full coverage throughout the territory of the country;
- developing fixed broadband networks to achieve 90 % access at speed of over 100 Mbps;
- ensuring the opportunity of optic connectivity and broadband access at speeds exceeding 100 Mbps to at least 50 % of the households in the country;
- ensuring the opportunity of optic connectivity and broadband access with speeds exceeding 100 Mbps to all business organizations in the country;
- developing the optic broadband infrastructure with speeds exceeding 100 Mbps connecting all public institutions;
- opportunity of full integration with European optic infrastructures.

6.2.2. Objectives for the Implementation of Priority 2:

- increasing the share of population that uses the Internet and electronic services of up to 75 %;
- increasing the coverage and improving the quality of electronic services in the field of education, healthcare, administration and etc. based on the use of next generation broadband access (NGA);
- facilitating and promoting the use of electronic services through next generation broadband access by businesses;

- enhancing trust in the Internet and electronic services by introducing high standards and security norms.

VII. STRATEGIC OBJECTIVES BY AREAS

7.1. Supplying broadband Access to the Internet

The study conducted by ARK Consulting in 2013[123] regarding the supply side of broadband access to the Internet focusing on high-speed and ultra-high speed Internet access, including rural regions, based on collected, integrated and processed data on the basis of proposed offers by Internet providers and other available public data, enable to evaluate the socio-economic development of settlements. The data analysis on socio-economic development of settlements achieves three main objectives:

- allowing to identify those combinations of socio-economic factors that determine the potential of supplying Internet access in the usual business case (business as usual), that is. without public interference in the investment process;
- identifying geographic areas that are appropriate for public intervention in building broadband structure not only in terms of the requirements for 'white' and 'grey' areas according to broadband Internet access supply, but also in terms of the development potential of these areas with view to their socio-economic indicators;
- allowing to evaluate the performance for Bulgaria of the relevant two indicative objectives of the Digital Agenda for Europe, namely 'coverage for the whole population with >30 Mbps until 2015.' (>30 Mbps coverage for all) and 'broadband coverage for all' since the latter is defined as 'basic broadband'.

The study of supplying broadband Internet access in Bulgaria collects and analyses data regarding the actual state (at the time of the survey) in a national scale and comprehensive for all settlements in the territory of the country in accordance with the Unified Classifier of Administrative and Territorial Units (UCATU), supported by the National Statistics Institute. The database allows integrated data results and corresponding statistic analyses to be introduced by MTITC in the GIS-based systems of the ministry and it allows the opportunity of visualizing the main results of the prepared investigations with view to easier identification of certain trends in various geographic areas. The developed methodology to investigate the supply of broadband Internet access includes as an integral part clusterization (unification) of settlements in terms of key socio-economic and internet-related indicators.

Four thematic groups of indicators evaluate: 1) broadband Internet access coverage, 2) economic development and offering public services, 3) social and demographic development and 4) administrative and territorial division. On the basis of primary indicators a common index of socio-economic intensity has been calculated, which allows to identify the development level of each settlement in Bulgaria in terms of the four thematic groups of indicators. The common index enables on the one hand comparison between separate settlements or groups of them, while on the other hand – it allows to identify the average development level of a given target area, as well as to determine those

[123] Socio-economic analysis on the demand and supply of products and services, based on information and communications technologies and the Internet, on the basis of the indicators set out in the Digital Agenda for Europe, ARC Consulting EOOD, 15.01.2014

settlements of this area that fall below or above that average value. The use of a methodology to calculate a common socio-economic intensity index of settlements allows to make a detailed and accurate picture of the development of settlements and at the same time, it enables a comparative analysis and making groups of settlements in spite of their various socio-economic characteristics.

The common index accepts numerical values from 1 to 10 and it is calculated according to a pre-defined algorithm of a set of empirical indicators. The methodology of creating the index and the organization of the primary indicators in a database on the basis of UCATU, allows aggregation of settlements and recalculation of the corresponding index not only for standard territorial and administrative units (settlement, municipalities, regions, planning regions), but also at the level of rural areas and mountain areas or set target areas.

7.2. Indicators to Assess the Provision of Internet Access

The main indicators to conduct a survey on Internet provision in Bulgaria are the following:

- availability of providers in terms of settlements;
- competitive environment – availability of more than one NGA provider;
- access technologies offered to the end customer, according to the above mentioned definitions;
- types of services offered (unbundled/bundled);
- type of broadband access regarding the speed of Internet connectivity – basic, high-speed and ultra-high speed;
- offer prices by types of broadband access;

7.2.1. <u>General Country Results According to the Data Received at the end of 2013:</u>

- over 86% of the population lives in a settlement where at least 1 provider of basic broadband offers connection with speed of >2Mbps, while the remaining 14% have no access to such service;
- 74.2% of the population in settlements where there is at least one broadband Internet provider offering Internet connection with speed of over 30 Mbps, while 71.6% can use connection with speeds of > 50 Mbps. Significantly lower portion of the population (55.3%) can take advantage of broadband Internet connection at speed of over 100 Mbps;
- 71% of the Bulgarian population is situated in 'black' areas, while 15.4% of the population is located in 'grey' areas, and 13.6% is in 'white' areas;
- 78.2% of the population is in settlements with at least one provider that offers FTTx;
- 13.6% of the population is in settlements with at least one provider that offers high-speed access by means of another technology;
- 8.2% of the population is in settlements without any high-speed access provider

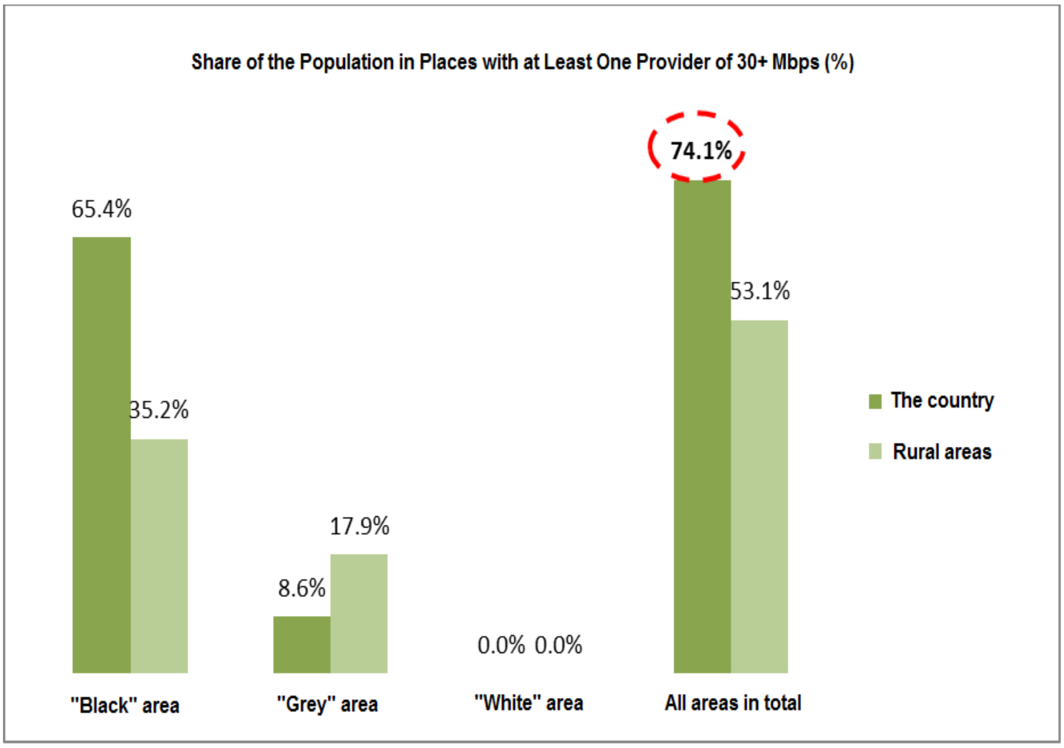

Figure VII.1 Share of the Population in Places with at Least One Provider of 30+ Mbps (%)

7.2.2. Rural Regions Results According to the Data of that Study:

- almost 40% of the Bulgarian population is situated in rural areas, 72% of which live in a settlement where at least one basic broadband provider is available (>2Mbps), compared to 28% without even one such provider. The population in these areas also has lower Internet speed than the average.
- 53.3% of the population has access to connectivity with speeds of at least 30 Mbps;
- 46.9% can use connection of over 50 Mbps;
- hardy 35.5% of the population in rural areas have at their disposal connection with speeds exceeding 100 Mbps;
- rural areas still lag behind in terms of Broadband Internet penetration, since only 40% of the population in these areas is in a ‘black’ area, while respectively 32% and 28% of the population is located in ‘grey’ and ‘white’ areas;

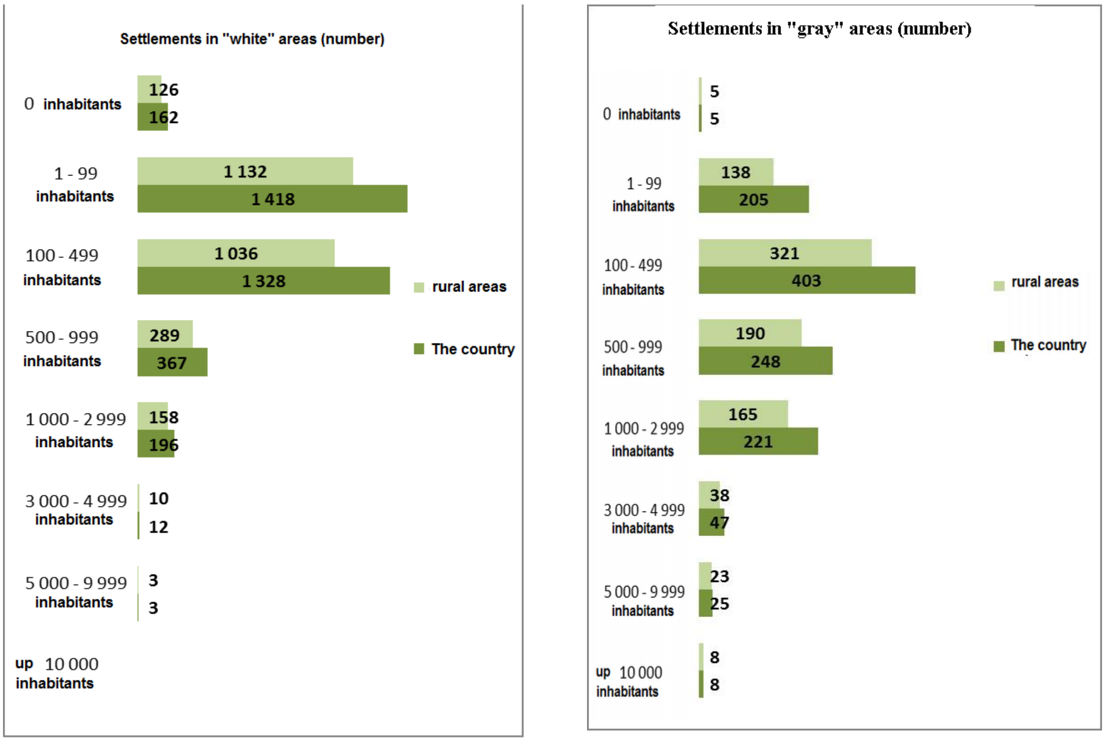

Figure. VII.2 Settlements in White and Grey Areas

- 66% of the settlements in these areas do not have any provider of basic broadband;
- in 22% of these settlements these is at least one provider;
- only in 12% of them there is more than one provider;

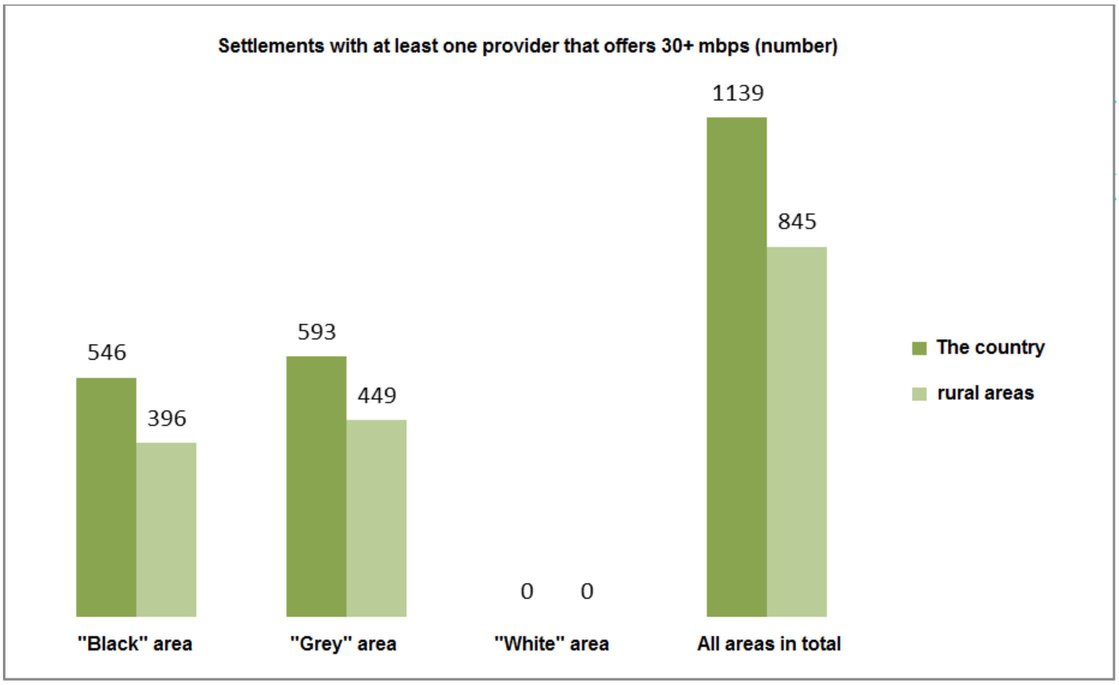

Figure VII.3 Settlements with More than One Provider

- 33.8% of the settlements in rural areas having at least one basic broadband Internet access provider offer connectivity with speeds exceeding 2 Mbps, while

- more than 66% of these settlements have no provider of such service.

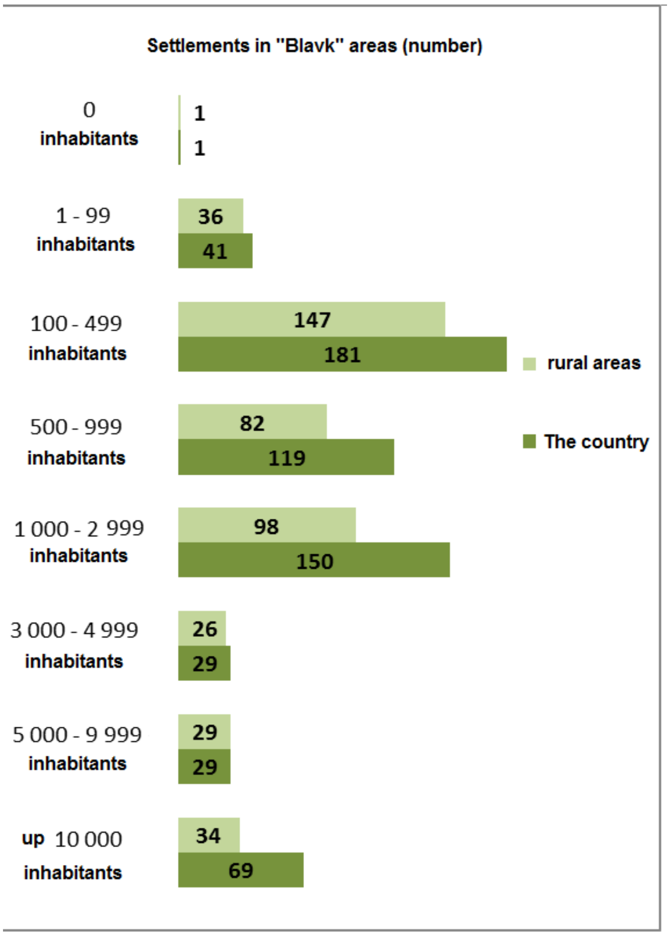

Figure. VII.4 Settlements in Black Areas

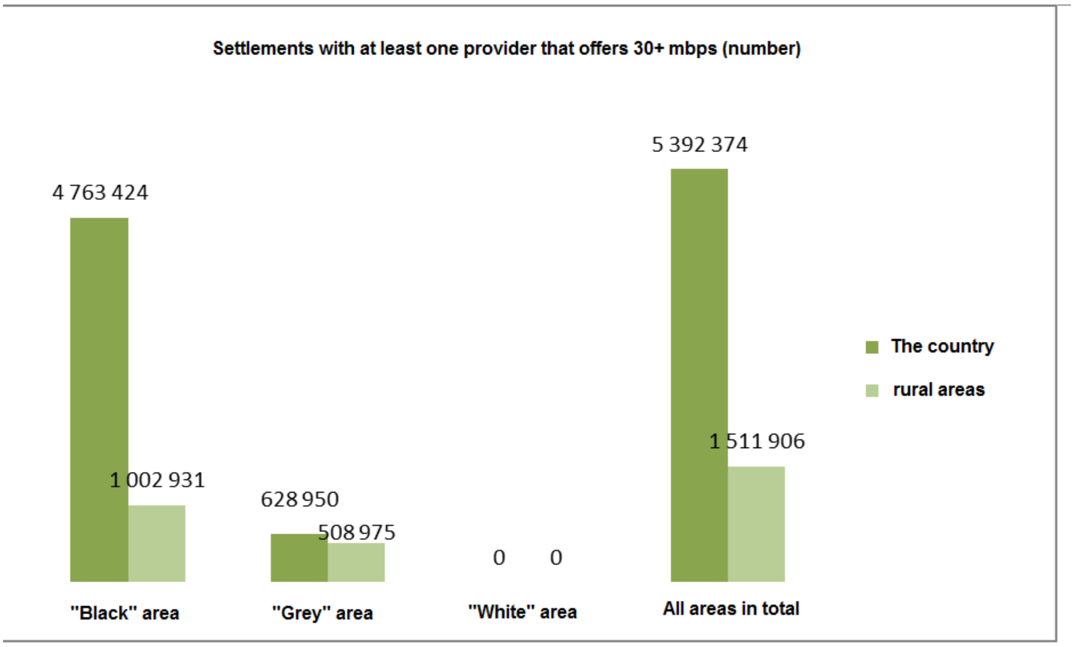

Figure VII.5 Settlements with at Least One Provider of 30 + Mb/s

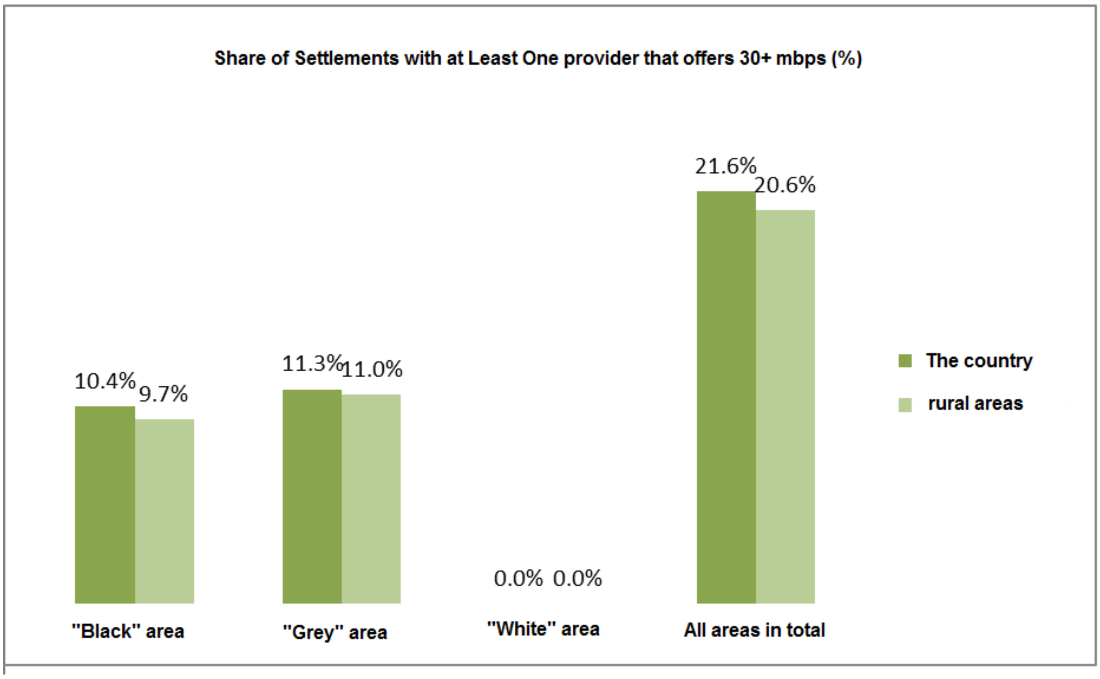

Figure VII.6 Share of the Population with at Least One Provider of 30 + Mbps

In the EU Guidelines on the Application of State Aid Rules related to the rapid development of broadband networks of 26 January 2013, the possible schemes of state aid for ultra-fast broadband networks have also been discussed, providing speeds that are far above 100 Mbps. With such schemes state aid may be approved even for 'black' areas, that is, where there competitive NGA infrastructure exists.

Distinctions have been made between admissive and in admissive state aid, according to the number and type of broadband networks (basic or NGA) in the corresponding area.

- upon the existence of at least 2 broadband networks that provide broadband services on competitive basis (black area). This means: No, to state aid;
- there are no broadband networks and development of such networks is not planned in the next 3 years (white area). This means: Yes, to state aid;
- only 1 broadband network operator, development of another one is not planned in the nest 3 years (grey area). This means that additional assessment is necessary;
- at least 2 NGA networks operate or they will be available in the next 3 years (black area): Do not receive state aid;
- there are no NGA networks and development of such is not planned in the next 3 years (white area): yes, to state aid;
- only 1 NGA network operates or it is planned in the next 3 years and there are no plans for any operator to develop an NGA network in this period (grey area). It means that further assessment is necessary.

7.3. Strategic Objectives Regarding NGA Coverage

On the basis of the target areas analysis and preliminary data regarding basic broadband Internet coverage[124] towards the end of 2012, as well as the identification of settlements in terms of white, grey and black areas, there could be set out the following strategic objectives for the development of key performance indicators by types of areas.

7.3.1. <u>Strategic Objectives for Settlements in a Black Area (with two or more providers offering 30+Mbps):</u>

- development of fixed broadband networks, in order to provide 100 % of the access with speeds exceeding 100 Mbps;
- enabling optical connectivity and broadband access with speeds of over 100 Mbps to at least 65 % of households;
- enabling optical connectitity and broadband access with speeds of over 100 Mbps for all business organizations;

7.3.2. <u>Strategic Objectives for Settlements Located in a Grey Area (with at least one provider that provides 30+Mbps):</u>

- development of fixed broadband networks, in order to provide 80 % of the access with speeds of over 100 Mbps;
- enabling optical connectivity and broadband access with speeds of over 100 Mbps to at least 55 % of all households.
- enabling optical connectivity and broadband access with speeds of over 100 Mbps for all business organizations;

7.3.3. <u>Strategic objectives of settlements located in a white area without any provider, that offers 30+Mbps):</u>

- ensuring next generation broadband access with full coverage in the area;
- development of fixed broadband networks, in order to provide 60 % of the access with speeds exceeding 100 Mbps;
- enabling optical connectivity and broadband access with speeds of over 100 Mbps for at least 34 % of all households;
- enabling optical connectivity and broadband access with speeds exceeding 100 Mbps for all business organizations.

The objectives defined in the National Broadband Infrastructure Plan (NGA) are in accordance with the technological neutralijty principle set out in article 5 of LEC, as the focus is on cable electronic communications networks.

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[124] >= 2Mbps download speed for the end customer

7.4. Strategic Objectives Related to the Development of the Areas

One of the main drivers for the penetration of computers and Internet in the households in Bulgaria for the period 2000-2005 was the demand for entertainment services by children and youths. This model repeats to a great extent at the moment in terms of broadband development in rural and remote areas that fall in a grey of white area. In this sense, other significant strategic aims are related to:

- *pursuing deployment of high-speed next generation broadband access in grey and white areas until achieving the goals set out in DAE;*
- *encouraging creation and use of e-services in their whole spectrum, as well as services related to promoting e-skills both in white and grey area;*
- integrated approach in stimulating the development of broadband Internet access, e-Governance, and e-Health services mainly in grey areas with shares of population in labour active and up to 19 years of age above the average value for the relevant larger area, since the latter two types of services are perceived and used primarily by users that have greater and longer term experience in using the Internert. In addition, part of the planned sector policies in the field of e-Health and e-Governance require guaranteed demand of high-speed Internet access due to the technical requirements of the very services.[125] This will create a specific pooling effect, in order to encourage private initiative regarding the supply of Internet access to end customers in these areas.
- *integrated approach for the development of high-speed broadband accessв in white and grey areas, characterized by levels of economic development and undertaking activity over the average of the relevant larger area*. This means that in these settlements the share of economically active individuals exceeds the average share for the corresponding larger area and broadband access development, including by means of promoting competition – that is turning the grey into black and white into grey or black areas would enable both the emergence of new economic entities and it would facilitate the existing ones. At the same time, the development of specific e-services aimed particularly at businesses – both at the level of settlements or municipality in the relevant white or grey areas and at central level could constitute as a pooling factor to enhance Internet among penetration among business enterprises in the corresponding areas. Thus, for instance, the supply of online services by the Nation Revenue Agency in the last decade and the Registry Agency after 2008 turned out to be among the main pooling factors for enhanced demand and use of broadband Internet among business enterprises and some professional groups (notaries, lawyers).

[125] i.e. the introduction of individual chip-cards containing the patient's health record presupposes enhanced exchange of video data between healthcare institutions, in order to store information from the individual chip-cards in a centralized repository. In the same way, the supply of more GIS-based services – i.e. by the territorial divisions of the Geodesy, Cartography and Cadastre Agency will result in a rapid increase of traffic and the need of at least basic or even high-speed Internet access for the end customer that uses similar services

VIII. INVESTMENT PRIORITIES, INVESTMENT AND FINANCIAL MODELS

8.1. Investment Priorities

Investment Priority 1. *Development of existing cable access networks.*

Until 2016

Increasing line transmission rate by developing HFC networks and upgrading existing FTTN and FTTC networks.

Investment Priority 2. *Building FTTx optical cable access networks.*

1. **In white areas:**
   - building optic cable access networks with speeds of 30+Mbps and 100+Mbps in settlements with population exceeding 500 inhabitants;
   - supporting the entry of providers offering speeds of 30+Mbps and 100+Mbps. in settlements with population of over 3000 inhabitant;.
2. **In grey areas:**

promoting the penetration of new providers offering 100+ Mbps.

Investment Priority 3. *Introduction (development) of wireless NGA technologies*

Until 2020

Application of new wireless technologies and approaches, in order to ensure fast and ultra-fast broadband access in settlements where construction of FTTx networks is impractical or impossible from technological aspect. In these cases, in order to achieve high-speed access wireless technologies (fixed, wireless, broadband) can be used, based on new concepts for innovative spectrum sharing or new cellular infrastructure.

Investment Priority 4. *Development of optical and wireless broadband access connectivity with speeds exceeding 30+Mbps to households ("last mile").*

1. ***In white areas:***
   - in settlements with population of over 3000 inhabitants. Construction of optic cable and/or wireless networks to provide access with speeds of 30+Mbps and 100+Mbps to households;
   - in settlements with population of over 3000 inhabitants. Supporting entering providers, in order to guarantee 'last mile' access to households with speeds of 30+Mbps and 100+Mbps,

2. ***In Grey Areas:***

   - promoting providers to ensure 'last mile' access to households and supplying 100+ Mbps.

3. ***In Black Areas***

- encouraging providers to provide 'last mile' access to all households and supply 100+ Mbps.

Investment Priority 5. ***Development of optical and wireless connectivity for ultra-fast broadband access with speeds exceeding 100 Mbps to business organizations ("last mile").***

1. ***In White Areas:***
   - supporting entering providers that offer speeds of 30+Mbps and 100+Mbps in providing 'last mile' access to business organizations;
   - building optical cable networks to guarantee access with speeds of 30+Mbps and 100+Mbps. to business organizations;

2. ***In Grey Areas:***
   - stimulating providers to improve speeds or construct new FTTC and/or wireless networks to provide 100+ Mbps. access to the "last mile" to business organizations.

3. ***In Black Areas***
   - encouraging providers to offer 100+ Mbps. by ensuring FTTB access for business organizations.

Investment Priority 6. ***Development of optical ultra-fast broadband access connectivity with speeds exceeding 100 Mbps to public institutions in the country ("last mile").***

1. ***In White Areas:***
   - supporting entering providers that offer speeds of 100+Mbps to ensure 'last mile' access for public institutions, including municipalities, town-halls, schools, health centers, courts, police stations etc.;
   - in settlements with population of under 3000 inhabitants, building optical cable networks to provide access with speeds of 100+Mbps to public institutions, including town-halls, schools, health centres etc;

2. ***In Grey Areas:***
   - promoting the provision of 'last mile' access with speeds of 100+ Mbps for public institutions, including municipalities, town-halls, schools, health centres, courts, police stations etc;
   - building optical cable networks to provide 'last mile' access with speeds of 100+ Mbps for public institutions, including municipalities, town-halls, schools, health centres, courts, police stations etc.

3. ***In black areas***
   - encouraging providers to provide 100+ Mbps access for public institutions, including municipalities, town-halls, schools, health centres, courts, police stations etc., by constructing entirely optical FTTB networks.

8.2. Evaluation of Investment Costs to Implement Investment Priorities

On the basis of the data obtained from the ARC Consulting surveys of 2013 concerning broadband access deployment in our country, the data regarding population and coverage of settlements in terms of areas, calculations have been made indicating that it is necessary to invest approximately 234 million BGN in the white areas, in order to achieve the above mentioned priorities and 54 million BGN for the grey ones. Calculations apply generally accepted average cost norms to construct the corresponding networks, including design, delivery of equipment and materials, building and installation, bringing to operation. Operational costs are not included.

Calculations have been made according to the following assumptions:

1. Implemented project on high-speed broadband access for 29 municipal centres and 24 settlements until 2015. Except the listed municipalities fast Internet access optical networks, the following 24 settlements will also be included along the roads from the area town to the municipal centre.
2. Out of 3486 settlements classified as 'white areas', 2754 are located in rural areas.
3. Out of 1162 settlements classified as 'grey areas', 888 are located in rural areas. In 593 of the settlements in grey areas there is supply of access with speeds of over 30 Mbps by at least one provider, as 449 of them are situated in rural areas.
4. Provided access as follows:
    - For settlements with population up to 100 inhabitants, connectivity is provided through radio-relay systems that ensure speeds of up to 300 Mbps.
    - For settlements with population from 100 to 3000 people optical infrastructures of mixed type topology (linear, star) are being established
    - For settlements with population of over 3000 people optical star topology infrastructures are being developed.
    - Development of connectivity is not studied in 'the last mile'

8.3. Investment and Financial Models

Investment in constructing next generation access networks have strategic significance. In spite of the long-tem benefits from high-speed broadband access, the successful business case for this purpose, especially at general national level is a challenge: governments and industry must work together. Intervention of public funds in the investment process shall be applied carefully in accordance with the EC principles set out in the 'EU Guidelines for the Application of the State Aid Rules, in relation to the rapid development of broadband networks' of January 2013. Public investment in NGA networks would be admissible in case of:

- When in the corresponding area/region there is no operator that offers digital services over NGA networks;
- When in the corresponding area/region there is only one operator that offers digital services over NGA networks;
- When in the corresponding area/region there are at least two competing operators that offer digital services over NGA networks, but other specific conditions are in place.

From the practice so far, five **major** investment macro models and approaches in construction of next generation optical networks (NGA) can be derived:

1. Private investment in networks beyond the scope of the regulatory intervention.
2. Limited, complementary public/private investment by the Incumbent as a leader.
3. Limited, complementary state/public investment by private operators.
4. Completely state/public investment by a state enterprise to build and support the network (ESMIS).
5. Private investment in networks subjected to strong regulatory intervention.

Here the level of public investment is identified on the basis of the country's participation as an investor/operator. The level of regulatory control is defined on the basis of the obligations that are imposed on the operator and the type of the selected way of sharing infrastructure. The regulatory intensity in these models may vary from low to high depending on situational factors.

8.3.1. Scale and Characteristics of Investment Macro Models

8.3.1.1. Level of State/public Investment

- Investor – the majour investor in the network (provides the majority of the funds to construct the network),
- Operator – the majour operator of the network. The operator deals with various issues concerning network sharing and develops one such sustainable efficient network.

8.3.1.2. Regulatory Intervention Intensity

Varieties of infrastructure co-sharing – the infrastructure owner may cover various layers of the network hierarchy and provide access to them to other participants.

8.3.1.3. Roll-out Strategy

Obligation of the infrastructure owner, in terms of infrastructure co-usage. The infrastructure owner may be obliged by means of regulatory measures to open its infrastructure to other participants (unbundled access).

8.3.2. Situational factors/indicators defining the sellection of strategy and priorities regarding construction and development of an NGA network.

Each country represents a unique selection of situational factors that require specific national solutions, in order to make an optimal balance of investment, operational and market approaches:

- demographic – Description with view to the size of area, density, % of urban population, demand and supply of services over broadband access networks;

- historically dominating technology – the Incumbent's market share on the market of fixed broadband networks and services;
- infrastructural competition;
- regulatory measures in the markes of wholesale broadband services, in order to obtain the optimal balance of investment, operational and market model.

None of the models is only correct or wrong. Each model is applicable and efficient according to the specific factors of the country and/or regional factors. The right understanding itself of strong and weak sides of each particular model is the foundation to create the national policy.

Countries that construct NGA, using various models have achieved various coverage towards December 2012:

- Lithuania - 100% coverage (HHp), 30.8% subscription of households (HHc), Model 2
- Singapoore – 95% HHp, 22.3% HHc, Model 3
- Japan – 90% HHp/42.5% HHc, Model 2
- Latvia – 61.2% HHp/12.1% HHc, Model 2
- Bulgaria – 53.7% HHp/14.7% HHc,
- Portugal – 51.8% HHp/10.1% HHc, Model 3
- France – 22.4% HHp/3.4% HHc, Model 3

Underdeveloped nations in terms of NGA construction:

- The USA– 19.0% HHp/9.5% HHc, Model 1
- Austria – 5.4% HHp/0.5 HHc, Model 5
- Germany – 2.7% HHp/0.5 HHc, Model 5

From the above examples it could be seen that strong regulatory intervention usually results in lagging behind in NGA network development. Although it is obvious that strong regulation without public/state support is unfavourable, it may be pointed out that most of the leading nations in terms of optical connectivity have active regulatory authorities and efficient regulatory framework in place. The leading NGA development countries have established conditions to stimulate private investors by applying Model 3 – *Complementary state/public investment by private operators.*

8.3.3. Key Factors for Successful Implementation

There are 5 key factors for successful NGA deployment within the territory of the whole country. They in turn shall be well adjusted to and complied with the specific requirements and conditions in the country. These areза:

8.3.3.1. Existence of National Broadband Access Plan

- Based on a socio-economic analysis, based on sustainable building and operational models.
- With objectives set out according to the situational factors which shall be implemented and measurable.

- Focusing on the level of NGA coverage, quality and level of services, in order to promote innovation in providing digital services and service.

8.3.3.2. Existence of differential and flexible regulation

- It should be based on demographic data (i.e. population density/level of competition), rather than by kind/type of operators.
- In regulation mode –the type of regulation should be taken into account (i.e. in terms of price).

8.3.3.3. Availability of public funding and promoting the consumption of digital services

- Based on socio-demographic factors and private investment plans – i.e. funding for commercially unattractive areas.
- By the use of complementary funding sources (European funds, national, regional).
- With measures that stimulate the demand of digital services.

8.3.3.4. Availabiligy of business cooperation and stakeholders - users, operators, regulator, central and local authorities.

- By promoting cooperation (i.e. co-investment and use of infrastructure) between telecommunications operators and between them and the other participants of the utility sector.
- By developing regionally differentiated models (for public-private partnership, for shared investment).

8.3.3.5. Availability of other requirements to participants and stakeholders for efficient spending of public resources such as:

- Minimizing regulatory intervention for selected areas, in order to achieve a network with ‘protected future’.
- Laying optical fiber in building and/or basic repair of technological infrastructure, for community services, building complexes, railways etc.
- Designing NGA networks in new buildings and repairs of such, for future infrastructure.
- Demanding standartization of network technologies – applying standards for open networks (Open Access Networks).

8.4. Public-Private Partnership Models

The Public-Private Partnership model is characterized by minimal regulatory intervention and public funding. Practice shows that public support, implemented by puplic-private partnership models to invest in unattractive areas is particularly effective.

Four main models are well known from practice regarding public-private partnership to invest in next generation access networks, described and systematized in European documents:

1. design, construction and operation of networks by a private investor, including non-profit organizations and/or cooperations (private Design Build and Operate).
2. design, construction and operation of networks, funded by public sources and implemented by a private entity (public outsourcing).
3. design, construction and operation of networks by mixed enterprices (joint venture).
4. design, construction and operation of networks by a an investor with public funds (public design, build and operate).

These models constitute a selection of opportunities to combine public and private investment and offer different levels of participation, commitment and distributed risk for the public sector. Each model is applicable under different circumstances, depending on the scale of necessary infrastructure, specific public sector objectives and the appetite of potential private sector partners in terms of investment/risk.

8.4.1. Public-Private Partnership Funding Mechanisms

Public-Private Partnerships provide potentially effective solutions. As an alternative approach of awarding public procurement, public-private partnerships have been successfully applied in order to implement a number of infrastructure projects. Public-private partnerships have been used to develop transport infrastructure projects, they have successfully been used to build schools, hospitals, courts, prisons, sports facilities.

Public-private partnership shall not be considered only as a method of funding. It could enable the public sector to transfer the risk and speed up the deployment of necessary infrastructure that service providers require to be available in place before they wish to provide broadband services to retail customers and business clients. Public-private partnership has the advantage that the degree of private sector participation and the funding commitment can be adapted so as to meet the specific requirements that exist for the corresponding region. There is no obligation to have one single solution that is good in all cases. The control level that public sector shall retain will differ in various cases. Public-private partnership provides the opportunity of applying projects with appropriate scope and accelerated time schemes by ensuring that public resources will be used in the most effective and efficient way, while promoting at the same time the greatest possible involvement of the private sector, especially in risk sharing. In the examples described public-private partnership takes various forms and uses different funding models. In each case the project differs in terms of the risk transfer level and the financial participation of the private sector.

Examples of this are the seven surveyed cases indicated in

Table VIII.1, described in the report of EPEC (European PPP Expertise Center) „Broadband: Delivering next generation access through PPP“, which demonstrates how various PPP models can be used.

Table VIII.1 Use of Different public-private partnerships

Project	Private DBO	Public outsourcing	Joint venture	Public DBO
Superfast Cornwall, UK				
Asturcon, Spain				
Metroweb, Italy				
Auvergne, France				
Progetto Lombardia, Italy				
MAN Project, Ireland				
Shetland Interconnect Project, UK				

8.4.2. *Comparison of the Four Public-Private Partnership Models*

The majour base to compare different models is the decision-making mechanism shared between the public and private sector. The common characteristic feature they have is that the public sector settles the necessary infrastructure, before private service providers are able to provide broadband services. Once the NGA network is brought into operation, provided services also include telephony and cable TV in addition to broadband Internet access. Bacsic, repetitive benefit everywhere is the efficient transition from coper networks to high-speed optic networks.

8.4.2.1. *Design, construction and operation of private investor’s networks, including non-profit organizations and/or cooperations (private DBO)*

There are a number of regions in Europe where broadband access demand is sufficient to attract the private sector, but additional financial support is necessary in the form of state aid, in order to obtain an acceptable investment model. In this form of public-private partnership the private sector constructs, owns and operates the infrastructure, but it is a subject of strict control on the part of public authorities, including setting development objectives and control indicators

Superfast Cornwall is a project in the United Kingdom that demonstrates how this model could be applied. British Telecom (BT) won a public procurement for the provision of fast broadband optic-based services to more than 266 000 households, including 30 000 enterprises in the Cornwall County. The amount of 132 million British pounds will be invested in building network infrastructure which will later be available to wholesale service providers. The European Regional Development Fund ("ERDF") funds 53.5 GBP million, as BT provides the remaining funding of up to 132 million. This scheme motivates BT to construct the broadband netswork in accordance with the open networks standard, which would enable digital service providers to rent capacity and wholesale services.

8.4.2.2. Design, construction and operation of joint venture networks (PPP joint Venture)

The public-private partnership model – jointly with an enterprise involves ownership division between public and private partners. Joint ventures enable the public sector to start the main part of the project, then they allow the public sector to take more and more control and responsibility on the basis of key performance indicators for work. The public sector initially assumes a greater financial commitment, while the private sector subsequently takes the responsibility to achieve return on investment.

The Metroweb project in Italy is such an example. 400 million EUR have been invested in optic infrastructure that serves the great Milano region. The initial investment is provided by a municipal financial institution and structure, subsequently private partners purchase the public investor's share. Thus, after ten successful years the independently financed expansion continues. This form of public-private partnership gives the opportunity to provide the expertise and support of the private sector, while the public sector retains its control in crucial early stages of network construction and it still has the rights of decision-making in commercial operations.

8.4.2.3. Design, construction and operation of networks, funded by public resources and implemente d by a private entity Public Outsourcing)

This public-private partnership model is defined as 'state property – operation by a private contractor'. The model is used in the United Kingdom and the USA for government sites, such as laboratories, operated by the private sector. It also includes construction and operation of a functional broadband infrastructure, in cases when funding is provided by the public sector. The private sector operator is determined on the basis of an open tender procedure. It takes the responsibility of bringing to operation the network infrastructure and operation of the network. In addition, the private operator is responsible for the sale of wholesale services, but in certain cases also for retail services.

Such an example is the Metropolitan Access Networks (" MAN ") project in Ireland. The optical network has bandwidth of 1000 Mbps per node and it covers 66 towns in Ireland. Total investment reaches 170 million EUR, as local and regional authorities provide 10%, 45%-ERDF and the remaining part is funded by the Irish Government. Infrastructure remains state property. The certain MAN's are managed by the private e|net operator for the period of 15 years.

The Auverdne project in France - France Telecom has a 10-year contract to operate and expand the existing broadband network that is budgeted to cost 38.5 million EUR. Both projects have attracted main providers to provide services to customers.

8.4.2.4. Design, construction and operation of networks by an investor with public funds (public DBO)

This model has a significantly higher level of public sector participation, related to the demanded greater control. In particular, the model offers an alternative when applying special funding for underdeveloped regions. The public sector develops the necessary broadband service infrastructure in the conventional way. The design, construction and operation of the particular network is implemented by public enterprises. A spectral association by public funds has been set up that on competitive basis provides wholesale access to the network of private service providers.

An example of such company is the Asturcon public-private partnership in Spain that operates and manages the network (55 million EUR investment), in order to retain control over the investment purposes and ensure consumers' security and protection. The Asturcon project is applied to an underdeveloped region of Spain where there was production of coal and steel. A special-purpose company and entirely public property was established which offers retail services to private service providers. The enhanced public control in the company has contributed to achieve competition between unlimited number of retail service providerss. End user services include 100/1000 Mbps connectivity for business customers and 20/100 Mbps for home users.

8.4.3. <u>Other Important Consequences</u>

8.4.3.1. Choice of Technology

From financial point of view it is becoming increasingly evident that in financial terms the implementation of FTTP (Fiber to the premises) technological solutions would not be applicable to all regional NGA network projects. The above mentioned projects, such as Superfast Cornwall and Auvergne also find out that it is difficult to apply FTTP to all target areas since costs are economically unaffordable. The focus is set on the provision of a significantly faster service than the currently offered one. Although this is not the perfect solution, it still proves to ensure better services (faster connection, cheaper, higher quality, more secure) within the limitations of economic environment. New technological alternatives, such as the offered 4G mobile technologies could overcome some of the current financial obstacles. As long as access demand to digital services continues to grow exponentially, each step of increasing the access speed in remote and underdeveloped areas is appropriate, even when it is still lower compared to what is offered in urban areas.

8.4.3.2. Project Sustainability

From the point of view of sustainability it is important for some of the main national operators to participate in similar projects. They ensure the provision of wholesale services of alternative operators, which are extention of services offered in other areas of the country. This helps to ensure that users have access to a wide range of products and services and it gives them access to the best deals and national market conditions.

8.4.3.3. Project Risk

One of the key issues in all projects is the distribution of commercial and technological risk. When the private sector participates it is important to share the risk as much as possible but it has to be done realistically, in order to ensure that private investment is provided.

In case of outsourcing, when the managing service enterprise takes up certain investment (i.e. in active equipment), actions must be taken to ensure that investment shall be promoted throughout the outsourcing contract period, and investment won't decrease due to the lack of return opportunities.

Public-private partnership models play a significant role to achieve the goals of the Digital Agenda for Europe - 2020, since neither investment itself from the public or the private sector alone could lead to success. Furthermore public-private partnership must be used to guarantee that public funds shall be distributed as fairly as possible and they shall only be used when market forces are unable to provide a solution. Public-private partnerships are a means of effective management which guarantees that public interests are protected and public objectives have been achieved.

8.4.3.4. The Need of Long-term Approach

To provide necessary investment to achieve the Digital Agenda objectives, state and public investments and the EU investments need to be supplemented by private sector investments. NGA public-private partnership projects may definitely be attractive for those investors that seek a reasonable but relatively sure annual return in long-term period, from a business with steady cash flow, such as pension funds.

To attract investment from organizations that seek such a return profile, it is of vital significance to minimize the risk by carefully defining the terms of the public-private partnership. Metroweb's experience shows that a reasonable return could be obtained by the establishment of a network with opportunities that can be used to repeat its deployment at a larger area. It is also true, however that Metroweb has been developed in a relatively rich part of Italy which is commercially attractive. Metroweb also benefits from its close relation with the Fastweb retail provider, which reduces the market risk. This is less probable to happen with most public-private partnership projects that focus on more underdeveloped areas.

8.5. Findings and Conclusions

- Five majour investment macro-models and approaches in building optical Next Generation Access (NGA) Networks can be derived from the practice so far:
  1. private investment in networks, beyond the scope of regulatory intervention;
  2. limited, supplementing state/public investment, by the Incumbent as a leader;
  3. limited, supplementing state/public investment by private operators;
  4. entirely state/public investment by a state undertaking to construct and support the (ESMIS) network;
  5. private investment in networks subjected to a strong regulatory intervention.

- Neither model is only right or wrong. Each model is applicable and effective according to the specific state of the country and/or regional factors. In its turn, the right understanding of strengths and weaknesses each model is a basis for the development of the national policy.
- Countries that are leaders in NGA construction have created conditions to promote private investors by applying model ***3*** – *Supplementary state/public investment by private operators.*
- There exist ***5 key factors*** for successful deployment of NGA in the territory of the whole country:
  - availability of a National Broadband Access Plan;
  - presence of differential and flexible regulation;
  - existence of public funding and promoting the consumption of digital services;
  - availability of cooperation between businesses and stakeholders - users, operators, regulator, central and local authorities;
  - existence of other requirements for participants and stakeholders to effectively spend public resources.

  In its turn they must be well-adapted to and in accordance with the specific requirements and conditions in the country.
- ***Four main public-private partnership models to invest in*** Next Generation Access Networks are well-known in practice:
  - design, construction and operation of networks by a private investor, including non-profit organizations and/or cooperations (*Private Design Buildand Operate*); design, construction and operation of networks, funded by public resources and implemented by a private entity (public outsourcing);
  - design, construction and operation of networks by mixed companies (joint venture);
  - design, construction and operation of networks by an investor with public resources (public design, build and operate).
- The public-private partnership provides potentially effective solutions. As an alternative method of assigning public procurement, the public-private partnership has successfully been applied in order to solve a number of infrastructure projects.
- The public-private partnership has the advantage that the degree of private sector participation and the funding commitment can be adapted so as to meet the specific requirements which exist for the corresponding region. There is no obligation to have one single solution that is good in all cases.
- The public private partnership takes various forms and uses different funding models. In each case the project differs in terms of the risk transfer level and the financial participation on the part of the private sector.
- The majour base to compare different models is the decision-making mechanism shared between the public and private sector. The common characteristic

feature they have is that the public sector settles the necessary infrastructure before private service providers are able to provide broadband services.

- From financial point of view it is becoming increasingly evident that in financial terms the implementation of FTTP (Fiber to the premises) technological solutions would not be applicable to all regional NGA network projects.
- New technological alternatives, such as the offered 4G mobile technologies could overcome some of the current financial obstacles. As long as access demand to digital services continues to grow exponentially, each step of increasing access speed in remote and underdeveloped areas is appropriate, even when it is still lower compared to what is offered in urban areas.
- From the point of view of **sustainability** it is important for some of the main **national operators** to participate in similar projects. They ensure the provision of wholesale services to alternative operators, which are extension of services offered in other areas of the country. This helps to ensure that users have access to a wide range of products and services and gives them access to the best deals and national market conditions.
- One of the key issues in all projects is the distribution of **commercial and technological risk**. When the private sector participates it is important to share the risk as much as possible but it has to be done realistically, in order to ensure that private investment is provided.
- **Public-private partnership models play a significant role** to achieve the goals of the Digital agenda for Europe - 2020, since neither investment itself from the public or the private sector alone could lead to success. Furthermore the public-private partnership must be used to guarantee that public funds shall be distributed as fairly as possible and they shall be used only when market forces are unable to provide a solution. Public-private partnerships are a means of effective management which guarantees that public interests are protected and public objectives have been achieved.
- To provide necessary investment to achieve the Digital Agenda objectives, state and public investments and the EU investments need to be supplemented by private sector investments. NGA public-private partnership projects may definitely be attractive for those investors that seek a reasonable but relatively sure annual return for a long period of time, from a business with steady cash flow, such as pensiou funds.

IX. MEASURES TO PROMOTE CONSUMPTION

9.1. Driving Forces for the Introduction of NGA

With the emergence of new content-rich services and the increasing demand for services, it is expected that the necessary bandwidth will constantly grow[126], while households' needs of access speeds will exceed 250 Mbps until 2015[127] This improvement of speed along with the increase in applications for business and mobile transmission could generate narrow places in contemporary PON network deployment, even those that are based on Gigabit Ethernet. NGA networks must satisfy the requirements of higher speeds, as well as to offer a profitable approach to modernize PON and support the elimination of legacy technologies. One appropriate solution for an NGA network that uses entirely the capacity and low losses in fiber-optic transmission and the inherent advantages of the PON architecture must have the potential to reduce the total price of the operator's ownership and offer better value to end users.[128]

9.1.1. Services as Driving Forces

The increase in bandwidth demand is caused mainly by the evolution of video services, including all variants (i.e. TV, video on demand, Internet and P2P) of the global user traffic. More video content will be provided on Unicast platforms that dramatically increase the traffic volume and moreover, video bandwidths will increase due to the evolution of today's SDTV and the forthcoming HDTV formats towards Super HD (4k) and Ultra HD (8k), as well as 3D formats. In addition to the traditional ways of video service consumption there exist some additional tendencies which promote bandwidth demand, respectively higher access speeds, such as:

- the growth of video over instant messaging and video calls;
- increasing number of connected devices in a fully integrated digital home;
- growing popularity of social network use that evolves from today's primarily text-based content to uploading video and streaming;
- availability of a wide range of cloud technologies on demand, both for dwellings and business customers;
- growth of online games and online distribution of game-based content.

Prevailance of traditional video distribution services (linear and on demand) means that households' traffic will remain saaymetrical. This, however, may change, if direct distribution is adopted, for instance, in order to offer video-streaming through P2P and PPLive. Convergence of home and business applications in a common access platform also causes the need of more symmetric in terms of bandwidth systems.

In addition to higher frequency bands, home and business users expect also a number of main features from the future next generation broadband access. For instance:

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[126] Cisco Visual Networking Index: 'Hyperconnectivity and the Approaching Zettabyte Era,' Cisco Systems, San Jose, CA, 2010

[127] Mckinsey & Company, 'Creating A Fiber Future,' Next Generation TelecomInfrastructure (NGTI) Initiative, Feb. 2010.

[128] D. Breuer et al., "Opportunities for Next-Generation Optical Access", IEEECommun. Mag., Feb. 2011

- security and integrity of all user data;
- simple configuration (plug and play) and minimal or no administration of equipment by the end customer in customer's premises;
- access to a rich portfolio of services that is not limited by the capabilities of access technology (high quality of service is expected irrespective of consumer behaviour and demand for service). In addition, business customers frequently have higher requirements with respect to guarantees of data security and integrity, network existence and bandwidth provision, which must also be taken into account for NGA.

9.1.2. The Network as a Driving Force

The development structure of the telecommunications network imposes some NGA specificities and requirements. The way of modernizing PON is determined to a great extent by the necessary investment. Since the total value to deploy fiber-to-the-home (FTTH) is dominated by investment in infrastructure, it is necessary to create such conditions for network migration that enable as much reuse of the existing optical infrastructure as possible.

The need to simplify the operational process results in the fact that network operators prefer to have NGN/A solutions which are appropriate for many providers and producers using a single interface. Migration to entirely bundled platforms and the trend towards general access and aggregation for local and various types of backbone networks lead to high demands on performance and reliability in the access network. It is important to consider the opportunities to consolidate nodes. Node consolidation enables operators to simplify network structure and reduce the number of access places/points. This is expected to improve the overall profitablility of the network. On the other hand, an important network feature is its flexibility. NGN/A networks should allow opportunities of flexible deployment, in order to meet the operator's needs and selection of engineering solutions

A significant factor to select technology and structure of NGN/A networks is the reduction of energy consumption. Access network equipment consumes the main share of the overall energy consumed by the network, while energy economy in telecommunications systems became increasingly important concern of operatorsпо with respect to operational costs (OPEX) and their contribution to greenhouse gas emissions.

Without pretending to be exhaustive, below we have listed measures that directly stimulate digital content consumption and pre-determine the development of next generation access networks.

9.2. Measures to Implement the objectives under Priority 2

9.2.1. Promoting theDdevelopment of Broadband Electronic Services:

9.2.1.1. Promoting e-Gpvermamce Development: (e-Administrative services; e-Government; e-Municipality.

- reducing permissive-prohibitive regimes;
- simplifying the regulatory framework of administrative services;
- facilitating access to e-administrative services;
- establishing a National Coordinating Council for e-Governance Development to the Council of Ministers;
- elaborating a revised national strategy on e-Governance development;
- development of working plans for e-Governance development by all ministries and state authorities;
- encouraging the development of municipal plans to introduce e-Municipality;
- developing a training course system for central, regional and local administration;
- financial provision of activities;
- financial support for municipalities.

9.2.1.2. Promoting e-Education Development: (Schools; Universities).

- developing a national strategy on e-education development;
- elaborating an e-Education development plan in schools;
- elaborating plans on e-Education development by all universities;
- improving the regulatory framework;
- developing a system of learning courses for teachers and lecturers;
- financisl provision.

9.2.1.3. Healthcare: (e-Health; pre-hospital medical care; hospital medical care).

- establishing a National Coordinating Council for the Development of e-Health to the Council of Ministers;
- elaborating a national strategy on e-Health development;
- improving the regulatory framework;
- elaborating working plans for e-Health development by all health centres;
- encouraging the development of municipal plans to introduce e-Health;
- Developing a system of learning courses;
- financial support of activities;
- financial support of municipalities.

9.2.1.4. Business: (Internet providers; e-Banking; e-Insurance; e-Commerce; e-Busines (co-creation); smart grids and smart buildings; work at home and flexible working hours etc.

- elaborating a national strategy to promote the development of e-services by businesses;
- improving the regulatory framework;
- developing models for financial promotion and support.

9.2.1.5. Other Services: (media, community centres, libraries, theatres etc.)

- elaborating a strategy to promote the development of services;
- developing a system of learning courses for the staff;
- financial support of activities.

9.2.2. Promoting the Use of Broadband Services

9.2.2.1. Promoting the use of Broadband Services by Households;

- introducing tax relieves for purchasing and using ICT;
- conducting communications campaigns to promote population's awareness regarding the opportunities provided by broadband Internet;
- developing a national strategy on promoting qualification and lifelong learning aiming at the use of ICT;
- elaborating financial support models to promote qualification and lifelong learning, aimed at the use of ICT.

9.2.2.2. Promoting the Use of Broadband Services by Businesses

- improving the regulatory framework and introducing tax alleviations to use ICT;
- developing models for financial support and assistance for the introduction of ICT;
- elaborating models for financial support of scientific research and innovative activity in the field of e-services by businesses;
- developing a national strategy to stimulate qualification and lifelong learning, aimed at ICT use;
- developing financial support models to stimulate qualification and lifelong learning, aimed at ICT use.

9.2.2.3. Promoting the use of Broadband Services by Educational and Scientific Research Organizations

- developing models of financial support to assist the introduce ICT;
- developing financial support models of education in the ICT field;
- developing models for financial support of scientific research and innovative activity in the ICT field;
- developing models of financial support of remote learning by electronic means;
- developing a national strategy to improve qualification in the ICT field of teachers and lecturers;
- promoting the lifelong learning system, aimed at ICT use.

9.2.2.4. Encouraging the Use of Broadband Services by Health Centres

- improving the regulatory framework;
- introducing fiscal alleviations for ICT use;

- developing models of financial promotion and support to introduce ICT;
- developing models of financial support of scientific research and innovative activity in the field of e-Services;
- developing a national strategy to improve qualification and lifelong learning, aimed at ICT use;
- developing financial support models to improve qualification and lifelong learning, aimed at ICT use.

9.2.2.5. Promoting the Use of Broadband Services by Cultural Organizations – schools, libraries, theaters etc.

- developing models of financial incentives and support to introduce ICT;
- developing models of financial support to introduce innovative e-services;
- promoting the improvement of qualification of officials in the ICT field.

X. MAIN FINDINGS AND RECOMMENDATIONS

The following more important conclusions could be made by the conducted review:

- Next generation access networks (NGA) are considered as an essential element to ensure fast broadband (> 30 Mbps) and ultra-fast broadband access (> 100 Mbps) that provides services with enhanced features, improved quality of service and symmetry of speed rates in both directions.
- Next generation access could be achieved by various technologies, but it is generally considered to be done via optical cables reaching the end user or much closer, as in the second case 'the last mile' is covered by very high-speed digital subscriber lines or wireless access, which are regarded as an addition to the last mile.
- According to the EC regarding NGA mainly two technologies are widely recognized – fiber-to-the-cabinet and fiber-to-the-home/building of the subscriber. The opportunities of some future wireless access technologies that could provide reliable high speeds to subscribers are also considered.
- There are two main ways of technological development towards NGA, by increasing transmission speeds or using future PON technologies. The choice of development depends on specific NGA requirements that must comply with the minimization of investment related to equipment, maintenance of existing devices, effective use of network capacity, protection and re-use of the existing fiber-optic infrastructure.
- Besides technology for each specific case, it is also important to consider the opportunities for implementation of a particular network topology. It is necessary to conduct benchmarking economic assessment of the ways to implement various topologies and network architectures, such as point-to-point, active or passive optical network.
- Bulgaria is among the EU countries with very good positions in the field of ultra-fast broadband access and it has a favourable basis for the forthcoming widespread deployment of next generation broadband access networks, but in order to achieve the objectives set out in DAE regarding 'access to the Internet at rates > 30 Mbps (fast broadband access) for all its citizens and at least 50% of the European households to Interne subscribers with speeds higher than 100 Mbps (ultra-fast broadband access) until 2020', it is necessary to provide NGA to all settlements in our country.
- .High costs for NGA development combined with the uncertainty mainly regarding demand and revenues (which includes a corresponding insecurity in terms of return on investment) hinder service providers from investing in NGA. In this respect, in order to achieve the DAE objectives, it is necessary for the state to take specific measures and develop mechanisms to foster consumption and provide NGA to the population.
- The positive socio-economic impact of access provision to high-speed and ultra-high speed Internet by constructing NGA infrastructure has an economic effect and it plays the role of a powerful catalyst for the economic development of countries and regions. It has a significant positive impact on their economic growth, measured by the Gross Domestic Product (GDP), as well as on employment and labour productivity. Moreover, economic effects are not only direct and short-term in nature, that is, the ones related to the growing economic activity in building the infrastructure. Indirect effects of

using the established access infrastructure are of great significance, as well as the effects that are induced in other industries and fields of activity (structural changes in economy, emergence of new products and businesses etc.), which have medium-term and long-term influence. The provided access to high-speed and ultra-high speed Internet has a considerable positive impact on business development and on citizens' incomes and welfare.

- The positive socio-economic impact from access provision to high-speed and ultra-high speed Internet by the construction of NGA infrastructure has some social effects.
- The provision of equal access to broadband infrastructure results in reducing the economic and social exclusion of people and entire settlements and makes them active participants in public life. Considerable social effects are anticipated by the improved access to basic public services by developing the systems of e-Governance, e-Education, e-Health etc. The provision of high-speed and ultra-high speed Internet access has a significant impact on improving the security of citizens and society and reducing crime. As a result citizens' quality of life improves.
- The positive socio-economic impact of access provision to high-speed and ultra-high speed Internet by the construction of NGA infrastructure has an impact on environmental protection. It is related to the improvement of people's ecological awareness and knowledge; the reduction of harmful transport emissions, due to its improved management; the provision of opportunities to introduce energy-saving technologies; the induced change in the structure of produced products and services that leads to reducing the costs of energy and non-renewable resources; decreasing the costs for paper etc.
- In comparative aspect Bulgaria is among the leading countries both in Europe, and in the world in offering broadband access (coverage), including regarding the technological level of development, access speed and price affordability, but it is among the last EU countries in terms of Internet use and penetration throughout the population and nearly the EU27 average regarding Internet use and penetration among enterprises.
- According to the latest comparative survey on broadband access coverage, assigned by the EC within the monitoring over the implementation of the Digital Agenda for Europe[129]. Bulgaria lags behind mostly in terms of next generation access (NGA),
- Regarding the supply of mobile broadband, in spite of the lagging behind, the share of population having access to third generation technologies (HSPA) in Bulgaria is comparable to the average European levels.
- A key factor for the currently observed lagging behind of rural regions from the national level remains the financial status of households – the income of households, living in rural areas is lower than the average for the country. This factor correlates with the highest degree of completed education, which in general is lower among the inhabitants in rural areas.
- The tendency for development of broadband services continues both at a national scale and in rural areas. The significant increase in the use of mobile devices to

[129] Broadbandc Cverage in Europein 2012. Mapping Progress Towards the Coverage Objectives of the Digital Agenda. Final Report by Point Topic.SMART 2012-0035

connect to the Internet both at home and outside makes impression, respectively the more frequent use of wireless access to the Internet.

- Settlements without a single Internet provider become fewer and fewer, while in practice, all households connected to the Internet have access to at least basic broadband, as more and more households have high-speed Internet access of over 30 Mbps.
- Despite the tendency of access development, it should be pointed out that in most cases guarantee at the level of SLA – Service Level Agreement) services is not provided.
- Continuous development of the Internet network in smaller settlements and rural areas could enable these services to reach increasingly higher share of households, regardless of their social and financial status.
- The existence of over-regulation, legal insecurity and unpredictability retains planning of NGA investment.
- The construction of dublicating backbone communications networks at a national, as well as local level (backhaul) are a distinctive characteristic features of the Bulgarian communications market.
- Municipal administrations play a crucial role in coordination and approval of investment projects.
- Proposals for amendments in the operating legislation, aimed at regulating the rapid development of broadband networks must be made only after profound investigation of effectiveness of applying the existing legislative and regulatory framework. Along with the series of regulatory acts, an appropriate regulatory framework is established, in order to stimulate investment in networking. Its effective implementation must be achieved by state and municipal administrations, stakeholder trade companies and coordinating organizations.
- Additional appropriate legislative decisions in LEC, LSP, the Law on Cadastre and and Property Register are necessary to expand and bind the powers of CRC, the Ministry of Investment Plaanning and the Agency for Geodasy, Cartography and Cadastre, in order to collect, maintain and use a database of specialized maps of companies/operators that operate technical infrastructure (supplies of electricity, water supplies, gas supplies, central heating, road infrastructure etc).
- One of the above mentioned institutions must build a unified information access point for stakeholders, whereby true information should be submitted about the existence of technical infrastructure or the upcoming development of such; to file requests for coordination and approval of investment projects and complex initiatives in the territory of all municipalities in the country and tracking/control over the deadlines to issue the corresponding administrative acts; regarding the progress of started procedures on providing rights of use, coordination and approval of investment projects and complex initiatives in the territory of all municipalities in the country; to impose fines or property sanctions for non-compliance of the established terms and deadlines.
- The new guidelines on broadband infrastructure development, including the NGA type will be reflected in the revised sector policy in the field of electronic communications, which outlines the trends and priorities in the sector. The legislative acts

related to building infrastructure, including that of communications, such as LSP, requirements can be set with view to planning the NGA communications infrastructure upon developing the detailed trrritorial plans by municipalities; investment projects and complex initiatives on building or repairing technical infrastructure must also contain technical solutions for provision of access to the passive part of the infrastructure of the corresponding network for operators of next generation communications networks and NGA, projects of new buildings, as well as for basic repairs of existing buildings to contain a project of NGA building installation.

- It is recommendable also to examine the application of the Law on Public-Private Partnership in the field of electronic communicaions vith view to promote deployment of next generation broadband networks. From the practice so far, five **major** investment macro-models and approaches in constructing next generation optical networks (NGA) can be derived: Neither model is only right or wrong. Each model is applicable and effective according to the specific state of the country and/or regional factors. The leading NGA development countries have established conditions to stimulate private investors by applying Model 3 – *Complementary state/public investmen by private operators.*
- There are 5 key factors for successful NGA deployment within the territory of the whole country. (pt. 8..3.3. They in turn shall be well adjusted to and complied with the specific requirements and conditions in the country.
- Four main public-private partnership models for investment in next generation access networks are well-known in practice (pt. 8.4.): The public-private partnerships provide potentially effective solutions. As an alternative approach of awarding public procurement, public-private partnership has been successfully applied, in order to implement a number of infrastructure projects.
- From the point of view of sustainability, it is important for some main national operators to participate in similar projects. They ensure the provision of wholesale services to alternative operators, which are an extension of the services offered in other areas of the country. This helps to ensure that users have access to a wide range of products and services and gives them access to the best deals and national market conditions.
- One of the key issues in all projects is the distribution of commercial and technological risk. When the private sector participates it is important to share the risk as much as possible but it has to be done realistically, in order to ensure that private investment is provided.
- Based on the analyses provided in this material calculations have been made, showing that it is necessary to invest approximately 234 million BGN in white areas for achieving, 54 million BGN for grey areas to construct new generation access infrastructure in Bulgaria

XI. LIST OF THE FIGURES

XII. LIST OF TABLES

XIII. SHORT GLOSSARY OF SPECIAL WORDS AND EXPRESSIONS

Sofia, December 2013